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# **A scalable business model for mass customization of broadband services in the emerging Africa market**

Development of a business model and quantified business simulator to enable the scalable development and mass customisation of the emerging consumer Africa Broadband market.

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## Acknowledgements

Firstly all praise to Him that provides the ultimate path, the final purpose and without Whom everything else will just be a void.

This has been a journey of enrichment, of learning, of growth and finally of understanding. My appreciation, indebtedness and acknowledgement go to the following individuals and groups for their respective support, insight and guidance.

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- The Q-KON Team.
- International and national customers, colleagues and business associates.

May you find fulfilment in knowing that you have contributed greatly, that you have given selflessly and that you have inspired endlessly.

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## **Authenticity Statement**

The author wishes to acknowledge all the valued inputs, recommendations and advice received from all parties including my family, colleagues, the Q-KON and SkyeVine teams as well as my study mentor.

The research work as consolidated in this thesis document was completed by myself and does not include research work completed by other parties or project teams in either Q-KON or SkyeVine. The research results as documented therefore reflect solely to myself and do not implicate or hold accountable any party or organisation that might be referred to in the text.

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## Key Words

Africa satellite industry

Business models

Business model simulator

Data broadcast networks

Innovation-loop business model

Market demand analysis

Matrix billing model

Pricing and Billing models

Price elasticity demand

Organisational structure

Satellite services models

Satellite system engineering

Symbiotic business structure

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## Abstract

Africa's rapid adoption of the mobile phone is quickly closing the digital divide in voice services. But, just as one divide is closing, another one is widening. Consumers almost everywhere are demanding more services and higher Internet access data rates. In the developing world the knowledge gained through access to information is creating unprecedented opportunities and is having a dramatic impact on the way people live and work. Africa, however, has been largely left behind in the shift to broadband. Increasing the availability and affordability of broadband services is thus high on the agenda for policy makers in Africa, though it will require major efforts from both government and the private sector.

Fundamental to the all efforts to close the "digital divide" is the need to provide a ubiquitous and affordable access network that will enable distribution of broadband services to anywhere, and anytime throughout Africa. While many kinds of broadband services are being offered to the African population, the currently available services have failed to reach the majority of Africans living in rural areas. This poses a very pertinent question that justifies further investigations: why have the existing broadband services failed to satisfy Africa's need for a ubiquitous digital communication service. The lack of penetration of the existing services makes it clear that a different technology and service offering is needed, a service offering that is affordable to the large consumer market segment and which can complement the mobile and ADSL broadband networks to provide services to all of Africa on a cost effective basis.

This research work investigates the current business and technology domains and develops new knowledge and the insights that are required firstly to understand why existing broadband services are failing to reach rural Africa and secondly to understand what criteria must be satisfied to deliver broadband access services to the mass consumer Africa market. The research work focuses on the interrelationships between markets, technology and business of the consumer broadband market and defines new thinking as reference to provide guidance to the future development of more suitable broadband offerings for the rural African market.

The study centres around three principal areas of knowledge contribution.

### **Analysis of the primary factors impacting the delivery of broadband services**

Firstly the study addresses the current market dynamics and technology realities to determine two critical aspects: 1) Can the mass market afford broadband services or will it remain the privilege of the higher income groups? And, 2) Can existing mobile broadband, ADSL and satellite access services meet the demands to service the mass market or is an alternative technology option required?

Through analytical review the study determined that there is a large, and growing, middle class market that can afford broadband access services. This market sector is quantified in terms of consumer income levels and demographic user data. The study formulates the commercial and service criteria applicable to a broadband access service on servicing this target market.

The study further investigates the availability, affordability and market penetration of the current mobile and ADSL broadband services and found that the available service options cannot effectively meet the current and future demand. The limitation in meeting the current market demand leads to a large under serviced consumer market in Africa. The study proposes a unique approach to quantify the specific under-serviced gap, which will not be met by currently available broadband technologies.

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The technology comparative study provides new insight into the limitations of mobile 3G broadband services and why this technology will not be able to meet the future demand for consumer broadband services in Africa. The technology study furthermore quantifies the advantages of using satellite technology to implement a mass consumer broadband service in Africa. The study proves that the ubiquitous nature and rapid deployment capabilities of satellite access networks provides distinct benefits when deploying a mass consumer network which makes satellite the technology of choice for consumer broadband services. We then continue to assess the ability of existing satellite broadband offerings to satisfy the needs of African end-users, and find that those offerings have been optimized for the needs and affordability levels of customers from the develop world. The result is that satellite broadband services aimed at the African end-user is primarily used by corporate and institutional customers, with little penetration of the consumer market. This finding provides the motivation for developing a business model that can leverage available technology to effectively service the African consumer market.

### **Innovation of new concepts to support a viable broadband business strategy**

The mobile prepay model as well as the DStv pay-TV subscription services have demonstrated the need for a specific business innovation to ensure successful market adoption of new technologies. Both these industries have demonstrated that innovative approaches in the commercialization of technology solutions are critical to ensure the mass adoption thereof. The second section of the study therefore focuses on the innovations that are required to overcome the obstacles as identified in section 1 in order to arrive at a business strategy and business model that will prove to be viable in the delivery of broadband services to the rural African consumer market.

The first challenge is the selection of the most appropriate technology platforms and the architectural design of the delivery systems to effectively service the mass consumer market. In order to adapt the business models employed by existing satellite broadband service providers the study defines the following two specific business innovation concepts that contribute to a new business paradigm for mass market broadband access services:

- 1) Through applied billing model innovation the study defines a new billing structure for broadband services and set a completely new paradigm for users to influence the cost of the service. The new billing model provides end-user the capability to adapt their broadband usage patterns to meet their budget constraints.
- 2) To successfully deliver a technology service to an emerging market requires a very specific organisational structure that effectively integrates knowledge, capability and funding while minimizing risk and uncertainty. The study proposes a new symbiotic organisational structure that elegantly combines capability and knowledge while minimizing funding requirements to ensure the acceptable market development risk.

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### **Development of a business model simulator for satellite broadband service delivery**

The deployment of a new type of satellite broadband service to rural Africa on an experimental basis is too expensive to be conducted for research purposes. A more practical approach that is also widely used in other domains of engineering is to construct a simulated model of the system being studied. The third knowledge contribution area of the study therefore focuses on constructing a mathematical model of the expected behavior of a business operation that provides satellite based broadband services to the African market. This simulator can be applied to quantitatively analyze various existing or proposed new business strategies. The business model simulation integrates all the business, market, technology and commercial relationships that impacts on the expected behavior of such an operation and provides a quantified model of expected business behavior based on the underlying dynamics of the satellite broadband industry.

The development and validation of the business model simulator represents a unique contribution to this industry as no results of a similar model that represents the operations of a satellite broadband access service provider has been published before. The model empowers Service Providers and industry stakeholders to analyze different business strategies and to quantify the impact of various business decisions. In general it can be stated that this research work adds knowledge and insight to the field of applied business strategy as applicable to providing advanced technology-based services for emerging markets.

The final outcome of this research study is the business model simulator. It integrates various market and business elements as well as satellite network engineering practises into an integrated financial cost modelling, business scenario planning and engineering network design tool. Through this integration of known disciplines the study provides an additional extension to the field of satellite business engineering.

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## Section 1: Reference Knowledge

### 1. Introduction

An introduction to the research works with a background to the field of study, motivation for the research and an outline of this thesis document.

*"In the beginning it's about technology,  
functions and features  
but in the final analysis  
it's about people, integrity and commitment"*  
Q-KON

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#### 1.1 BACKGROUND TO THE FIELD OF STUDY

This research study focus on developing an integrated business and technology model to enable the effective provision of satellite-based mass broadband access services to the emerging Africa market.

The infrastructure challenges in Africa are well known, of the 6.3 billion people in the world today, 1.6 billion do not have access to basic energy services and 500 million of them live in Sub-Saharan Africa. Nearly 90 percent of Africa's population relies on biomass for energy. They need support for sustainable forest management and improved cooking stoves and fuels to reduce the air pollution inside their homes (Balancing-Act, 2010).

Africa's infrastructure may have supported economic growth reasonably well through the 1960's and 1970's. But high population growth combined with rapid urbanization has led to a severe mismatch between the need for infrastructure and its supply. By most estimates, African countries need to invest about 9 percent of their GDP— roughly \$40 billion per year—in building new infrastructure and maintaining old facilities if they want to meet the Millennium Development Goals. This is more than twice what they have spent over the past 40 years.

Against this background of daunting economic challenges it is easy to question the need and feasibility of providing broadband Internet access services to the Africa mass consumer market. It can be argued that it is more important to meet the demand for primary health and medical care rather than broadband Internet access services, which some will consider to be a luxury item.

However, the 2010 Information Technology and Innovation Foundation (ITIF) report estimated that the annual global economic benefits of the commercial Internet equals \$1.5 trillion, more than the global sales of medicine, investment in renewable energy, and government investment combined. ITIF also estimates that, assuming e-commerce continues to grow just half as fast as it grew between 2005 and 2010, by 2020 it will add \$3.8 trillion to the global economy (ITIF Report, 2010).

Broadband Internet access is thus one of the most effective and compelling options available to developing countries to stimulate the economy and create jobs at all levels of society.

It is thus not a question of “IF” Africa should have broadband access but rather “HOW” broadband Internet Access services can be delivered to Africa so that it can be leveraged to play its critical and essential role in the development of the African continent.

### 1.1.1 DEFINITION OF BROADBAND

For the purpose of this study, the term ‘broadband’ will be used to refer to an access service to the Internet via any last mile technology such as wireless, satellite, 3G or asymmetrical digital subscriber line (ADSL) and will exclude dial-up services.

According to the ITU (ITU 2003), “Broadband is commonly used to describe recent Internet connections that are significantly faster than today’s dial-up technologies, but it is not a specific speed or service”. Recommendation I.113 of the ITU Standardization Sector defines broadband as a transmission capacity that is faster than primary rate ISDN, at 1.5 or 2.0 Mbit/s.

In some cases broadband is considered to correspond to transmission speeds equal to or greater than 256 kbit/s, and some operators even label basic rate ISDN (at 144 kbit/s) as a “type of broadband” (ITU 2003). For the purpose of this study, while not defining broadband specifically, 256 kbit/s is regarded as the minimum required speed for broadband.

Broadband is thus not a system or a technology, but rather refers to the speed or capacity (bandwidth) of the connection. The FCC uses the term "advanced telecommunications capability" to describe services and facilities with upstream (customer-to-provider) and downstream (provider-to-customer) transmission speeds exceeding 200 kilobits per second (kbps). "High-speed" denotes those services with over 200 kbps capabilities in at least one direction.

Despite the FCC's official definitions, many people use the term broadband to refer to any high speed, always-on, Internet connection. It is in this context that the term “broadband services” will be used in this study.

## 1.1.2 THE SCOPE AND SCALE OF AFRICA

### Africa – The Continent

Africa is the world's second largest continent after Asia, with a total surface area of 30,221,532sq km, including several surrounding islands. It stretches from 40 degrees latitude in the north to 34 35' degrees south and has 54 independent countries - 48 mainland and 6 island states - with an estimated total population of 900 million. In landmass Africa's 30.3 million sq km is bigger than China, the USA and Europe together (African Studies Center, 2010).

In February 2008 President George Bush announced the launch of five funds through the U.S. Overseas Private Investment Corporation, totalling \$875 million, for investment in Africa. On the eve of his trip to Benin, Tanzania, Rwanda, Ghana and Liberia, he stated a conclusion which many Africa business executives echoed: " This new era is rooted in a powerful truth: Africa's most valuable resource is not it's oil, it's not is diamonds, it is the talent and creativity of its people."

Despite the macro-economic challenges facing Africa, the needs of its people must be met on a daily basis: they need to eat, have clean water, shelter, clothing and medicine. They want cell phones, bicycles, computers, automobiles and education for their children – and they need Internet access.

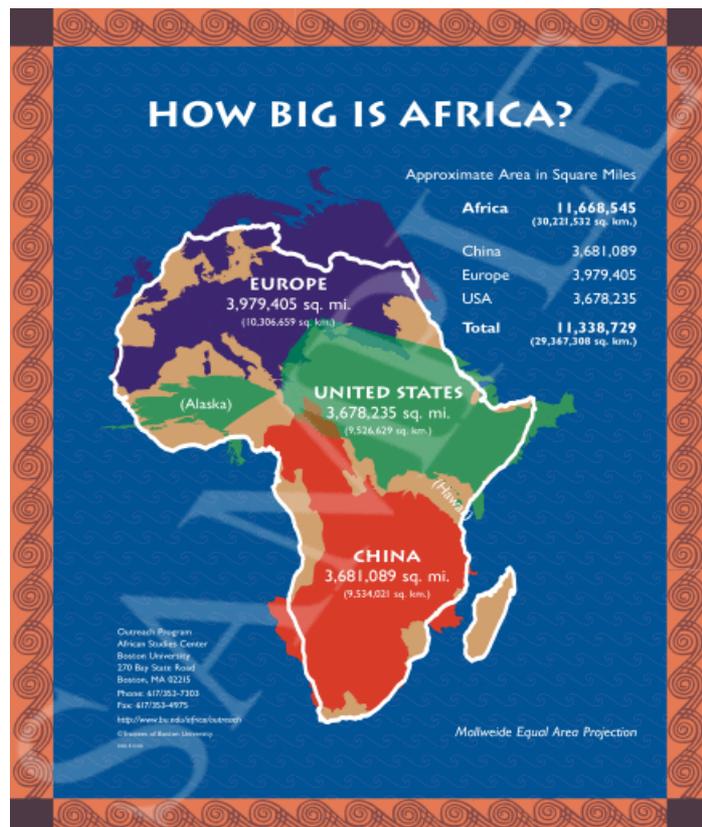


Figure 1-1: The Size of Africa

Source: African Studies Center, Boston University

Including the entire continent, Africa is wealthier than India on the basis of gross national income (GNI) per capita, and a dozen African countries have a higher GNI per capita than China. Rising investment from private equity and an active diasporas are expanding investments and new business opportunities. Communications, banking and other drivers are creating the infrastructure to support further development (Mahajan, V. 2009).

## Africa Gross National Income

If Africa was a single country, according to World Bank data (World Bank, 2010), it would have had a \$1,4 trillion total gross national income (GNI) in 2008. This combined gross national income potential places Africa ahead of India in terms of total market potential. Africa would be the tenth largest economy in the world. Without disregarding the relative poverty experienced by a large section of the African population, it can be stated that Africa is wealthier than most will expect and that it offers far more potential than generally expected.

**Table 1-1: World Gross National Income Statistics**

Ranking	Country	GNI 2008 (US\$)
1	United States	14 285 369 359 834
2	China, People's Republic of	4 222 473 115 468
3	Germany	3 708 852 779 095
4	France	2 875 483 693 302
5	United Kingdom of Great Britain and Northern Ireland	2 724 143 686 904
6	Italy	2 267 756 479 786
7	Russian Federation	1 620 887 385 017
8	Brazil	1 561 831 885 497
9	Spain	1 561 384 920 886
10	Africa	1 469 574 920 873
11	India	1 245 292 674 286
12	Mexico	1 068 418 578 654

Source: World Bank 2010

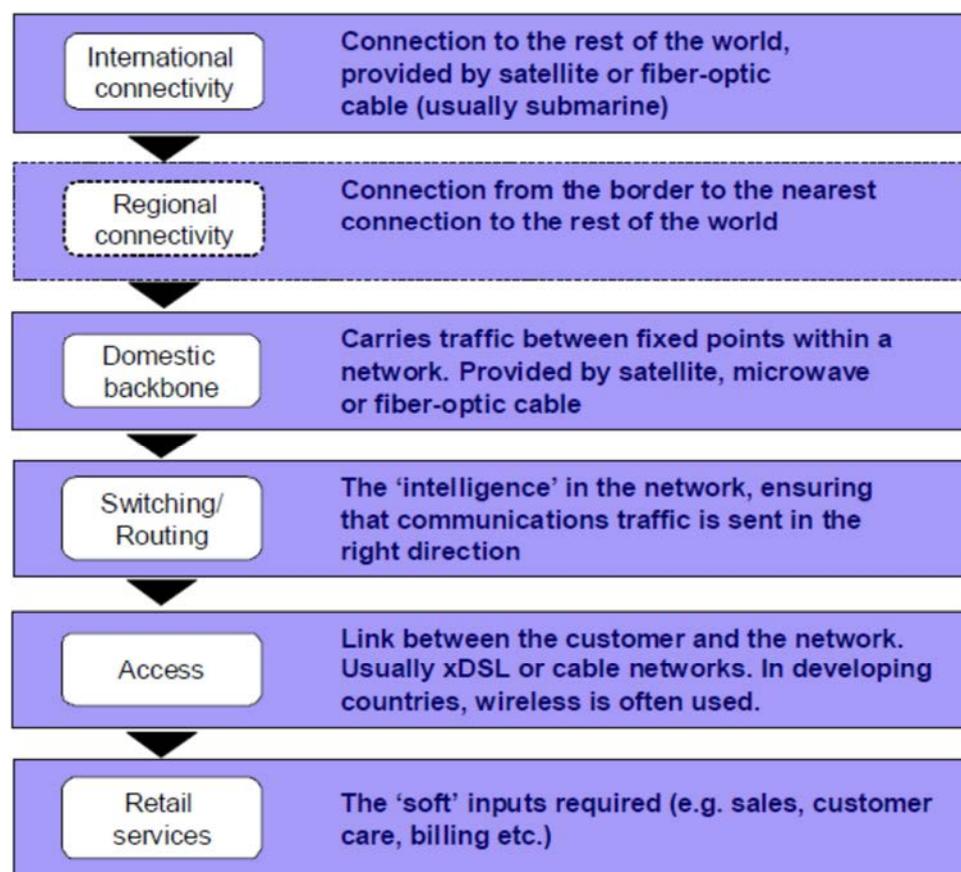
### 1.1.3 AFRICA TELECOMMUNICATION INDUSTRY

Large parts of Africa gained access to international fibre bandwidth for the first time via submarine cables in 2009 and 2010. In other parts of the continent, additional fibre systems have brought competition to a previously monopolised market. This has led to massive investments into terrestrial fibre backbone infrastructure to take the new bandwidth to population centres in the interior and across borders into landlocked countries.

Africa's Internet and broadband sector is set to benefit the most from these developments. Wholesale prices for Internet bandwidth have come down by as much as 90% from previous levels based on satellite access, and the cost savings are slowly being passed on to consumers at retail level (Internet World Stats, 2009). Broadband is rapidly replacing dial-up as the preferred access method, and this process is already virtually completed in the continent's more developed markets.

Supplying communications services involves a combination of network elements, data processing, and business services. These can be thought of as the “telecommunications supply chain.” At the top of the chain is the international connectivity that provides the link to the rest of the world. The second level is the domestic and regional backbone networks that carry traffic from the landing point of the international communications infrastructure to other points within the country.

The third level is the “intelligence” contained in the networks. Below this is the access network that links the core network to the customer. Finally, there is a suite of retail services such as customer acquisition, billing, and customer care that allow the business to function. This supply chain is illustrated in Table 1-2 below.



**Table 1-2: Telecommunication supply chain.**  
Source: Williams M.D.J., 2010

In practice, there are many variations on the structure of this supply chain. For example, voice services do not rely as heavily on international connectivity as Internet services, and landlocked countries require regional connectivity if they are to access high bandwidth submarine fibre-optic cable networks. Domestic backbone networks lie at the heart of any communications services supply chain and are an integral component in the provision of broadband connectivity.

#### 1.1.4 ADVANTAGES OF BROADBAND SERVICES

"Broadband may be considered a luxury too many African governments whose citizens still lack access to basic amenities, such as clean drinking water" says Avita Dadoo, Project Officer for Internet Policy at ITU. "However, failure to deploy such technologies may deny these countries an opportunity to participate fully in the knowledge economy of the 21st century" (ITU 2004).

For a region such as Africa, broadband should therefore not be viewed as a luxury, but as a necessity in an increasingly information-based society. Providing broadband access opens up a new door to a knowledge-based economy, which in turn will promote the region's social and economic development. Broadband can be harnessed to improve a number of key initiatives:

- **Community Access:** In rural or developing areas, broadband can be utilized in order to "leapfrog" the need for traditional fixed line infrastructure and provide access to voice, data and Internet services in regions which previously did not have access to fixed line services. The ITU's Telecommunication Development sector is in the process of implementing 3 pilot projects to determine the performance of WLANs for providing community access in rural areas of Uganda as well as Bulgaria and Yemen (ITU, 2008). With the help of broadband technology, rural and developing areas may be able to bypass the need altogether to install the older copper lines which are more common in the developed world.
- **Community Telecenters:** Crucially, in a region where personal computer penetration levels are among the lowest in the world, community telecenters play a key role in allowing small and medium sized enterprises (SMEs) who would otherwise not be able to afford it access to ICT tools. SMEs, along with cyber cafés are likely to be the biggest users in Africa of broadband and providing broadband access to telecenters would enable SMEs to benefit from it and to enhance their ability to compete in today's global marketplace.
- **E-health:** The power of broadband will vitally enhance e-health initiatives, such as Telemedicine - providing medical services and healthcare remotely. In a number of African countries telemedicine is making a real impact on the availability of health care and health care information. Broadband technology enables rural doctors to send complex x-rays to experts in major cities for diagnoses, who then in turn, send back their advice.
- **E-learning:** Utilizing broadband can help e-learning initiatives such as the AVU (African Virtual University), a distance learning project, which offers tertiary level training options to students living in the most remote and isolated communities in sub-Saharan Africa. Broadband will help to expand interactivity between students and professors, using two-way video and audio streaming to help students in Zimbabwe query a professor in Canada, for example, whilst students in Rwanda or Kenya offer comments.

### 1.1.5 THE AFRICA INVESTMENT CLIMATE

Investment opportunities and returns are abound in Africa, but it comes with risks. Stories of woe are plentiful - in May 2010 First Quantum Minerals Ltd lost a licence for one of its mines in the Democratic Republic of Congo, because the government handed it to another party. Rio Tinto Group had its assets stripped by the former government of Guinea. African Consolidated Resources Plc. has been in dispute with Zimbabwe over the cancellation of its permit to mine in the Marange diamonds fields since 2006 (Livingston, S., 2011).

Foreign companies mainly consider two aspects before investing in a developing country: the rate of return on the investment and the risk associated with it. Assessing the rate of return is easy but the latter is more complicated. Investors are very concerned about those risks to their businesses that they cannot control.

Among these are inadequate business regulations, poorly defined ownership rights, failure to enforce the rule of law, exchange control restriction, limitations on repatriation of funds, war, civil disturbance and terrorism. The financial crisis may have reduced the global appetite for risk and shelved many companies' investment plans. Yet the Multilateral Investment Guarantee Agency's latest World Investment Outlook and Political Risk Report (World Bank Group 2009, MIGA) predicts the trends that sustained the expansion of Foreign Direct Investment (FDI) before the downturn are expected to boost the revival of FDI in the near future.

'Africa offers huge investment opportunities in energy and infrastructure and the growing intra-trade should help reposition the region,' says Kato Mukuru, the head of research for Renaissance Capital. The investment bank published a report giving 10 reasons why Africa is now a destination for foreign direct investment. Huge natural resources, strong growth in the equities market, relatively high GDP growth performance and attractive valuations of banks on the back of limited liquidity, are some of the primary reasons outlined in the report (Trade Invest Africa, 2010).

These opportunities appear to be alluring, but the risk exposure for investors, who are now expanding into more countries, has never been greater. Investors vary in their approaches when it comes to factoring political stability into their risk assessment of potential projects. There is diverse opinion on whether high-risk investments have the potential of high returns, or should just be considered a dangerous gamble. Zimbabwe-based Kingdom Financial Holdings' chief executive officer Nigel Chanakira says in terms of consistent returns, stable countries such as South Africa attract higher FDI, unlike Zimbabwe, which he thinks glows an angry red on Africa's political risk map (Trade Invest Africa, 2010).

The challenges for providers of telecommunication services in Africa are how to develop networks, engage with the market and secure investor returns, while at the same time minimising the political and other Africa specific risks. From this perspective satellite technology, which is based on an architecture that broadcast to all regions from one location, provides some unique risk mitigation options.

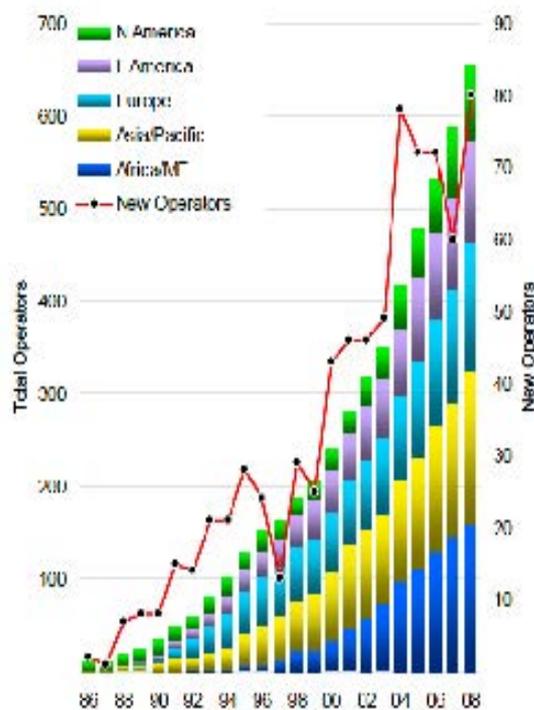
## 1.2 AN OVERVIEW OF THE SATELLITE INDUSTRY

### 1.2.1 GLOBAL GROWTH

The future of satellite services is strong. Even with the deployment of fibre access networks throughout developed countries and now starting in Africa, satellite remains an effective technology as it can provide wide spread ubiquitous connectivity.

The global perspective is summarised by the recent Comsys research report that indicates the strong growth experienced by the VSAT industry over the past 13 years. The numbers of network operators have exploded. Even the United States has seen a marked increase of new entrants after consolidation whittled down the number in the early years of the industry (Comsys 2009).

The number of international operators has grown as liberation opened up new markets and as newer technologies lowered the cost of entry.



**Figure 1-2 World-wide VSAT Network Operator Growth**  
 Source: Comsys Report 2009

In 1992 Comsys reported on 77 different service providers. In 1994 the figure was 100 - a substantial increase considering the US fall-out. Europe alone accounted for 22 different operators running 40 shared hubs. Elsewhere in the world there was a proliferation of shared hubs in different countries, but not to the scale seen in Europe.

The number of operators has continued to grow despite losses through natural selection and acquisition. By 2009 Comsys provides detailed coverage of over 250 operators and is tracking at least a further 250 out of a worldwide total of over 650, up from 540 in 2006.

## 1.2.2 INDUSTRY SEGMENTATION

The application of satellite technology to provide connectivity to Africa is well established and proven. Since the early development of the Africa telecommunication market service providers have used satellite technology to provide intercontinental and regional point-to-point connectivity services.

Subsequently the satellite market has grown and developed to meet a wide range of different user requirements for different market sectors. For ease of reference the overall satellite access market can be classified into the following sectors (as displayed in Figure 1-3):

- a) Point-to-point high capacity trunk circuits used to provide connectivity between Africa and the international networks.
- b) VSAT point-to-multipoint networks that service a wide range of corporate customer applications and has become the dominant architecture to service end-users in remote locations.
- c) Two-way data broadcast (datacast) access networks that provide two-way connectivity services for Internet, data and telephony applications.
- d) Digital satellite broadcast networks that provide the perfect solution for broadcasters such as Multichoice for the DStv service.

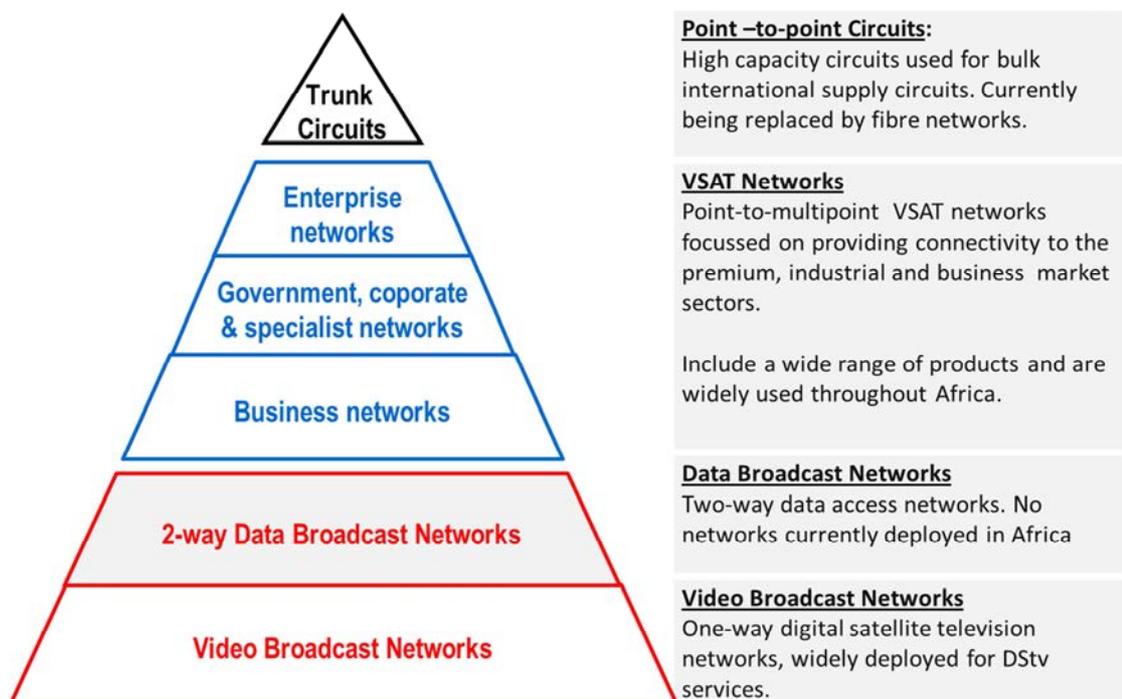


Figure 1-3: Satellite market and product segmentation. Depicted from high-volume low-cost mass market services to high-value low-volume specialized applications.

### 1.2.3 A REGRESSION OF ANTENNA DIAMETER

#### **Point-to-Point Satellite Links**

The very first deployment of satellite technology for telecommunication applications was to implement intercontinental communication circuits between Africa and the world. These solutions were mostly implemented using very big earth station installations of typically 9.3m to 11m in diameter with transmission capabilities of 155Mbps and higher.

In the Internet industry these types of circuits were deployed to provide bulk capacity to capital cities throughout Africa. The satellite circuits were deployed as backhaul circuits while local ADSL or wireless networks were used to distribute the Internet access services to end-users.

The growth and development of intercontinental fibre access networks between Africa and Europe, as well as the growth of terrestrial fibre networks, have led to this sector of the satellite market being phased-out and mostly being replaced by fibre access circuits.

#### **Point-to-Multipoint VSAT Networks**

The next era in satellite access networks were the deployment of Very Small Aperture Terminal (VSAT) networks. VSAT networks operate in a point-to-multipoint network configuration with a central “hub” or master site and several hundred remote terminals. These remote terminals typically deploy remote sites with antennas diameter of typical 2.4m, 1.8m or 1.2m.

These networks are currently the preferred architecture to provide Internet access services to remote locations in Africa. The central hub terminal is located at a fibre access node in Europe or Africa capital cities. The central hub provides Internet access, via satellite communication channels, to the remote terminals throughout Africa. The VSAT architecture has proved to be very effective and this market is currently well serviced by a number of Service Providers such as iWay Africa, Global TT and Bentley Walker.

#### **Two-way Data Broadcast Networks**

Satellite Service Providers are constantly working to improve the cost-performance relationship of VSAT networks and strive to provide service at a lower equipment cost per terminal in order to access the mass market.

This has led to the development of two-way data broadcast networks that provide “VSAT-type” services using customer terminal equipment of 75cm in diameter and that is based on digital broadcast technology. The combination of a smaller customer terminal antenna and the underlining digital broadcast technology enables the deployment of this kind of satellite access networks to service the mass market.

Deployment of data broadcast network, however, requires large scale investments in core infrastructure and access to a mass market that can afford the service and support the business case. Currently there is a very limited number of such networks in the international market and no deployment in the Africa market.

## Digital Broadcast Networks

Digital broadcast networks currently provide one-way delivery of video content from a single location to millions of remote terminals. These network solutions are perfect for the delivery of digital television channels and are widely used in Africa for distribution of the DStv signal bouquet.

### 1.2.4 A DATA BROADCAST NETWORK FOR AFRICA?

Given the low-cost customer terminal of two-way data broadcast networks it logically follows that Africa should be a perfect market for such a network. With its vast open areas, mass underserved market and poor terrestrial infrastructure; it presents an attractive option for the deployment of a satellite access network to deliver affordable broadband services to the masses.

The obvious question then is: Why has it not been done yet and is it feasible to deploy a network of this magnitude to service the Africa market?

This question is fundamental input and motivation for this study and drives this research work. On the one hand to prove that there is sufficient market potential and on the other hand to investigate how such an implementation should be done to maximise the probability of success while minimising the required funding and implementation risks.

## 1.3 MOTIVATION FOR THE STUDY

### 1.3.1 THE NEED FOR A VIABLE BUSINESS MODEL

The need for broadband services and the benefits that broadband services will have towards the economic upliftment of Africa, as well as the lacking abilities of the currently available networks have been widely discussed and reported by various interested role players (World Bank, 2010; Ayanagbo, K. *et al*, 2011). Furthermore, the success of mobile networks in terms of service delivery, network communication coverage, direct investor returns and in-direct industry benefits have been applauded by politicians, analysts and the general global community.

What has not been done is to put forward recommendations and tangible feasible models to define, quantify and simulate the possible business models that can provide broadband services to the mass Africa market. There is a very real absence of business concepts that are integrated with telecommunication network options to provide a mass consumer broadband access service alternative to Africa.

This study is specifically focused on the research, analysis and financial modelling required defining a viable business model and related business model simulator that can be adopted to provide broadband consumer services to the mass Africa market. The definition, formulation and financial validation of the business model is an integrated process that consolidates technology inputs, market inputs and operational inputs to

synthesize a business model that provides tangible product outputs and offer an affordable service to the market (refer Figure 1-4).

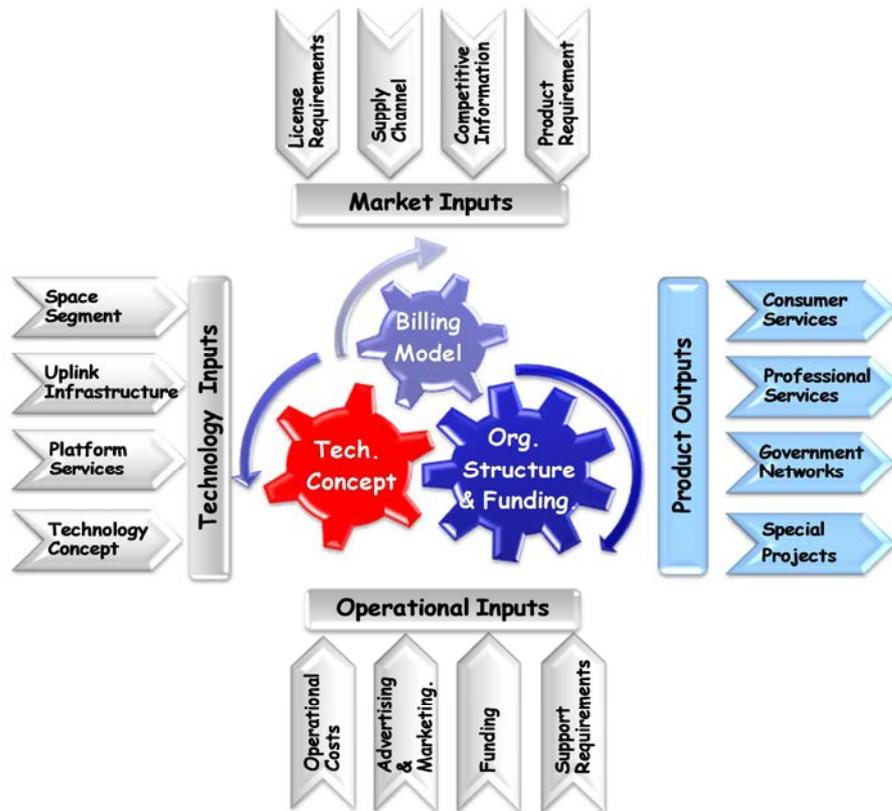


Figure 1-4: Integrated Business Model Development Process

The analyses of the various business and technology inputs are completed in relationship with the following three anchor principal of the business model;

#### **The technology principle**

The technology concept analysis is focused on investigating the specific satellite network architecture that enables the feasible deployment of consumer broadband services.

#### **The billing model principle**

The billing model principle defines the structure and metrics required to offer a viable consumer broadband service.

#### **The organisational and funding principle**

The organisational structure, operational and funding principle forms the essence of the delivery capability and is central in ensuring the feasibility of providing a broadband service to the market.

#### **Business model simulator**

The definition and development of an integrated mathematical business model simulator that can be used to evaluate different technology, market and business strategies and scenarios.

### 1.3.2 THE BUSINESS MODEL REQUIREMENTS

The large discrepancies between Africa and the rest of the world regarding the current availability of broadband services as described earlier, provides clear evidence that the broadband strategies developed for First World countries are not directly applicable in Africa. In order to close the digital divide in Africa, to implement and operate broadband networks and to stimulate the growth of a knowledge economy, a new broadband business model must be developed specifically for Africa.

This Africa broadband business model must be able to map a feasible business path and practical implementation plan, while effectively including and addressing the following Africa dynamics:

- **Moderate Investment.** The business plan must require only moderate investment that can be effectively recovered from the provision of broadband services to the emerging consumer Africa market.
- **Risk Adverse.** The business plan must provide suitable mitigation against socio-political instability and other macro-economic risks factors typical of the African continent. The business plan must be able to leverage the synergies of Africa, while at the same time not fall prey to the dangers present within specific countries.
- **Flexible User Profiles.** The Service must be sufficiently flexible to cater for the vastly diverse range of broadband user profiles in Africa and must effectively meet the unique service profile and billing requirements of each user group.
- **Technology Competent.** Broadband services forms part of the rapidly evolving ICT technology industry. The technology to be deployed to support the Africa broadband model must therefore be both very robust, while at the same time enabling operation for at least the next 5 to 10 years to allow the recovery of the upfront investment.
- **Feasible and Rapid Implementation.** The proposed network architecture must be easy to install and maintain allowing rapid deployment of end-user units.

The objective of this research project is to synthesize a technology, operational and financial model that will meet all these requirements, in the process defining “A scalable Business Model for Mass Customisation of Broadband Services in the emerging Africa market”.

## 1.4 OUTLINE OF THE THESIS

### 1.4.1 OVERVIEW

The results and information applicable to this research work is documented as follows.

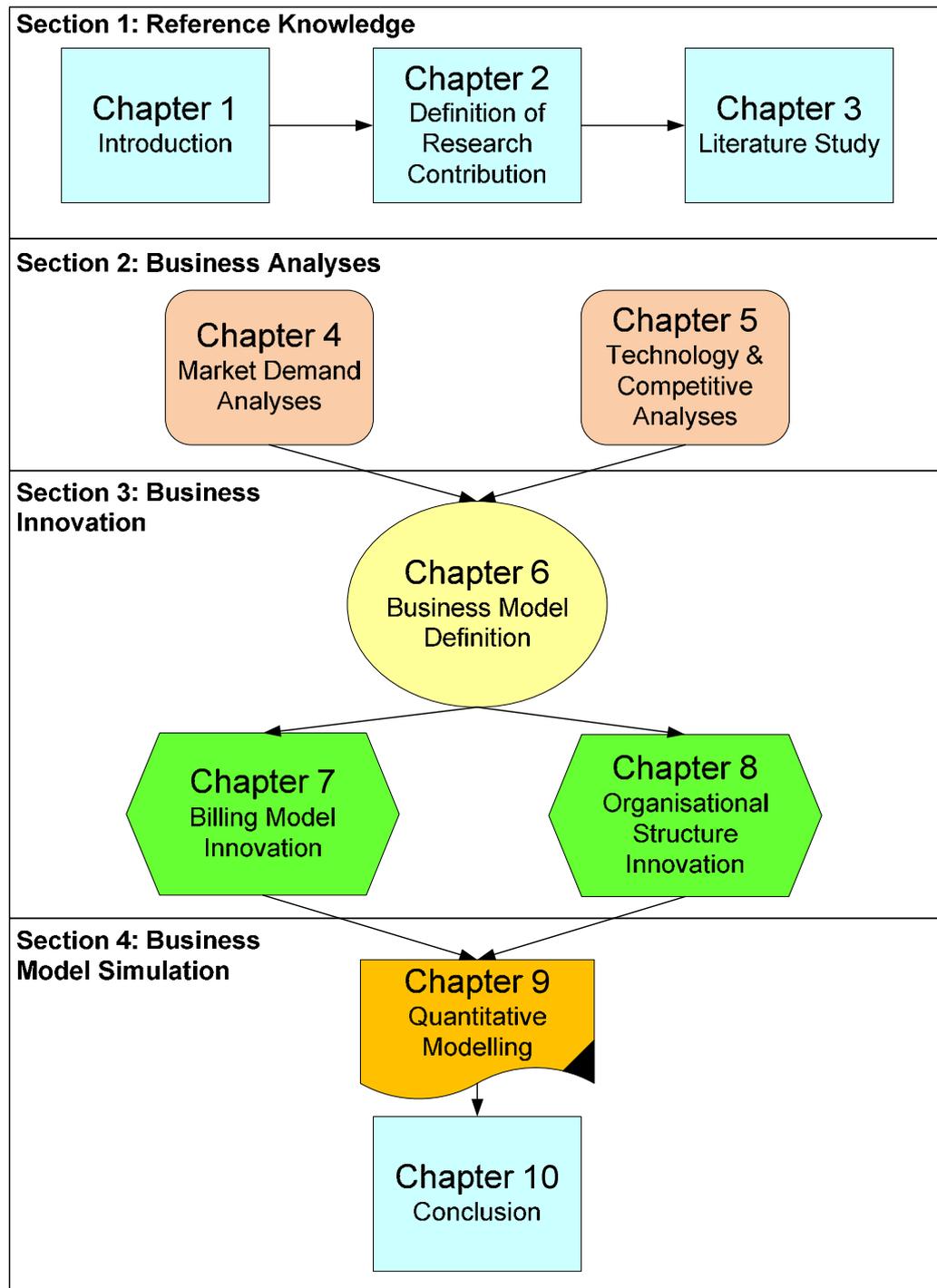


Figure 1-5: Outline of the thesis document.

## 1.4.2 CHAPTER SUMMARY

Development of the business model for a satellite two-way data broadcast network is not a linear step-by-step process. To define the optimum business model requires an integrated and iterative process that simultaneously considers all the different business input domains, the respective business implications and the related implementation requirements. Only once a balance is reached between all the influences is the business model definition complete.

The business model development done in this study was integrated into a mathematical simulator of the business model to review various different business options. The various inputs, business process and result sheets, collectively form the quantitative and qualitative business model. The complete mathematical business model is included in the appendixes.

Each of the principal areas of the business model is discussed and documented in a separate chapter in the thesis. When a business outcome or specific scenario is discussed then reference is also made the applicable business simulator schedule included in the Appendixes.

### **Section 1: Reference Knowledge**

Section 1 forms the preamble to the work and documents the frameworks and background against which the study is completed.

#### **Chapter 1. Introduction**

Chapter 1 provides the introduction to the work and provides the context for this study.

#### **Chapter 2. Definition of Research Contribution**

Chapter 2 defines the specific research problem statement and formulates the different research goals that are tested by the research work. The chapter provides an outline of the specific research contribution provided by this study.

#### **Chapter 3. Literature Study**

A summary of the literature research and a framework of the current knowledge is provided in Chapter 3.

### **Section 2: Business Analyses**

Section 2 documents the specific content and subject information that defines the market and technology landscape applicable to the proposed satellite data broadcast service.

#### **Chapter 4. Market Demand Analyses**

The characteristics, drivers and constraints of the Africa broadband market is researched in Chapter 4, to determine the addressable market for broadband access service. The analysis is focused on quantifying the total broadband market, as well as verifying the market demand for two-way satellite data broadcast service.

**Chapter 5. Technology and Competitive Analyses**

In Chapter 5 current mobile 3G and ADSL available technologies are investigated against the market requirements to determine the minimum technical requirements and also to validate the competitiveness and suitability of the proposed satellite broadband service.

**Section 3: Business Innovation**

All information collected from, and insights developed through the above investigations, culminates into the creation of a new business model that is documented in section 3.

**Chapter 6: Business Model Definition**

Here, the business model and strategy definition includes the development of the business elements and framework that integrates technology, product and market dimensions into a sustainable and profitable business operation.

**Chapter 7: Billing Model Innovation**

Chapter 7 documents the outcome of the research and billing model innovation work that led to the definition of the matrix model proposed to be the most suited Internet billing model for Africa. The process integrates user preferences, business drivers and technology capabilities into an affordable model for high value services.

**Chapter 8: Organisational Structure Innovation**

Different organisational structures enable and underwrite different operational delivery capabilities. To successfully deliver mass consumer broadband services to the emerging Africa market required new thinking in organisational structure work. Chapter 8 documents the research and innovation processes that led to the definition of a new symbiotic organisational structure concept.

**Section 4: Business Model Simulation****Chapter 9: Quantitative Business Model Simulator**

The quantitative and qualitative business model simulator was developed and constructed using integrated spreadsheet models. Chapter 9 provides an outline and description of the business model simulator and the applicable business domain interrelationships.

**Chapter 10: Summary and Conclusion**

The results, findings and conclusion of this research work are consolidated in Chapter 10.

## Section 1: Reference Knowledge

# 2. Definition of Research Contribution

## An outline and quantification of the research objectives and specific value contribution of this research study.

*“Think outside the limitations of existing systems  
– imagine what might be possible”*  
Vinton G. Cerf

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### 2.1 INTRODUCTION

The concept of a business model within the context of telecommunication services rests upon the interrelationship between technological and operational capabilities, market requirements and financial constraints. The business model defines which technology network architecture is best suited to provide which specific product at what level of pricing to which market and defines the investment that will be required as well as the resources and infrastructure required to provide the service.

Different business models are applicable to different target markets. The prepay-model adopted by the mobile telephony industry to provide services to the mass market is a classic example of the powerful impact that the perfect business model can have on an industry. Another example of creative business model engineering is the pay-TV satellite distribution model that is used by Multichoice to provide the DStv product to the Africa market. One of the key assumptions of this study is that the most appropriate billing model can have a similar impact on the Africa market for broadband services.

In this thesis we do not intend to develop new management models applicable to the satellite broadband industry – we rather focus on developing a simulation model that can accurately describe the expected behaviour and performance of a broadband access service provider providing services in the digital satellite industry. In the process we will use existing management models to develop behavioural models for the different aspects of a business operating in this sector. The simulation model will be constructed in such a way that it is generic for the industry, i.e. it will allow the user to configure it in such a way that it can be used to model a wide spectrum of different approaches to launch a new business in this sector of the mass Africa market. To the best of our knowledge no results have ever been published on such an endeavour.

The relevance and value of the simulation model resides in the fact that the overall behaviour and performance of such a business is very dependent on the interaction between market, technology and financial factors. While some of these factors are fairly well understood when viewed in isolation, very little is currently known about the way that these factors will interact to impact on the performance of a new venture in this industry. As explained in chapter 1, no digital satellite networks have been deployed in Africa until the present day. Secondly, the target market (rural Africa) has never been addressed before with a broadband offering, as ADSL and cellular networks cannot reach this market. Thirdly, most players involved in the satellite industry currently employ a vertically integrated strategy, and derive most of their income from established markets in developed countries. The financial viability of an operation focussing exclusively on Africa and employing a vertically disaggregated (or symbiotic) organisational structure has therefore not been practically tested before.

Performing practical experiments to investigate the factors that are impacting business success in this industry will not only be a very costly exercise, but will also take such a long period of time that the market itself and the supporting technologies will materially change during the course of such an experiment. There is hence much value in the development of an accurate and reliable simulation model that incorporates most of the important factors and that can give a clear indication of which strategies are likely to be more successful than others. This is similar to a situation where a complicated new piece of machinery must be developed, and where it is standard practice in the engineering industry to firstly build a comprehensive simulated model to sort out most of the design options, before building the first working prototype. Taking this approach, which is well known in the field of engineering, and applying it to business strategy and innovation, also represent some element of novelty, as no studies of this kind have been published before in the satellite broadband industry.

### 2.1.1 THE IMPACT OF BUSINESS MODELS

The definition of a successful business model is a prerequisite to provide any form of service and more particularly telecommunication services to emerging markets. Business model engineering and innovation is as critical to the success of service provisioning as is the underlining technology innovation. The challenge is to find the optimum balance point between infrastructure investment requirements, political risk and market return.

In order to provide mass broadband services to the Africa consumer market, it is therefore first required to define a feasible business model. Without a sound business model that effectively integrates the technology, market and business dynamics, industry players can not define suitable market penetration strategies and service delivery plans.

Currently mobile networks are the dominant option to provide services to the Africa consumer market; the business case for mobile networks is however primarily based on providing voice services. Although mobile networks have evolved and is now also providing data services, this offering is limited to metropolitan areas and lack the means to enable a wide geographical roll-out.

### 2.1.2 BUSINESS MODELS FOR INTERNET ACCESS

Billing models for Internet access is a long-standing issue, which was heavily discussed in the early days of the worldwide web (Mackie-Mason, 1995, Courcoubetis, 2003). CA\$hMAN (CA\$hMAN 1999) expanded on the experience of earlier projects and M3i (M3I) provides a good survey of different billing approaches. The industry has however shown little interest in academic research on this topic and has taken a different path which, rather than looking into the value of specific flows, takes a more holistic view of user traffic. After a flat fee approach for access, followed by discrimination based on the size (i.e. bandwidth) of the access “pipe”, Internet Service Providers (ISP’s) have started to introduce a “volume-based” factor in the way they charge users.

Broadband services are today mainly offered to the Africa consumer market through either ADSL services or Mobile 3G services (BMI TechKnowledge, 2010). ADSL services are mostly based on a flat fee approach, whereas 3G services are predominantly based on a usage fee. These pricing models directly relate to the underlining principles of the respective technology networks and are clear indications that different business models are driven by the relationship between technology and billing.

The question is: which business model to use for Africa? Which business model will provide the best balance between risk and reward, between technology and service, between current needs and future requirements? The current differences between ADSL and 3G indicate that the perfect model has not been found yet and that more work is required to define the perfect option.

## 2.2 RESEARCH FRAMEWORK

### 2.2.1 OVERALL OBJECTIVE

It is the objective of this study to develop a business model and mathematical simulator for providing broadband access services to the mass consumer market in Africa. In order to achieve this objective it is necessary to gain in-depth insight into the nature of this market, into the requirements of different market segments and into the applicable technology domains required to satisfy the market needs on a cost-effective basis.

Achievement of the above set of objectives implies the development of new knowledge that can describe the structure of this industry, its detailed needs, the product-service sets that could satisfy those needs and the optimal selection and deployment of technology to support the delivery of the required services. As this has proven to be a complex undertaking, it was decided to break down the problem statement into a number of sub-research objectives, each of these focusing on a specific aspect and representing a key element of the overall business model.

Eventually all of these elements are integrated into a single business model simulator that can be used to analyse alternative business strategies and to study the relationships between different input and output parameters forming part of the model.

#### Research Objectives

The overall research objective is to develop a scalable business model that can be applied to service the mass consumer broadband market in Africa, and to convert this business model into a simulation model that can provide quantitative feedback regarding expected business behaviour.

The research work aims to achieve this objective by addressing the following underlining research questions;

1. To determine the size and behaviour of the target market segment that can afford this service?
2. To determine the architecture and feasibility for digital satellite network technology to provide an affordable solution to service this market?
3. To define the business model and strategy that can effectively integrate technology, market and product dimensions into a single business operation?
4. To develop the billing model that will be the most effective w.r.t monthly revenue versus subscriber quantities?
5. To define the organisational structure will offer the most efficient and lowest risk operating model?
6. To define a mathematical simulator of the business model and used this to evaluate different architecture, financial and market risks in order to evaluate different business strategies?

## 2.2.2 RESEARCH PROCESS

Key to the research process of this study is that it is conducted within a continuous development cycle with all the aspects of the research being investigated and analysed individually and collectively.

It can best be depicted in a circular nature as displayed below. The outputs of one phase form the inputs to the next, while the complete process is iterated several times until an acceptable balance is found for all the criteria of the business model.



Figure 2-1: Diagrammatic representation of the business model research process

The research work includes the following activities:

### Current literature research

Academic and industry publications of the last 2 to 3 years were reviewed and studied to obtain a general broad understanding of the different aspects and considerations. References of earlier years were included if the subject matter was found to be still relevant, or if the principles discussed were found to add value to the current business environment.

### Industry research

Different business model concepts and scenarios were tested against the broadband industry in Africa by sending specific questionnaires to targeted industry forums, including known and unknown entities present on a contacts data base. The industry research also includes market research done by BMI TechKnowledge ([www.bmi-t.co.za](http://www.bmi-t.co.za)) specifically for this project.

### **SkyeVine Case Study**

SkyeVine is a company formed in 2010 with the specific objective to provide mass consumer broadband services to the emerging Africa market. This research work is strongly motivated and directed by the actual product, business and technology issues that must be resolved to ensure the successful establishment of the SkyeVine business. The SkyeVine case study provides a very real reference and direct application of the results and concepts contained in this research work.

## **2.3 DEFINITION OF RESEARCH OBJECTIVES**

This paragraph provides a brief overview and description of each research objective. The research objectives form the overarching framework against which the overall research study to develop a scalable business model is completed.

### **2.3.1 OBJECTIVE 1: MARKET DEMAND**

Given the current large scale penetration of ADSL and cellular telephony in the Africa consumer market, the first objective is to verify whether there is a market for satellite based services and whether mobile 3G and ADSL services will not become the *de facto* service platforms. The question is whether the market for satellite access can be differentiated based on availability and functionality delivered in spite of higher equipment and subscription costs.

#### **Objective 1: Quantify the target market**

Broadband Internet access is no longer a pure luxury and there is a substantial underserved mass consumer market demand throughout Africa, both in urban and rural areas. The objective is to quantify the target market sector that cannot be effectively serviced by the current 3G and ADSL services, that can afford a broadband service and that therefore have the need for an alternative technology solution.

### **2.3.2 OBJECTIVE 2: DIGITAL SATELLITE ACCESS SERVICE FOR AFRICA**

Various existing satellite technology platforms provide broadband access services to business and corporate users within the Africa market. In order to provide services to the consumer market satellite access networks will have to be designed and deployed in a very specific manner, to meet the specific requirements of the mass consumer market.

The current satellite network solutions deployed throughout Africa is not suited for the mass consumer market. The question is therefore whether this new technology can be extended in terms of functionality, implementation and operational requirements to be suited for the consumer market in Africa.

**Objective 2: Verify the suitability of Satellite-based Data Broadcast Technology for Africa**

This objective is researched at two levels. Firstly the research objective is to prove that satellite technology can meet the principal market demand, i.e.:

- 1) The need for ubiquitous service coverage.
- 2) The need for affordable end-user equipment and implementation.
- 3) The need for affordable monthly service fees.

Secondly, the research objective is to analyse the current competitive landscape of the satellite industry and to determine the optimal positioning of a potentially new

**2.3.3 OBJECTIVE 3: BUSINESS MODEL DEFINITION**

The ultimate success of technology innovation lies in the ability to integrate the technology with an effective business model to ensure market adoption and long term success. Assuming that market demand for a consumer data broadcast product has been confirmed and that satellite is a feasible technology to meet the demand, the question then is: what is the business model and strategy that can take the solution to the market and ensure long-term success?

**Objective 3: Define a Business Model that will enable the supply of satellite data broadcast services to the Africa market on a viable basis**

Define the most suitable business model to deliver satellite-based data broadcast services to the consumer Africa market and prove that this strategy is the most suited and viable strategic option.

**2.3.4 OBJECTIVE 4: BILLING MODEL REQUIREMENTS**

Affordability characteristics of emerging markets have a dominant influence on the adoption of new products by the market. The general opinion is that Africa can accept advanced products and services as long as the products are offered in affordable price brackets allowing consumers the option to acquire the service at affordable rates.

**Objective 4: Define the preferred billing model**

Through applied research and market pilot projects this study defines and tests different billing models. The optimum billing model is then defined based on successful adoption by the market, as well as financial benefits offered to users and providers.

### 2.3.5 OBJECTIVE 5: SYMBIOTIC BUSINESS STRUCTURE

A vertically disaggregated approach based on a symbiotic model can potentially be more attractive to penetrate this market compared to a vertically integrated single company approach, as it will pool expertise and resources from different consortium members and will reduce the incremental investment required to provide the envisaged services.

**Objective 5: Prove that business structure innovation can effectively leverage resources, reduce investment and reduce risk.**

The scale of the financial and resource investment required to implement the initial satellite-based data broadcast service is estimated. Against the background of the uncertain nature of this emerging market, it is argued that a customized organisational structure is required to minimise the risk and maximise resource utilisation.

Financial modelling will be used to provide evidence that a higher return on investment at lower risk levels can be achieved through a symbiotic consortium model, compared to a vertically integrated model.

### 2.3.6 OBJECTIVE 6: QUANTIFIED BUSINESS SIMULATION MODEL

The complexity and scope of the technology implementation, market penetration and the financial costs associated with the deployment of a data broadcast satellite based service is very substantial and cannot be justified on an experimental basis or even on a regional or trial project basis. It is therefore critical to evaluate the different business scenarios, market factors, technology design criteria and billing models through an integrated mathematical business model simulator.

**Objective 6: Prove that the business can be modelled and simulated**

Through this part of the research work, it is shown that it is possible to construct a simulated mathematical model that enables the effective analysis of different business scenarios through the integration of quantified market, technology and financial parameters. It is furthermore demonstrated that the simulator can serve as a valuable support tool to enable improved decision making, while minimizing the risk of non-viable physical deployments.

## 2.4 NEW KNOWLEDGE GENERATED THROUGH THIS STUDY

This research work is focused on the integration of knowledge from the following domains:

- business management theories,
- satellite systems engineering,
- market demand analysis, and
- organisational structure design,

as required for the successful deployment of broadband Internet services for the African consumer market. It falls outside the particular scope of any one of these disciplines when viewed in isolation, yet it integrates the key aspects of all of these subject areas in order to synthesize a viable business strategy for this market. Refer to Figure 2-2 for a diagrammatic overview of the knowledge domain of this study.

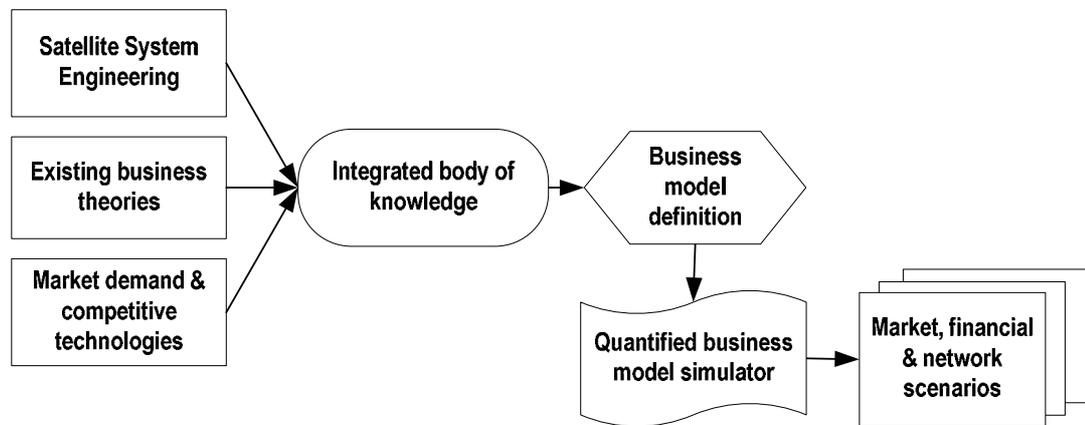


Figure 2-2: Overview of the knowledge domain of this research study.

To the best of our knowledge, such a study aimed at the satellite broadband industry has not been documented and published before in the publicly available literature. This work will therefore fill an important gap in the current understanding of the intersect point of business management theories, satellite systems engineering, market demand dynamics and competitive technology options. This integrated knowledge domain will provide a reference for the definition of future broadband service provider business models and can make a significant contribution to economic development in Africa.

Using the current knowledge base in all of the respective areas as a departure point for this study, our research adds new understanding and insight to guide the envisaged practical deployment of satellite broadband services.

The research work specifically contributes the following key concepts to the respective fields of study:

### **Innovation-loop Model**

The business innovation-loop model developed in this study integrates the classical approach to business modelling proposed by Ungerer *et al* (Ungerer, Pretorius & Herholdt, 2007), the product innovation thinking offered by Burgelman *et al* (Burgelman, Maidique, Wheelwright, 1996) and the STOF design process documented by Bouwman, de Vos en Haaker (Bouwman, De Vos & Haaker, 2008) into a single model that can be applied to simultaneously consider both technology and business dimensions when developing a new business strategy.

The required approach for developing a business strategy using the innovation-loop model is captured in the work recently completed by Ostwalder & Pigneur (2010) and can best be described as a “design attitude” that incorporates ambiguity and uncertainty.

By integrating the various concepts and knowledge perspectives from prior research the innovation-loop model as defined and proposed by this study offers an integrated framework that consolidates different knowledge fields.

### **Price elasticity of demand model**

In order to determine the expected market demand for a satellite broadband service in the selected target market as well as the impact of equipment and services pricing on the addressable market, the study incorporates the work done by Rappoport *et al* (2002) who described the demand for residential Internet access in USA, the work done by Crandell *et al.* (2003) who researched the effect of price changes on DSL services and Yamori (2008) who determined the average price elasticity coefficient for broadband services.

Using these references as basis the study continues to incorporate research on the current broadband Internet access subscriber market and the current pay-TV subscriber market in Africa in order to arrive at a model that can be used to calculate the expected addressable market for satellite access services in the Africa environment.

By referencing available market research from a currently known market sector and extending it with the existing knowledge on price elasticity of demand for services the research study provides a new understanding of the African market potential for broadband satellite services.

### **Matrix Billing Model**

The literature research study includes extensive research work in the field of pricing and billing models for Internet access services; most of these studies on the relationship between demand, price and network resources. Sallent J.O *et al* (2006) proposed auction-based schemes, while Chan *et al* (2005) proposed an optimization-based scheme as well as a demand/supply based scheme.

This research work consolidates these known models, defines a pricing structure that is based on content, time and volume and provides the first satellite Internet broadband pricing model that eliminates network congestion.

### **Symbiotic Organisational Structure**

Building on large amount of research done in the field of organisational structure and management by Mintzberg (1989), Milleman and Gioja (2000) and others this study specifically focuses on the optimization of resources to minimize risk and limit investment requirements.

The concept of a symbiotic organisational structure is discussed by Wilckens and Shepard (2010) for the pharmaceutical industry in an evaluation project framework. Pfeffer and Salancik (1976) discussed symbiotic organisations in the context of either competitive interdependence or symbiotic interdependence and implemented through joint venture structures.

This research work developed the concept of a symbiotic organisational structure that is on developing a mass market to the mutual benefit of all symbiotic organisational partners. What is different to the symbiotic organisational structure defined in this study is the fact that the respective organisational partners are not integrated through a formal joint venture or shareholding structure. The symbiotic partners are joined through mutually agreed investments that each partner make in order to establish an industry wide capability as required to service the emerging mass market. Although the symbiotic partners remain separate organisational entities, the respective investments made to service a common goal forms the basis of a symbiotic relationship.

### **Satellite Systems Engineering**

The application of satellite communication channels as a medium to transmit IP content, such as the Internet, is a relatively new technology field. The first deployment of Internet over satellite solutions was done in 1999 by Q-KON engineers working in association with Intelsat, at the time operating under the name PanAmSat ([www.intelsat.com](http://www.intelsat.com)). While the engineering methodologies for calculating the performance and characteristics of a space transmission link is well documented by Freeman (1996), Roddy (2006) and others, the interdependence between the system engineering process and the business model parameters has not yet been addressed.

The satellite system engineering process determines various system requirements such as power levels, equipment performance, reliability, etc. to ensure the reliable technical performance of the satellite link. It also determines many business model variables such as the geographical target market, the addressable market, the input costs and the end-user service definition.

This relationship between engineering design and business parameter outcome has not yet been formalized in a quantitative manner and this study provides a significant contribution

to a knowledge field that forms the intersection point between satellite systems engineering and business model definition.

### **Business Model Simulator**

The technical network design and specification of a satellite based telecommunication services network are defined through the satellite system engineering process that includes various engineering design tasks as outlined in Freeman (1997). This process is well documented and also integrated in various commercially available design software application packages that automate the calculations of satellite link engineering data ([www.satmaster.com](http://www.satmaster.com)).

Business models are widely discussed in the literature, including profit models (Slywotzky and Morrison, 1997) and strategy maps (Kaplan and Norton, 2004). Other definitions of business models emphasize the design of the transactions of a firm in creating value (Amit and Zott, 2001), the blend of the value stream for buyers and partners, the revenue stream, and the logical stream (the design of the supply chain) (Mahadevan, 2000), and the firm's core logic for creating value (Linder and Cantrell, 2000). In an attempt to integrate these definitions, Osterwalder, Lagha, and Pigneur (2002) propose an e-business framework with four pillars: the products and services that a firm offer, the infrastructure and network of partners, the customer relationship capital, and the financial aspects.

Although both satellite system engineering models and business models have been widely discussed and documented in the public literature no reference could be found of a model that integrate the satellite system engineering criteria directly with the commercial drivers of a satellite service provider business model. In addition no published evidence could be found of any significant efforts to implement such an integrated business model in the form of a simulator that allows quantified studies in this field.

In order to fill this gap our study incorporates the definition, validation and application of such a business model simulator that integrates both the system engineering and business modelling process to enable potential service providers to simulate various business outcomes based on different satellite system engineering scenarios. The simulator furthermore incorporates the interaction between pricing and market demand and the impact of the matrix billing model on market adoption rates. The assumptions on which the simulator is based are all tested against actual realities in this industry, and its design allows the simulator to be configured for a wide range of practical scenarios.

To the best of the author's knowledge no research results have been published before about a similar endeavour allowing the studying of satellite Internet business scenarios using an accurate simulation model. The description of the simulator and the results from the simulated scenarios therefore also represent an important and unique contribution to the field of study.

## 2.5 SUMMARY

Section 1 provides the reference knowledge and background for the research work. Section 1 incorporates chapter 1, 2 and 3. Chapter 1 provides the introduction to the study, the objective of the study, the motivation of the study and an outline of the thesis document.

Chapter 2 focused on documenting the specific research contribution of the study, the research process followed, the respective research areas and finally definition of the research objectives that will be direct this study.

Chapter 3 is the next chapter and provides an overview of the literature study to summarise the current known knowledge field. Chapter 3 concludes the reference knowledge discussion.

## Section 1: Reference Knowledge

### 3. Literature Study

Review and summary of the current knowledge and information in the collective fields of business models, strategy, innovation, broadband markets and technology.

*"In the spider-web of facts, many a truth is strangled."*  
Paul Eldridge

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#### 3.1 INTRODUCTION

The objective of this research work is to define and formulate a scalable business model for mass customisation of broadband services in the emerging Africa market. In the context of this study the business model definition includes the qualification of all market, technology and organisations parameters required for the successful end-to-end delivery of broadband services to the target market.

From this objective it follows that the input knowledge domain of this research work integrates and consolidates a wide range of academic research fields. The research contribution of this study is on the integration and consolidation of the respective knowledge fields into a specific business model rather than the extension of one particular subject. Through integration of various business, market and technology fields the study contributes knowledge to the "satellite business engineering" domain. By developing a simulation model that enables quantitative analysis of relevant scenarios new insights are obtained into the interaction between business, market and technology factors.

This chapter outlines the current knowledge base in the related study fields. The chapter is the result of academic and industry research work using both the printed media as well as conducting interviews and discussions with industry leaders.

The literature research provides the reference and context to this study, based on which the proposed business model for the delivery of data broadcast services to the emerging Africa is developed.

### 3.1.1 RESEARCH INFORMATION CONTEXT

The Africa telecommunications industry in general, and specifically the Internet broadband access industry, is a very fast developing industry that evolves almost on a daily basis. Within this rapidly changing environment the relevance of this literature study and the subsequent research work is anchored in two perspectives.

Firstly, market demand figures, subscriber numbers and revenue statistics were obtained from currently available material representing the market status by end 2010 and reflecting the latest information in this field. This information provides the current reference and is used to quantify the demand and growth numbers at this point in time.

It is expected that the market dynamics will continue to change and that the nominal values and forecasts used in these references will not remain valid over time. What will remain valid over the next 5 to 10 years are the relative numbers and the applicable market trends. Both the current nominal values and the expected future trends are required to provide the underlining business justification for this research work.

Secondly, the literature study includes references to information regarding the underlining trends and characteristics of the market, which are founded on the core nature and culture of the Africa market. These fields of information refer to the very nature of the Africa market, its people and characteristics, which provide a timeless reference for this research work, as well as other studies.

### 3.1.2 FIELDS OF LITERATURE STUDY

In order to support the development of an integrated business model simulator for broadband services in the emerging Africa landscape the research work spans a very wide range of subject fields. Figure 3.1 provides an outline of the respective knowledge areas that were studied to provide context to this research work.

Given the extensive scope of these fields it is not the intention of this study to provide an in depth review of each subject but rather obtain context and understanding as required to define the consumer business model. The research study is thus more on creating value through the integration and consolidation of various knowledge fields rather than the extension of one particular knowledge field.

Through the study and review of the respective fields the following principal thoughts and concepts were formed as knowledge nuclei for the development of the business model:

- Customer service as central objective for business model development.
- The need to incorporate service innovation as a key competitive advantage.
- The iterative and continued improving nature of business model development.
- The integrated nature of service, technology, organisation and funding.
- Different billing model scenarios and innovation offered by billing model designs.
- The capabilities and limitation of satellite access technologies.

By integrating knowledge from these fields the research study developed the following innovative concepts;

- Creation of an alternative billing model for broadband access services that enables the extension of satellite services to market sectors that would otherwise not be able to afford this service.
- Definition of a symbiotic organisational structure as the optimum for satellite broadband services in Africa in terms of an acceptable balance between funding requirements and risks on the one hand and acceptable returns on the other.
- A quantitative business model simulator that provides an analytical tool for evaluation of different business strategies, making it possible to evaluate and review alternative strategies before committing significant funds for service deployment.

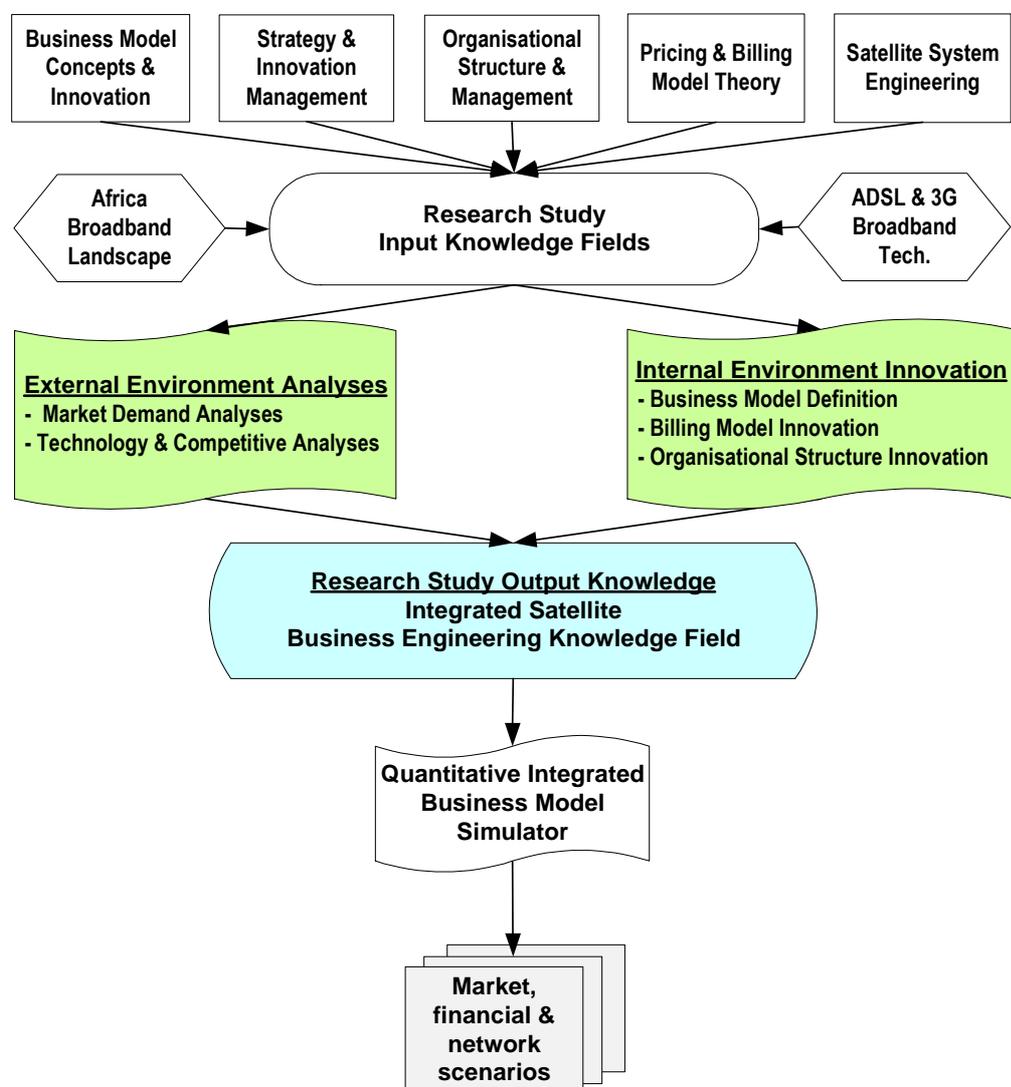


Figure 3-1: Outline of the relevant reference knowledge fields and specific subject areas of this research study.

## 3.2 BUSINESS MODEL CONCEPTS & INNOVATION

### 3.2.1 BUSINESS MODEL SIMULATIONS

Even though the concept of a business model is potentially relevant to all companies, literature research in the fields of organisation design, economics and business strategy produced only a few articles on simulated business models, and no large-scale studies on the topic. Instead several authors have provided useful frameworks for analyzing businesses, such as profit models (Slywotzky and Morrison, 1997) and strategy maps (Kaplan and Norton, 2004). These approaches are based on a long tradition of classifying firms into “internally consistent sets of firms” referred to as strategic groups or configurations (Ketchen, Thomas, and Snow, 1993). These groups—typically conceived of, and organized through the use of typologies and taxonomies (e.g., Miles and Snow, 1978; Miller and Friesen, 1978)—are then often used to explore the determinants of performance.

Most of the academic research that could be found on business model simulations was done in the context of e-business—new ways of doing business enabled by information technology. Research on e-business models has primarily on two complementary streams: taxonomies of business models and definitions of components of business models (Hedman and Kalling, 2001). For example, Timmers (1998) defines a business model as including architecture for the product, service, and information flows, a description of the benefits for the business actors involved, and a description of the sources of revenue. While Timmer’s definition does not limit the notion of a business model to e-commerce, he applies business models to that domain, using two dimensions: 1) degree of functional integration (number of functions integrated) and 2) degree of innovation (ranging from simply translating a traditional business to the Internet, to creating completely new ways of doing business), resulting in eleven distinct Internet business models.

Business model definitions and descriptions have proliferated since the work of Timmers; only a few references will be discussed by way of example. Tapscott, Ticoll and Lowy (2000) focus on the system of suppliers, distributors, commerce service providers, infrastructure providers, and customers, labelling this system the business-web or “b-web.” They differentiate business webs along two dimensions: control (from self-control to hierarchical) and value integration (from high to low). Weill and Vitale (2001) include “roles and relationships among a firm’s customers, allies, and suppliers, major flows of product, information, and money, and major benefits to participants” in their definition of a business model. They describe eight atomic e-business models, each of which can be implemented as a pure e-business model or combined to create a hybrid model. Rappa (2003) defines a business model as “the method of doing business by which a company can sustain itself” and notes that the business model is clear about how a company generates revenues and where it is positioned in the value chain. Rappa presents a taxonomy of business models observed on the web, listing nine categories.

Other definitions of business models emphasize the design of the transactions of a firm in creating value (Amit and Zott, 2001), the blend of the value stream for buyers and partners, the revenue stream, and the logical stream (the design of the supply chain) (Mahadevan,

2000), and the firm’s core logic for creating value (Linder and Cantrell, 2000). In an attempt to integrate these definitions, Osterwalder, Lagha, and Pigneur (2002) propose an e-business framework with four pillars: the products and services that a firm offers, the infrastructure and network of partners, the customer relationship capital, and the financial aspects.

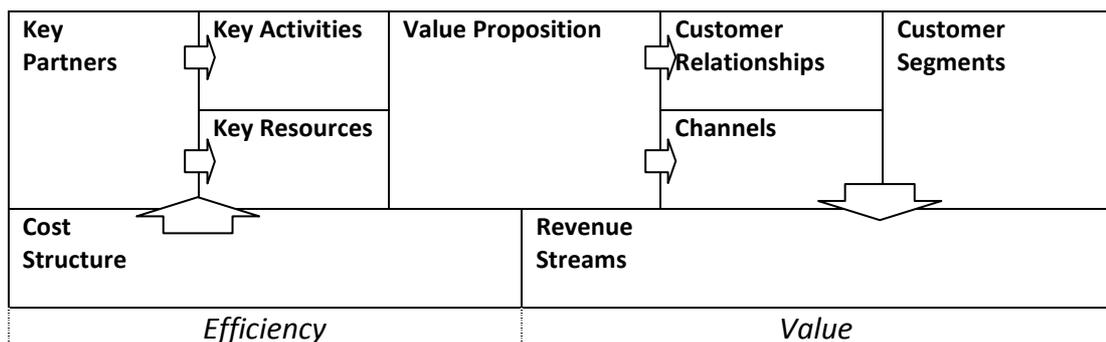
Common to all of these definitions of business and e-business models is an emphasis on how a firm makes money; some go beyond this and discuss creating value. Porter (2001) described the emphasis in business models on generating revenues as “a far cry from creating economic value”. In contrast, Magretta (2002) argued that the strength of a business model is that it tells a story about the business, focusing attention on how pieces of the business fit together - with the strategy describing how the firm differentiates itself and deals with competition. Within the context of this research study a focus on business models has the added attraction of being potentially comparable across industries, allowing a particular field of study (in this case the satellite broadband industry) to learn from the experiences of other industries.

### 3.2.2 BUSINESS MODEL INNOVATION

#### Business Model Generation

##### Business Model Concept

According to Ostwalder and Pigneur a business model describes the rationale of how an organisation creates, delivers and captures value (Ostwalder and Pigneur, 2010). They continue to outline the business model concept in nine basic functional areas covering the four main areas of a business: customers, offer, infrastructure and financial viability (refer Figure 3.2).



**Figure 3-2: Business Model Canvas**  
 Source: Ostwalder & Pigneur 2010

This simplified, yet effective structure is positioned as a background framework to stimulate the innovation process to define new and emerging business models. The focus is on integrating the formal structure of business with the flexibility and creativity required to define new business concepts.

### **Business Model Generation Process**

The integration of business structure and business creativity is facilitated through a 5 phase business model design process that includes: Mobilise, Understand, Design, Implement and Manage (Ostwalder and Pigneur, 2010). Critical in following these five steps is to note that business model innovation remains unpredictable and not necessarily a step-by-step process. This process must be guided by a “design attitude” that incorporates ambiguity and uncertainty and requires evaluation of different concepts through time and analyses.

The business model simulator that is developed in this study fits perfectly into this framework and concept of “design attitude”. The business model simulator provides a quantitative model to evaluate different scenarios and to consider various diverse business models in order to define the most optimal.

### **Service Innovation as part of Business Model Innovation**

The increasing importance of service innovation is supported by the development and progress of information and communication services which enables innovation at different levels and customer interaction points. Furthermore, there is a shift from product oriented innovation towards service innovations, and service innovations are driven by much more than technical R&D alone, specifically with regard to information and communication technology (Bouwman *et al*, 2008).

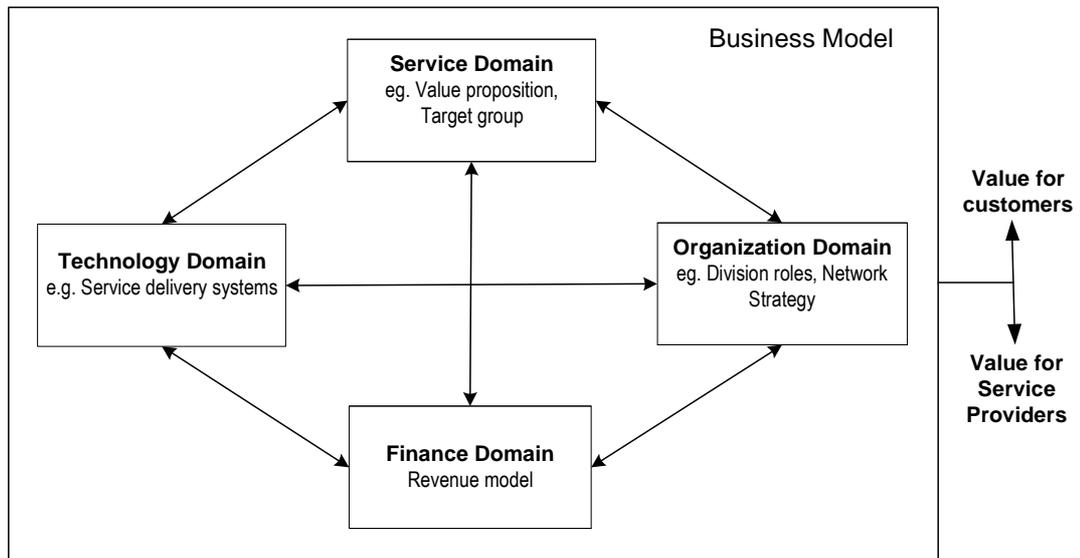
However, before service innovation can be accomplished, the underlying business models have to be attractive to all the business partners involved. A business model addresses the creation of value via service innovation and the capturing of a portion of that value by mediating between customer needs, organisational resources and capabilities, financial arrangements and technological possibilities (Bouwman *et al*, 2008).

In chapter 6 the definition of the consumer business model incorporates these principals and in chapter 9 the business model simulator provides a structured mechanism to evaluate different alternatives.

### **STOF Business Model Concept**

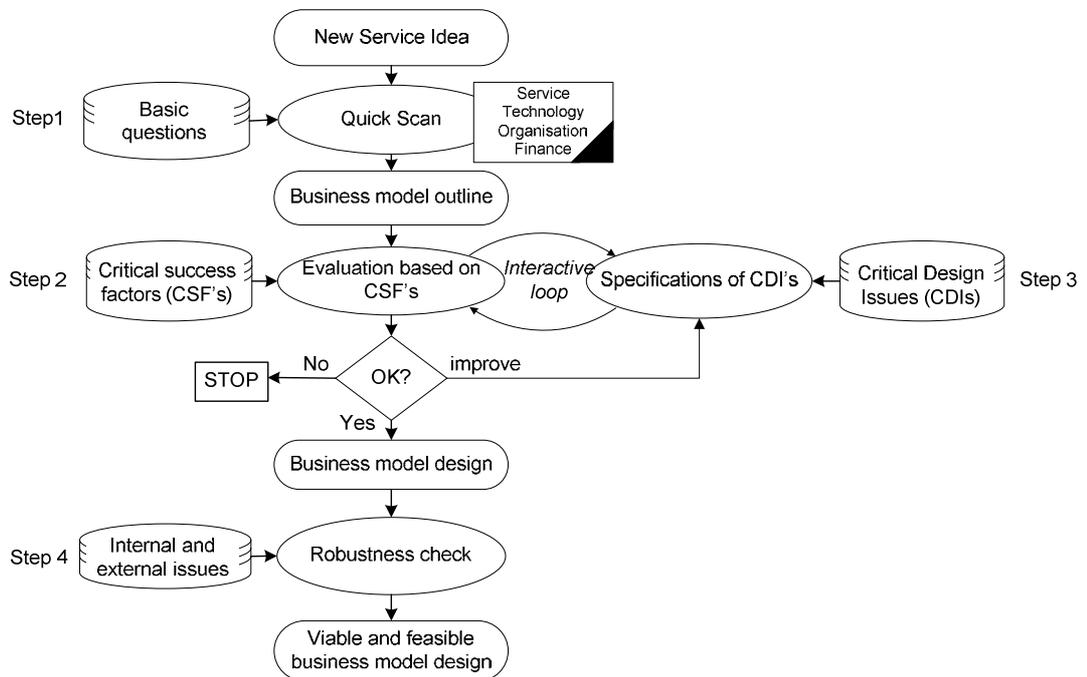
Research done by Bouwman *et al* (2008) identified a wide variety of business model concepts and definitions; they concluded that this is indicative of the lack of a common framework and continued to define their definition of a business model concept that is focused on four domains: service, technology, organisation and finance. They used the acronym “STOF” to describe their concept of a business model.

The outcome of the STOF business model framework is the value generated for customers and service organisations and its starting point is the value proposition defined in the service domain. The four business domains, i.e. Service, Technology, Organisation and Finance are shown to be interlinked and each element is further analysed in detail to identify the respective business activities and drivers (Bouwman *et al*, 2008).



**Figure 3-3: The STOF business model**  
 Source: Bouwman *et al.* 2008

**The STOF Design Process**



**Figure 3-4: STOF design process (layout modified by adding the interactive loop)**  
 Source: Bouman, de Vos & Haaker, 2008

The objective of the STOF design process is to provide a systematic approach that aids the completion of a more rigorous business design effort thereby reducing the chance of overlooking important issues and preventing market failure. It also provides a framework for continued analyses and for adaptation of the business model once the service is offered to the market.

Figure 3.4 provides an overview of the STOF process which has been adapted to show the interactive process between steps 2 and 3 in order to reach a feasible business model option. This interactive loop process is an element which is also incorporated in the “innovation-loop” business model process as defined and detailed in chapter 6.

### 3.2.3 CUSTOMISATION AND PERSONALISATION

In today’s consumer-driven society customisation and personalisation have become essential requirements for technology-based products and services. From the background colour of computer desktops to the faceplates on cell phones, consumers are now able to individualize a wide variety of ICT products and services. Devices such as iPods allow for idiosyncratic organisation of music without regard for industry-driven status markers such as album-level groupings of songs or airplay-based ratings. Various video games allow users to define the look of their Avatar and customize different aspects of game play such as difficulty levels (Sundar S.S. and Marathe S.S., 2010).

On the Internet, users can customize the kinds of information they receive by actively or passively specifying preferred sources, as well as content categories. Portals are common venues for customization (Kalyanaraman and Sundar, 2008) and offer a vast range of gate keeping options to users, from choosing the particular content categories (weather, horoscope, puzzles, sports, etc.) to specifying how to streamline content (weather in their hometown only, horoscope just for the user star sign, only mathematical puzzles, statistics only for a user’s favourite sports team, etc.) and where to get it from.

A theoretical understanding of the psychological appeal of customization is critical in the Web 2.0 media landscape, which is dominated by tools allowing users to customize their information universe. From social bookmarking sites such as Digg.com to personal broadcasting technologies such as Twitter.com, new media offers receivers unprecedented opportunities to serve as information sources and gatekeepers. Scholars have debated the pros and cons of this phenomenon for deliberative democracy, but none of it has stemmed the dramatic proliferation of customizable products in the marketplace. If anything, it has led to a “virtuous cycle”, wherein systems that offer customization deliver greater value to users by understanding their needs and continually monitoring their changing tastes and preferences at individual consumer level in order to provide even more well-honed customization (Adomavicius and Tuzhilin, 2005).

Customized offerings can be especially gratifying in a medium such as the Web, known for its staggering problem of information overload (Eppler and Mengis, 2004), because it essentially packages the net’s vast repository of evolving information for an audience of one. In fact, Kalyanaraman and Sundar (2006) have demonstrated overwhelmingly positive

attitudes toward a Web portal as a function of the degree to which it tailors content to individual users.

Customisation of web access pages on mobile phones is becoming the major differentiator in the wireless-data space (Swartz, N, 2000). According to Alltel, research shows that as the clicks customers have to go through to get to a destination on site on their phone increase, so do the chances they'll turn their phones off (Swartz, NM, 2000). For customers, the ability to customise where you want to go on the Internet first and fastest, is an important benefit and value proposition.

### **The Concept of Mass Customisation**

Sophie C.H *et al* (1999) showed that with an increasing number of serious participants, it has become possible for companies to initiate substantial and innovative business strategies surrounding the notion of electronic commerce. For example, through various network, database and flexible manufacturing applications it has become possible for firms to know each customer's individual preferences, tailor the product or service accordingly, and provide it in a timely manner at a reasonable price. Through electronic ordering and routing systems, blue jeans giant Levi can now customize blue jeans for each individual customer based on their measurement (Rifkin, 1994). Similarly, National Bicycle Inc. can manipulate 11 million variations of made-to-order bicycles according to each customer's measurement and preferences (Hiatt, 1990).

The concept described above is called "mass customisation", combining the efficiency of "mass" production and the craftsmanship of "customisation". "Mass customisation" is a strategy to produce customised goods and services with mass-production efficiency and cost (Toffler, 1970). There appears to be different approaches to achieve the "mass" and the "customisation" simultaneously; some work and others don't. For instance, companies retaining stock of every variety in order to satisfy customer orders may find inventory costs to be out of control. Turnaround time can be too lengthy causing loss of sales and customer dissatisfaction. Producing new varieties without long-term testing makes quality assurance difficult. Providing too many unimportant options only confuses customers and do not result in a serious sales boost.

### **User Benefits of Mass Customisation**

Research work done for ETSI (Bartolomeo, G. *et al*, 2008), indicates the following relevant benefits of personalisation of services and device profiles from a user's point of view:

- Personalized services and devices will provide a better user experience.
- Allowing reuse of users' existing knowledge will help them to manage new terminal devices and services, thus leading to faster and easier uptake of new technologies.
- Synchronization and harmonization of profiles across services and devices allow much faster and easier use of services and devices.
- A profile that suits a specific situation and that handles many areas will only need to be defined once. The end-users will not have to re-enter their preferences each time they acquire new services and devices.

- Enhancement of emergency telecommunications, in which the user might allow emergency services to have access to useful information in their profile that would help them to provide appropriate aid to that user, is viewed as a benefit.

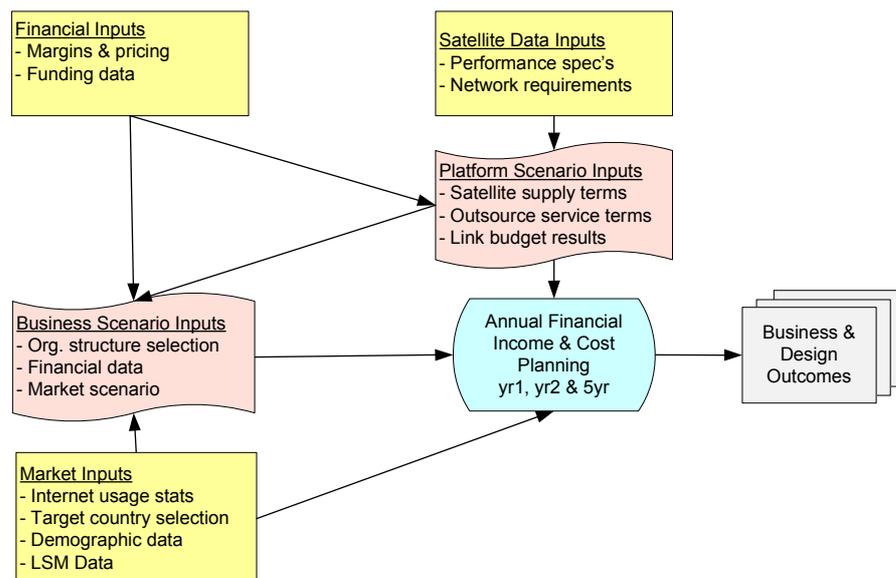
To manufacturers and service providers these profiles will be critical to the uptake and success of new and advanced communication services, especially among the larger market of the non-technically astute, or non-technically inclined. Development costs and time to volume markets will be decreased. In addition, larger user segments will be reached more easily, thereby ensuring quicker uptake of key technologies.

### 3.2.4 APPLICABLE BUSINESS MODEL DEFINITION

The application of the concept of a business model in this field of study refers to the interrelationships between technology, market, product and organisational structure. In this context a business model is defined as the specific set of technical, business and organisational decisions that transforms technology into an effective and successful (or not) business.

Within this definition of a business model, the system design, product definition and organisational structures are integrated through a complex web of interrelationships and each aspect has an influence on the outcome of the other. Different business strategies and different design decisions will lead to very different cost and funding outcome requirements.

In order to evaluate different possible scenarios and decisions, management need to be able to quantify and estimate the different possible outcomes and the effects they will have, for example the impact that a change in satellite will have on price of a broadband Internet product. These interrelationships are referred to as the applicable business model that will be captured in the business model simulator as described in detail in Chapter 9 and that is summarized below.

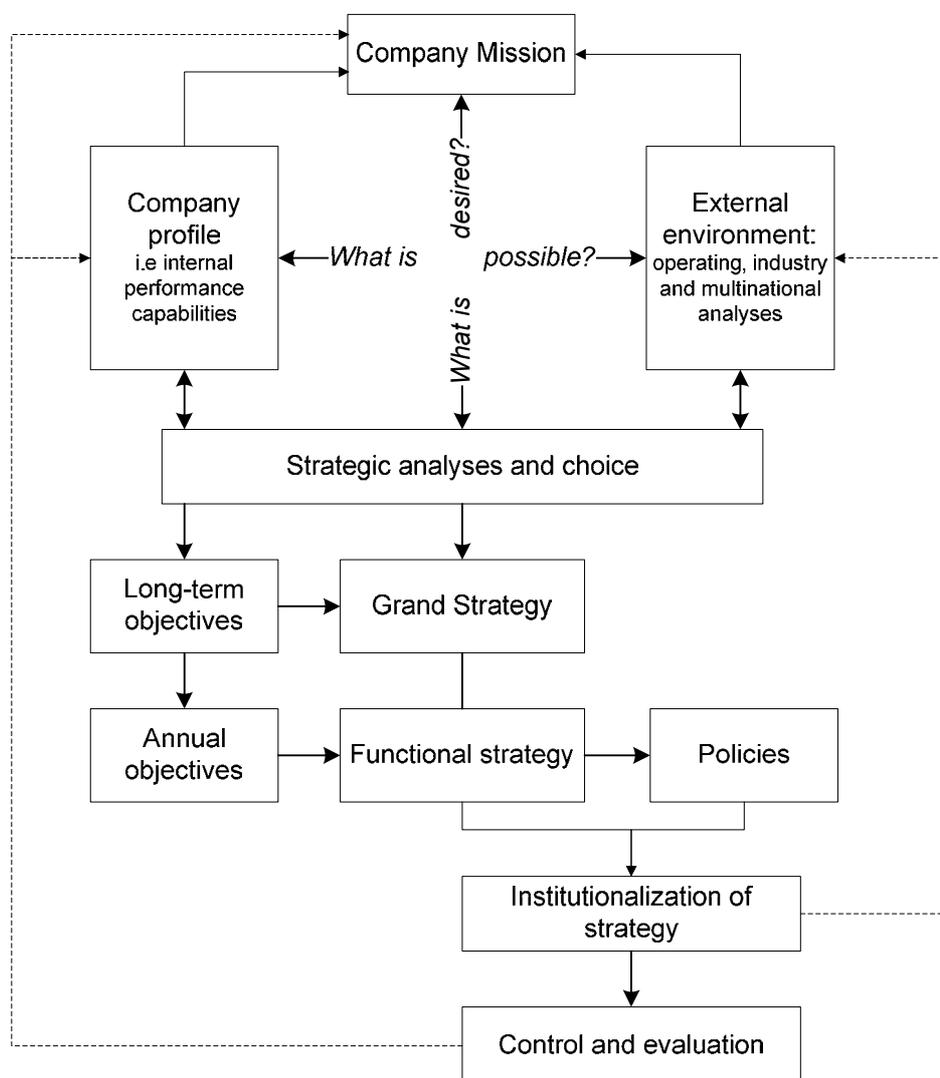


**Figure 3-5: Simplified concept of a business model simulator for a satellite ISP business**

### 3.3 STRATEGY & INNOVATION MANAGEMENT

#### 3.3.1 STRATEGIC MANAGEMENT FRAMEWORK

Pearce and Robinson (Pearce and Robinson, 1988) focused on development of a strategic management model that incorporates all aspects of a business. They define strategic management as “the set of decisions and actions resulting in the formulation and implementation of strategies designed to achieve the objectives of the organisation” and by strategy they mean “large-scale future-oriented plans for interacting with the competitive environment to optimise the achievement of the organisation objectives” (Pearce and Robinson, 1988).



**Figure 3-6: Strategic management model**  
 Source: Pearce & Robinson 1988

Pearce and Robinson also points out that the model can be seen as providing a prescription for completion of strategic planning and they underline that it must be considered as a framework and not a step-by-step plan.

In chapter 6 we develop a business model that incorporates strategic uncertainty and we continue in chapter 9 to develop a business model simulator with the specific focus to evaluate different strategic scenarios. This business model simulator enables management to review various strategic options and to complete the strategic management process with quantified data and scenario results.

### 3.3.2 STRATEGY AND INNOVATION PROCESSES

#### Strategy Formulation Process

The processes for business model development and strategy formulation has been widely discussed before in literature and various conceptual models have been documented (Mitchell D. and Coles C., 2003 and others). The integration of the current reality with future possibilities and suitable business model structures are discussed by Ungerer (2007). His model (refer figure 3.7) provides an overview of the relationship between the different elements as a framework for more detailed work.

Ungerer does not address the specific possibilities and implications that technology adds to the strategy development process and proposes a model for generic business application. His model put in context the relationship between the business model and the business strategy.

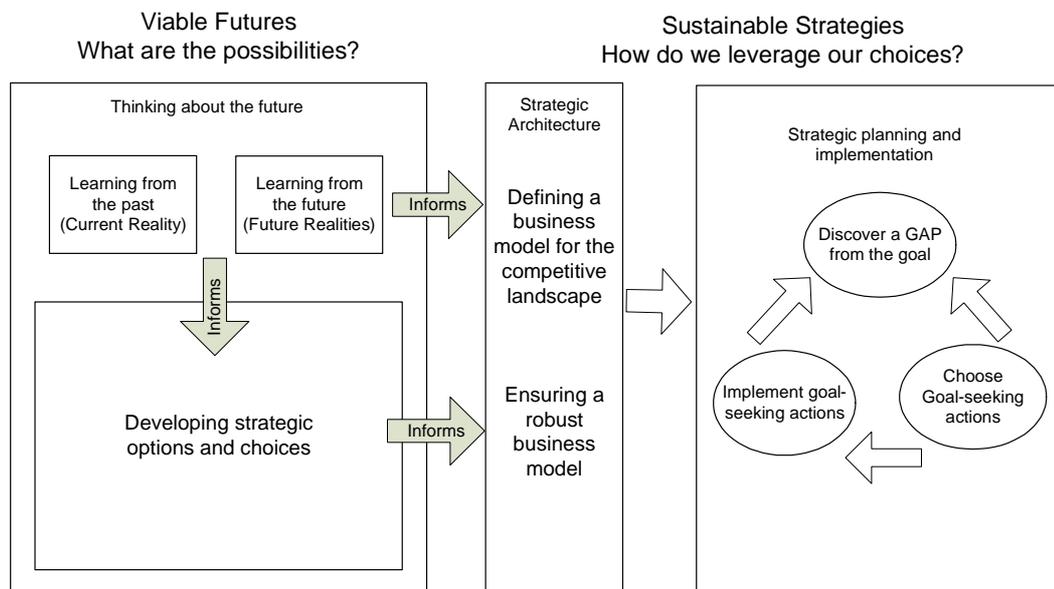
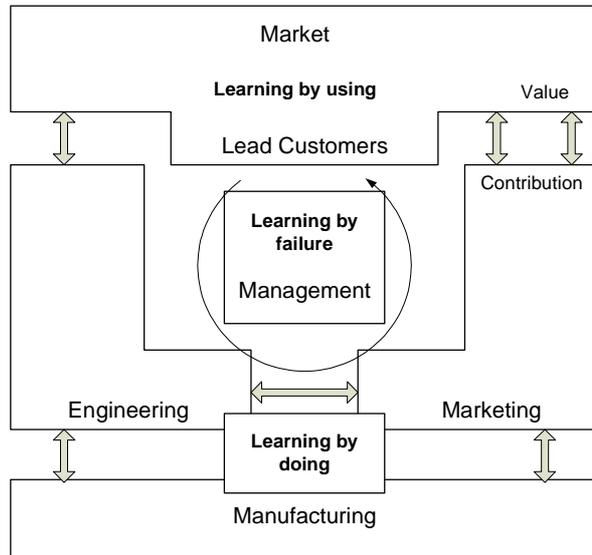


Figure 3-7: Business Strategy Process as defined by Ungerer (2007).

## Product Development and Innovation Process

Burgelman *et al* (1996) describes a technology innovation process that is captured in the development process for new products using seven different factors, i.e. the market, lead customers, value offer to the customers, engineering, management, marketing and manufacture.



The interdependent relationships among these different factors are depicted in figure 3.8 and show the various relationships. Burgelman *et al* (1996), argues that the innovation process is a constant struggle between the forces of change and the status quo.

Differences in perceptions between the innovator and the customer and also between the groups that make the building blocks of the innovation process – engineering, marketing and manufacturing – all conspire to shunt the new product development or to

deflect it from the path of success.

**Figure 3-8: Product development and innovation process (Burgelman *et al* (1996), p 701)**

Effective management attempts to integrate these constituencies and to allocate resources in a way that makes the new possible.

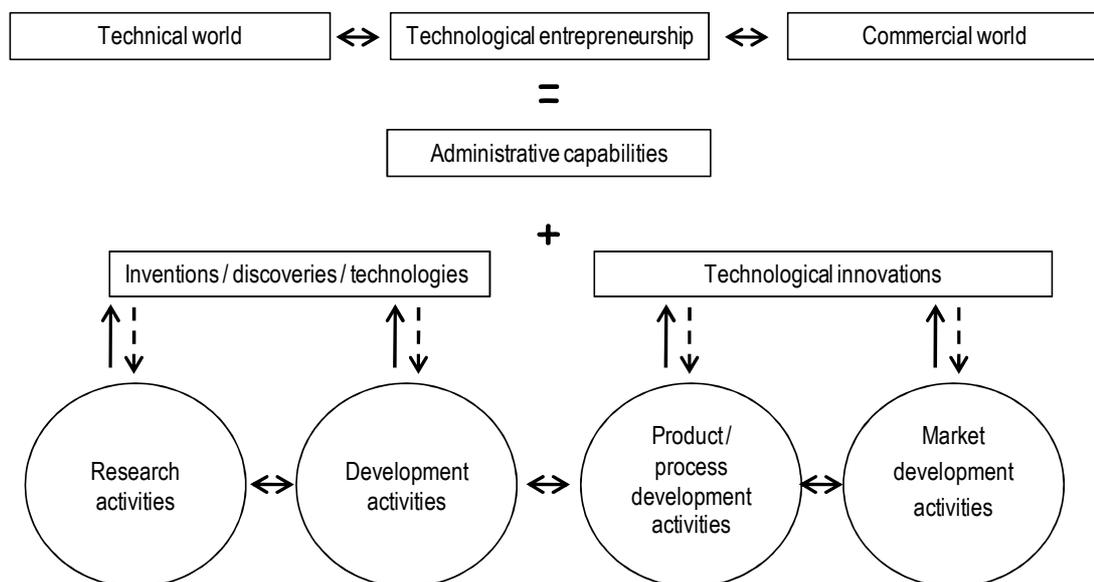
This process provides insight into the nature of the innovation process, i.e. the conflict between different business elements and the iterative nature of the process (Burgelman *et al*, 1996). It does not include detail of the different processes nor does it provide visibility of the internal and external environments.

Combining the concept of an iterative innovation process that integrates different elements (Burgelman *et al*, 1996) with the strategic business model relationships (Ungerer, 2007) and adding the market, technology and product development processes we define the “Innovation-loop” process as described below in Section 6.5.

### 3.3.3 STRATEGIC MANAGEMENT OF TECHNOLOGY AND INNOVATION

#### The role of Leadership

A variety of concepts, tools, perspectives and roles are important and useful to the management of technology, strategy and innovation. According to Burgelman *et al* (1996) it is the leadership of general managers that is the critical element to ensure success of these endeavours. In their opinion, although much can be done to assist general managers with the strategic tasks nothing can substitute or replace their leadership. Figure 3.9 provides an overview of the relationships between the key concepts concerning technological innovation and management leadership.



**Figure 3-9: The relationship between key concepts concerning technological innovation**  
 Source: Burgelman *et al*.

#### Technology Strategy, Value Chain and Competitive Advantage

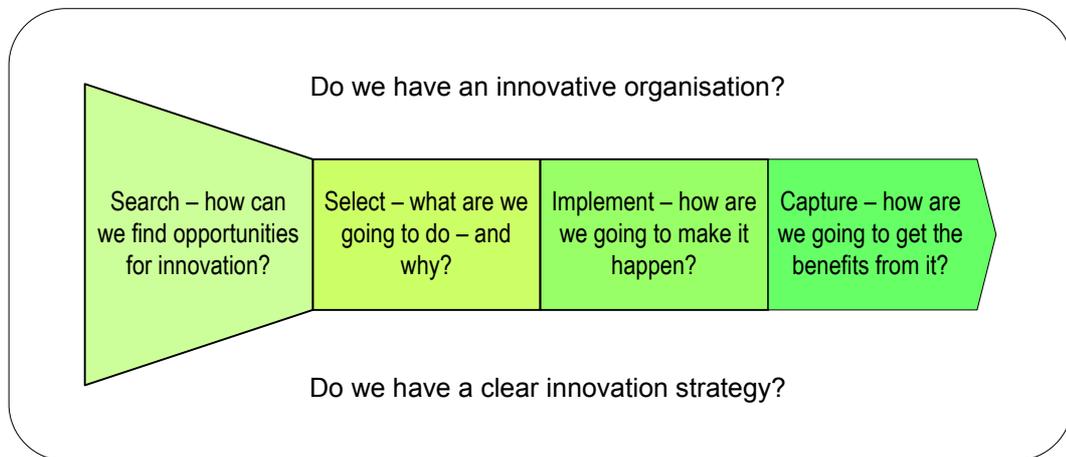
Technological change is one of the principal drivers of competition. It is a great equalizer, eroding the competitive advantage of even well-entrenched firms and propelling new players to the forefront. Porter (1985) suggests the following sequence of analytical steps in formulating a technological strategy that is integrated with the business value chain:

- a. Identify all the distinct technologies and sub-technologies in the value chain.
- b. Identify potentially relevant technologies in other industries or under scientific development.
- c. Determine the likely path of change of key technologies.
- d. Determine which technologies and potential technological changes are most significant for competitive advantage and industry structure.

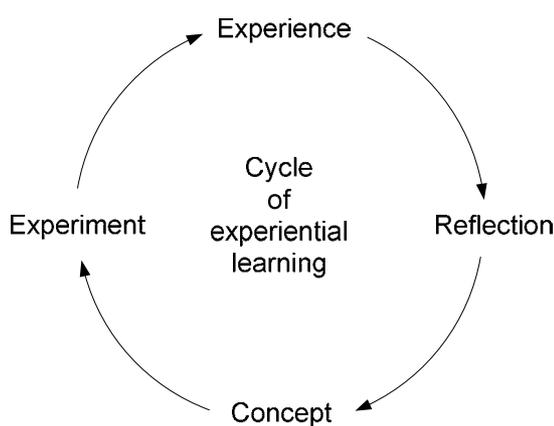
- e. Assess a firm’s relative capabilities in important technologies and the cost of making improvements.
- f. Select a technology strategy, encompassing all important technologies, that reinforces the firm’s overall competitive strategy.

### Managing Innovation

In order to manage innovation with the objective to establish a sustainable competitive advantage it is required to develop two dimensions of learning, as pointed out by Tidd and Bessant (2009): firstly the acquisition of new knowledge in applicable fields such as technology, market, regulatory and competitive landscape and secondly the knowledge about the innovation process itself. In order to develop an “innovation capability” the innovation process (see Figure 3.10) provides a framework for developing the routines and behavior required.



**Figure 3-10: Simplified model of the innovation management process**  
 Source: Tidd & Bessant, 2009



The concept of a step-by-step process framework might create the perception that innovation is a linear process that can be completed by starting at the beginning and continuing until the end. However, this is not the case; Tidd & Bessant (2009) points out that it is a learning loop process which is executed in an “adaptive” learning system which stimulates organisational growth within the changing environment.

**Figure 3-11: Kolb's cycle of experiential learning**  
 Source: Tidd & Bessant, 2009

In chapter 6 we will develop the “innovation-loop” framework that was used as a guide to develop a business model for the mass broadband consumer market. This “innovation-loop” model extends the concept of the Kolb’s cycle of experiential learning and incorporates more detailed elements and inputs into the model.

### 3.3.4 SERVICE SECTOR INNOVATION

#### **The need for Service Innovation**

Reneker (2006) completed a study titled “Research and development needs for business related services firms” that was summarized by Bouwman *et al* (2008) and who listed the following conclusions as reasons why much progress can still be made in the services innovation domain and why service innovation deserves further study attention. The following points provide a shortened version of Bouwman’s summary:

##### **Lack of service innovation strategy**

The application of specific service innovation strategies at management board level is rare and there are few formalised approaches to drive service innovation strategies. A limited number of open innovation models are used, leaving room for improved collaboration between service firms and research organisations.

##### **Lack of a formalised service innovation approach**

Service innovation is mostly funded and applied in a non-structured manner and often in dispersed activities throughout the organisation. A specific formalized service innovation initiative is the exception; most service innovation practices form part of distributed activities, such as business development and service improvement, and are hidden in client specific solutions.

##### **No specific service innovation development models**

Mostly firms apply generic management models or product development models to guide and direct service innovation efforts with none of the firms applying specific service innovation development models or tools such as service design, service blueprinting or service engineering.

##### **Weak innovation culture and learning**

Establishing an innovation-oriented culture that is in sync with and supportive of service innovation needs is seen as key to fostering a creative environment. The lack such of widespread service innovation cultures creates the need for cross-firm and cross-industry learning as well as for fundamental research in the service innovation domain.

##### **Limited leverage of innovation policies and schemes**

Most firms do not access or leverage available innovation policies and funding schemes as they find the schemes to be of limited value or hard to gain access to. They also have no internal management structure to support the systematic acquisition of funded innovation projects, or broadly supported management models for collaboration with research institutions that are active in the services innovation domain.

## Drivers for Service Innovation

Bouwman *et al* (2008) provides an overview of the research and literature work that outlines the key drivers and needs for firms to actively focus on service innovations. These points are summarized as follows:

### Consumer trends & demand growth

Demographic (e.g. aging population), socio-technical (e.g. early adoption of technology) and socio-economic (e.g. income-level, environmental) interests drive consumer trends and needs. The need for new service concepts such as self-service and community based pricing are driven by specific consumer trends such as individualism, self-chosen collectivism, cultural diversity and feminization (Idenburg, 2005).

### Technical developments

Technical developments, specifically in the field of information and communication, offer opportunities for service innovation. Technology developments such as the digitisation of information, the increased processing capacity of computer chips, miniaturisation and increased interoperability between services, security and natural interfaces enable mature architectures and platforms for knowledge sharing, collaboration, and electronic commerce transactions, anywhere, anytime (Bouman, Van den Hoof, Van de Wijngaart & Van Dijk, 2005).

### Competitive Strategies

A firm's competitive strategy impacts strongly on the corporate service innovation objectives. Service innovations that are successful can have a high impact on value creation, as is the case for Amazon and Google. However, services, like information, are easy to copy, and service innovations that are difficult to copy have to be based on technical features and unique capabilities and resources available to the firm (Bouwman *et al*, 2008).

### User driven

Service innovation is to a large extent directed towards providing a specific user experience and as such must be strongly influenced and driven by inputs from the consumer of the service. For this reason, service innovation is an interactive process that involves various actors which includes the consumers. Service innovation is about co-creation, a process of interaction between the service provider and those consumers who provide feedback, suggest alternatives or even develop their own service or content.

This specific user focused approach brings to the fore the issue of how to move from personalised services suited and defined for a specific user to services that are reusable and scalable (Bouwman *et al*, 2008).

In Chapter 7 our research study focuses on this specific aspect. The goal of the research work is to define an Internet billing model that simultaneously allows each user to select and determine the preferred cost structure for his personal Internet behaviour patterns, while at the same time enabling Internet service providers to provide a service to the mass market.

## A Service Innovation Model

Service innovation is unique in that it cannot exclusively be applied and completed in dedicated R&D environments with specialist engineering teams. It is important to look at service innovation from various perspectives (e.g. customer, service provider, technology) and to take into account that a number of disciplines (e.g. marketing, management, finance) have to contribute to understanding and supporting service innovation.

Bouwman *et al* (2008) discusses the key service innovation processes followed to date and provides a service innovation model, which is briefly summarized below.

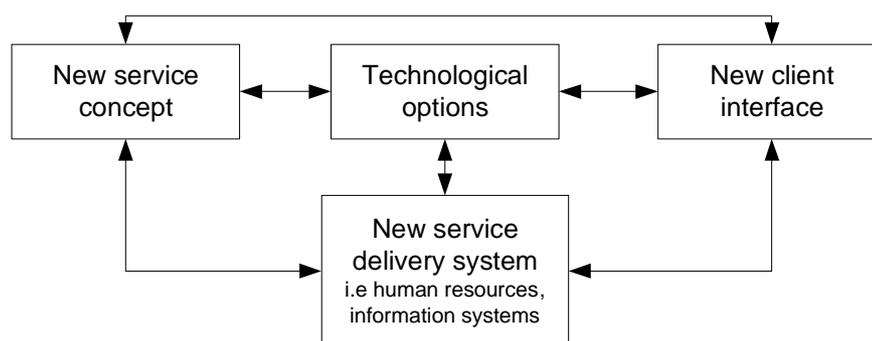
### Service Innovation Approaches

To date service innovation was driven by two approaches; one has a strong focus on the service delivery process and the other focuses on the role played by technology, specifically information and communication technology and the Internet.

For a long time an approach that on service delivery dominated the development in service innovation; this led to slow incremental changes like stores staying open longer, service quality supported by personal contact and engagement, etc. The second approach, i.e. to leverage technology, provides an option to open completely new markets and separate services from the service delivery capability of the organisation.

### Service Innovation Model

The need to develop service innovation as a holistic approach was addressed by Berry *et al* (2006) who identified nine drivers for service innovation. Den Hertog (2000) followed similar thinking and defined four dimensions that are important to service innovation: service concept, client interface, service delivery systems and technological options. This model was adapted and slightly expanded by Bouwman *et al* (2008) who added information systems as part of the service delivery aspect (refer Figure 3.12).



**Figure 3-12: Four dimensional model of service innovation**  
Source: Bouwman *et al* 2008

### **Regulatory environment as an enabler or obstacle for innovation**

Van Gorp & Middleton (2010) completed a study of the Canadian broadband market that is considered an early adopter of broadband services. Their study found that the regulatory framework still limits the potential innovation in broadband services even though the regulatory policy encourages competition from its inception.

### **Business Innovation as input to service innovation**

Mobile broadband is increasing rapidly both with respect to traffic and the number of subscriptions. The swift growth of demand will require substantial capacity expansions. Operators are challenged by the fact that revenue growth from mobile broadband is limited to just a few per cent of the average revenue per user, and is thus not compensating for declining voice revenues, creating a so called "revenue gap". Markendahl *et al* (2009) investigated these aspects and concluded that different business strategies that include cooperation both with other operators as well as with non-telecom actors can address the revenue gap. This demonstrates that innovations in the business domain can enable technical solutions to be more fully exploited.

### **Business Model Innovation: - A Prerequisite for Service Innovation**

According to Chesbrough (2003) service innovation is best supported in an open networked environment in which multiple actors collaborate in delivering innovative services, each contributing their own specific resources and capabilities. However this can only be accomplished if the underlying business models are defined and it addresses the interests and needs of all respective parties. Business models are not only relevant; they also help to design and influence feasible services.

Furthermore business models are both a potential form of innovation as well as a prerequisite to create the environment that stimulates and supports service innovation. Bouwman *et al* (2008) quotes various sources that illustrate this point and states that innovation cannot take place on the product side only, it requires organisational innovation as well as collaborating and sharing of resources between companies. The underlining business model has to be attractive to all parties, it should capture the creation of value through service innovation and also ensures resources collaborate, infrastructure is shared and all parties can share in the value chain created.

The need for business model innovation that leads to organisational structure innovation as a consequence of service innovation is also underlined in this study. The definition of a new broadcast Internet satellite access service necessitates a new business model definition as described in Chapter 6 as well as a related billing model and organisational structure innovation that are described in chapters 7 and 8 respectively.

## 3.4 ORGANISATIONAL STRUCTURE AND MANAGEMENT

### 3.4.1 ORGANISATIONAL THEORY

#### **The importance of organisation structure**

A number of writers have pointed out the importance of an organisation's structure and the relationship between it and an organisation's size, strategy, technology, environment and culture. Mintzberg (1989) has written extensively and significantly on the importance of organisational structure. Miller (1961) has explored the importance of configurations of organisational structure. Burns and Stalker (1961) concluded that if an organisation is to achieve maximum performance then its structure must fit with or match the rate of change in its environments. Handy (1990, 1993) has discussed the importance of culture in relation to organisational design and structure and the need for new organisational forms. Pascale, Milleman and Gioja (2000) state that "design is the invisible hand that brings organisations to life and life to organisations". Further, organisational structure and design are closely intertwined with the many aspects of human resource management (Mabey, Salaman & Storey, 2001). Structure therefore has a key role in the all the important human dimensions of an organisation.

#### **Organisational Categories**

Mintzberg's work classifies organisations into the following 5 different categories, each of which is centred around the five basic parts of the organisation as depicted in figure 3.12 (Mintzberg, 1983):

- The simple structure.

Typical of entrepreneurial firms combining most functions in one person. Simple structures are suited for risky and changing environments.

- The Machine Bureaucracy.

These structures have an obsession for control and the concept is applied in stable environments with no changes. It was typically applied in steel, airline and giant manufacturing industries in the 1980's.

- The Professional Bureaucracy.

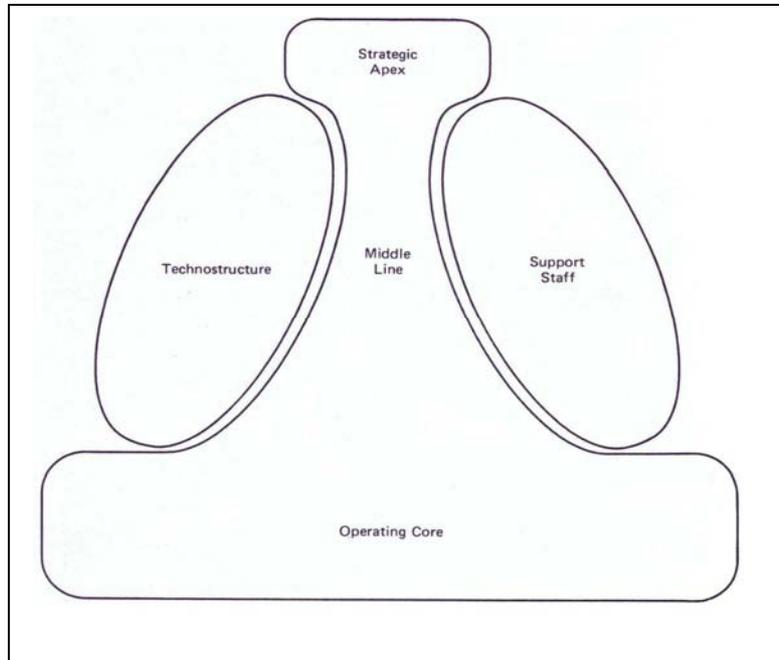
These organisations are on the standardization of skills and are commonly found amongst universities, general hospitals, school systems and public accounting firms.

- The Divisionalized Form.

Based on integration of different operating divisions, the divisionalised form of structure is employed mostly by the private sector of the industrialized economy. This structure is most suited to large organisations that service a diverse market.

- The Adhocracy.

This structure allows fusion of different experts from different disciplines into a single project team and support high innovation environments such as complex prototype manufacturing, an avant-garde film company, etc.



**Figure 3-13: The five parts of organisations.**

Source: Mintzberg, 1983

### 3.4.2 THE WHAT AND WHY OF ORGANISATIONAL ARCHITECTURE

The term "organisational architecture" emerged out of the consulting work performed by Delta Consulting and is first documented in the book, *Organisational Architecture: Designs for Changing Organisations* (Nadler et al, 1992). The concept is also explored in a *Harvard Business Review* article titled, "The CEO as Organisation Architect" (Howard, 1992) and in the book, *Discontinuous Change* (Nadler et al, 1995).

Organisational architecture covers more than a typical reorganisation, restructuring, reengineering or strategic planning initiative. It involves the creation and ongoing management of a framework for the "organisation of the future" that encompasses *all* formal and informal systems and structures as well as their inherent interactions. This framework guides continual, fundamental organisation-wide transformation and enables both a content (what) and process (how) focus on large-scale change. Large-scale organisational change is a lasting change in the character of the organisation that significantly alters its performance (Beckhard and Pritchard, 1992).

Most architecture that exists today has been unconsciously put together in a haphazard fashion over the lifespan of the organisation. Thus, initiatives conflict with each other in terms of goals and priorities, the same terms are inconsistently defined, and organisational

direction appears fragmented and un. It is as though we have been given many jigsaw puzzle pieces to assemble, but in the process of putting them together we discover that the pieces are from different jigsaw puzzles. In addition, change initiatives implemented under the guise of total quality management, reengineering, or strategic planning are not as successful as anticipated, because the underlying culture is not addressed or fundamentally altered to align with them.

The goal of organisational architecture is to create organisations that provide on-going value to current and future customers while, at the same time, they optimize the performance of, and align, all aspects of the system.

In this context, the organisational system includes suppliers, the organisation, its distribution systems, its customers, and the external environment within which these elements interact on a regular basis. To proactively, rather than reactively, respond to internal and external environmental forces requires today's organisations to be more agile than ever before. Without mechanisms in place to continually transform, organisations tend to operate in crisis mode. Operating from this mentality over long periods of time can cause high turnover, low morale, increased stress, and inefficient work processes. In addition, downsizing may be seen as the only option for addressing increasing costs and loss of market.

### **3.4.3 STRUCTURE FOLLOWS STRATEGY**

The historian Alfred Chandler based his 'Structure follows Strategy' thesis on four case studies of American conglomerates that dominated their industries from the 1920's onward. Chandler's thesis argued that new organisational forms are no more than a derivative of strategy as he defined it (Chandler 1962).

Further research argued that Chandler's thesis is oversimplified and that the relation between structure and strategy is not necessarily one dimensional. Mintzberg argued that the current organisational form can also be regarded as constraining strategic change (Mintzberg, H., 1983). Current views such as Pettigrew's hold that structure and strategy are to be regarded as equal to one another and Rumelt concluded that structure also followed fashion.

Even with the further development from Chandler's work and the consequent variations of the concept, the principle remains valid to a large extent. When developing a new product for a new market the core strategy will still be fundamental to the definition of the organisational structure.

#### 3.4.4 ORGANISATIONAL STRUCTURES IN VERTICAL MARKETS

The influence of organisational structure on business processes and deliverables are widely commented on in the literature.

According to Kirchner (Kirchner, 1996) symbiotic arrangements do not fit into the traditional pattern of antitrust law. Vertical distribution agreements, exclusive sales and buying agreements, franchise agreements and others may have positive effects on the level of interbrand competition, but negative effects on the level of intrabrand competition. In this case interbrand competition refers to the competition between different brands for the same product, e.g. Coca-Cola versus Pepsi and intrabrand competition refers to competition of the same brand sold by different channels, e.g. Levi jeans sold at a lower price in a discount store as compared to a department store.

Neither German nor European antitrust law have developed a consistent concept to deal with symbiotic agreements. Kirchner (1996) criticizes the present German and European approach and comes to the conclusion that the relevant issues are creation or strengthening of a dominant market position and/or the foreclosure of the market by increasing market entry barriers.

Cooperation between different players implies the sharing of ideas – such ideas may be stolen without compensation, which exposes the participants to risk. On the other hand the crossing of ideas between companies enhances the rate of innovation and creates symbiotic relationships between firms (Hellmann, 2006).

In a competitive environment telecommunication firms have an incentive to cooperate or to collude. This may have implications for regulatory policies to ensure competition in a fair and efficient manner, while at the same time providing sufficient incentives for competitors. Collaboration can induce increase in joint profits through improved efficiencies, as well as lower tariffs and lower prices to consumers. Collusion will tend to increase profits by increasing tariffs and prices to consumers. Efficiency in telecommunications will be enhanced by increase in competition (Massimo, 1998).

The process of liberalization and privatization drastically influenced the relationships between players in the telecommunications industry. Under symbiotic production conditions there may be a combination of vertical mergers and unintegrated carriers. Competition will have an impact of the way that profits are shared, as determined by market prices, intermediate tariffs and market dimensions. In general, vertical integration and horizontal competition tends to lower final prices (Cricelli, 1999).

In terms of the theory of economic behaviour people may be tempted to exploit cooperation in their own interest in the short term, which will tend to break down the cooperation. In practice however such cooperation between individuals or organisations in fact tends to persist in the long run because of the costs involved in duplicating the skills of the other parties to the cooperation (Amann, 1998).

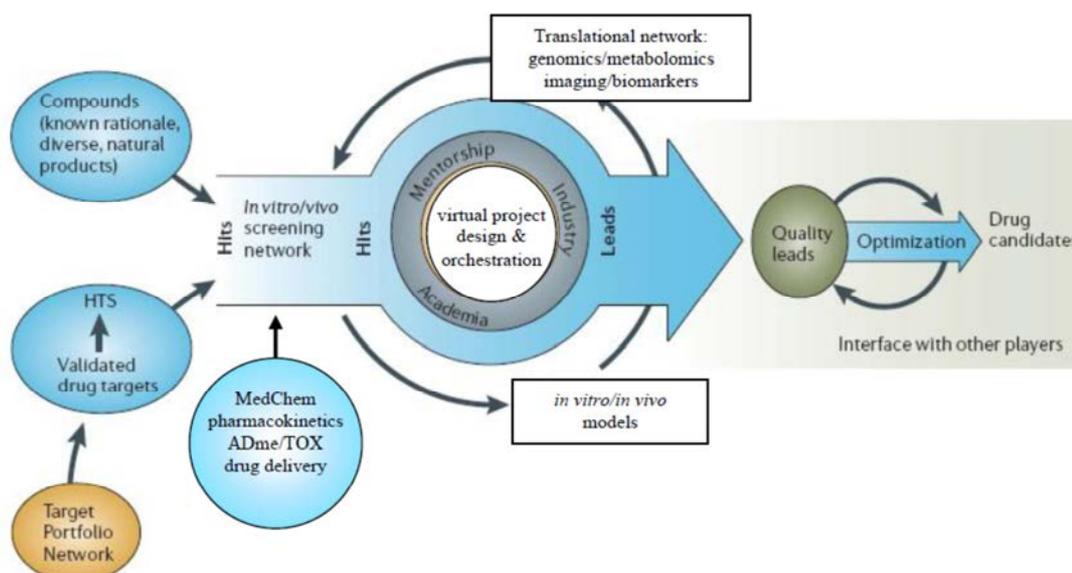
### 3.4.5 SYMBIOTIC STRUCTURES

#### Symbiotic Innovation: A Case Study

The InnVentis Symbiotic Innovation project is a modular web-based drug discovery concept for optimized value generation in academia-industry competence networks and collaborations (Wilckens & Shepard, 2010). The InnVentis project provides a positive reference of how a symbiotic structure can create more value than a simplistic organisational or project structure. It also indicated that this type of structure requires specific attention to clear communication and the definition of mutual roles and objectives in order to coordinate and harness joint activities.

Today drug discovery organisations are facing an increasing amount of data and opportunities combined with a wealth of technologies that are needed sequentially or in parallel to deliver a product to the market. The increasing complexity results in the need for more effective organisational structures to enable informed decision-making at the highest level of confidence; i.e. efficient exploitation of existing resources requires matrix networks that allow *collective learning*.

Current institutional and industrial organisations cannot generate the symbiotic and synergistic anatomies to address these complex challenges, since they evolved under another drug discovery paradigm. Thus, novel models must be explored, that in the long run replace existing models. InnVentis was designed as an explorative field study with the goal to identify and address key obstacles in creating novel and more efficient organisational structures to create value from science. InnVentis found that virtual concepts using existing resources, combined with the knowledge of leaders in their fields, are the only way to ensure high quality data, reduce the risk of failure and reduce or limit costs. The following figure summarizes the virtual business and cooperation model in a symbiotic engagement project.



**Figure 3-14: Diagram of Symbiotic Innovation concept in the pharmaceutical industry.**

Source: Wilckens & Shepard, 2010

## **Symbiotic Ownership**

Scholars have long recognized that “resource owners increase productivity through cooperative specialization” (Alchian & Demsetz, 1972, p. 777). Based on the work of Pfeffer and Nowak (1976), we define symbiotic ownership as the mutually beneficial joint ownership of joint-venture firms established by investors from different industries. As mentioned above, this type of ownership widely exists today among multinational enterprises involved in international expansion.

According to the resource-dependence perspective (RDP) developed by Pfeffer and Nowak (1976) and by Pfeffer and Salancik (1978), business organizations establish symbiotic ownership mainly for managing their resource interdependence with other organizations. In other words, this type of ownership is used to stabilize inter-firm interdependency and to reduce resource uncertainty.

Consistent with the construct of symbiotic ownership, Pfeffer and Salancik (1976, 1978) have distinguished between two types of inter-firm dependence: competitive interdependence and symbiotic interdependence. The former refers to interdependence between or among partners from the same industry and the latter to interdependence between or among partners from different industries. When a firm establishes a strategic alliance with symbiotic ownership, such as an equity joint venture with firms from other industries, it is mainly in response to their symbiotic interdependence (Pfeffer & Nowak, 1976), which has been suggested to be able to help improve their performance in international markets.

The above definition of symbiotic ownership refers to a joint venture type organisation structure with shareholding by two or more firms. In this study we develop a model whereby the symbiotic structure is implemented through mutual contracting of complementary value offers from players operating at different levels in the same industry and not through mutual equity in the same company.

### **3.4.6 BROADBAND ORGANISATIONAL STRUCTURE DEFINITION**

The organisational structure and management background provided in this section provides a reference for the definition of an optimal business model for providing broadband services to the emerging Africa market. The optimum organisational structure will harness the resources needed to develop and service such a big market while at the same time limiting the risk and funding requirements.

In Chapter 8 we define the specific symbiotic organisation structure to provide broadband service to the emerging market and apply the business model simulator that is described in Chapter 9 to show that the symbiotic organisational structure offers the optimum balance between resources, capabilities and funding requirements.

### 3.5 PRICING & BILLING MODELS

The commercial and practical realities of Internet access services create an environment where pricing policies and principles cannot be readily changed and tested. The possible impact on customer services and service reputation of the ISP's prevent business development teams from experimenting freely with pricing models in practical scenarios.

This has led to extensive efforts in the academic environment to model and simulate pricing structures and to determine possible effects through mathematical modelling (refer table 3.1 below for a summary of studies conducted). The literature review conducted for this research work shows that from early 2000 to 2008 various mathematical models were developed in the academic environment, yet industry did not pay much attention to these and continued to implement mostly a simplistic billing model based on access speed of the connection to the Internet as well as the maximum allowed data capacity.

Paper	Description	Demand function	Interpretation
Hou, J <i>et al.</i> 2002	Congestion control based on pricing in hard-capacity cellular networks	$D = e^{-(p/p_0-1)^2}$	Demand in terms of percentage of user ( $D$ ) who will accept price $p$ given normal price $p_0$
Wang, Q. <i>et al.</i> 2007	Network pricing and admission control for public safety and commercial services	$D = k_1 - k_2p$	User demand in terms of arrival rate ( $D$ ) is a linear function of price with parameters $k_1$ and $k_2$
Lee, J.W <i>et al.</i> 2005.	Utility maximization-based power allocation in CDMA wireless networks	$D = \max_q (U(q) - pq)$	Power demand ( $D$ ) is a solution of transmit power $q$ based on net utility maximization, where $U(\cdot)$ is a utility function of SIR $q$
Badia, L. <i>et al.</i> 2006	Revenue maximization in multimedia WLANs	$D = 1 - e^{-kum/pn}$	User demand ( $D$ ) to accept a service is a function of rate utility $u$ and price $p$ , where $k$ , $m$ , and $n$ are model parameters
Saraydar, C.U. <i>et al.</i> 2001	Non-cooperative game formulation for distributed power control and pricing in CDMA networks	$D = \max_q U(\mathbf{q}) - pq$	Transmit power demand ( $D$ ) is a solution of net utility maximization, where $U$ is the utility function of transmit power vector $\mathbf{q}$
Sun, J. <i>et al.</i> 2006	Wireless channel allocation based on second-price auction algorithm.	$D_i = E(X_i   p_i)$	Payoff or throughput demand ( $D_i$ ) depends on expected channel quality $X_i$ and is a function of all prices
Gandhi, S <i>et al.</i> 2007	General framework for wireless spectrum auction	Piecewise linear price-demand (e.g., $D = (B - pi)/A$ )	Spectrum demand ( $D$ ) is a linear function of price $pi$
Xing, Y. <i>et al.</i> 2007	Pricing in competitive spectrum market with multiple sellers	$U = \alpha(q - q') + (1 - \alpha)(p' - p)$	A user demands spectrum if utility $U$ is maximized where $q$ and $p$ denote the quality and price whose lower bound and upper bound are $q'$ and $p'$ , respectively; $\alpha$ is a model parameter which lies between 0 and 1
Zhang 2005	Bearer service allocation and pricing in heterogeneous wireless networks	$D = Ap^{-\alpha}$	Bandwidth demand $D$ is controlled by price elasticity $\alpha$ and demand potential $A$
Chan, H. <i>et al.</i> 2005	Utility-based network selection for heterogeneous wireless networks	$D = \max_r N(U(r) - pr)$	Bandwidth demand $D$ is a solution $r$ of user revenue maximization gained from utility function $U(r)$ under $N$ active users

**Table 3-1: Summary of pricing model references.**

### 3.5.1 MATHEMATICAL PRICING MODELS

#### Criteria Influencing Pricing for Wireless Access Networks

Consolidating the different approaches to mathematical modelling Niyato (Niyato, D. 2008) concludes that to design a pricing model for a heterogeneous access network, the following issues must be considered:

##### **Heterogeneity of access**

The capacity, coverage area, frequency band of operation (e.g. licensed or unlicensed band), and the quality of service (QoS) provisioning mechanisms are different for different wireless access systems.

##### **Competition among multiple service providers**

The different access networks are operated by different service providers, and each of the service providers wants to maximize its revenue.

##### **Inequality in service offering**

Inequality in service offering by the different wireless access networks may arise due to several reasons (e.g., different coverage area, data rate, and mobility support).

##### **Service substitutability**

Wireless services from the different access networks may not be perfectly substitutable. This may be due to some of the mobile terminals not being equipped with all of the radio interfaces supported in the system. Also, for better energy conservation, some users may prefer short-range wireless access to long-range wireless access.

##### **Vertical hand-off**

The connection of a mobile user can be handed over vertically between different types of networks, for example, from a WiFi network to a WiMAX network when a user moves out of a WiFi cell. In this case, a pricing scheme must be developed by considering the possibility of vertical hand-off.

#### Approaches to develop Pricing Models

The following three different approaches, namely auction, optimization, and demand/supply-based schemes have been used for developing pricing models for heterogeneous wireless networks:

##### **Auction-based scheme**

In an article by Sallent *et al* (2006), a user periodically bids for the radio resource by informing the service provider of the price and the QoS requirement. The service provider then makes a decision on resource allocation that maximizes its revenue. In this multi-unit sealed-bid auction, a manager agent facilitates negotiation between a mobile user and a service provider. This model has not yet been evaluated in an active deployment situation.

#### **Optimization-based scheme**

In Chan, H. *et al* (2005) a service allocation and pricing method based on optimization was proposed for a heterogeneous wireless network consisting of WLAN, universal mobile telecommunications system (UMTS), and global system for mobile communications (GSM) networks. The capacity of the system was optimally allocated to different service types (e.g., voice and data). The objective was to maximize the revenue of a service provider (and hence network utilization) under the capacity constraint of each of the access networks.

#### **Demand/supply-based scheme**

In Chan, H. *et al* (2005), a resource allocation framework was proposed for heterogeneous wireless networks, based on the concept of demand/supply in microeconomics. The supply function was obtained by solving an optimization formulation to maximize the revenue of a service provider, whereas the demand function was obtained by solving a utility maximization problem for a user. The equilibrium was defined as the price at which demand equals supply. Based on this equilibrium price, network selection and admission control methods were developed.

### 3.5.2 THE PARIS METRO PRICING (PMP) MODEL

#### **Definition of Paris Metro Pricing**

About twenty years ago, Odlyzko (Odlyzko, A., 2000) proposed an intriguing way to use the flat-rate pricing to better satisfy users with different aversion to effects of congestion, known as *Paris Metro Pricing* (PMP) (Paris Metro Pricing for the Internet, 1999). The scheme is inspired by the following convention used by Paris metro at one time: The 1st and 2<sup>nd</sup> class cars are charged different prices, although physically the cars are the same (in terms of the number and quality of the seats). Since fewer people would pay more for the 1st class fare, it is also less congested. Thus, users more concerned about getting a seat can opt for 1st class, and more cost-conscious users can opt for 2nd class.

Up until now, PMP has not seen wide adoption in communication and service networks. Implementation issues could be a reason. But the most fundamental theoretical question for the viability of PMP has also not been settled. That is *whether PMP will increase the social welfare and service provider profit compared to flat-rate pricing*. There is in fact some confusion due to conflicting conclusions in answering this question.

Although Gibbens, R., (2000) and Jain, R., (2001) found Paris Metro Pricing to be viable; based on a similar model Ross and Tuffin (2004) found that PMP may not be more viable than flat-rate pricing. It turns out that the answer depends on the nature of the congestion external to the underlying communication and service network.

### **Viability of Paris Metro Pricing**

Based on a general model of congestion externality Chau, Chi-Kin (2010), provides proof of two conditions under which the Paris Metro Pricing can be applied to the benefit of both the end-user and the ISP.

#### **Network Multiplexing**

In this incident the ISP's Internet access network either prefers multiplexing (having more people share proportionally more capacity), or not; if the ISP wants to guarantee a gain (in terms of profit or social welfare) by dividing the network into multiple classes with different prices, then the network should employ different access rules to the users and should be based on multiplexing.

#### **Multi-Class System Criteria**

The second realisation indicates that, if the ISP starts with a multi-class network, offering different service profiles to users with the same price and then wants to move to charging different prices, the service classes the ISP set up should generate monotonic preferences among users.

### **3.5.3 RESPONSIVE PRICING MODEL**

#### **Definition of Responsive Pricing Model**

The responsive pricing concept describes a dynamic price-setting strategy imposed by an ISP. Responsive pricing is based on the assumption that users are adaptive and respond to price signals (Cocchi, R. *et al*, 1993).

In the case of high network utilization, resources are stressed and the ISP increases the price for the resources. Adaptive users then reduce the traffic offered to the network. Similarly, in the case of low network utilization, the ISP decreases the price and adaptive users increase their offered traffic. In this scheme, both network and economic efficiency are increased.

#### **Responsive Pricing as a Model for Internet Access Services**

The problem of eliminating congestion via a proper bandwidth assignment, considering the capacity constraint in a communication network, has lately been the focus of many research efforts. The concept of responsive pricing was proposed with the aim to incorporate feedback generated by the network (MacKie-Mason and Murphy, 1997). In Chod and Rudi, (2005) responsive pricing with resource flexibility was considered. They describe the effects of demand variability and correlation assuming a normally distributed demand curve. In Ninan and Devetsikiotis, (2005) a model for incorporating pricing in next generation networks with users sharing bandwidth under a fixed charge per bandwidth is presented. Optimal resource allocation of next generation network services under a flat pricing scheme and quality-of-services (QoS) policies were considered by Kallitis (2007).

Using mathematical modelling Radonjic & Acimovic-Raspopovic (2009) showed congestion can be alleviated by a usage based scheme with users getting charged for the amount of traffic they consume. Users' preferences may be modelled through utility functions, which describe users' sensitivity to changes in QoS and price. Utility can be expressed as the amount of money each user is willing to pay for certain QoS guarantees.

The important advantage of the responsive pricing model for Internet access services is that it ensures a high level of network utilization. It is achieved by congestion control and traffic management. The advantage is also the incentive offered to each user to choose the level of service to be charged for. At the same time the ISP considers users' preferences regarding QoS.

#### 3.5.4 FREE INTERNET ACCESS

Since 1998 an increasing number of European Internet Service Providers (ISP's) have been offering their services – the access to the global network for consumers through their hardware and software technologies – free of charge (Fioramanti, 2004). The question then is: why does a profit maximizing operator practise this pricing policy? This behaviour is sensible because the Telephone Operator (TO) gives part of his revenue, resulting from clients' calls to the ISP's Point of Presence (PoP), to the latter.

The theoretical background for free access lies in the fact that, when a consumer wants to surf on the Net, he must pay a two-part tariff  $t + p x_i$ , where  $t$  is the fixed part paid for the access service to the ISP, and  $p$  is the quantity-dependent ( $x_i$ ) part the Telephone Operator receives for the connection service between the consumer and the ISP's PoP. Since the two services are complementary, the price of the former limits the demand for the latter.

Haan (2001) shows that, in a two sided monopoly with predetermined demand in which both the ISP and the TO fix their prices proportionally to the quantity, the free-access equilibrium could emerge. The game scheme is a price competition *a la* Stackelberg, where the TO is the leader and the ISP is the follower. In such a game the TO offers a "take-it-or-leave-it" lump-sum contract to the ISP if the latter sets his price – the access price – to zero. At the same time, the TO sets the connection price in order to maximize his modified profit function, that accounts for the lump-sum disbursement.

Free Access pricing policy can thus only be considered for Internet access services that incorporate a fixed line access price element, as well as, an ISP access element. For internet access services using 3G GSM, wireless or satellite access services this model cannot be considered since the role of the Telephone Operator is not duplicated by the satellite or wireless access providers.

### 3.5.5 PRICING AND AFFORDABILITY OF MOBILE SERVICES IN AFRICA

Although the above rationale is generally correct it may be questionable when considering the mass adoption of mobile services in Africa. Call charges for mobile services on a per-minute basis are indeed high and cannot be considered as “low-cost” services, yet this has not deterred the market from rapidly adopting this service.

What is of importance is that mobile services are offered in small denominations available on a “pre-pay” basis to the end-user which results in the product being within the reach of each limited budget. This enables each user to have access to the technology and receive messages and calls while making a very limited number of calls. By changing the billing model that incoming calls and messages are charged to the called and not the calling party, the mobile network operators have changed the affordability index of the service while at the same time preventing a decrease in the actual service charges (Knott-Graig, 2009).

### 3.5.6 PRICING FOR BROADBAND SERVICES

Research done in the USA (Flamm, 2007) has questioned the presumption that, just because high prices for broadband co-exist with low penetration rates the latter is primarily caused by the former. Continued research provided evidence that this is indeed the case, i.e. that broadband pricing is indeed a statistically significant driver of broadband demand.

This perspective confirms that the absolute service charge is not the only determinant of market product acceptance, but rather the complete package that is offered. Per-unit charges may still be high enough to motivate network investment that is critical for deployment of services, while the minimum denominations can be small to keep the service affordable.

### 3.5.7 QUANTIFICATION OF MARKET DEMAND CURVES

When considering the adoption of new services and technologies within the emerging Africa market, the general point of departure is that low-cost services will ensure mass adoption, while higher priced services will not be able to penetrate the mass market. This objective needs further consideration, before we can conclude that lower service price ensures mass market adoption.

#### **Mathematical Pricing Models**

Several earlier studies investigated the relationship between service price and market demand in the domain of telecommunication services (see Appendix C for a summary of formulas proposed for the relationship between market demand and service price). Hou, J. *et al* (2002) investigated congestion control based on pricing in hard-capacity cellular networks. They proposed an exponentially decreasing relationship between the percentages of users ( $D$ ) who will accept price  $p$  given normal price  $p_0$ .

Wang, Q. *et al* (2007) proposed a linearly decreasing relationship between demand and price for public safety and commercial services, which may be applied to network pricing. Lee, J.W *et al* (2005) and Saraydar, C.U. *et al* (2001) studied utility maximization-based power allocation in CDMA wireless networks, and found that power demand is a solution of transmit power based on net utility maximization.

In their investigation into revenue maximization in multimedia WLANs Badia, L. *et al* (2006) arrived at an exponentially decreasing relationship between user demand ( $D$ ) to accept a service as function of rate utility  $u$  and price  $p$ , using model parameters to fit the relationship to empirical data. In their study of wireless channel allocation based on second-price auction algorithm Sun, J. *et al.* (2006) found that throughput demand depends on expected channel quality and is a function of all prices offered to users. Gandhi, S *et al.* (2007) constructed a general framework for wireless spectrum auction and used a simple linearly decreasing function for demand in terms of price. Xing, Y. *et al* (2007), studying pricing in competitive spectrum markets with multiple sellers, derived a formula for utility in terms of quality and price, as well as the lower bound for quality and the upper bound for price. In his study of bearer service allocation and pricing in heterogeneous wireless networks, Zhang (2005) used the concept of price elasticity of demand, which is based on the assumption that the relative change in demand will be proportional to the relative change in price. Chan, H. *et al* (2005) investigated utility-based network selection for heterogeneous wireless networks and found that bandwidth demand  $D$  is a function of user revenue maximization gained from a utility function.

For the purpose of this study, the challenge is to arrive at a substantiated estimation of market demand for broadband service in rural Africa at different pricing levels. The costs involved in deploying experimental broadband services in the vast Africa market did not make it a viable option to generate several empirical data points based on what the most likely relationship between demand and price could be based on. The only empirical information available to this study is the current overall broadband market size in Africa, given the current average pricing for broadband on the continent. In order to fit a functional relationship through this single data point, it was decided to make the assumption of a constant value for price elasticity of demand  $E_d$ :

$$E_d = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\Delta Q_d / Q_d}{\Delta P / P}$$

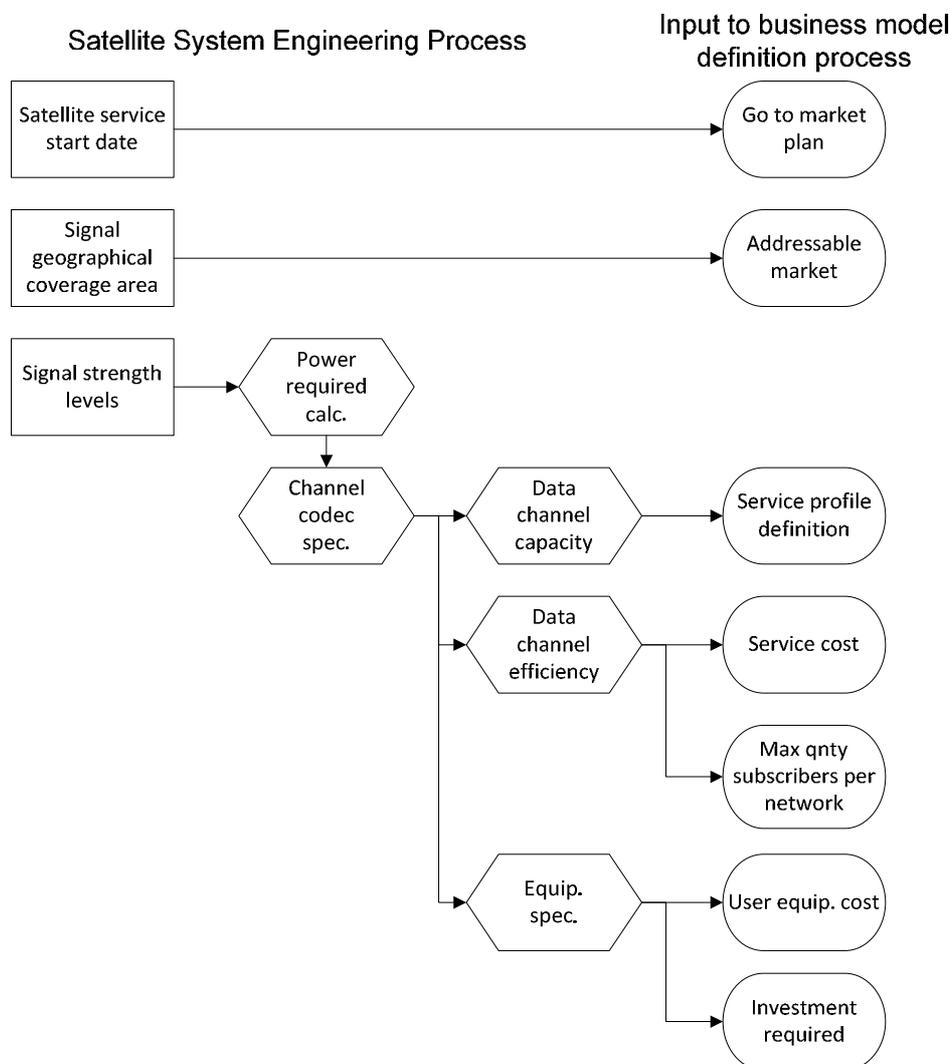
In chapter 4, it will be shown how this relationship was used to derive a formula for market demand  $Q_2$  at price  $P_2$ , given a known market demand  $Q_1$  at known price  $P_1$ .

## 3.6 SATELLITE SYSTEM ENGINEERING

### 3.6.1 SYSTEM ENGINEERING AND BUSINESS MODEL DEFINITION

Satellite system engineering plays a critical part in the business model definition of satellite based broadband services. Although the specific system engineering design decisions can be considered purely technical the outputs thereof have a direct impact on the business model feasibility and business output parameters.

The interdependence between the system engineering process and the business model definition process forms a critical element of this study and constitutes one of the areas where new knowledge is added. The integration point between classical satellite system engineering and business architecture definition remains a field that has not yet been discussed in great details in either the academic or industry environments.



**Figure 3-15: System engineering process and business model definition interdependencies**

### 3.6.2 LINK BUDGET ENGINEERING

#### Overview of the process

The first step in designing a satellite network is to perform a satellite link budget analysis. The link budget will determine what size antennae to use, transmit power amplifier requirements, link availability and bit error rate, and in general the overall customer satisfaction with the service.

#### What exactly is a link budget?

A link budget involves a relatively simple addition and subtraction of gains and losses within an RF link. When these gains and losses of various components are determined and summed, the result is an estimation of end-to-end system performance in the real world. To arrive at an accurate answer, many factors must be taken into account such as the uplink power amplifier gain and noise factors, transmit antenna gain, slant angles and corresponding atmospheric loss over distance, satellite transponder noise levels and power gains, receive antenna and amplifier gains and noise factors, cable losses, adjacent satellite interference levels, and climatic attenuation (Roddy, 2006).

Several companies now market quite sophisticated link budget calculation programs that contain large databases of information regarding satellite performance parameters, ground station antenna performance data, and other information vital to these calculations. With one of these programs, all the user must do is to fill in the data regarding earth station location, planned satellite(s) to use, required link availability, and "quick as a wink" the program generates a very good estimation of link performance.

#### Input Data for a link engineering calculation

The data required to perform a link bower budget are:

- The saturated EIRP and saturated flux density of the transponder.
- The satellite G/T figure appropriate to your planned uplink location.
- Satellite transponder bandwidth.
- Satellite transponder output back-off or attenuation.
- Satellite transponder input back-off or attenuation.
- Latitude and longitude of the uplink and downlink earth stations.
- Planned data or information rate.
- Modulation type (BPSK or QPSK)
- Forward error correction rate (1/2 or 3/4)
- Spread Factor - if any (use only for spread spectrum system)
- Uplink and Downlink frequencies.
- Uplink and Downlink antenna sizes.
- Uplink and Downlink antenna efficiency.
- Uplink and Downlink transmit and receive gains at frequency.
- Minimum digital signal strength (EB/No) for desired Bit Error Rate (BER) performance.

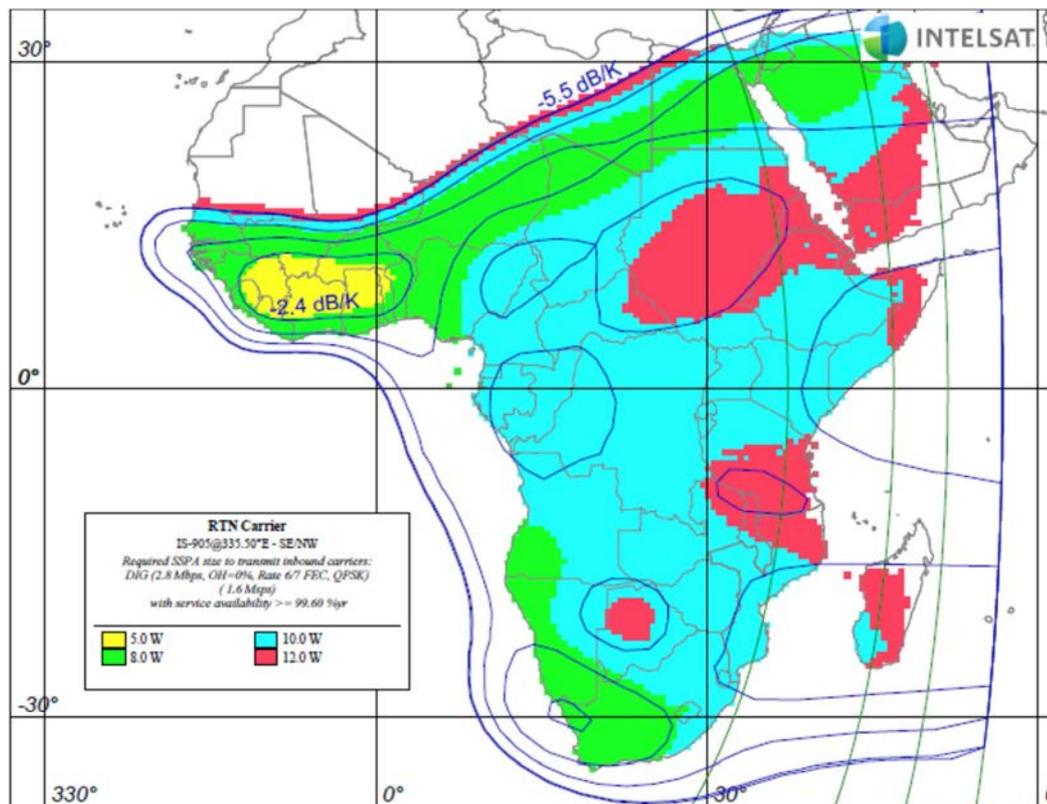
**Typical Output Data**

(Data sample from Freeman 1999)

- EIRP of satellite	+30 dBW
- Free-space loss	-196.8 dB
- Satellite pointing loss	-0.5 dB
- Off-contour loss	0.0 dB
- Excess attenuation rainfall	0.0 dB
- Gaseous absorption loss	-0.5 dB
- Polarization loss	-0.5 dB
- Terminal pointing loss	-0.5 dB
- Isotropic receive level	-168.8 dBW
- Terminal G/ T	+20.0 dB/ K
- Sum	-148.8 dBW
- Boltzmann's constant (dBW)	-228.6 dBW
- C/ N0	79.8 dB

**Network Area Signal Design**

Link budget engineering for a total network and many geographical locations is often completed by computerized algorithms that calculate the expected signal strength and network performance characteristic at different locations as displayed in figure 3.16 for the Africa continent.



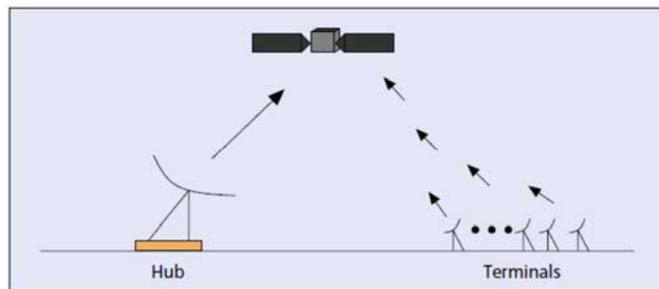
**Figure 3-16: Satellite network signal level calculation as a function of geographical location**

Source: Developed by Intelsat.

### 3.6.3 VSAT NETWORKS FOR INTERNET ACCESS

#### Architecture

Almost all VSAT networks operate in a client/server configuration with a group of VSAT terminals (the clients) transmitting on one or more multiple access channels to the hub station (the server), and the hub station transmitting on a shared wideband broadcast channel to the VSAT terminals. (Abramson 2000) The hub station also forms the integration point between the satellite communication network and the terrestrial Internet and telephony networks.



There are compelling link budget reasons for this configuration. By requiring all traffic in the satellite-based part of the network to either originate or terminate in the large hub station, it is possible to decrease the size and cost of the VSATs in the network.

**Figure 3-17: VSAT network architecture**

Source: Abramson, N. 2000

A client/server configuration means that any intra-network traffic from one terminal to another must traverse a two-hop path to the hub station and back again. Since most of the traffic in these networks is directed to or from the hub station, this limitation is not a problem, especially for the Internet applications.

Two-way interactive data networks involve much more than the combination of two one-way channels. The two directions of communication flow in the channels of a two-way VSAT network with a client/server configuration involve two fundamentally different forms of communication. In the direction from the hub to the terminals, the communication channel is one to many, or a *broadcast* channel. In the direction from the terminals to the hub, the communication channel is many to one, or a *multiple access* channel.

Transmitting data from a single hub station to a large number of remote terminals (the broadcast channel) is a relatively simple problem. This channel architecture is almost always configured in a simple time-division multiplexed (TDM) mode. Furthermore, the adoption in 1998 of the European Telecommunications Standards Institute (ETSI) Direct Video Broadcast (DVB)/MPEG-2 standard encouraged the development of a variety of TDM-based transmitting and receiving equipment for the high-speed digital broadcast channel. Transmitting data from large numbers of remote terminals to a single hub (the multiple access channels) is a much more challenging problem.

Abramson (2000) continue to show that use of Ku band satellite capacity and small earth stations for high-speed low-latency Internet access can be achieved using low-cost VSATs with dish diameters less than 1m. In order to achieve these objectives in networks

supporting large numbers of users, it is necessary to employ a wideband connection-free architecture in the multiple access direction. The connection-free architecture will enable data services, such as the Internet, to be broadcasted to a large number of subscribers without the need to establish a specific two-way data circuit protocol with each subscriber terminal.

### **Methodology**

Grami (2007) points out that designing a satellite system presents many challenges. It is a huge, multi-dimensional non-linear optimization problem. Optimization will be achieved by meeting the satellite's mass, real estate, power, bandwidth, complexity and schedule constraints and accommodating the system's cost, market, performance, coverage, capacity, networking and service requirements.

The primary design objective is to arrive at the lowest capital cost per subscriber (for a given average data consumption per subscriber this is equivalent to the lowest capital cost per bits per second or \$/kbps), while accommodating all relevant system, user and performance requirements. In the satellite communications arena there is no explicit mathematical objective function to maximize in the research leading to the optimum design of a satellite system, and equally important, there is no specific set of quantifiable constraints to meet.

A novel optimum design is one in which all available satellite resources—including mass, power, real estate, and bandwidth—are all fully exploited, and user requirements—such as terminal size, cost, and speed—are completely met, while delivering the target performance—in terms of link availability and bit error rate—and yet achieving the lowest capital cost per bits per second.

This research work extends the field of satellite network design by combining satellite system engineering with the other factors impacting on a satellite service provider into an integrated model. The quantitative simulation of this model allows the interaction between these diverse factors to be studied. The business model simulator as described in chapter 9 incorporates a quantified methodology to determine the optimum satellite access network configuration, and therefore provides a structured mechanism to perform a comparative evaluation of different VSAT networks while taking into account the respective product pricing, market adoption and financial returns considerations.

### 3.7 THE AFRICA BROADBAND LANDSCAPE

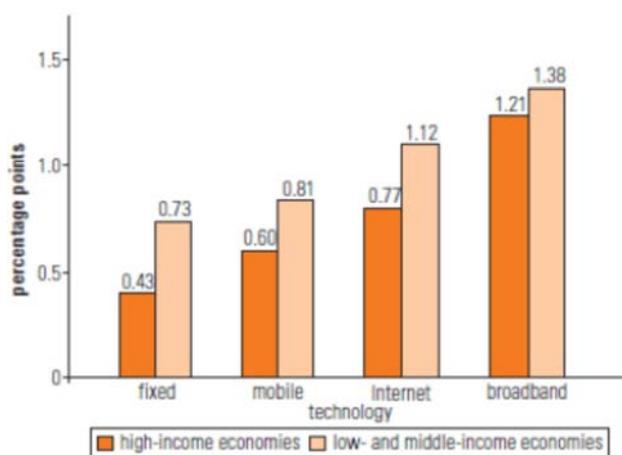
Information and Communications Technology (ICT) has transformed the global landscape over the past few decades. By connecting people and places, ICT has played a vital role in national, regional, and global developments, and it holds enormous promise for the future.

The empirical literature on the correlation between telecommunications and economic growth is now extensive, and there is a reasonably strong consensus that telecommunications infrastructure contributes significantly to sustainable development (World Bank, 2006).

In addition, there is mounting anecdotal evidence from country specific studies that access to telecommunications in rural areas enhances economic development (Elbers and Lanjouw, 2001; ITU, 1998; Lawson and Meyenn, 2000; Pitroda, 1993). The economic benefits of rural ICT access stem primarily from increased access to information, markets, and business opportunities (Grace, Kenny, and Zhen-Wei Qiang, 2004).

#### The Economic Impact of the Internet

A recent World Bank econometric analysis of growth in 120 countries between 1980 and 2006 addresses the impact of the Internet and broadband, in addition to fixed and mobile phones. Results show that for every 10 percentage point increase in penetration of broadband services there is an increase in annual economic growth of 1.3 percentage points (Qiang 2009). Furthermore, economic growth due to the development of broadband infrastructure is the highest at 1.38% for low-to-middle income economies, higher than that for Internet services at 1.12% followed by mobile services at 0.8% and telephony services at 0.73%. For high income economies the effect of ICT infrastructure on economic growth is somewhat lower (refer Figure 3-18).



The impact of ICT infrastructure on low-to-middle economies is expected to be even more significant once the penetration reaches a critical mass. As most developing countries are at an early stage of broadband development, they are likely to gain the most from investing in these networks to reach the critical mass for higher impact and before the diminishing returns take effect.

Figure 3-18: Economic growth effects due to the development of ICT infrastructure

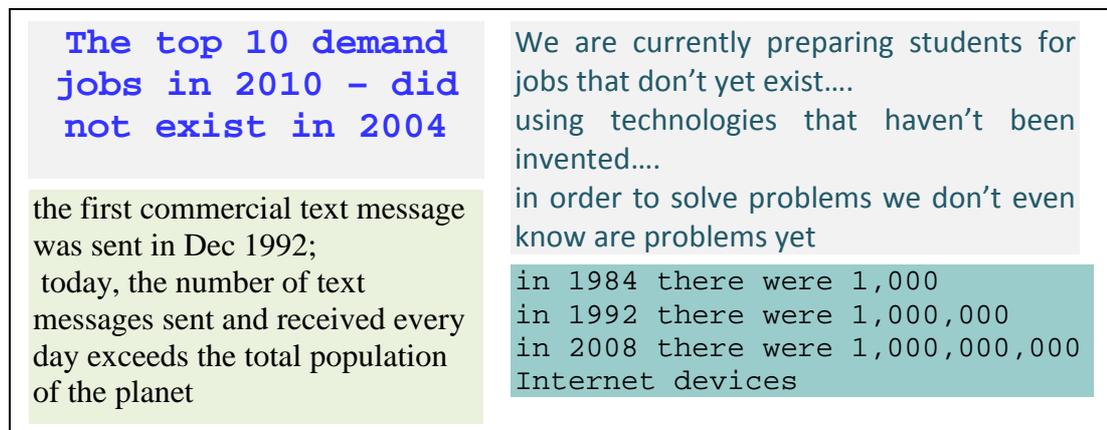
Source: Qiang, 2009

Africa is starting to appreciate the potential of broadband services and is leveraging the technology in the medical, education and health sectors. A relevant example is the African Virtual University that was created to facilitate the use of effective distance education and e-learning across Africa and that to date has trained thousands of teachers and more than 40,000 students. The African Virtual University has 53 centres in 27 countries and its greatest asset is its ability to work across borders, language groups, and conflict zones e. g. in Somalia where the Africa Virtual University has graduated 4,000 students, 30% of which are women.

### We live in exponential times

The impact of the Internet and rapid technology developments on our lives is clearly demonstrated by the research worked done by Karl Fish ([www.thefischbowl.com](http://www.thefischbowl.com)). Education, skills development, employment and innovation are all critical areas of society that are enabled and enhanced by the Internet.

Broadband access services have already changed the way we live and will do even more so in the future. The impact on work, social and private behaviour demonstrates the potential of broadband access services to contribute to job creation, education, instant communication and the application of Internet access devices (refer Figure 3-19).



**Figure 3-19: Statistics demonstrating the exponential growth w.r.t. ICT usage in general society**

Source: [www.thefischbowl.com](http://www.thefischbowl.com)

When considering the adaptation of communication technologies by society from the first commercial radio to current online media such as Facebook, it is clear that technology is impacting on everybody and is rapidly becoming a life necessity. The adoption of the 1<sup>st</sup> 50 million radio devices took 38 years, television took 13 years, the internet 4years, iPod devices 3 years and Facebook users 2 years (refer to Figure 3-20).

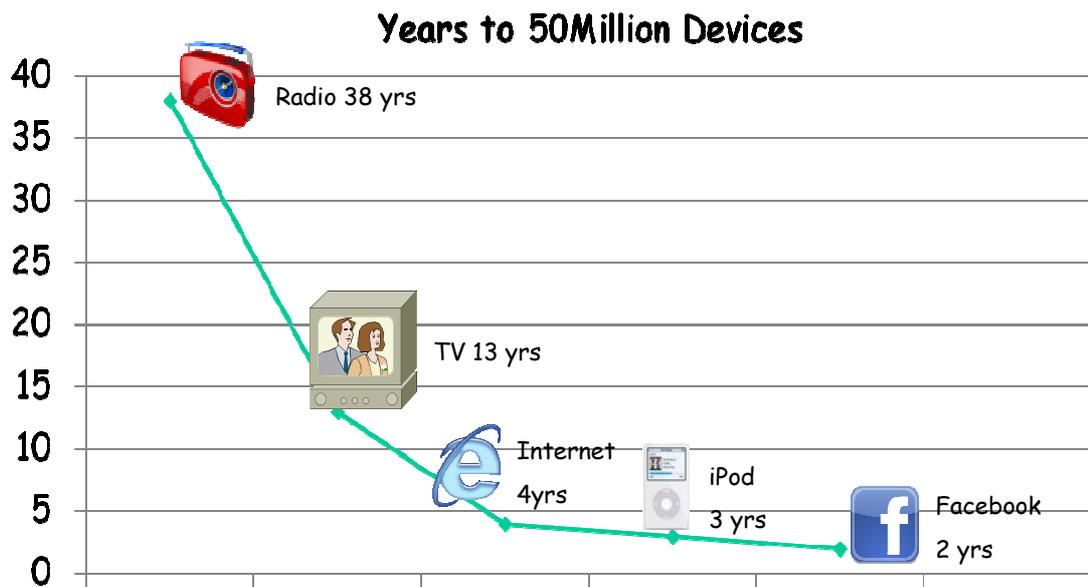


Figure 3-20: Diagram representing the exponential decline in technology adoption periods  
Source: www.thefishbowl.com

### 3.7.1 THE DIGITAL DIVIDE

#### Definition and Description

Manuel Castells defines the digital divide as “inequality of access to the Internet” (Castells, 2002). Access to the Internet is moreover “a requisite for overcoming inequality in a society in which dominant functions and social groups are increasingly organized around the Internet” (Castells, 2002). Jan van Dijk who, besides Manuel Castells, can be considered as the most important theorist of the network society, defines the digital divide as “the gap between those who do and do not have access to computers and the Internet” (Van Dijk, 2006). Pippa Norris sees it as “any and every disparity within the online community” (Norris, 2001), while Ernest J. Wilson III describes it as “an inequality in access, distribution, and use of information and communication technologies between two or more populations” (Wilson, 2006).

Which types of the digital divide can be identified? Van Dijk and Hacker (Van Dijk, 2003) argue that there are four types of barriers to access:

- The lack of “mental access” refers to a lack of elementary digital experience.
- The lack of “material access” means a lack of possession of computers and network connections.
- The lack of “skill access” is a lack of digital skills.
- The lack of “usage access” signifies the lack of meaningful usage opportunities.

Van Dijk has demonstrated that in terms of physical access to computers and the Internet, the digital divide is closing in on developed countries, whereas in developing societies it is

still growing. In terms of skill access and usage access, the digital divide is both widening and deepening.

He argues that information skills (the skills needed to search, select, and process information in computer and network sources) and strategic skills (the capacities to use these sources as the means for specific goals and for the general goal of improving one's position in society) as aspects of the skill access, are "extremely unevenly divided among the populations of both developing and developed societies" (Van Dijk, 2006). Concerning usage access, Van Dijk has found that people with high levels of education and income tend to use database, spread sheet, bookkeeping and presentation applications significantly more, than people with low levels of education and income who favour simple consultations, games and other entertainment (Van Dijk, 2006).

### Africa and the Digital Divide

Across Africa new information technologies are rapidly changing the lives of a small but growing number of people. In rural Togo a farmer gets real-time information on market prices in the capital, Lomé, through a cellular phone. In Accra, Ghana, entrepreneurs who in the past were not able to get a dial tone on their land-line telephones can now connect immediately using Internet telephony, technology that allows phone calls to be made through the Internet. And in Niger, the Bankilare Community Information Centre downloads audio programmes from the African Learning Channel and rebroadcasts them on local radio (ITU World facts 2010).

These are examples of some of the few fortunate Africans. For most people, even making a telephone call, is still only a remote possibility in an era when most of the world is now communicating almost instantly across cities, regions and the globe using wireless and satellite technologies to send high-speed electronic messages.

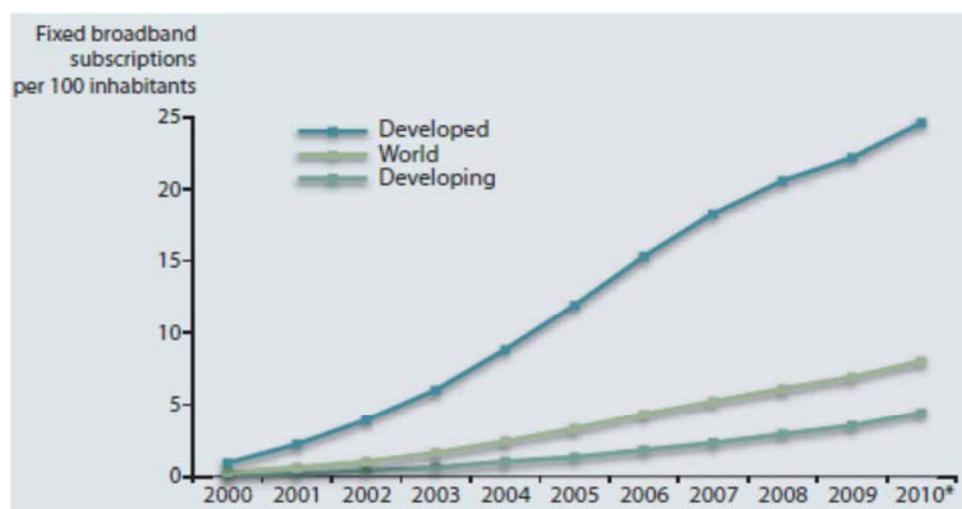


Figure 3-21: Broadband penetration per 100 inhabitants for different economies.

Source: ITU World Telecommunication / ICT Indicators database. Note: \* Estimate

Most African countries now have commercial DSL services, but their growth is limited by the poor geographical reach of the fixed-line networks. Improvements in Internet access have therefore been mostly confined to the capital cities so far. However, the rapid spread of mobile data and third-generation (3G) broadband services is changing this, with the mobile networks bringing Internet access to many areas outside of the main cities for the first time.

Although Africa makes up 14.8% of the world population, in 2010 only 5.6% of all Internet users lived in Africa ([www.worldinternetstats.com](http://www.worldinternetstats.com)). By the end of 2010, Internet user penetration in Africa will reach 9.6%, far behind both the world average (30%) and the developing country average (21%) (ITU, World Facts 2010) (Refer to Table 3-2).

Internet Users and Population Statistics for Africa						
Region	Population (2010 Est)	Pop % in World	Internet Users, Latest Data	Penetration (% pop)	User Growth (2000 – 2010)	% Users in World
<b>Total for Africa</b>	1,013,779,050	14.8 %	<b>110,931,700</b>	10.9 %	2,357.3 %	5.6 %
<b>Rest of World</b>	5,831,830,910	85.2 %	<b>1,855,583,116</b>	31.8 %	420.5 %	94.4 %
<b>WORLD TOTAL</b>	6,845,609,960	100.0 %	<b>1,966,514,816</b>	28.7 %	444.6 %	100.0 %

**Table 3-2: Internet User and Population Statistics for Africa over the period 2000 – 2010.**

Source: [www.worldinternetstats.com](http://www.worldinternetstats.com), 2010

These numbers confirm the digital divide dilemma for Africa - this imbalance exist both with respect to physical access to technology, as well as the resources and skills needed to effectively participate as a digital citizen.

### 3.7.2 INVESTMENT AND MARKET GROWTH

Between 1996 and 2006 a total of US\$23 billion has been invested in ICT in Africa, mostly by the private sector, and 23% of Africa’s population now has mobile phone access. (Williams 2008). While broadband penetration is still low, there is evidence of strong demand for broadband connectivity. The relatively low current usage is mostly the result of limited availability and high prices (on average \$190/month compared to \$6-44 in India and \$12-40 in Europe) (BMI TechKnowledge 2010).

While broadband in the rest of the world was deployed on the back of existing landline networks, in Africa the penetration rate of such networks in 2007 was less than 2%. Companies wishing to provide broadband services must therefore use expensive wireless access solutions. Little direct evidence exist of likely take-up if broadband was available more widely at lower prices. Indirect evidence can be based on mobile phone penetration that is growing faster than anywhere else in the world.

Broadband evidence from other developing nations can also be used as an indicator for the expected adoption of broadband services in Africa. In China Internet users doubled from 7.9% to 16% in 2 years between 2005 and 2007; three quarters of these use broadband (CNNIC 2008). In India broadband subscription is also still low but growing at 50% p.a.

A third indicator of broadband market development in Africa is a comparison with the international Internet bandwidth: from 2004 to 2007 it grew at a rate of 96% p.a. in Africa compared to a global growth rate of 51% (Telegeography 2008). There has, furthermore, been strong interest in obtaining WiMAX licenses to overcome the access infrastructure bottleneck experienced in most countries.

It should be noted that in Africa most network operations are vertically integrated, compared to the situation in the developed world where there is more vertical disaggregation, providing an incentive for regional players to invest into market development. It is also noted that for rural areas the cost of the landline backbone forms a much larger part of the overall cost to provide broadband services, compared to urban areas where users are concentrated. It is thus unlikely that commercial broadband services based on landlines, will be deployed to areas other than urban ones.

### **3.7.3 BROADBAND SERVICE FOR EDUCATION**

During 2007 infoDef and the World Bank supported the completion of a “Survey of ICT in Education in Africa”, which provided a general overview of activities and issues related to ICT use in education in the Africa. ICT use in education is at a particularly dynamic stage in Africa, with new developments and announcements happening on a daily basis somewhere on the continent. These reports should therefore be seen as “snapshots” that were current at the time they were taken; it is thus expected that certain facts and figures presented may become outdated very quickly ([www.infodev.org/ict4edu-Africa](http://www.infodev.org/ict4edu-Africa)).

#### **South Africa Report**

A 2007 World Bank report (Isaacs S., 2007) indicated a 22% penetration of PCs in all public schools supported by a policy for e-Education in schools and in Further Education and Training (FET) colleges. Movement towards broadband and ubiquitous ICT access is being planned and a significant growth in ICT access is therefore expected.

#### **Educational Statistics**

South Africa has 12.3 million learners, 386,600 teachers and 26,292 schools, of which 6,000 are high schools. A total of 5,778 have computers for learning and 13,011 have computers for administration. Less than 5% of schools can afford Internet connections.

In the absence of broadband, the quality of ICT for teaching and learning is low. In 2005 computer penetration in schools varied between 7.8% (Eastern Cape) and 76.6% (Western Cape).

More than 1 million students are annually enrolled in 24 tertiary education institutions nationally with a national education budget in 2007/8 of R105.5 billion. Illiteracy of adults over 15 years stands at 24% and in terms of Network Readiness Index (NRI), SA is ranked 37<sup>th</sup> out of 115 countries. By 2005 SA had 165,290 broadband subscribers and 3.6 million Internet users.

### **Policy**

Government policy includes the transformation of learning and teaching through the use of ICT. Sectoral strategies include the establishment of an Educational Network (EduNet), an entity that would network all public schools and training institutions.

The e-rate will allow discounted Internet access (50%) to educational institutions. Schools, however, struggle to access this discount as ADSL suppliers do not yet give it through to ISPs to pass on to schools. The goal of e-Education is that every learner in the primary and secondary school system should be ICT capable by 2013; that includes connection to ICT infrastructure and the use of ICT for curriculum delivery.

KPMG has been appointed as the transactional adviser to investigate the feasibility of rolling out a national program for all public schools and FET colleges. E-School's Network is a non-profit organisation that currently links 1,700 schools by e-mail – it provides SchoolMail (mailbox for each learner and teacher) at a rate of less than R1,000 p.a. Gauteng Online has established PC labs in about 1,200 schools. The Khanya Project has as goal to empower all teachers by 2012 to deliver curriculum using technology. PCs and networking has been provided to 613 schools, impacting on 500,000 learners. Many other similar initiatives are in progress in cooperation with industry.

### **Central African Republic Report**

The 2007 InfoDev World Bank ICT Survey completed for the educational services in the Central African Republic (Fall B., 2007) shows that the school student enrolment is low and dropping. Primary school enrolment dropped from 47.8% in 1988 to 42.9% in 2000 and 40.7% in 2003. Junior high school enrolment is 10.8%. Compared to similar figures for South Africa, this demonstrates that even within the African continent, there is a huge digital divide between more and less developed countries.

In 2002 the government decreed a process to set up the National Plan for Information and Communication Infrastructure (NICI). Literacy rate is 49.6%, with 2 fixed telephone lines, 3 mobile phones and 1.9 PCs per 1,000 people, 1,800 Internet subscribers, 20 Internet cafes in the capital, and 0.34 lines/100 people growing at 8% p.a.. The United Nations Program for Development (PNUD) has developed an ICT plan to create universal connectivity, including Internet access, through community centres including schools and to make ICT affordable in poor areas. CISCO Academy of Bangui has been created at the University of Bangui. The ADEN project being conducted between 11 French speaking countries in cooperation with France intends to improve Internet access to all ([www.infodev.org/ict4edu-Africa](http://www.infodev.org/ict4edu-Africa)).

## **The under-serviced Educational Sector**

These statistics are samples of the general status of broadband services in the educational sector in Africa. The status in South Africa and Central Africa Republic (CAR) provides clear indications that the educational sector is still very much under serviced by current available broadband services.

The conclusion can be made that there is a gap in the market for an alternative and affordable broadband service to provide Internet access services to those areas and sectors not currently serviced by existing broadband networks.

### **3.7.4 BACKBONE NETWORKS FOR BROADBAND**

#### **Terrestrial Backbone Network Constraints**

According to World Bank report 53643 (Williams 2010), existing cellular networks were designed mainly for voice communications and these networks are struggling to cope with the need for data services. The increasing digital divide is furthermore due to the lack of a broadband fibre optic network in most African countries, and the large distances between the majority of the population and broadband fibre optic backbones that do exist.

It is, however, unlikely those populations outside of the urban centres will benefit directly from increased backbone network deployment projects. The low initial fixed costs and scalability of wireless networks make them the more attractive choice, compared to optic fibre, for early stage deployment of backbones where demand is uncertain and there are technical and political risks. Current policy recommendations to governments in Africa include deregulation of the market to promote competition, and stimulation of demand, including increased use of computers in schools, as higher demand will make broadband services more affordable to the masses.

#### **Undersea Backbone Network Growth**

About 80 percent of global data transmission uses undersea cables. As of mid-2009, 40 percent of continental Africa's nations were without a direct high-bandwidth cable service.

Africa's connectivity to the rest of the world is however rapidly changing. Figure 3-5 illustrates the undersea high-bandwidth cables that will service Africa by 2011.

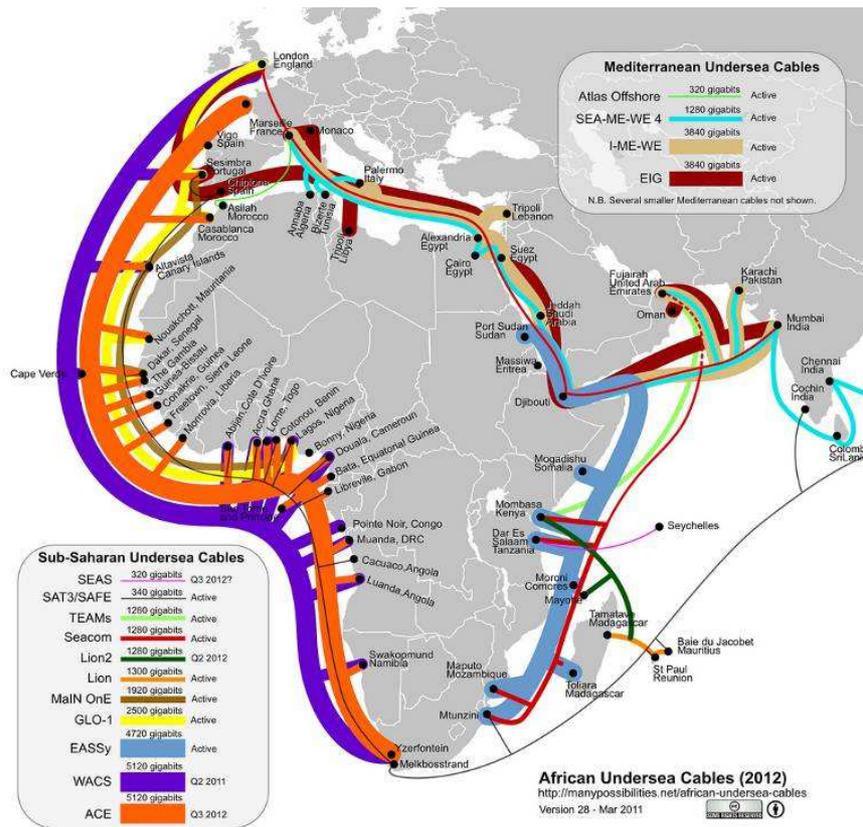


Figure 3-22: Africa planned Undersea Cable Network  
 Source Livingston, S. 2011

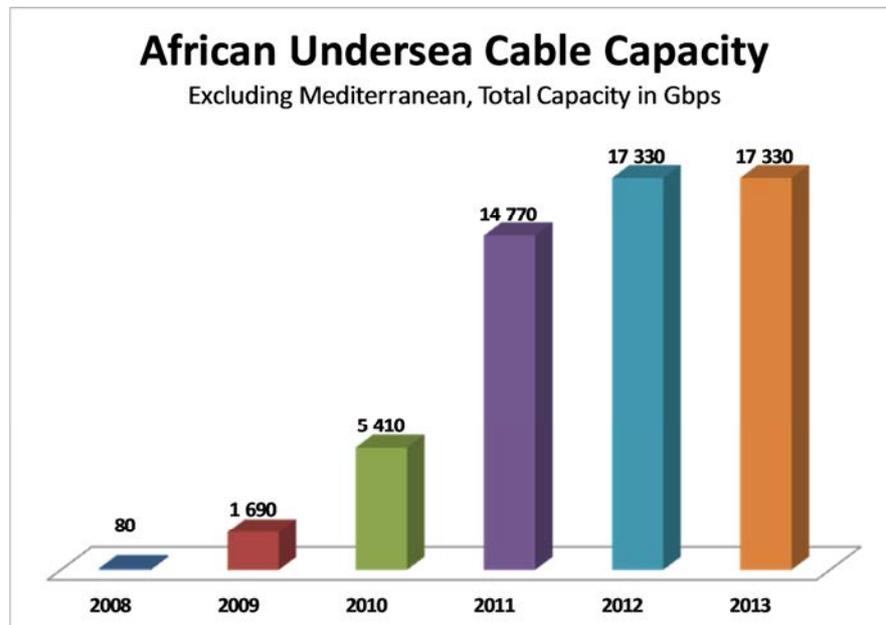


Figure 3-23: African Undersea Internet Access in SA 2010.  
 Source: World Wide Worx

The new cable system will alter the current pricing structure, opening up new opportunities for the growth of high-speed Internet and better cellular telephony.

It is estimated that once all 12 undersea cables are fully operational in 2011, Africa's total international bandwidth will increase from about 6 terabytes per second (tbps) in 2009 to as much as 34 tbps (refer Figure 3-23).

### 3.7.5 AFRICA INVESTMENT CLIMATE

The Africa Progress Panel report (Africa progress panel 2010) provides a complete view on Africa's potential and confirms that Africa offers large, untapped markets with nearly one billion potential customers and all the benefits of emerging economies, such as comparatively high rates of return and attractive possibilities for portfolio diversification. Before the economic crisis reached Africa, many of the continent's states have been able to record remarkably high rates of growth – average GDP growth in Sub-Saharan Africa between 2004 and 2008 was 4.8 percent.

These countries have worked hard to achieve macroeconomic stability (maintaining stable and low inflation and sustainable levels of debt), pursue sound economic policies, and reinforce their institutions. They have strived to become part of mainstream international trade through national development strategies, promote exports, enhance competitiveness and facilitate inter-regional trade through infrastructure improvements.

African countries furthermore increased their revenue mobilization and broadened their tax base, achieving an overall current account surplus of 2.7 percent in 2007 and 2008. Most importantly, however, they have improved the business conditions on the continent by simplifying administrative processes and removing bureaucratic bottlenecks.

According to the World Bank's Doing Business Report 2010 (World Bank, 2010), African governments have implemented more business-friendly reforms in each of the last two years than in any previous year covered. Countries such as Egypt and Botswana have regularly featured in the top ten reformers, with Rwanda being the top global performer in 2010.

These improvements are part of the reason why the IMF is projecting that, following a dip to 1.7 percent in 2009, average economic growth in Africa will return to 4 percent in 2010, outpacing that of most other regions.

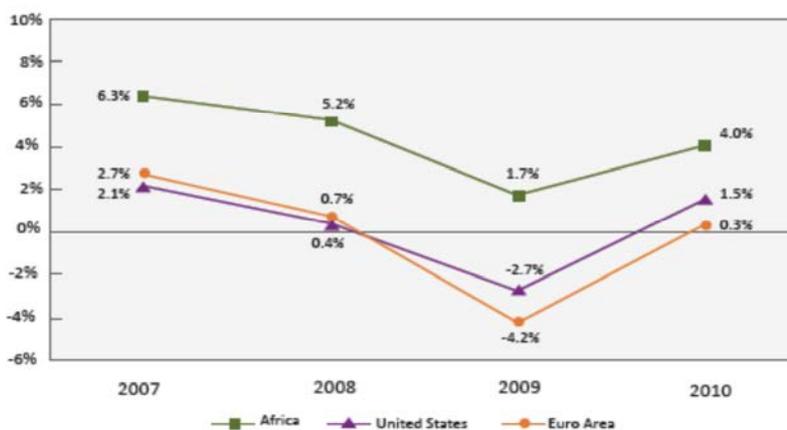


Figure 3-24: Africa's Real GDP growth Rate

Source: IMF World Economic Outlook, October 2009

Historically challenges in the operating environment have deterred companies from engaging in African markets. The combination of commercial potential and improving regulatory conditions have however transformed large parts of Africa into attractive business venues for companies prepared to find new ways to overcome these challenges.

By looking beyond standard business models, they can invest in promising growth sectors such as those identified by the full World Bank report (that is, agriculture, financial services, energy and mining, information and communication technology, pharmaceuticals, and tourism), gain greater market shares, and attract the loyalty of producers and consumers as incomes grow and needs expand.

### **3.7.6 THE AFRICA FUNDING DILEMMA**

Investment in broadband communication platforms has been largely undertaken and led by the private sector and this should continue. Private operators have been investing heavily to upgrade existing infrastructure, expand capacity and enable a new wave of high-bandwidth services. The scale of this upgrade means that private telecommunication operators are among the largest private investors in their respective economies. This may rapidly change though, as economies retract given the highly pro-cyclical nature of telecommunication investment over the previous 20 years and firms' limited access to capital.

Telecommunication operators historically have had strong cash flow positions during economic down turns, but may face increasing difficulties raising sufficient capital to extend and upgrade their networks.

Despite the significant progress made by operators, there are also still areas in OECD countries without broadband access due to the lack of a reasonable business case. These areas have historically been the target of government plans to extend connectivity. The recent economic downturn has led policy makers in OECD countries to consider fiscal policies to help return their economies to growth. Most of these plans involve large government expenditures to support demand for goods and services while simultaneously increasing the longer-term productive capacity of the economy. Investments in network infrastructures such as electricity, gas, water, transportation and communications are key elements of most packages due to their immediate impacts on demand and employment as well as their strong potential to expand future supply.

While the mobile industry is a perfect example of a successful development and enrichment industry in the Africa environment, it remains a nearly isolated case with many investments and initiatives being less successful.

## 3.8 MOBILE BROADBAND SERVICES

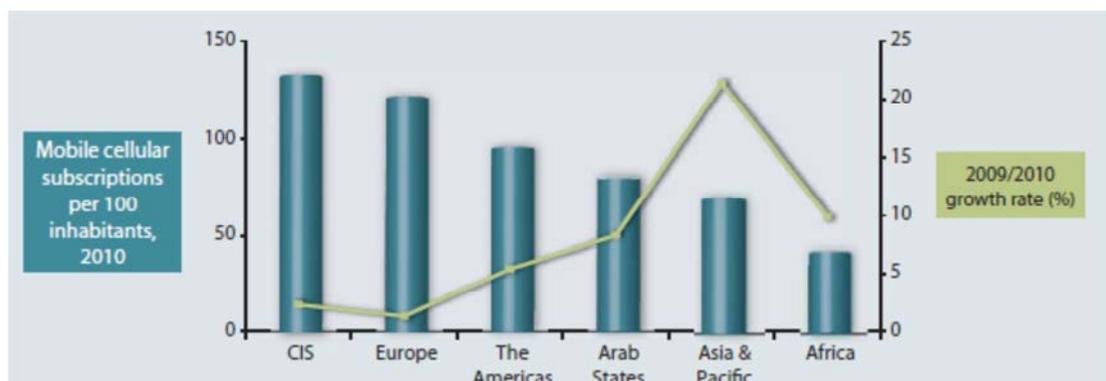
Cellular mobile networks have propagated throughout Africa to provide an effective telephony service to the emerging Africa market. Network coverage and subscriber growth have been so phenomenal that in many locations it is considered the *de facto* option to provide voice and data connectivity.

### 3.8.1 THE DOMINANCE OF MOBILE SERVICES

In the telephone sector mobile phone networks dominate Africa's telecommunications markets, providing around 90% of all subscriber connections. The subscriber base is 506 million and still growing at around 30% per year across the continent, but the growth curves have begun to flatten in the continent's more mature markets, forcing operators to compete more aggressively on price, quality of service and by introducing new services.

In the developing world, mobile cellular penetration rates will reach 68% by the end of 2010 - mainly driven by the Asia and Pacific region. India and China alone are expected to add over 300 million mobile subscriptions in 2010. In the African region, penetration rates will reach an estimated 41% at the end of 2010 (compared to 76% globally) leaving significant potential for further growth (ITU 2010).

The mobile industry continues to invest heavily in the roll-out of new infrastructure and new services. The GSM Association predicts that investment in mobile communications in sub-Saharan Africa alone, will be worth some US\$50 billion over the next five years (on top of the US\$35 billion already committed to the region) (GSMA 2006).



**Figure 3-25: Global mobile penetration and growth rates**  
Source: ITU World Telecommunications / ICT Indicator database

### 3.8.2 MOBILE AND FIXED NETWORK COVERAGE

Research done for the World Bank Development Research Group (Buys et al, 2009) used spatial prediction algorithms to predict the probability of GSM network coverage throughout Africa. Based on these forecasts, it can be expected that the current mobile network communication coverage will continue to grow to provide services to the most populated areas to service the majority of the urban Africa population.

The research, however, also shows that for vast areas of the continent the probability for deployment of mobile networks is less than 30%, with the probability of deploying 3G networks even lower. While landline telephone coverage is slowly increasing, it will take a very long time to reach universal or even widely shared coverage, including African countries where coverage has improved. While urban coverage varied between 5 and 45 %, by 2005, rural coverage was in general below 2%, with a maximum of just over 5% in South Africa. Solutions to provide access to telecommunications infrastructure to these areas will therefore have to be based on alternatives like satellite broadband (Banerjee S. *et al*, 2009).

Buys, P. *et al* (Buys P 2009) reports rapid growth in cellular coverage of most African countries since 1999 – on average today more than 50% of populations are covered. Policy reforms have proven to directly impact on the rate of growth, as markets are deregulated, making it more attractive for commercial competitors to enter the market.

A critical point is that large rural areas are likely to remain uncovered by cellular networks due to low population densities. This makes it unattractive to expand the cellular network to such areas. Alternative services may be required to close the digital divide for these areas.

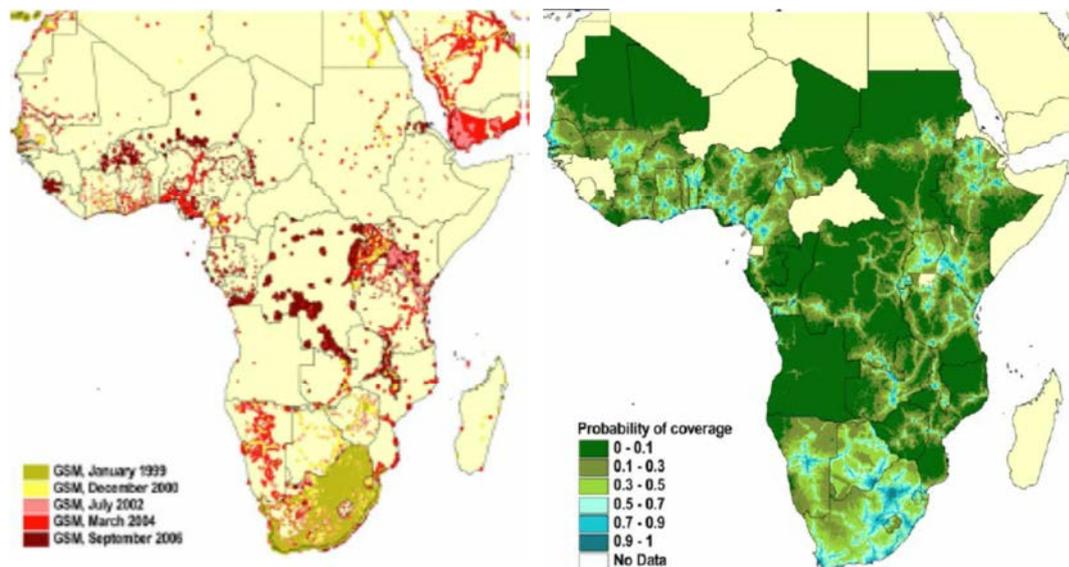


Figure 3-26: GSM Cell Phone Expansion in Sub-Saharan Africa, 1999 – 2006 (left) and Predicted Probability of Cell Phone Coverage (right)

Source Buys *et al*, 2009

### 3.8.3 DRIVERS FOR PERFORMANCE IN THE MOBILE INDUSTRY

The solid growth, as described in the previous section, has been the result of an effective blend of competition-oriented regulation, technology deployments and sharp marketing acumen. Once dominated by state-owned monopolies, African telecommunications markets have become amongst the most competitive in the world, as regulators awarded more licenses and widened the service scope of individual licenses.

#### **Deregulation**

The average number of operators per market has risen to 3.6 in 2009 from around 2.5 in 2005. Tanzania was expected to have around eight operators by the end of 2009; Cote-d'Ivoire and Ghana both have six players and even ostensibly small markets such as Rwanda will have at least three operators. While the increased competition has raised persistent questions about the financial viability of new entrants, it has increased the level of competitive intensity as operators cut prices, expand networks and develop new offerings to protect or gain market share.

#### **Technology Improvements**

Technology improvements have also been a major driver of growth. Advances in spectral efficiency and network optimization tools, the deployment of IP-based solutions and more cost-efficient network configurations allowed operators to increase network capacity at a relatively marginal cost and lower overall network operating expenses. The sharp decline in the average cost of a mobile base station (BTS) similarly allowed new players to penetrate markets at a faster rate than was previously possible; technology enhancements therefore made services more affordable and accessible. Prepaid platforms were refined, allowing customers to purchase airtime at a price as low as USD 0.25 per minute, share airtime and even buy airtime on credit. Handset prices were slashed, with the introduction of ultra-low cost handsets, bringing prices to as low as USD 15 per unit.

#### **Marketing**

Another key growth catalyst has been marketing. Borrowing a page from the brewery industry and other consumer goods sectors, mobile operators developed an aggressive, omnipresent brand of marketing. Mobile services are highly visible, and airtime packages are increasingly innovative and targeted towards specific consumer sub-segments.

### 3.8.4 MAIN CHARACTERISTICS OF THE MOBILE INDUSTRY

The African mobile subscriber base has a number of distinguishing characteristics.

#### **Prepaid**

It is predominantly prepaid (99% of the customer base in most markets), with the prepaid platform being a preferred billing model rather than an indicator of income level. Subscriber churn is high; depending on the market, 5% to 10% of all subscriptions are disconnected each month, though this has not represented an insurmountable obstacle to operator ability to generate consistent cash flows (AfricaNext, 2008).

### **Voice Centric**

The market is still voice-centric, with voice services accounting for 90% of revenue or more; large-scale data adoption remains limited to SMS's. Nonetheless, non-SMS mobile data adoption is picking up. Nearly 4% of mobile users access the Internet through mobile networks (10% in the larger markets), and mobility already accounts for about 35% of an admittedly small broadband subscription base (AfricaNext, 2008).

### **Small denomination**

An additional benefit of the prepaid model is that the minimum service fee denominations can be lowered to \$2 or even lower. This has the advantage that subscribers can access the services with the minimum cash needed and thus eliminates the barrier of entry that is caused when services are linked to high monthly subscriptions.

The billing model enables a subscriber that wants to make a single call to indeed make that single call. The model does not prescribe to the subscriber to pay for a month's service when the need is only to make this single call now. By enabling the market to purchase on such a micro level the GSM providers not only lowered the barrier to entry, but effectively eliminated it.

## **3.8.5 PAY-FOR-USAGE CONCEPT**

The telephony market in general has always been based on a "per-minute" billing, i.e. telephone calls are billed for the duration of the call. This concept is very simple to be understood by the user and it was even further optimized by introducing per-second billing. Users have certainty about the product – being able to make a call, and about the price of the product – measured in the time duration of the call. Although users do not have a direct display of the cost of a call they do have the option to check available airtime on their account.

To complete the review of the GSM billing model, consideration should also be given to the debate about users sometimes complaining that a "minute" is not necessarily 60 seconds and that service providers are increasing margins by manipulating the duration of calls. Notwithstanding this issue, users generally accept the pay-for-use telephony services model.

## **3.8.6 OVERALL MARKET IMPACT**

The impact of the African mobile boom on the larger economy has been far-reaching. In many markets, the telecoms sector has become one of the main sources of foreign direct investment, often only surpassed by the oil and gas sector.

Telecoms revenue and expenditures now contribute a combined 5% to as much as 10% of GDP in many countries. African mobile network capital expenditure reached around USD 12.5 billion in 2008, and investment in communications has reached around 5-6% of total investment spending on the continent. In addition, the mobile sector has had a notable contribution to employment, directly, and indirectly through the establishment of extensive

networks of dealers, sub-dealers and sub-contractors. In Nigeria for example, MTN's distribution network includes more than 10,000 sub-dealers, 30,000 sub-sub-dealers and more than 50,000 retail points and street hawkers (Farroukh, 2006).

Just as significant has been the impact of mobile networks on other economic sectors. Financial institutions, for example, are increasingly using mobile banking to expand the reach of their offering.

Mobile operators themselves have expanded the financial services field with new applications such as M-PESA, Safaricom Kenya's popular money transfer service. The mobile platform is similarly becoming a favourite tool to optimize the economic potential of urban and rural areas. In Uganda for example, MTN Uganda launched a service combining its mobile network with the Google platform allowing end-users to have access to basic, localized, and actionable information through short message services (SMS).

### 3.8.7 BROADBAND ACCESS IN AFRICA VS THE WORLD

Research completed by BMI during August 2010 (BMI 2010), shows that the expected number of broadband subscribers using PCs as access devices will increase from 7.6million to 24.1 million and that the W-CDMA / HSPA mobile technologies will overtake ADSL by the end of 2010.

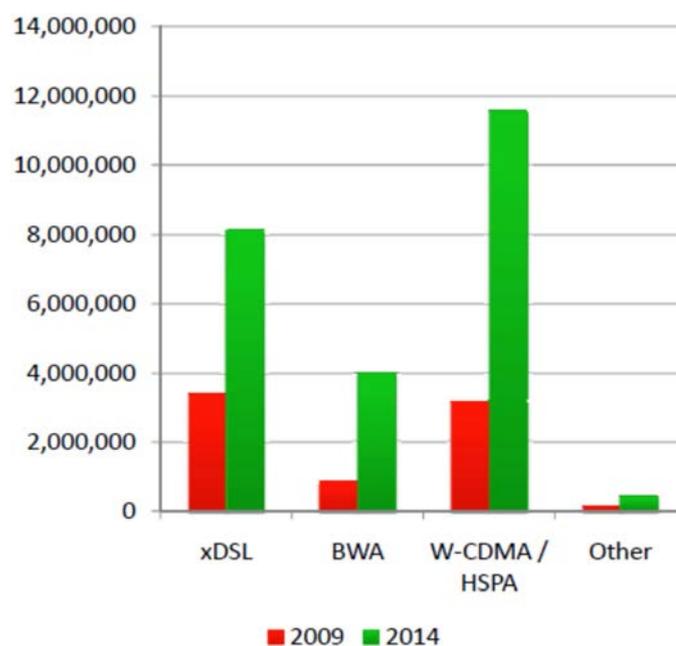


Figure 3-27: Africa PC user Internet access connections  
Source: BMI research, 2010

### 3.8.8 CRITICAL COMMENT

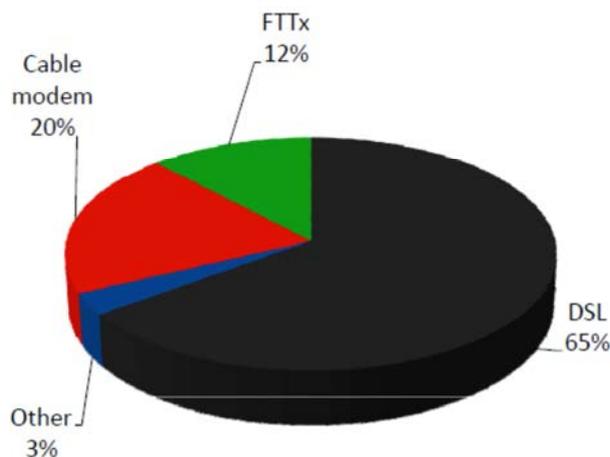
The dominance of mobile technology as a solution for broadband services in Africa should not necessarily be interpreted as an indication of its perfect suitability as a broadband access solution. This domination can also be an indication of the lack of any viable alternative solution to meet the emerging broadband demand in Africa.

A review of the world-wide broadband access statistics (BMI 2010) shows that 65% of global broadband connections are via DSL due to the well-developed copper infrastructure in Europe. In Asia, fiber last mile access services are more dominant to meet the huge appetite for broadband services.

On a global scale mobile 3G broadband connections form part of the 3% classified under “other” connection types. This includes Africa’s connections, which are mainly South Africa and Northern Africa.

## 3.9 ADSL SERVICES

### 3.9.1 THE SOUTH AFRICAN ADSL MARKET



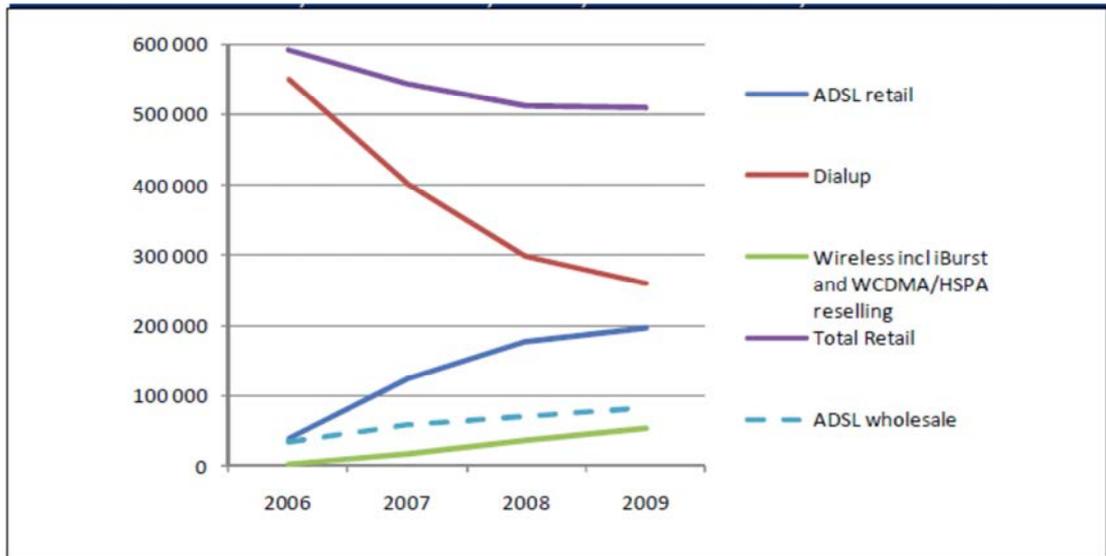
The South African broadband market has shown considerable growth over the past seven years since the advent of ADSL in 2002.

High growth rates have been sustained in the past three years by falling prices and has been driven further by the emergence of alternative broadband suppliers to Telkom, most notably mobile operators with their W-CDMA/HSDPA services.

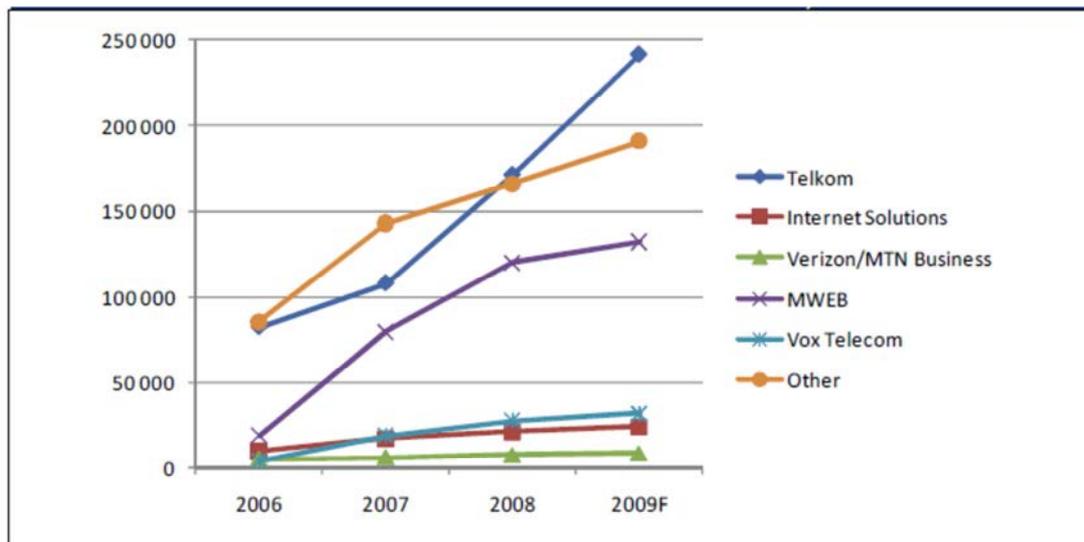
Figure 3-28: World Broadband Connection by 2009

Source: BMI research

ADSL remains the market's preferred connection type and market leader for broadband in revenue terms, but the mobile operators' W-CDMA/HSDPA services have gained the ascendancy in respect of subscriber numbers. Mobile operators have taken full advantage of both the mobility functionality advantage and have also exploited their marketing power and overall position in the telecoms market, thereby far outstripping other wireless broadband technologies (Refer figure 3.28).



**Figure 3-29: Internet access subscriptions including wholesale ADSL and Retail.**  
 Source: BMI-T 2010 (2).



**Figure 3-30: Retail ADSL connections and estimated market shares, 2006 – 2009**  
 Source: BMI-T, 2010 (2)

### 3.9.2 ADSL SERVICES IN AFRICA

The number of operators providing ADSL has more than doubled from 21 to 44 between 2005 and 2008. This achievement has brought broadband to many capital cities, but still leaves 10 out of 54 African countries without ADSL. Those without ADSL include Burundi, Comoros, Guinea, Guinea Bissau, Equatorial Guinea, Liberia, Mayotte, Malawi, Sierra Leone, and Swaziland (Balancing Act, 2008).

The top tier markets have seen 38 incumbents invest in DSLAMs and enabling exchanges outside the capital city. In many ways, this reflects the physical extent of the operators' PSTN and the transmission network. Where transmission networks to exchanges outside the capital, is provided by satellite, there is insufficient transmission capacity to support ADSL. In such cases, operators have deployed VSAT broadband networks.

2005	2007
<b>70% of capital cities</b>	100% of capital cities
<b>20% of main cities</b>	50% of main cities
<b>2% of secondary cities</b>	10% of secondary cities
<b>0.1% of towns</b>	2% of towns

**Table 3-3: Geographical distribution of broadband (2005 – 2007)**  
 Source: Balancing-Act, 2008

### 3.10 A CASE FOR SATELLITE ACCESS

#### 3.10.1 AN AFFORDABLE UBIQUITOUS SERVICE

A recent study on policies and strategy options to improve Africa's telecommunication infrastructure; this study ranked the need to develop wireless and satellite infrastructure very high as a mechanism to overcome geographical-oriented obstacles (Mbarika, V.W., 2009). In essence, the use of satellites would provide faster and broader telecommunication access to Africa's least developed economies due to the ubiquitous coverage offered by satellite technology (Meso, P. *et al*, 2005).

Wireless and satellite infrastructure in this context, include the use of semi-fixed analogue mobile phone networks placed in communities without telecommunication access and a satellite link to regional hubs. The implementation of cellular telephony to create wireless local loops, as an alternative to wired systems, is receiving increasingly favourable reviews, especially in developing economies. The reasons are compelling: dramatically lower line cost, improved reliability, and greatly enhanced flexibility.

While we can speak of the utility of wireless technology, the unresolved question is; how to bring this technology to the average citizen of Africa — not forgetting the provision of such services in rural areas. This dilemma is accurately summarized by the words of one commentator: "Though I strongly agree on the suggested approaches above (the adoption of wireless technologies), one thing I'll like to point out is the cost factor. We are actually in a dilemma. It's a waste, to install complex wireless communication systems in some rural areas, where they are much underutilized, but at the same time, we want to ensure that those in the rural areas can communicate without such complex systems. If the resources were available, those in the rural areas would most likely opt for some other thing; such as electricity, water, hospitals, schools, etc. All the suggested options (the adoption of wireless

technologies) may solve the problem, but this is subject to the pricing of the service.” (Mbarika, V.W., 2009).

### 3.10.2 MOBILE USERS ACCESS CONSTRAINTS

Access and utilization of the general Internet via mobile devices are less than optimal. Research work done by (Gitau, S. *et al*, 2009) uncovered the following six significant hurdles, which may be insurmountable if, specific training and support are not provided. These limitations greatly limit the general adaptation of mobile 3G services as a *de facto* broadband alternative.

#### **GPRS Settings.**

The first challenge that a would-be mobile internet user comes across is the need to match the handset’s GPRS settings to the requirements of the mobile operator. This can be accomplished using multi-step menu-based USSD (Unstructured Supplementary Service Data) commands. Users are required to have knowledge of the phone specifications (manufacturer, model number). A second method, is to call or visit a customer service centre, which can send the GPRS settings to the phone via SMS. This is less error prone, but also requires prior knowledge of the phone specifications.

#### **Security Settings**

A case study of cellular operators in the South Africa shows that operators have made it impossible to navigate beyond their ‘home’ page without agreeing to their terms and conditions. This is a tedious exercise that distracts the user from their initial navigation goal. Further, one of the operators in South Africa has added their own branded banners both as a header and footer to all websites accessed through their network’s premium services. This practise complicates the web browsing experience and limits the practical use of web browsing through handsets.

#### **WAP / Menu Confusion**

There is a great deal of inconsistency between how handsets present the mobile internet, even within handsets from the same manufacturer. On one participant’s handset, the browser was located within a folder named ‘Fun’, which also contained games and other applications. On another, one could access the browser from the menu by directly selecting a globe labelled ‘WWW’. On others, a menu item said ‘Internet’. Even the use of the globe icon was confusing – on some phones it represented network applications, on others it invoked the browser directly.

#### **Unfamiliarity with Passwords**

All participants were familiar with PINs, having used them to activate their SIM cards, or on ATMs. But when prompted for a password, the new term was confusing; many entered their existing PINs in response. Password and PIN requirements vary in terms of character string length and character types.

#### **No Mobile Version of Web Site**

Practitioners stress the importance of locally-relevant and/or local language content online. The arrival of the mobile internet may represent “two steps back”. All the mobile websites in the research participants found were in English only. Furthermore, many websites do not

have a WML version of their content. For this reason, Opera Mini became popular as the study progressed. It did a reasonable job of scaling the full version of the website onto the handset, allowing the participants to zoom in and out of the various pages and access the links. This provided a workable solution for mobile access to sites that were not available in WML.

#### **Web-mail: Chicken or the Egg?**

The study found that the majority of the web-based e-mail operators do not support mobile-only origination of email addresses. For example, when trying to sign up for a G-mail account, we were instructed “Want a Gmail account? Go to [www.gmail.com](http://www.gmail.com) on your computer”. To circumvent this obstacle, we prompted the participants to use Opera Mini to access to the full version of the website. However, even this presented some challenges; one of the participants’ applications for an email addresses was blocked when they could not use the image-based authentication employed by the registration system. The following message was displayed: *“If your mobile does not correctly display the image below please login successfully on the desktop to enable your mobile login again. Enter the correct password above and then type the characters you see in the picture below.”* Of course, the handset did not display the image correctly, and the user could not access a desktop device.

### **3.10.3 CASE STUDY: SATELLITE BROADBAND SERVICES IN AMERICA**

The market for broadband satellite services has hit critical mass, and is poised for explosive growth. As of September 2008, an estimated 780,000 consumers relied on satellite delivered broadband throughout the United States. Consumers are increasingly choosing satellite-delivered broadband services, responding to new and innovative high-capacity satellite broadband alternatives (SIA 2008). Also refer to paragraph 5.7 for more information on current satellite access network deployments.

Satellites now deliver broadband at speeds ranging from 200 kbps to 5 Mbps for fixed offerings, and from 200 kbps to 500 kbps for mobile offerings. These speeds allow full e-mail, large file transfer, and Internet access, providing users with significant broadband capability wherever they may be located, unlike a traditional 56K dial-up connection. Even higher speeds are planned as next-generation satellites, now under construction, enter into service.

Through the launch and deployment of several new fixed and mobile satellite systems, the satellite industry is making the substantial investments needed to provide increased access to an array of services to support the anticipated increase the number of in satellite broadband subscribers.

Satellite-based broadband systems offer unique scalability. It allows for rapid increase in subscriber numbers simply by adding affordable and easy-to-install remote terminals at user locations once a satellite system is launched and operational. In contrast, expansion of the user base in most terrestrial networks requires significant and costly infrastructure investments (i.e. laying of fibre optic cable or installation of towers and access nodes). As the “take up” rate increases for satellite broadband services, and as new systems come on

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line, economies of scale dictate that equipment prices will become even more affordable and competitive than they are today.

### 3.11 SUMMARY

Chapter 3 concludes Section 1: Reference Knowledge - and provides an overview of the current knowledge within the respective subject fields.

#### **Research Approach**

The objective of this research study is to define a business model for providing broadband services to the Africa market and to capture this business model in a quantitative simulator. This means that the study field is very wide and incorporates all aspects applicable to such an operation, from the business model theory, strategic and innovation management, and billing models to the market dynamics and Africa macro environment.

Given that the focus of this study is the definition of a specific business model and the quantitative evaluation thereof, the literature study was completed to provide a broad reference and understanding of the key applicable knowledge fields. The vast field covered by all these subjects prevents a detailed review of any particular field in this study but rather provides an overview of the relevant fields within context of this study.

#### **Literature research outcome**

The literature study outlines the following information which is of key importance to this research study:

- Business model development can be accomplished by following a defined process provided it makes provision for an iterative approach supported by a design attitude.
- Business models are the actualisation of business strategy and innovation in elements of the business model can unlock sustainable competitive advantages.
- Broadband services in Africa is not a luxury and is required for basic economic development
- ADSL and mobile broadband service addresses a large portion of the market but cannot service the complete market.
- Satellite broadband services are very effectively applied in America to complement ADSL and mobile broadband.
- Development of the correct billing model is critical to the success of providing mass consumer broadband services
- The organisational structure and funding mechanism must be defined with due cognisance of the risks and uncertainties in the Africa market
- The satellite system engineering process determines all the network performance parameters that determine the network cost and service capabilities and which should be tightly integrated with the business model definition process.

## Section 2: Business Analyses

### 4. Market Demand Analyses

This market analysis qualifies the respective market drivers and quantifies the addressable market for satellite data broadcast services.

*To look is one thing, to see what you look at is another.  
To understand what you see is a third.  
To learn from what you understand is something else.  
To act on what you learn is all what really matters.*  
Anonymous

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#### 4.1 INTRODUCTION

This chapter addresses the following research objective:

##### **Objective 1: Quantify the target market**

Broadband Internet access is no longer a pure luxury and there is a substantial underserved mass consumer market demand throughout Africa, both in urban and rural areas. The objective is to quantify the target market sector that cannot be effectively serviced by the current 3G and ADSL services and that can afford a broadband service and that therefore has the need for an alternative technology solution.

The chapter analyses the current status of the broadband market and provides research results to quantify the “gap” in the current broadband market, i.e. the portion of the market sector that cannot be effectively serviced by currently available ADSL or mobile broadband services.

Research work is conducted to qualify the dynamics and nature of this “gap” in the broadband market from the following perspectives;

- The underserved broadband market size, scope and characteristics.
- Case studies in the international market where satellite technology has effectively been deployed to service the “gap” market.
- The dynamics of direct-to-home broadcast satellite-based consumer based services.

### 4.1.1 RESEARCH PROCESS OUTLINE

The rationale to qualify and quantify the addressable market for data broadcast services is outlined in the following table. The different areas of market research that was conducted, the activities involved and the outcomes that were reached for each area (to be discussed in more detail in the rest of this chapter) are described. The research work followed an integrated approach including desktop market research, direct feedback from the market, an analytical formula-based approach, as well as commercial evaluation of the concept in the market.

Market Research Area	Activity	Outcome
<b>Research Area 1</b> External environment	Confirms that the market is deregulated and has strategic support from governments in Africa and that it is considered to be a principal development objective.	<b>Outcome 1</b> Broadband services are a necessity and essential for future economic development.
<b>Research Area 2</b> Market Demand and Affordability	Quantify the size of the addressable market in terms of number of prospective customers and income levels. Demonstrate that there is a large medium income group that can afford satellite services.	<b>Outcome 2</b> There is a large current and future demand for consumer broadband services in Africa.
<b>Research Areas 3</b> Competing broadband services	Document the competing service types, signal coverage and limitations of the current ADSL and mobile broadband services.	<b>Outcome 3</b> Mobile and ADSL broadband services cannot meet the market demand.
<b>Research Area 4</b> Quantify the Addressable Market	Quantify the addressable market for satellite services in terms of projected number of customers, revenues and profits.	<b>Outcome 4</b> There is a sustainable market that need and can afford satellite broadband services.
<b>Research Area 5</b> Market Sectors Analysis	Review and qualify the different Internet applications including consumer broadband services that can best be serviced by satellite access networks.	<b>Outcome 5</b> Satellite networks can effectively service various broadband market sectors.
<b>Research Area 6</b> Satellite related technical services	Review international satellite broadband networks and pay-TV networks.	<b>Outcome 6</b> Data broadcast services are technically feasible for Africa.

**Table 4-1: Market research and quantification process outline**

### 4.1.2 CHAPTER OUTLINE

The information and knowledge gained through the research process is presented in this chapter according to the following outline as displayed in Figure 4-1.

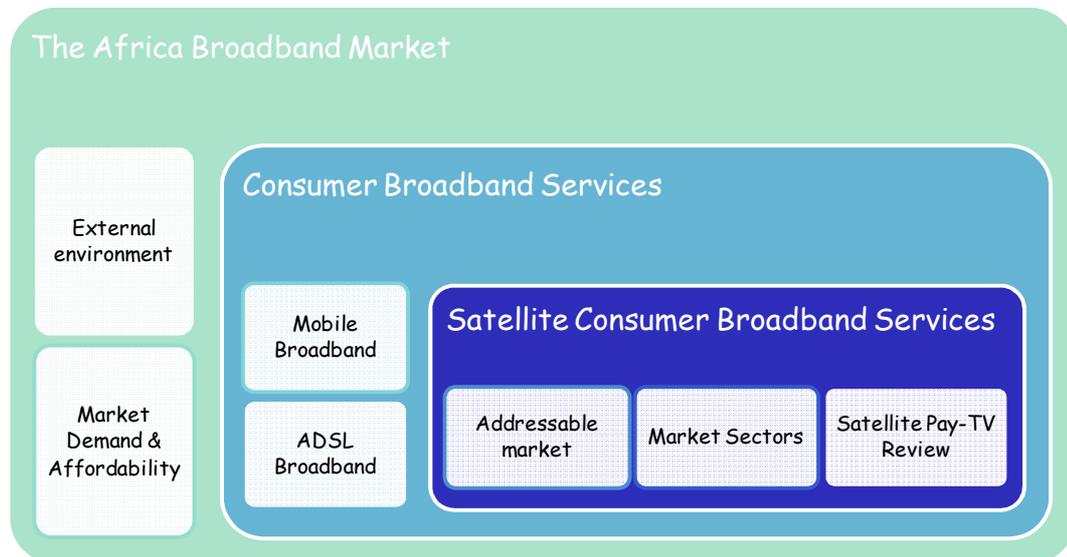


Figure 4-1: Information outline for Chapter 4.

#### **The Africa Broadband Market**

First the Africa broadband market is investigated to define the macro environment for broadband services in Africa. This section includes:

- The external environment
- The market demand and affordability analysis.

#### **Consumer Broadband Services**

Next the specific current consumer broadband services are investigated to determine if the market is fully serviced or alternatively if a market “gap” exists. The study addresses the primary broadband options that are currently available, i.e.:

- Mobile broadband services
- ADSL broadband services

#### **Satellite Consumer Broadband Services**

The final section is on obtaining knowledge of the under-serviced market and the feasibility of this market being serviced by satellite technology. This includes the following research areas:

- Quantify the addressable market, i.e. define the “gap” market;
- Investigate the different market sectors; and
- Provide information on satellite pay-TV services as a reference.

## 4.2 THE EXTERNAL ENVIRONMENT

### 4.2.1 GOVERNMENT AND REGULATORY ENVIRONMENT

#### **Africa's Institutional, Regulatory, and Administrative Reform**

During the last decade, African states have made concerted efforts toward institutional reform in infrastructure. A fair assessment of the current status would be that the institutional reform process is approximately halfway completed (Vagliasindi N., 2009). While some progress has been made, only a few countries have a modern institutional framework that governs the regulatory aspects of the telecommunication sector.

The focus also varies for different types of infrastructure. In telecommunications the emphasis has been on implementing sectoral reforms, and in water supply on improving the governance of state-owned enterprises. Private participation in the supply of infrastructure also varies enormously between different countries and also between different industry sectors (Vagliasindi N., 2009). Since the mid-1990s, many African countries have experimented with various forms of private participation in the provision of infrastructure, with varied results.

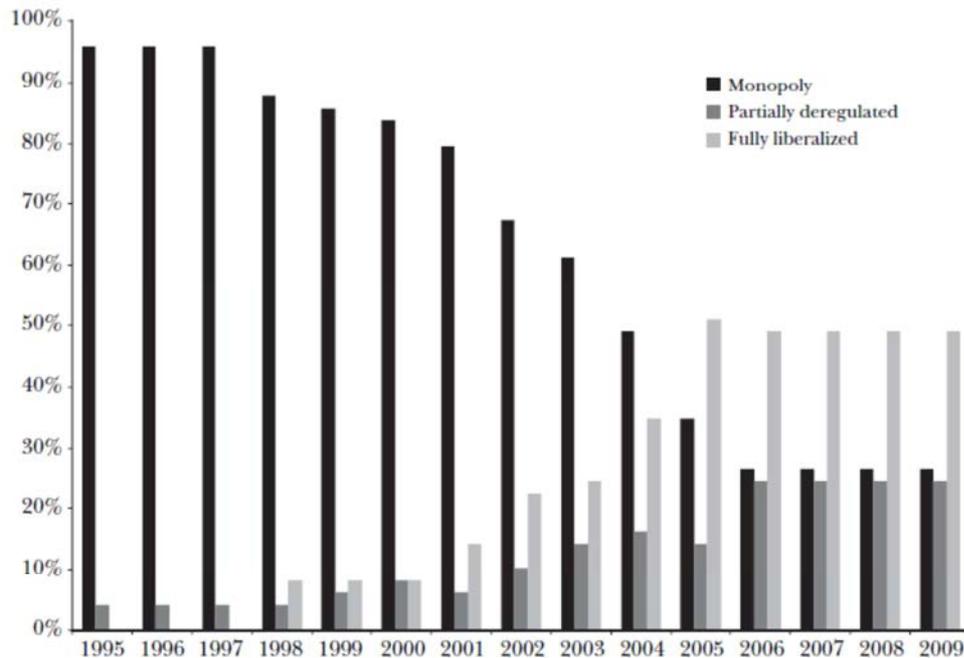
The private sector has proved to be willing to invest in amongst others cellular communications infrastructure, power plants, and container terminals. The number of mobile subscribers and the share of the population receiving mobile signals increased by a factor of 10 in five years, as a result of competition among private operators (ITU, 2010). Private investors have also provided significant finance for thermal power generation (3,000 megawatts) and for container terminals at ports, even if the volumes fall substantially short of requirements (African Studies Centre, 2010).

#### **Deregulation of Telecommunications**

The telecommunications regulatory environment has played a key role in fostering increased adoption of ICT technology in general and of mobile telephony in particular. In 1997 over 75 per cent of countries in sub-Saharan Africa had no mobile phone network, while all of the existing networks were monopolies. By 2009, in contrast, a mobile phone network existed in every country, with 49 per cent of markets fully liberalized, 24 percent partially deregulated, and 26 per cent still operating as monopolies. Certain countries have maintained monopolistic structures (such as the Central African Republic, Chad, and Ethiopia), whereas others have tried to re-establish monopolies (including Benin, Sierra Leone, and Zimbabwe) (Aker and Mbiti, 2010).

There is a strong correlation between mobile phone coverage, the types of services offered, the price of such services, and the telecommunications market structure for a particular country. In markets with limited competition, profit-maximizing firms tend to offer more limited services at higher prices. GSMA, an association that represents the interests of the worldwide mobile communications industry, found that, on average, prices decreased and services increased following market liberalization; average call prices fell by a minimum of

31 percent with partial liberalization and by up to 90 percent following full liberalization. (GSMA 2009)



**Figure 4-2: The Evolution of Cell Phone Market Structure in Africa, 1995–2009**

*Notes:* Data is provided by the GSMA for various years. “Monopolies” refer to those countries where all international mobile traffic was handled by an incumbent. “Partially deregulated” countries are those where markets are deregulated (but no licenses were issued) or where operators must channel their mobile traffic through a fixed line operator. “Fully liberalized” refers to markets where market operators are granted their own international gateway licenses.

Source: Aker and Mbiti, 2010.

In general, one can state that African governments have accepted the necessity to deregulate the telecommunication sectors in order to stimulate and empower the development of telecommunication services, in the process also boosting economic development.

#### 4.2.2 DEMAND FOR BROADBAND SERVICES

The literature research documented in chapter 3 provides an overview and outline of the economic impact of the Internet and the intense demand for broadband services at all levels of society.

The demand for and necessity of broadband services in Africa can be summarized as follows:

##### **Government Programs**

Government programs such as “one-laptop-per-child” and “broadband-for-all” demonstrates the drive on government level and of Pan-Africa initiatives.

##### **Backbone Infrastructure**

The current and planned undersea fibre optic cables will provide extensive growth in the terrestrial connectivity and will result in significant reduction of the bulk wholesale Internet access rates.

##### **Application Developments**

The Internet is being used in many different applications, from education, health and medicine, agriculture and industry in general; this leads to the demand for Internet access as a fundamental need in order to develop the economy.

#### **Outcome 1: Broadband Services in Africa is mandated.**

Deregulation of the telecommunication sector, government broadband and ICT strategies and implementation of large scale undersea fiber cable access systems have created a macro environment that enables the development of broadband access services.

The economic development and social upliftment benefits of mass consumer broadband services have been clearly demonstrated. Governments throughout Africa have clearly communicated their objectives to provide “broadband-to-all” and to support any initiative towards this goal.

## 4.3 MARKET DEMAND AND AFFORDABILITY

### 4.3.1 OVERVIEW OF THE AFRICA BROADBAND MARKET

An overview of the status of the Africa broadband market is required to provide insight into the current penetration and growth levels as indicators of the under-served market demand.

#### Africa Broadband Market Penetration

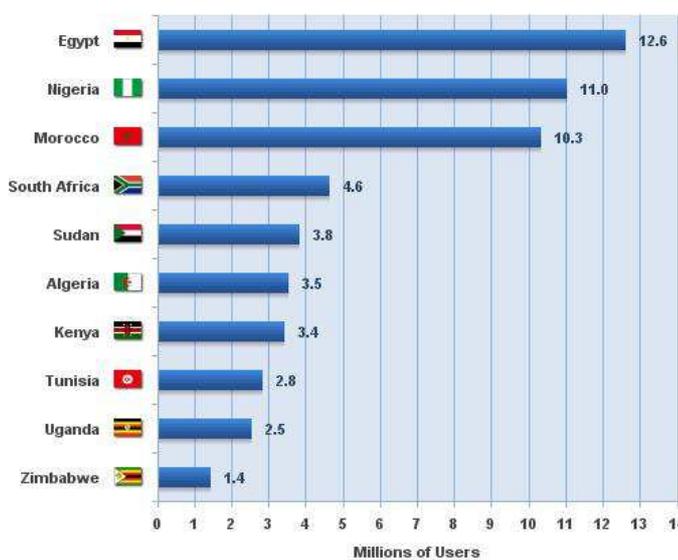


Figure 4-3: Africa Top 10 Internet Countries, June 2009

Source: Internet World Stats –

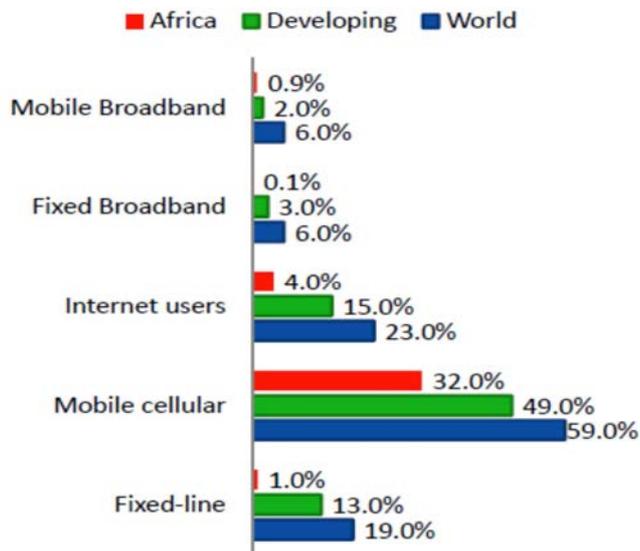
[www.internetworldstats.com](http://www.internetworldstats.com) - June 2009

The average Africa Internet access market penetration is only 6.7% against a world average of 24.9% (Internet World Stats, 2009).

The top 10 African countries in terms of number of Internet users are listed in figure 4-3. Egypt is the leading country with 12.6 million Internet users, while Zimbabwe with 1.4 million users is in the number 10 spot. Refer Figure 4-3.

These statistics clearly show that market penetration and adaptation of the broadband services in Africa is far behind world averages and that the underserved market is huge.

## Africa Telecommunication Services Overview



Currently Africa has the lowest penetration of telecommunication in the world; the comparative figures per 100 inhabitants are; displayed in figure 4-4.

- Mobile broadband: 0.9%
- Fixed broadband: 0.1%
- Internet users: 4%
- Mobile cellular: 32%
- Fixed line: 1%

However, what is of particular importance is the fact that Africa currently has the fastest growing telecommunications market:

**Figure 4-4: Africa Telecommunication Penetration**

Source ITU 2008

- Internet users, in Africa are growing at an annual rate of 30.6% compared to the World average of 17.0% (CAGR (2003 – 2008)).
- Mobile cellular subscriptions in Africa grow by 47%, compared with the average world growth of 23% (CAGR (2003 – 2008)).

These statistics (ITU, 2008) provides an indication of the demand, affordability, growth and potential of providing telecommunication services to the emerging Africa market.

## The South Africa Internet Market

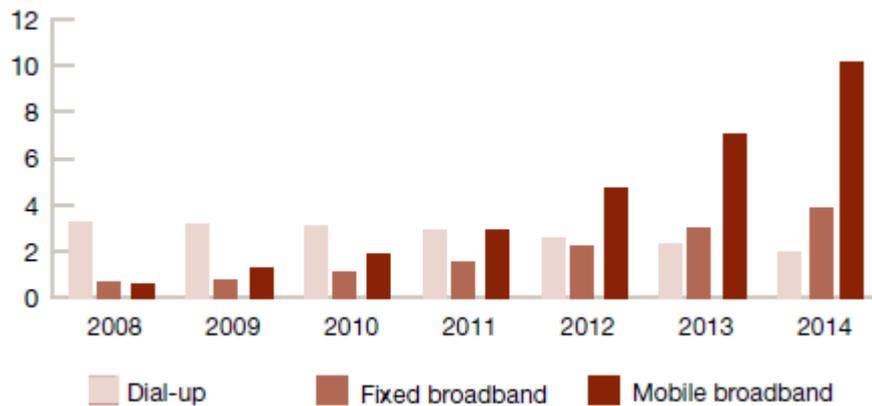
### Growth Indicators

The Internet market in South Africa is still in its development phase. By 2009 fewer than 10% of households had a broadband connection and the mobile Internet access market is only emerging. While only 2.7% of wireless telephone subscribers used their mobile devices to access the Internet, more people accessed the Internet through mobile devices than through a fixed broadband connection.

There were 1.3 million mobile broadband users in 2009 compared with 800,000 fixed-line broadband users. When the 3.2 million dial-up users are included, the total number of Internet users was 5.3 million. Mobile broadband will be the fastest growing technology during the next five years with an expected 50.7% compound increase to 10.1 million users by 2014. By 2014, 72% of broadband users will access the Internet through mobile devices

and 63% of all Internet users will be accessing the internet via mobile devices (PricewaterhouseCoopers 2010) (refer to figure 4-5).

It is also expected that fixed broadband will show significant growth, rising to 3.9 million users in 2014, a 37.3% compound increase. The number of dial-up users will decline by 9.0% on a compound annual basis, falling to 2 million in 2014 from 3.2 million in 2009. Dial-up will account for only 12.5% of Internet users in 2014 compared with 60% in 2009. (PwC 2010).



**Figure 4-5: Internet Users in South Africa from 2008 to 2014**  
 Source: PricewaterhouseCoopers LLP, Wilkofsky Gruen Associates

**Affordability Indicators**

Internet use in South Africa is concentrated among people aged 25 to 45 (refer Table 4-2). Although comprising only 28% of the total population in 2009, 56% of Internet users were in this age bracket. People aged 55 and older were more likely to access the Internet than those aged 25 and under. The proportion of Internet users among the older age group was 27% higher than its share of the population. At the other extreme, only 2% of Internet users were 19 or younger although this age group accounted for 40% of the population.

This unexpected distribution is most likely due the current high cost of Internet access that place Internet access above the average income of students and young users. Another reason could be economic disparities between different sections of the population.

Age Group	% of Internet Users	% of Population
19 and under	2	40
20 – 24	11	12
25 – 34	31	17
35 – 44	25	11
45 – 54	17	9
55+	14	11

**Table 4-2: Distribution of Internet users by age**  
 Source: PricewaterhouseCoopers LLP, Wilkofsky Gruen Associates

## The Africa ICT market

Access to advanced information and communication technology (ICT) is a key factor in the economic and social development of Sub-Saharan Africa. Analysis of economic data at the national level shows that investment in ICT results in a higher rate of long-term economic growth (Roller and Waverman, 2001). At the level of small businesses, research shows that access to basic ICT services can result in a sustained increase in the incomes of the poor in developing countries (Jensen, 2007). Although limited data make the impact of broadband harder to quantify, emerging evidence suggests that access to more advanced ICT services, such as those that require broadband connectivity for delivery, can also have a positive economic and social impact (see, for example, Goyal, 2008 and Qiang and Rossotto, 2009).

As the understanding of the positive impact of ICT has grown, African governments have begun to prioritize the ICT sector and to focus on providing affordable ICT services to as many people as possible. This is clearly vocalized by the following quotation taken from a Rwanda government publication:

*“We have high expectations of ICT and its transformative effects in all areas of the economy and society. Communications technology has fundamentally changed the way people live, work, and interact socially, and we in Rwanda have no intention of being left behind or standing still as the rest of the globe moves forward at an ever increasing pace” (Paul Kagame, in Government of Rwanda, 2006).*

## Broadband for Education

Mahama Usman and Dr. Adrienne Yande Diop of the Economic Community of West African States (ECOWAS) recently jointly stated that "recourse of ICT is unavoidable in the development of West Africa. The 21st century is characterized by the development of ICT, which are essential tools to access to knowledge;" ICTs representing a solution to "the diverse challenges confronting education in the ECOWAS region," dr Diop emphasized (Ecowas Government, 2010).

West Africa is not the only African region that believes in the critical role of ICT in education. A number of organisations have been created to increase the use of ICT in education, including pan-African organisations such as the African Education Knowledge Warehouse (Africa Education Knowledge Warehouse, 2010) and, on a local-level, the South African Institute for Distance Education (South Africa Institute for Distance Education).

At the same time Africa is, however, suffering from a lack of infrastructure that prevents many from accessing the Internet. Less than 1% of internet users worldwide are in Africa, and Internet access remains mostly constrained to capital and large cities, while rural areas lack connectivity. In the world, on average, 1 person out of 22 uses the Internet; in Africa, this figure falls to 1 person out of 825 (International Development Research Centre).

The International Institute for Communication and Development (IICD) views the great need to increase access to computers as a major issue in achieving better education through ICTs. It also recognizes the need for alternative solutions to the Internet, and

encourages the development of off-line based applications (e.g. CD roms) to more effectively reach children and teachers in Internet-deprived areas.

The search for low-cost and practical solutions is of great importance as well, combining for instance the use of free open access platforms with that of low-cost or free second-hand computers provided by the private sector and not-for-profit initiatives. (ICT's for Education, 2007). The benefits of ICTs to primary education will, however, remain fictional to many Africans until such issues are fully addressed, in addition to even more basic needs such as access to electricity and other infrastructures. Against this background there is dire need for innovativeness on the part of good corporate citizens in the ICT sector.

A relevant example is the Ericsson Millennium Villages initiative: it tackles low connectivity issues by enhancing the state of local infrastructures and by developing applications useful to villagers, e.g. for census purposes, to record the births and deaths of villagers, as well as to record their medical history. This example illustrates the fact that only when ICTs are applied innovatively and are adapted to Africa's conditions, will they fully contribute e.g. to enhancing the basic human right to health and education.

#### 4.3.2 **CONSUMER MARKET MEASUREMENT**

##### **SAARF Living Standards Measure**

The current standard reference to measure the adoption of telecommunication services in a market is to measure teledensity. Teledensity is defined as the number of users who has access to the service as a percentage of the total population of the country. This is a very important reference to measure the overall penetration of telephone services in a country and is mostly used as a reference for government programmes.

What teledensity does not provide is an indication of the level of adoption of the service as a percentage of the market potential, where market potential is defined as that portion of the population that can be regarded as potential users of such a service.

In order to provide a more specific analysis of the consumer market, the South Africa Advertising Research Foundation (SAARF) Living Standards Measure (LSM) was developed (South Africa Advertising Research Foundation). The LSM has become the most widely used segmentation tool in South Africa and Africa. It is a means of segmenting the South African market that cuts across race, gender, age or any other variable used to categorise people. Instead, it groups people according to their living standards.

The LSM references, as displayed in Table 4-3 below, provide a better understanding of the size of the potential Internet access market. For Internet Access services the LSM 7, 8, 9 and 10 consumer group can be regarded as the realistic target market; this is a total of 26,2% of the population which equates to 11 million potential subscribers in South Africa. It is against this potential that Internet access services must be evaluated.

**Summary of the Living Standards Measure (LSM) Groups**

	Demographics	Media	General
<b>LSM 1</b> <b>6.1%</b>	Female 16-24, 50+ Primary Completed Rural, Traditional hut R1003 per month	Radio primary medium Commercial radio, mainly African language services (ALS)	Minimal access to services Minimal ownership of durables, except radio sets
<b>LSM 2</b> <b>12.2%</b>	Female 16-34 Primary completed Rural, Matchbox house R1210 per month	Commercial radio, mainly ALS	Water on plot Minimal ownership of durables except radio sets and stoves
<b>LSM 3</b> <b>12.6%</b>	16 – 24 Up to some high Rural, Matchbox house R1509 per month	Commercial Radio mainly ALS TV: SABC 1 Outdoor advertising	Electricity, water on plot Minimal ownership of durables, except radio sets and stoves Activities – lottery tickets
<b>LSM 4</b> <b>14.9%</b>	16 – 49 Up to some high R1924 per month	Commercial radio, mainly ALS Metro FM TV: SABC 1,2 , eTV Outdoor	Electricity, water on plot, flush toilet. TV sets, Hi-Fi/radio set, electric hotplates, fridge Activities – stockvel meeting, lottery tickets, buy take away food
<b>LSM 5</b> <b>13.5%</b>	Male 16-49 Up to matric, Urban  R2,674 per month	Commercial radio, mainly ALS Metro FM TV: SABC 1,2,3 and 4TV Daily / Weekly news- papers, Magazines Outdoor	Electricity, water, flush toilet TV sets, Hi-Fi radio set, stove, fridge. Activities: Started exercising, painted interior of house, stokvel meeting, purchase take-away food, lottery tickets
<b>LSM 6</b> <b>14.4%</b>	Male 25-49 Matric and higher, Urban  R4 400 per month	Wide range of commercial / community radio TV: SABC 1,2,3, e.tv Daily/Weekly Newspapers, Magazines Cinema and Outdoor	Electricity, hot running water, flush toilet Ownership of a number of durables plus cell phone Participated in a number of activities

<b>LSM 7 7.8%</b>	25+ Matric and higher, Urban  R6 880 per month	Wide range of commercial /community radio TV: SABC 1,2,3, e.tv, M-Net Daily/Weekly Newspapers, Magazines Accessed internet 4 weeks Cinema and Outdoor	Full access to services Increased ownership of durables plus motor vehicle Participation in all activities
<b>LSM 8 5.7%</b>	Female 35+ Matric and higher, Urban  R9 304 per month	Wide range of commercial /community radio TV: SABC 1,2,3, e.tv, M-Net, DStv Daily/Weekly Newspapers, Magazines Accessed internet 4 weeks Cinema and Outdoor	Full access to services Full ownership of durables, incl. DVD, PC and satellite dish Increased participation in activities
<b>LSM 9 6.7%</b>	Female, 35+ Matric and higher, Urban  R12 647 per month	Wide range of commercial /community radio TV: SABC 2,3, e.tv, M-Net, DStv Daily/Weekly Newspapers, Magazines Accessed internet 4 weeks Cinema and Outdoor	Full access to services Full ownership of durables, Incl. PC, DVD and satellite dish Increased participation in activities, excluding stokvel meetings
<b>LSM 10 6%</b>	Male, 35+ Matric and higher, Urban  R19 974 per month	Wide range of commercial /community radio TV: SABC 2,3, e.tv, M-Net, DStv Daily/Weekly Newspapers, Magazines Accessed internet 4 weeks Cinema and Outdoor	Full access to services Full ownership of durables, Incl. PC, DVD and satellite dish Increased participation in activities, excluding stokvel meetings

**Table 4-3: Summary of South African LSM groups**

### Drumbeat Africa Regional LSM Data

The Drumbeat Africa Regional LSM data as displayed in Table 4-4 provides consumer data for all sub-Saharan African countries, having been developed from a sample of nine sub-Saharan countries. The DAR LSM segmentation has 17 groups, where DAR LSM 1 has the lowest living standard and DAR LSM 17 the highest in Sub-Saharan Africa.

DAR LSM	% of Population	DAR LSM Comment
17	1.54%	All LSM 17s have access to the Internet or e-mail at home and in the office. They prefer high speed Internet and use this medium for communication, research and information gathering.
16	0.78%	Around 90% have accessed the Internet and used e-mail, both at work and at home.
15	1.05%	Usership of the Internet and e-mail is very high, accessed both at work and at home for business and personal communications as well as personal information gathering. LSM 15s are heavily exposed to television (including DSTV), radio and print.
14	1.10%	They use the Internet and e-mail, usually accessed at work for business communications. Over a fifth own personal computers at home.
13	1.78%	Around 95% of this group access the Internet, usually at work for personal communications but incidence of personal computers at home is evident. About one in two LSM 13s have a satellite dish
12	2.34%	Around 60% are exposed to the Internet and e-mail with almost one half being exposed to DSTV. Internet and e-mail are accessed mainly for business purposes at work.
11	3.29%	Over a third of this group have access to DSTV, Internet and e-mail. Those who access the Internet do so mainly for business purposes at work or for educational purposes.
10	3.26%	Almost all have access to radio, television and print media while about a third has access to the Internet, e-mail and DSTV. Less than 10% have personal computers at home. They typically have fixed telephones as well as cell phones.
9	5.11%	LSM 9 is exposed to a wide range of media. The majority of them have access to radio, television and print. There is some evidence of access to DSTV, the Internet and e-mail. Those who access the Internet do so mainly for business purposes at work. Less than 5% have personal computers at home. Half have vehicles either belonging to them or the company.
8	7.86%	In this LSM we begin to see some exposure to the Internet, mostly in Internet cafés. Those with access to the Internet use it principally for personal use. In Angola, however, the majority of LSM 8s who use the Internet access this medium in the work environment, mainly for business and personal research.
7	9.69%	No reference to Internet or PC's
	37.80%	Total

**Table 4-4: DAR LSM Population Data**  
 Source: Research International Data

A single tool for the entire region, the DAR LSM predictor questionnaire, is used during a quantitative research interview, recruitment of research respondents for qualitative research, in classification of staff by HR departments, or in segmentation of client bases and various other screening processes.

The market data represented by DAR LSM can either be analysed in its separate categories, e.g. DAR LSM 1,2,3,4, etc, for detailed operational and marketing planning, or different categories can be combined, e.g. creating 6 Super-groups i.e. DAR LSM 1-3, 4-6, 7-9, 10-12, 13-15, 16-17, for normal strategic planning.

Table 4-4 provides an overview of the DAR groups with Internet activity and the extent of this activity. This indicates that 37.8% of the Africa population is Internet literate and forms the potential market sector.

### **The New African Middle-Class**

If ever there was a continent of haves and have-nots, then it has to be Africa – land of extremes. These extremes apply to resources, politics, opportunity and wealth. While much attention is paid to the plight of so many Africans living in poverty, this often results in a skewed view of the way that people on this continent are living; more specifically there is little knowledge at all of the emergence of an African middle class.

*Vivien Marles, Synovate's Pan Africa Research Director*, states that parts of key cities, such as Nairobi, have an almost European feel to them. "These are modern, high-rise cities, with four-wheel-drives and Mercedes Benzes on the streets, and some of the most amazing houses you've ever seen anywhere. There's a lot of poverty and corruption, that's true, but people have it wrong if they think its all mud huts. There's a lot of money here – it's just very concentrated and very slow to trickle down" (EMS Africa Unveiled 2010).

EMS AFRICA is the first ever regional media consumption survey of Africa covering the top 15% aged 25-64 (EMS Africa Unveiled 2010). The criteria for selection was based on either income or Living Standard Measures (LSM) with population universe 2,7 million (EMS Africa Unveiled 2010).

While in the past wealth has been in the hands of a very exclusive few, and just about everyone else was poor, in many African countries a middle class is evolving. These people are probably in business, maybe in academia, own property and travel regularly.

Affluent Africans are young, multi-lingual, like to buy well-known brands and are willing to pay top dollar for quality. In the EMS Africa sample (EMS Africa unveiled 2010):

- 34% are aged 25-34
- 33% are aged 35-44
- 27% are aged 45-54
- 90% understand English
- 26% understand French
- 24% are members of a private members' club

- 40% have a fitness centre or gym membership
- 22% earn the equivalent of €40,000 or more
- 2% have personal income of €100,000 or more

These people like to enjoy their wealth, and 64% say they're usually among the first people to buy technologically innovative products. Amongst EMS Africa respondents, 79% say they prefer to buy well-known brands, 91% say they don't mind paying extra for quality, and 69% own at least two cars. In the past year, 7% have bought a luxury watch, and 26% have bought designer shoes in the same period.

From an Internet access market perspective – this group will certainly consider Internet access a must-have and would easily be able to afford a premium quality service product.

### 4.3.3 MARKET QUANTIFICATION

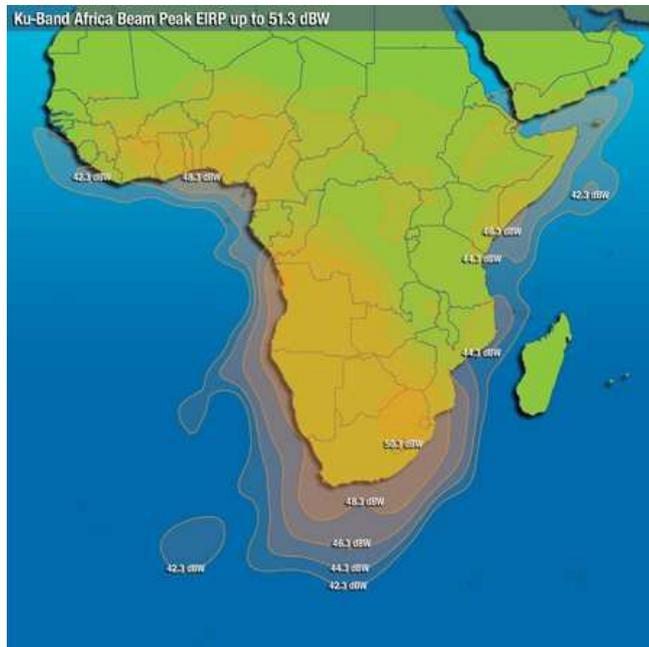
#### Methodology and Reference

To quantify the potential market for satellite broadband services the focus area needs to be defined and the market metrics applied. For this research work the following methodology and market definition was applied.

Step	Activity
<b>Step 1 Satellite Selection</b>	Select the preferred communication satellite. This defines the communication signal coverage and thus the maximum geographical target market.
<b>Step 2 Country Selection</b>	Within the satellite coverage area select the target countries based on 1 <sup>st</sup> order market information as well as organisational delivery capability.
<b>Step 3 Demographics</b>	Define and document the current country demographic and applicable market subscriber information.
<b>Step 4 Target market selection</b>	Based on the available LSM data for each country, select the target consumer groups.
<b>Step 5 Calculate the market size</b>	Apply the applicable LSM population data and calculate the size of the total broadband target market.

Table 4-5: Market quantification methodology

## Step 1: Satellite Selection



**Figure 4-6: The New-Dawn satellite communication coverage pattern**

Source: [www.intelsat.com](http://www.intelsat.com)

Communication satellites provide signal coverage, i.e. signal footprint over different geographical areas. The signal footprint determines the maximum market coverage area and set the outer limits of the potential addressable market.

The selection of a suitable communication satellite for a service is based on a wide variety of factors including market, commercial, technical and operational.

These criteria are discussed in more detail later in this study; for now only the signal coverage area is considered in order to calculate the market potential.

For this study the New Dawn satellite operated by Intelsat and located at 33° Eastern longitude is selected. The New Dawn satellite is a joint venture between Intelsat, the largest international operator of satellites and South African funded investors. It is ideally located directly above Africa and provides good communication coverage of Sub-Sahara Africa with strong focus areas in Southern Africa and Nigeria.

## Step 2: Country Selection

The list of potential target countries is selected based on an integration of the technical specifications of the satellite, as well as, specific business and operational requirements. The organisational requirements depend on the specific service and different criteria can apply for different services. The following criteria were applied to the selection of countries for inclusion in the satellite broadband service business model.

### Signal coverage

It is a prerequisite that the satellite provides acceptable communication signal coverage throughout the country. Partial coverage of a country complicates service distribution and marketing activities and can only be considered under special conditions.

**Established DStv Operations**

The provision of satellite broadband services has very similar distribution, implementation and support operational business requirements than the current DStv pay-TV service in Africa. Countries with current strong DStv subscriber bases are thus preferred as target markets for broadband services.

**Established Relationships**

Provision of broadband services in a country must be done in compliance with the local telecommunication regulatory requirements. Established business relationships with operating ISP’s within the country greatly benefit the initial business development efforts.

**Established Distribution**

Delivery of services to the consumer market requires strong equipment distribution channels and the availability of established distribution facilities to enhance the business process. This is however not a prerequisite, since alternative distribution channels can be established in selected countries.

**Country Selection Summary**

Based on the criteria discussed, the countries selected for the satellite broadband service are summarised in the following table.

African Country	Signal Coverage	Strong DStv	Established Relationsh	Establish Distrib.	Country Selection
Angola	Yes	Yes	Yes	No	Yes
Botswana	Yes	Yes	Yes	Yes	Yes
DRC	Yes	Yes	Yes	No	Yes
Côte d'Ivoire	Yes	No	Yes	No	Yes
Ghana	Yes	Yes	Yes	No	Yes
Kenya	Yes	Yes	Yes	No	Yes
Lesotho	Yes	No	Yes	Yes	Yes
Malawi	Yes	Yes	Yes	No	Yes
Mozambique	Yes	Yes	Yes	Yes	Yes
Namibia	Yes	Yes	Yes	Yes	Yes
Nigeria	Yes	Yes	Yes	No	Yes
Swaziland	Yes	Yes	Yes	Yes	Yes
Tanzania	Yes	Yes	Yes	No	Yes
Uganda	Yes	Yes	Yes	No	Yes
Zambia	Yes	Yes	Yes	Yes	Yes
Zimbabwe	Yes	Yes	Yes	Yes	Yes

**Table 4-6: Target market country selection schedule**

### Step 3: Country Demographics

The applicable country information is compiled using current available statistical data and market information with regards to the broadband and pay-TV subscriber numbers.

Africa Country	Population	Major Cities	Population per City	Remaining Population	% Urban	% Rural	Broadband Subscribers	Pay-TV Subs
Angola	18 993 000	Luanda Huambo	4 511 000 1 034 000	13 448 000	58%	42%	41 023	169 852
Botswana	1 978 000	Serowe Gaborone	582 394 284 839	1 110 767	60%	40%	48 486	20 243
DRC	67 827 000	Kinshasa Lubumbashi Mbuji-Mayi Kisangani	8 401 000 1 543 000 1 488 000 812 000	55 583 000	35%	65%	37 201	13 322
Ghana	11 820 542	Accra Kumasi Kumasi	2 269 000 1 834 000 1 834 000	5 883 542	52%	48%	64 846	39 330
Kenya	40 863 000	Nairobi Mombasa	3 375 000 1 003 000	36 485 000	22%	78%	162 634	54 629
Lesotho	2 084 000	Maseru	220 000	1 864 000	27%	73%	10 313	
Malawi	15 692 000	Lilongwe Blantyre	821 000 856 000	14 015 000	20%	80%	105 210	17 732
Mozambique	23 406 000	Maputo Matulo Beira	1 589 000 793 000	21 024 000	38%	62%	63 213	19 560
Namibia	2 212 000	Windhoek	342 000	1 870 000	38%	62%	69 927	45 732
Nigeria	140 879 000	Major cities	25 132 000	115 747 000	50%	50%	845 672	379 728
South Africa	48 687 000		29 699 070	18 987 930	61%	39%	3 808 546	2 800 000
Swaziland	1 202 000	Mbane	74 000	1 128 000	25%	75%	9 360	3 385
Tanzania	7 945 455		1 986 364	5 959 091	25%	75%	94 726	21 884
Uganda	28 699 000	Kampala	1 535 000	27 164 000	14%	86%	108 697	242 525
Zambia	13 257 000	Lusaka	1 413 000	11 844 000	36%	64%	20 294	49 068
Zimbabwe	12 644 000	Harare	1 606 000	11 038 000	38%	62%	135 562	30 759

**Table 4-7: Demographic data applicable to the selected target market countries**

## Step 4: Target Market Sector Selection

### Africa Market

The primary and secondary Africa markets are defined as an allocated percentage value of LSM groups 17 down to 8, with LSM groups 17 to 13 the primary market and LSM15 to 8 the secondary market. LSM groups 15, 14 and 13 form part of both the primary and secondary market. (Refer to the Business model sheets in Appendix A for detail).

### South Africa Market

For South Africa the primary market is LSM group 10 and 9 and the secondary market is LSM groups 7, 8 and 9. (Refer to Business models sheets for detail)

## Step 5: Target Market Calculation

The total consumer target market is calculated by applying the primary and secondary market percentage values for Africa and South Africa to the country household data.

The respective target market percentages are calculated through the LSM data application that is applied to the total households per country.

The LSM data has been adjusted to make provision for the lower distribution of higher LSM groups in the rural areas.

This yields a figure of 11 million households as the total target market for broadband service.

<b>Total consumer market based on LSM data</b>			
Country	Total Households	Primary Market	Secondary market
<b>Africa</b>		<b>4.11%</b>	<b>7.24%</b>
<b>South Africa</b>		<b>8.85%</b>	<b>8.48%</b>
Angola	3 162 393	130 085	228 815
Botswana	449 438	18 488	32 519
DRC	11 293 404	464 554	817 134
Ghana	4 958 333	203 961	358 760
Kenya	7 960 000	327 435	575 946
Lesotho	491 910	20 235	35 592
Malawi	2 957 198	121 644	213 968
Mozambique	4 580 000	188 398	331 386
Namibia	395 683	16 276	28 630
Nigeria	25 783 333	1 060 597	1 865 553
South Africa	12 493 766	1 105 698	1 059 471
Swaziland	269 663	11 093	19 511
Tanzania	7 945 455	326 836	574 893
Uganda	5 945 455	244 566	430 183
Zambia	2 157 191	88 736	156 084
Zimbabwe	2 133 106	87 745	154 341
<b>Total</b>	<b>92 976 328</b>	<b>4 416 348</b>	<b>6 882 787</b>
<b>Total</b>			<b>11 299 136</b>

**Table 4-8: Calculation of the expected target market**

**Outcome 2: The consumer market segment for satellite data broadcast services is large and can afford the service.**

Current broadband market penetration is still low and expected to grow rapidly as part of the general telecommunication market sector. Using consumer market measurement data and applying this to current household data of selected countries, the potential market for a satellite-based broadband household service can be calculated.

This target market calculation quantifies the target market for broadband services with due consideration to the socio economic requirements, such as household power infrastructure, computer literacy and the consumer desire to participate in the digital economy.

#### 4.3.4 DATA CORRELATION

The market research study heavily relies upon the accuracy and reliability of the market data that was obtained from various public sources as referenced in this text. In most cases it was not possible to obtain more than one independent source of the same data regarding population sizes or the number of users of a specific service.

In order to validate the reliability of the data it was decided to conduct a correlation study to verify if the data from different sources, as well as the data representing different countries corresponds regarding the patterns of usage for different types of technology enabled services. The set of base usage figures per type of service and per country that was used for this validation exercise is displayed in Table 4-9.

For this purpose, two types of correlation analyses were performed:

- The first analysis verifies the degree to which the usage patterns for different types of services correspond between different countries. For this purpose the correlation coefficient was calculated, over all countries forming part of this study, and between the usage or subscriber numbers for different types of services. These results would e.g. indicate whether the usage pattern over all countries for broadband subscribers is correlated with the usage pattern over the same countries for DSTv subscribers. The results appear in Table 4-9. It can be seen that all of the usage patterns are strongly positively correlated, which would have been expected, as there are significant cultural similarities between most of the countries involved, and as the respective market segments come from more or less the same LSM levels.

	Population	Total Households	BB Subscribers	DStv Subscribers	Internet Users
Population	1.00	0.96	0.40	0.47	0.88
Total Households	0.96	1.00	0.50	0.56	0.86
BB Subscribers	0.40	0.50	1.00	0.97	0.31
DStv Subscribers	0.47	0.56	0.97	1.00	0.41
Internet Users	0.88	0.86	0.31	0.41	1.00

**Table 4-9: Data Correlation Results Schedule**

- The second analysis verifies if the relative usage levels for different services corresponds between the different countries. For this purpose we calculated the correlation coefficient over the usage figures for specific services and between different countries. These results would e.g. indicate if the relative level of usage of all services in South Africa is correlated to the level of usage of the same services in the DRC. The results are displayed in Table 4-10. In order to limit the number of correlation coefficients to be displayed it was decided to compare all countries against South Africa as a reference case; these correlation coefficients appear in the last column. It can be seen that the relative usage levels for the different types of technology enabled services are almost identical for all of the countries, which provides significant support for the robustness of the market research data – should these usage patterns have been very different for the different countries it would have cast some doubt on the reliability of the source of market research data, as there is no reason to expect significantly different consumer behavior from the same LSM levels of the different country populations.

Country	Population	Total Households	BB Subscribers @ \$50 aver	DStv Subscribers	Internet Users	Correlation between countries for all services
Angola	18 993 000	3 162 393	41 023	169 852	607 400	0.99660
Botswana	1 978 000	449 438	48 486	20 243	120 000	0.99929
DRC	67 827 000	11 293 404	37 201	13 322	365 000	0.99619
Ghana	11 820 542	4 958 333	64 846	39 330	1 297 000	0.98068
Kenya	40 863 000	7 960 000	162 634	54 629	3 995 500	0.99833
Lesotho	2 084 000	491 910	10 313		76 800	0.99930
Malawi	15 692 000	2 957 198	105 210	17 732	716 400	0.99843
Mozambique	23 406 000	4 580 000	63 213	19 560	612 500	0.99806
Namibia	2 212 000	395 683	69 927	45 732	127 500	0.99692
Nigeria	140 879 000	25 783 333	845 672	379 728	43 982 200	0.96374
South Africa	48 687 000	12 493 766	2 800 000	850 000	5 300 000	1
Swaziland	1 202 000	269 663	9 360	3 385	90 000	0.99950
Tanzania	7 945 455	1 589 091	94 726	21 884	676 000	0.99896
Uganda	28 699 000	5 945 455	108 697	24 252	3 200 000	0.99831
Zambia	13 257 000	2 157 191	20 294	49 068	816 700	0.99704
Zimbabwe	12 644 000	2 133 106	100 000	30 759	1 422 000	0.99609
<b>Total</b>	<b>438 188 997</b>	<b>86 619 964</b>	<b>4 581 602</b>	<b>1 739 476</b>	<b>63 405 000</b>	

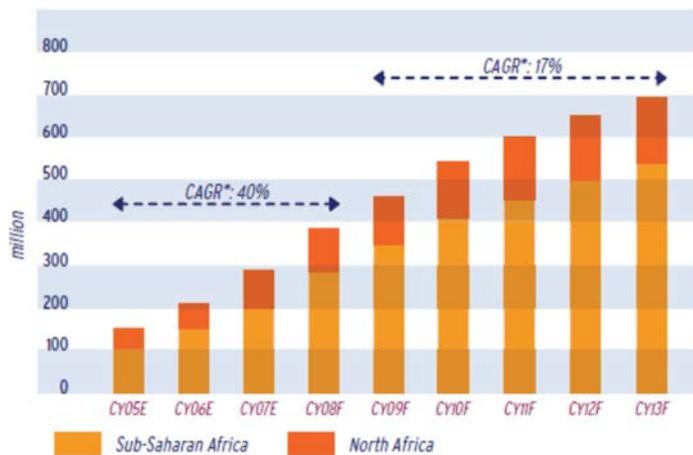
**Table 4-10: Data Correlation Input Data & Results**

In conclusion, we can state that the above correlation study provides a sufficient level of validation of the robustness of the available market size and consumer usage data, to allow us to accept this data as basis for the rest of this research work.

## 4.4 MOBILE BROADBAND SERVICES

The successful development of the GSM mobile telephony market provides a very good reference case for the introduction of advanced technology in a mass consumer market. Analysis of the key success factors of GSM market will yield some of the principles and concepts that must be included in an Internet billing model aimed at the Africa consumer market.

### 4.4.1 GROWTH AND MARKET PENETRATION



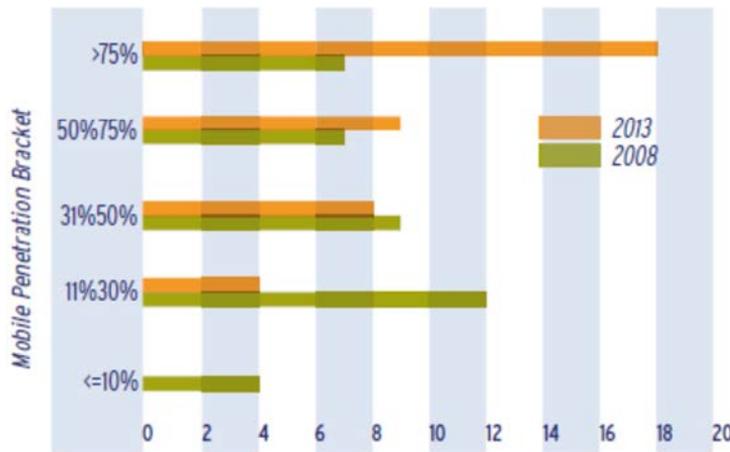
**Figure 4-7: Evolution of Africa's mobile subscriber base, 2005-2013\* CAGR: Compound Annual Growth Rate;**  
 Source: AfricaNext, 2009

By all accounts the growth of the African mobile industry over the past decade has been remarkable. By the end of 2008 the total number of mobile subscriptions in Africa reached about 375 million, up from 280 million in 2007 (AfricaNext, 2009).

The overall subscription base is nearly three times larger than it was in 2005 and has grown by a compound annual average rate of around 40% over the 2005-2008 period.

Where the pattern of growth was initially confined to a small sample of countries, it is now widespread; by 2008 two thirds of African markets had a mobile phone penetration higher than 30% (AfricaNext, 2009). A few African markets have broken the once mythical 100% mobile penetration threshold, and projections of similarly high penetration levels across the board are no longer viewed to be unrealistic.

As the subscriber base has expanded, so has the market's revenue performance. Revenues generated from mobile services in Africa reached around USD 45 billion in 2008, up 20% from 2007, and revenue growth is expected to remain at least in the high single to low double digit range over the next five years (AfricaNext, 2009). Even as overall economic growth slowed in 2009, the African mobile market has continued to expand, seemingly impervious to the surrounding global economic downturn and a tightening in consumer spending. Figure 4-8 indicates the number of countries, which has reached the respective market penetration levels, with the 7 countries at 75% penetration in 2008 expecting to increase to 18 countries by 2013.



This phenomenal growth rate of mobile service in the Africa market is an undisputed proof that the Africa market is a lucrative market for high-technology based services that is offered at affordable levels.

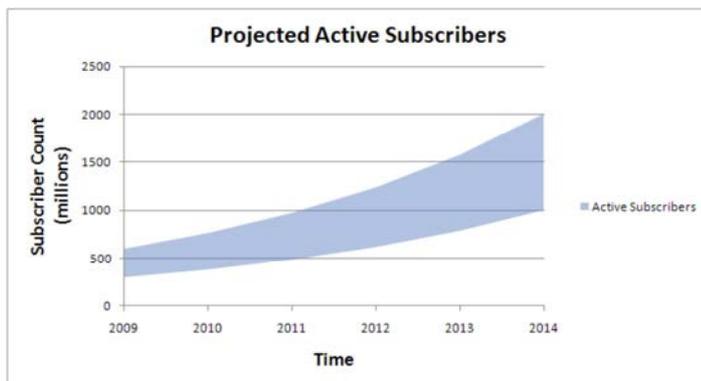
**Figure 4-8: Distribution of mobile penetration of the population in Africa, 2008 and 2013 (forecasts)**  
 Source: AfricaNext, 2009

#### 4.4.2 MOBILE BROADBAND BUSINESS CHALLENGES

##### Mobile Subscriber Data Revenues

Despite the phenomenal growth of mobile voice services since its inception in the early 2000's, not all is well with the mobile market. It is important to maintain perspective when discussing the mobile Internet – for all we've seen, heard and experienced history will remember these years as the infancy of wireless broadband. Estimates vary based upon the exact classifications (for example, "users" versus "subscriptions"), but it's generally accepted that in 2009 there were globally between 300 million (Strategy Analytics) and 600 million people experiencing the Internet on a mobile device, accounting for roughly \$60 billion (Ross, J., 2010) in data revenues.

While significant, these numbers are dwarfed by projections suggesting between 1 billion and 2 billion users by 2014,

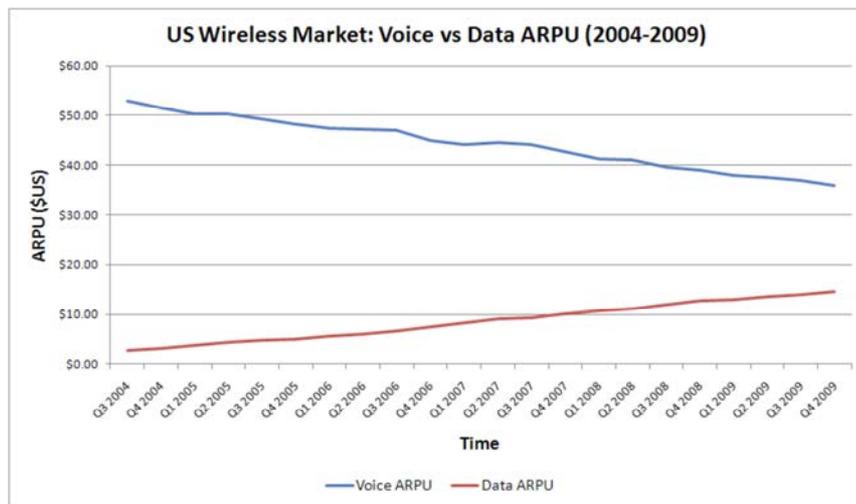


and revenues well in excess of \$100 billion. This, however, also represents one of the points of concern for wireless providers – while the number of users is expected to triple or even quadruple in the next five years, revenue is predicted to only double.

**Figure 4-9: Projected Active Mobile Internet Subscribers**  
 Source: Sandvine Report.

At the same time, network operators are making infrastructure investments to satisfy the growing appetite of subscribers, pressuring the bottom line. Furthermore, mobile service providers are grappling with falling voice ARPU (average revenue per user) and are exploring ways to offset those declines by introducing usage-based plans that increase data ARPU. Additionally, many operators are trimming operational expenses by improving network efficiencies.

According to analyst firm ABI Research (ABI Research Report, 2010), mobile voice revenue will peak in 2010, at \$580 billion, before starting to contract from 2011 onwards. Additionally, global end-user average revenue per user (ARPU) per month dropped globally between 6 percent and 9 percent from Q3 2008 to Q3 2009. In the United States, from Q3 2009 to Q4 2009, voice ARPU per month declined by \$0.98 and was only partially offset by a \$0.53 increase in data ARPU.



to voice and data in the United States from 2004 through 2009. If these trends continue unabated, voice ARPU and data ARPU will intersect in 2013 at roughly \$23 each.

Figure 4-10: Average-revenue-per-user (ARPU) for voice and data services in the US wireless market

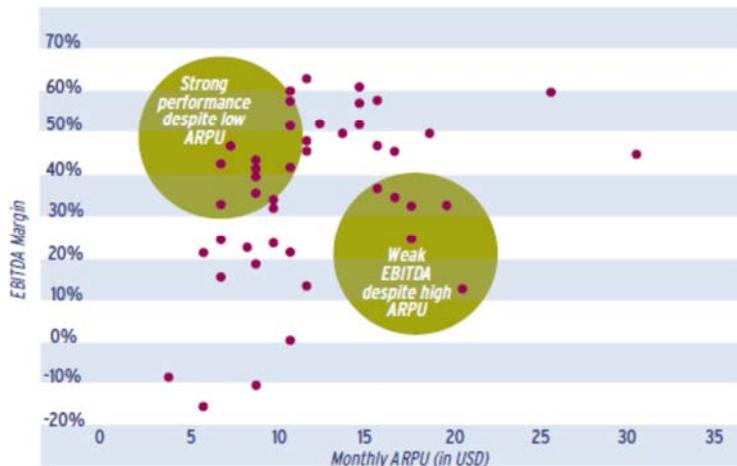
Source: ABI research report

Although this is in general good news for the mobile industry it indicates that in areas where subscribers are accustomed to unlimited usage for a flat rate, network operators will face challenges. These challenges will drive the need to define a better and more optimal billing model for data services on mobile networks.

### Business Case Compression

Without disregarding the achievements of the African mobile industry, the outlook is as uncertain as it is promising. While the number of subscribers continues to grow, marginal revenue per subscriber has declined precipitously, reaching less than USD 5 per month in many markets. This has redefined the traditional parameters of telecoms profitability (for example reducing the reliance on average revenue per user) and compelled operators to optimize their models to remain viable. Profitability levels remain low outside of the top tier operator group, as the business undergoes a dramatic transformation from premium, value-based models to the scale- approaches more typical of commodity businesses.

African markets are also challenging traditional paradigms of mobile profitability analysis; for example, average revenue per user (ARPU) has long been one of the most popular indicators of operator performance. This is largely a matter of convenience; it is a relatively easy concept to grasp and does have some value as an indicator of revenue generation. In African markets however, ARPU has emerged as a poor indicator of operator performance –



specifically once it falls below USD 10. Many African operators are generating high margins, as illustrated below, despite ARPU levels that are considered low; to date, market share and capital expenditure levels have emerged as the best indicators of profitability.

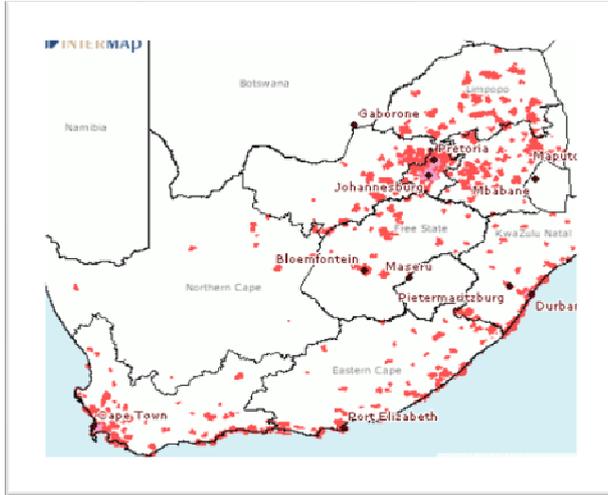
**Figure 4-11: African mobile ARPU vs Ebitda margin. Based on data for FY2008/09**  
 Source: AfricaNext, 2009

The African mobile model, long built on the spending power of high end consumer segments and urban areas, is now about building volumes and driving profits through economy of scale efficiencies and the sheer power of massive numbers. Research conducted in a sample of 35 African markets indicates that operating expenses are growing faster than revenues, and that at least a third of all African mobile operators are not profitable on a net income basis. Capital requirements are higher, with the cost of mobile licenses on the rise and the need to build scale necessitating increased investments. Intense competition has raised concerns of increased negative returns and long term consolidation.

With these challenges have come a new set of opportunities, as the mobile industry is now seeking to achieve for the Internet market what it did for voice telephony. The obstacles are numerous: limited infrastructure in key portions of the Internet network value chain; high cost of bandwidth and customer equipment, low literacy levels and small addressable markets. And yet, the opportunity carries this perennially unique African blend of highly promising potential and often uncertain returns, setting the stage for the next phase of mobile market expansion on the continent.

4.4.3 **NETWORK COVERAGE LIMITATIONS**

**Macro Level Limitations**



By 2010 the Vodacom 3G network coverage in South Africa was significant (BMI, 2010) when considering the large metropolitan areas covered, yet when considering the service coverage on a national basis it is very and limited. See figure 4-12.

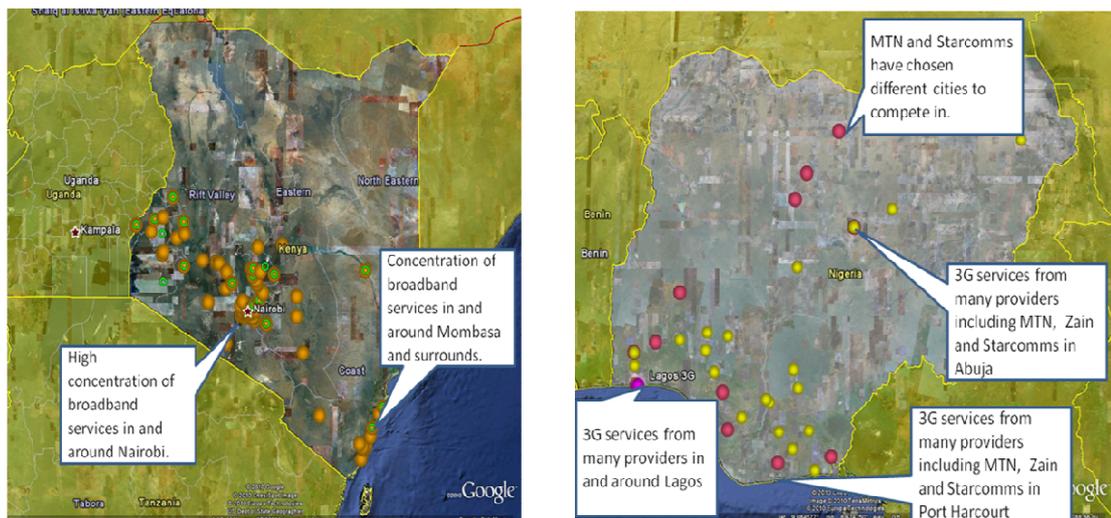
When considering mobile 3G as a technology option to provide broadband services to the complete South Africa market the financial and practical limitations are clear.

**Figure 4-12: Vodacom 3G coverage**

Source: BMI reports, 2010

Research work done for Kenya and Nigeria, the two biggest markets for

broadband services in Africa, shows that in the rest of Africa the 3G coverage is even more limited and is restricted to selected cities and high density population areas (refer to figure 4-13). Viewed in this perspective the option to provide ubiquitous broadband services to Africa using 3G technology is not viable or realistic. The strength and focus of 3G networks will remain high density metropolitan areas, where significant subscriber services can be provided with the minimum network investments.



**Figure 4-13: Broadband Country Maps. Kenya left, Nigeria right**

Source: BMI 2010

## Detail Level Limitations

Analysing the 3G broadband network communication coverage on a detailed street level in a typical metropolitan area yields similar coverage limitations. Due to the principle nature of radio wave propagation the different terrain profiles and physical obstructions limits signal wave propagation. These obstructions and the presence of lower lying areas create signal “dead-zone” areas within the broader network coverage.

The Alberton area in Gauteng was analysed as an example of signal communication coverage limitations on a detailed street level. The available broadband signal coverage ranged from “No Access”, “GPRS”, “Edge” to “3G” access depending on the specific radio signal level and quality.

This analysis shows that even in high density metropolitan areas mobile broadband services are also not ubiquitous and should be considered as a “best-effort” service solution.



Figure 4-14: Detail mobile services coverage for Vodacom in the Alberton, Gaunteng area  
Source: [www.vodacom.co.za](http://www.vodacom.co.za)

## More Coverage - More “Gaps” – More Demand

The mobile broadband signal coverage investigation in Alberton, Gauteng also demonstrates another interesting dynamic of 3G network coverage– i.e. more coverage means more gaps resulting in more demand for an alternative solution.

This characteristic applies because as mobile broadband networks expand in metropolitan areas by the very nature of radio wave networks, the broadband networks will provide coverage in most of the target area, while creating service “gaps” in other areas. At the same time, marketing efforts from the mobile broadband networks will raise the expectations for broadband services in the general target area, and subscribers which falls within the “gap” areas, will have to look for alternatives to meet their expectations.

This characteristic applies on a general basis and reference to the Alberton coverage area is used only as an example. It is expected that the specific nature and extend of these “coverage gaps” will be determined by the specific coverage of a network and the demographics of the target market.

#### 4.4.4 MOBILE BROADBAND USER SPEEDS

##### Mobile Broadband Network Metrics

Network congestion is at the top of everyone’s mind in the telecommunications industry as it impacts stakeholders in different ways. Operators fear it, users complain about it, governing bodies hold meetings over it, while telecom vendors introduce new solutions to deal with it. In contrast, infrastructure vendors cannot get any happier as network congestion provides the dais for increasing revenue.

Given the significant focus on this issue, it is important to define network congestion. How does one benchmark the level of congestion experienced by a network? Industry experts relate network congestion to the increase in global data consumption, which is expected to rise 100-fold over the next four years! While some industry groups blame the proliferation of mobile broadband devices, such as smartphones and embedded devices, others argue that unlimited data business models are the cause.

Effective network throughput planning is a complex challenge that includes the following activities:

1. Understand the population demographics and internet usage patterns.
2. Decide on the intended throughput per user.
3. Based on projected subscriber base and intended throughput per user, the operator has to work backwards to determine the number of sites and infrastructure capacity required.

Intended throughput per user is not a straight-forward figure and is subject to environmental conditions and interference. The following table outlines the average throughput a user would experience (the intended throughput) against the theoretical speed for different network capacities (Greenpacket, 2010).

	Theoretical Speed per cell	Actual Speed * per cell	Maximum Users / Cell	Average Throughput / User (Intended Speed)
HSPDPA	3.6Mbps	2.16Mbps	60**	36kps
	7.3Mbps	4.32Mbps		72kps
	14.4Mbps	8.64Mbps		144kps
HSPA+	21.1Mbps	12.66Mbps		211kps
	28.8Mbps	17.28Mbps		288kps

**Table 4-11: Average throughput per user for selected mobile access technologies**

\*Estimated to be about 60% of theoretical speed in view of environmental conditions and interference. \*\*Infrastructure vendors define a range of 48-64 users/cell as bottleneck of an HSxPA base station. Source: Greenpacket, 2010

Hence, depending on the intended bandwidth operators wish to extend to their subscribers, the network deployment has to be planned accordingly. For example, if an operator intends to offer a bandwidth of 256Kbps/user, a HSPA+ 21.1Mbps site has to be deployed (on assumption that the cell hosts a maximum capacity of 60 users).

Alternatively, operators can either reduce the forecast of intended active users/cell to 30 and double the number of cells to cater for that traffic (at a significant capital cost) or increase the number of sectors per base station for similar throughput.

### **Mobile Broadband Service Limitations**

Available frequency spectrum, infrastructure investment requirements and radio wave propagation characteristics all represent aspects that must be accommodated by mobile broadband networks.

The maximum possible network data transmission speeds are impressive with HSPA+ @ 21.1Mbps, HSPA @ 14.4Mbps or HSDPA @ 7.2 Mbps. In reality, however, the data speed experienced by end-users is still limited by the network architecture, physical environment and network congestion statistics. All of these factors result in a much less impressive average user speed of 36kbps to 288kbps.

#### **Outcome 3a: Broadband mobile services cannot meet the demand for ubiquitous Internet services, creating an under serviced market “gap”**

Mobile broadband services have inherent limitations and constraints that prevent these services to become the *de facto* solution for the Africa broadband market. In particular these limitations are;

- Voice ARPU is declining and the business case for operators to continue the network investments required to meet the exploding data capacity demands are getting less and less compelling.
- Network signal coverage is limited, both on a national and regional basis, and large service area gaps are created by the roll-out of mobile networks.
- Dependable end-user data speeds are determined by the network technology, network capacity and subscriber congestion numbers. All of these result in the actual user speeds being far less than the maximum network capabilities.

## 4.5 ADSL BROADBAND SERVICES MARKET

### 4.5.1 SOUTH AFRICA ADSL AVAILABILITY

The provisioning and operation of ADSL access is distance-sensitive and the connection speed depends on several factors:

- distance between the subscriber and the exchange
- speed increases with copper wire line diameter
- the presence of bridge taps - bridge taps are extensions, between the subscriber and the exchange, that extend service to other subscribers. Bridge taps may increase the distance limit but slow down the access speed.

The maximum distance from a digital exchange to a subscriber using an ADSL service is 7km. This significantly limits the practical implementation and roll-out of ADSL services in South Africa and Africa. Figure 4-15 provides a theoretical coverage map using this distance limitation and the available digital exchanges.

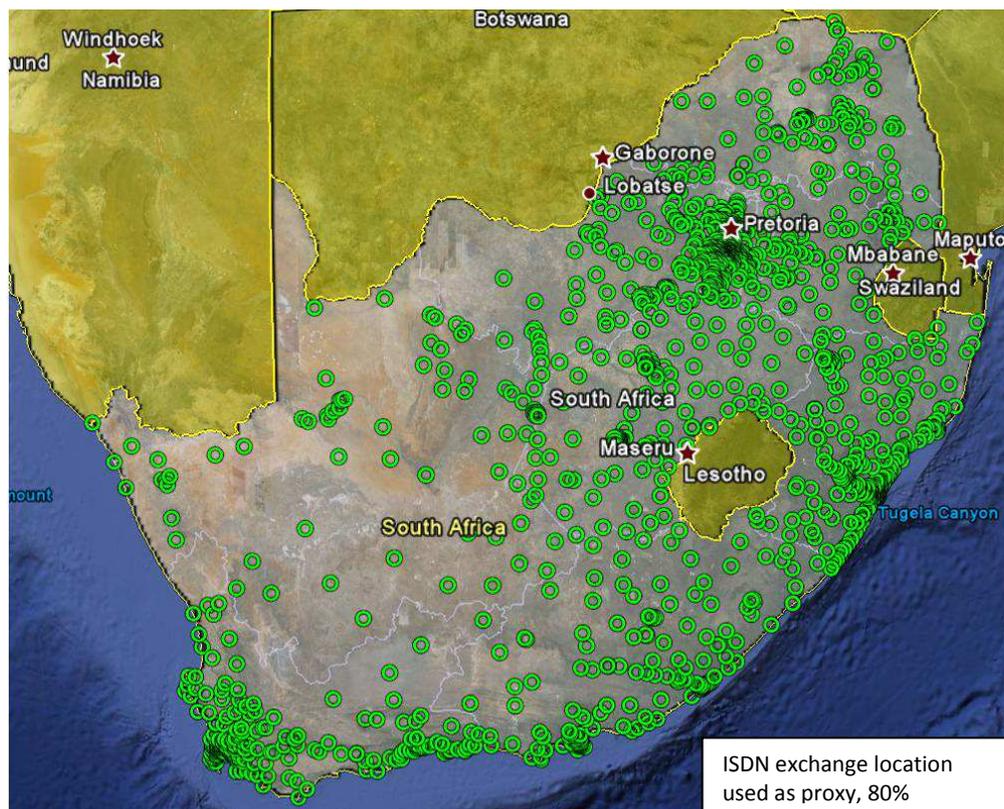


Figure 4-15: Telkom ADSL Footprint  
Source: BMI-T 2010 (1)

#### 4.5.2 ADSL IMPLEMENTATION REQUIREMENTS

The deployment of new access lines for fixed broadband services is time consuming and yields unattractive returns. The implementation constraints are summarised as follows

Technology	Time to Deploy	Capex per Sub <sup>1</sup>	Services
DSL (FTTN) Existing Line	Low	USD 750	Voice, data
DSL (FTTN) New Line	High	USD 2,000	Voice, data
FTTH	High	USD 2,400	Triple play
FTTB	Medium	USD 1,300	Triple play
WIMAX <sup>2</sup>	Low	USD 120	Data
HSPA <sup>2</sup>	Low	USD 110	Voice, data

(Analyses Mason, 2010):

- Deployment of new copper or FTTx lines does not make a viable business case due to the high cost of civil works.
- Such investment is only justified for FTTB deployments for multi-dwelling units and with relatively high ARPU
- Poor quality of existing copper lines and ongoing copper theft present challenges to an ADSL service
- Scalability, maturity of the device ecosystem and added support for voice favour HSPA as the most cost-effective access solution.

**Table 4-12: Comparative Evaluation of Deploying Broadband Technologies in South Africa**

Source: Analyses Mason 2010.

Triple play refers to voice, video & data

#### **Outcome 3b: Broadband ADSL services cannot meet the demand.**

##### **Creating an under serviced market “gap”**

When available, ADSL services are the most effective and preferred technology to provide broadband services to the consumer market and has dominated the access technology markets in Europe and USA.

Due to the following dynamics of the South Africa and Africa markets, the deployment and utilization of ADSL services is very limited and will not become the de facto technology for broadband access;

- Limited coverage. ADSL services are only available in the main cities and towns within 7km from digital exchange infrastructures. This leaves vast geographical areas and population sectors without any services.
- Expensive Deployments. The implementation cost and time associated with ADSL services makes ADSL service non-viable for the Africa market.
- Copper Thefts Risk. In addition to these constraints ADSL services in the Africa market is further constraint by the on-going and uncontrolled theft of installed copper lines.

## 4.6 QUANTIFY THE ADDRESSABLE MARKET

The addressable market for broadband services in Africa is currently an unknown value. One approach to quantify the expected market value is to deduce it from another quantified market, such as the PC households in Africa or the current DStv subscriber base. This approach will provide quantification of the addressable market as a function of the current market characteristics and provides a conservative estimation and which excludes future growth.

### 4.6.1 PRICE ELASTICITY DEMAND FOR BROADBAND SERVICES

#### PED Description

In economics, elasticity is the ratio of the proportional change in one variable with respect to proportional change in another variable. Price elasticity, for example, is the sensitivity of quantity demanded or supplied to changes in prices, as explained by the following equation:

$$E_d = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\Delta Q_d / Q_d}{\Delta P / P}$$

The greater the extent to which demand falls as price rises, the greater the price elasticity of demand. However, some kinds of content such as news programme will be accepted by the users even if the price is high. Price elasticity is useful to understand the dynamic response of supply and demand in the market.

Price elasticity demand can be used to deduct an unknown value (in this case the potential market for satellite broadband services at new pricing levels) from a known value (in this case the current market size for the same product at current pricing levels). To apply the price elasticity relationship the service charge and market volume of the known reference product (i.e. DStv subscription) must be known at different pricing level in order to determine the value of the price elasticity coefficient, using the about definition for  $E_d$ .

Using the market size of the service being investigated (broadband services) under current pricing conditions, the expected market size of this product (in this case satellite broadband services) at new pricing levels can be determined. Using differential calculus this is done as follows:

$$E_d = \frac{\frac{\Delta Q_d}{Q_d}}{\frac{\Delta P}{P}} = \frac{P}{Q_d} \frac{dQ_d}{dP}$$

For small changes in both  $P$  and  $Q_d$ . It can then be proven that

$$Q_d = k P^{E_d}$$

with  $k$  a constant that can be determined by using a known combination of values for  $P$  and  $Q_d$ . If the current price of a broadband service is  $P_1$  and the resulting market size is  $Q_{d1}$ , we know that the constant  $k$  will be given by

$$k = \frac{Q_{d1}}{P_1^{E_d}}$$

The market size  $Q_{d2}$  at price  $P_2$  can then be written as

$$Q_{d2} = kP_2^{E_d} = Q_{d1} \left( \frac{P_2}{P_1} \right)^{E_d}$$

which means that the market size  $Q_{d2}$  at price  $P_2$  can be calculated using market size  $Q_{d1}$  at price  $P_1$  if the value of  $E_d$  is known.

### **PED for Broadband Services**

Only a few papers have analysed the extent of retail demand elasticities for broadband internet services. Rappoport *et al.* (2002) use a nested logit discrete choice model to describe the demand for internet access of residential customers in the US. They conclude that demand for DSL is elastic (own price elasticity of -1.462) and that therefore DSL and cable belong to the same retail market. Crandall *et al.* (2003) confirm these results (DSL own price elasticity of -1.184). Ida and Kuroda (2006) estimate a similar model for Japan including fibre (FTTH) – a rapidly growing access technology in Japan – in their choice set.

For Internet access services the price elasticity coefficient is between -2 and -1 with an average of -1.5 (Yamori, 2008); we will use this value in the quantified business model to extrapolate current levels of market penetration at current pricing levels for satellite broadband to anticipated figures to be achieved at reduced pricing levels.

#### 4.6.2 MARKET QUANTIFICATION AS A FUNCTION OF CURRENT BROADBAND SUBSCRIBERS

The market size to be determined is the expected number of broadband subscribers in currently unserved areas, mostly rural areas and areas that are peripheral to urban areas. The information that we do have is the number of urban subscribers and the current pricing for broadband equipment and services, as well as the size of the rural population compared to the urban population.

As proven above the addressable market size for broadband satellite services at new pricing levels can be calculated using the price elasticity relationships between the current broadband subscriber numbers and the ratio between the new and current pricing levels for satellite broadband service. Current broadband services have an average monthly subscription of \$65 per month. The satellite broadband market that would have existed in urban areas (where the current services are offered) is then calculated for \$130 per month subscription fees respectively, using the price elasticity of demand figure as discussed in the previous section. The addressable market is considered the rural sector of the total market to whom satellite services may be offered. The expected figures for these rural markets are calculated based on the rural population demographic numbers compared to urban demographic numbers.

Table 4-13 provides an overview of the formulas applied to calculate the addressable market data, using the equations as derived in the previous section.

Data field	Source / calculation
<b>Broadband subscribers with an average service fee of \$65</b>	Source Balancing Act 2010 Angola = 41,023
<b>Satellite broadband subscribers at an average rate of \$130</b>	Angola Market for Satellite Broadband services = BB subs * (Sat ARPU / BB ARPU) <sup>Ed</sup> = 41,023 * (\$130/\$65) <sup>-1.5</sup> = 17,248
<b>Addressable rural market</b>	Angola: Addressable market = total market * rural population = 17,248 * 42% = 7,244
<b>Addressable market at an equipment cost of \$905 vs \$250 for broadband services</b>	Angola Market for Satellite Broadband services = addressable market * (Sat equip / BB equip) <sup>Ed</sup> = 7,244 * (\$905/\$250) <sup>-1.05</sup> = 1,876

**Table 4-13: Addressable market calculation examples**

<b>Addressable Market Estimate as a function of current Broadband Subscribers</b>					
Country	Current BB Subscribers	Estimate subscribers at ...	% Rural Population	Addresable market (Rural)	Adressable market estimate adj for equip price
	Equip price: <b>\$250</b>				<b>\$905</b>
	ARPU: <b>\$65</b>	<b>\$130</b>			
Angola	41 023	17 248	42%	7 244	1 876
Botswana	48 486	20 386	40%	8 154	2 112
DRC	37 201	15 641	65%	10 167	2 633
Ghana	64 846	27 264	48%	13 087	3 389
Kenya	162 634	68 379	78%	53 336	13 813
Lesotho	10 313	4 336	73%	3 165	820
Malawi	105 210	44 235	80%	35 388	9 165
Mozambique	63 213	26 578	62%	16 478	4 268
Namibia	69 927	29 401	62%	18 228	4 721
Nigeria	845 672	355 561	50%	177 781	46 041
South Africa	2 800 000	1 177 255	39%	459 129	118 905
Swaziland	9 360	3 935	75%	2 952	764
Tanzania	94 726	39 827	75%	29 871	7 736
Uganda	108 697	45 701	86%	39 303	10 179
Zambia	20 294	8 533	64%	5 461	1 414
Zimbabwe	100 000	42 045	62%	26 068	6 751
<b>Total</b>	<b>4 581 602</b>	<b>1 926 326</b>		<b>905 812</b>	<b>234 586</b>

**Table 4-14: Addressable market calculated as a function of the current broadband subscriber market**

### 4.6.3 MARKET QUANTIFICATION AS A FUNCTION OF DSTV SUBSCRIBERS

Using the same price elasticity methodology the addressable market for the broadband satellite market, can be calculated with reference to the current DStv subscriber numbers. In this case the market forecast is adjusted for both the expected service fee increase from \$40 for DStv service to \$100 for satellite broadband services, as well as for the expected equipment increase from \$200 for DStv subscriber terminal equipment and \$905 expected cost for broadband subscriber terminals.

Addressable Market as a function of DStv Subscribers					
Country	DStv Subscribers	Total addressable market at ...	% Rural Population	Addressable market (Rural)	Addressable market estimate adj for equip price of..
	Equip price: <b>\$400</b> ARPU: <b>\$100</b>	<b>\$130</b>			<b>\$905</b>
Angola	169 852	122 361	42%	51 391	21 801
Botswana	20 243	14 583	40%	5 833	2 475
DRC	13 322	9 597	65%	6 238	2 646
Ghana	39 330	28 333	48%	13 600	5 769
Kenya	54 629	39 354	78%	30 696	13 022
Lesotho		-	73%	-	-
Malawi	17 732	12 774	80%	10 219	4 335
Mozambique	19 560	14 091	62%	8 736	3 706
Namibia	45 732	32 945	62%	20 426	8 665
Nigeria	379 728	273 554	50%	136 777	58 023
South Africa	850 000	612 336	39%	238 811	101 308
Swaziland	3 385	2 439	75%	1 829	776
Tanzania	21 884	15 765	75%	11 824	5 016
Uganda	24 252	17 471	86%	15 025	6 374
Zambia	49 068	35 348	64%	22 623	9 597
Zimbabwe	30 759	22 159	62%	13 738	5 828
	<b>1 739 476</b>	<b>1 253 110</b>		<b>587 768</b>	<b>249 342</b>

Table 4-15: Addressable market calculation as a function of DStv subscribers

#### 4.6.4 SUMMARY OF ADDRESSABLE MARKET ESTIMATES

Using different estimation models the target market for satellite broadband services can be quantified at different levels and with different accuracies. The LSM population based estimates provides a mass market perspective, while the broadband and DStv subscriber service estimates provides an estimate of the near future market potential.

<b>Adressable Market Estimate Summary</b>		<b>Business Scenario: <span style="color: blue;">Symbiotic, Conserv, Use</span></b>	
		<b>ARPU: \$130</b>	
<b>ADDRESSABLE market estimates</b>			
Addressable market as a function of current broadband subscribers			<b>234 586</b>
Addressable market as a function of current DStv subscribers			<b>249 342</b>
	Average:		<b>241 964</b>
<b>TOTAL Market estimates:</b>			
Total market based on population data for LSM groups			<b>11 227 506</b>
Total market as a function of current Internet subscribers			<b>8 454 536</b>
Total market as a function of current PC households			<b>2 193 336</b>

**Table 4-16: Summary of the addressable market estimate**

**Outcome 4: There is a sustainable market that need and can afford satellite based broadband services.**

**Servicing the under serviced market “gap”**

The market for satellite broadband services can realistically be estimated using the following current market penetration data;

- The LSM and country demographic data.
- The current number of Internet broadband subscribers and PC households.
- The current number of DStv subscribers

Using price elasticity relationships the potential market for consumer satellite broadband service is proven to be sustainable and affordable.

## 4.7 MARKET SECTOR ANALYSIS

The Internet access market services a very wide range of applications and market sectors, each with different requirements and service specifications. Satellite access services provide different advantages for the different market sectors.

### 4.7.1 BROADBAND ACCESS SERVICES

#### **Consumer Broadband Services**

##### **Requirements**

The key requirements for consumer broadband services are:

- Affordable monthly service that can be managed and fit into a personal budget plan.
- Internet access services suited for individual profiles including social media and video streaming.
- Services available throughout the national territory.

##### **Satellite Services Advantages**

Satellite access services can be effectively applied to meet the requirements of the consumer market with the key elements being;

- The billing model can be optimised for consumer usage to be affordable and subject to personal budget constraints.
- Satellite access networks are very well suited for broadcast type communication such as social media and video streaming
- The ubiquitous signal coverage ensures availability anywhere, any time.

#### **Business Broadband Services**

Satellite Internet access services to the business sector provides a highly reliable service that is independent of the local terrestrial infrastructure and environment. This is of particular importance for mining and other industrial operations in Africa that need to ensure reliable communications in harsh and very remote locations.

Satellite services also provide the option of access services in a share pool concept between a number of offices. This decreases the net cost of the service on a “per-site” basis, while ensuring maximum performance when needed.

#### 4.7.2 THE INTERNET-OF-THINGS

Estimates from different market analysts vary in terms of predicted figures, but they all agree that data usage will at least double every year until 2015, when data will outweigh voice 30 times over. These predictions are based on the concept that anything that benefits from being connected will be connected.

Consumers are increasingly getting used to constantly connected devices, behavioural patterns are changing and the value of connectivity for people, business and society is becoming more evident. More than 50 billion connected devices is a vision where the convenience brought to people's lives through the use of access networks will be considered normal and expected; a vast number of machine-to-machine (M2M) interactions will constantly take place; and a myriad of new services will raise dependency on mobile networks and secure a massive number of connections.

Devices will access networks directly or through gateways. They will communicate with each other, be part of an end-to-end machine-to-machine system, as well as communicating with individuals and central control systems. People will make use of numerous everyday devices that benefit from M2M connectivity at home, work, on the move, in remote locations and elsewhere. The most obvious examples include: washing machines, coffee makers, car keys, ticket machines, fridges, window sensors, and utility meters. In addition, mobile devices will be adapted to serve many other applications, such as a connected wallet, a connection to medical services, and an interactive location guide.

The basic mechanism of all machine-to-machine communication is short packet-based transactions, which are very well delivered using satellite access networks as gateways to the domestic devices.

**Outcome 5: Satellite access networks can effectively service multiple broadband access markets.**

Satellite access networks will be able to service a wide range of broadband access markets, from consumer and business broadband to industry telemetry networks and gateways for Internet-of-things networks.

The following technology architecture and basic principles of satellite access networks ensures an optimum platform for different applications to service different market sectors:

- Anywhere, anytime, always-on functionality.
- A point-to-multipoint broadcast architecture
- Transaction based communication channels
- Asymmetrical communication for high bandwidth uni-directional communication

## **4.8 SATELLITE PAY-TV MARKET REVIEW**

### **4.8.1 INTRODUCTION**

Due to limited competition, the difficulty of obtaining content and the lack of an affordable mobile pay-TV platform, pay-TV markets in Africa and the Middle East are currently dominated by a small number of direct-to-home satellite pay-TV operators.

In the longer term, growth will accelerate significantly as regulatory changes and rising incomes enable new pay-TV entrants to begin tapping the region's very underpenetrated pay-TV market.

Over the next five years, it is expected that these positive changes in the market environment will improve pay-TV subscription adoption rates in the region, leading to an overall CAGR of 13% through 2013 and a total of 27.5m subscriptions by year-end 2013. This means the pay-TV market in Africa and the Middle East will enjoy the world's highest growth rate over the next five years (Pyramid Research 2009).

Although infrastructure shortcomings and limited content availability will continue to affect growth in the short term, we expect total regional pay-TV revenue to reach \$8bn by 2013, almost double 2008 levels.

### **4.8.2 CASE STUDY: PAY-TV IN SOUTH AFRICA**

South Africa's pay-TV market generated \$666m in service revenue in 2008, making it the single largest pay-TV market in Africa, accounting for 15% of the region's total revenue. Growth in the pay-TV market has been robust, with subscriptions increasing from 1m to 1.7m over the past four years. This has given South Africa a pay-TV household penetration rate of 12%, twice the Africa-Middle East region's average. Despite this growth, we believe several factors have prevented South Africa's pay-TV market from achieving its full potential (Pyramid Research 2009).

The primary inhibitor is the lack of competition in the SA pay-TV sector. For the past 13 years DSTv, owned by MultiChoice, has been the sole provider. The lack of cable or IPTV options has kept pay-TV ARPU high, at \$34.71, well out of reach of many in South Africa, where the average income just exceeds US\$6,000 per year.

Given the potential that pay-TV market holds, the South African government has taken several measures in recent years to stimulate competition. Most important among these was the awarding of four pay-TV licenses in mid-2007 to Telkom Media (a division of incumbent fixed operator Telkom South Africa), On Digital Media (ODM), WOWtv and e.tv. Initial results have been disappointing given that new operators have been faced with the daunting, and highly expensive, task of acquiring premium content in a market where MultiChoice has long held a monopoly and maintains significant market power, which it leverages to snap up the broadcasting rights for the most popular sports (particularly Premier League Soccer).

More promising than the addition of two traditional pay-TV operators, is the entry of non-traditional players into the market, specifically the entry of Vodacom, South Africa's second largest mobile operator. Vodacom is aggressively pursuing the pay-TV opportunity through various avenues. It has more than 40,000 mobile TV viewers who subscribe to its Mobile TV Playa or i-Video services via Vodafone Live! Rates range from R29.00 (\$3.23) per month to R59.00 (\$6.57) per month. Since mid-2007 Vodacom has also been reselling DStv pay-TV packages over DTH. Moreover, in cooperation with MultiChoice it has begun pilots of DVB-H service, which was launched commercially in 2010.

### 4.8.3 **DSTV BILLING MODEL ANALYSES**

#### **Monthly Flat Rate**

Until very recently (mid 2010) DStv offered services only on a flat fixed monthly rate for a complete bouquet of channels. This set a minimum level of financial commitment that is required in order to subscribe to the DStv services and has placed the service above the income potential of the majority households in South Africa.

#### **Service Bouquet Offers**

In June 2010, in response to competitive offers from Top-TV (the service brand of ODM), DStv introduced services packages with lower monthly rates that offers subscribers options to select different bouquets with fewer channels. These options, combined with some aggressive marketing, resulted in DStv securing an additional 400,000 subscribers in just over two months.

#### **Pre-pay Concept**

DStv services are also provided on a monthly "in-advance" payment basis. In South Africa the subscription is underwritten by debit order agreements, which is a practical and reliable method.

In Africa, the model is that subscribers must make monthly advance payments at customer service counters. This is a less optimal arrangement and often results in discrepancies between the service provisioning system and the billing systems.

## 4.9 SUMMARY

This chapter analyses the principal requirement for any business – confirm the market demand.

### Research Information Sources

The market analysis is conducted through an integrated approach that consolidates information from the following sources;

- A broadband market research study conducted by BMI TechKnowledge (BMI-T A2C 2010) for this research project.
- Market information obtained from literature during 2010.
- Specific targeted research questionnaires done with current business customers and partners.
- Specific concepts and elements of the market research finding were evaluated in actual business environments using the current satellite broadband platform. (Q-KON 2010).

### Findings

The research work confirms with the required level of confidence that there are multiple market opportunities and particularly confirmed the following:

- That a large “underserviced market gap” exists within the current broadband market sectors.
- That there are multiple additional market sectors for an ubiquitous affordable IP access solution.
- That these markets cannot be effectively serviced by the current ADSL and mobile broadband services options.

#### Objective 1: Market Demand and Dynamics

##### Objective 1:

Proof that broadband Internet access is no longer a pure luxury and there is a substantial underserviced market demand throughout Africa, both in urban and rural areas. Also proof that this market sector cannot be effectively serviced by current 3G and ADSL services and requires a new technology solution to be developed.

##### Finding:

The research proves the existence of large underserviced market gaps. It also shows that ADSL and 3G broadband services have fundamental technical limitations that prevent these technologies from becoming the *de facto* solutions for broadband access services in Africa.

## Section 2: Business Analyses

# 5. Technology and Competitive Analyses

**An overview of available broadband technologies including a comparative and competitive analyses as applicable to Digital Satellite Access Services.**

*"The walls between art and engineering exist only in our minds"*  
Anonymous

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### 5.1 INTRODUCTION

This chapter focuses on the technology aspects of the broadband Internet market and investigates the different technology options with reference to the respective strengths and weaknesses. The objective is to research the broadband technology environment in view of the second research objective.

#### **Objective 2: Verify the suitability of Data Broadcast Technology for Africa**

This objective is researched at two levels. Firstly the research objective is to prove that satellite technology can meet the principal market demand, i.e;

- The need for ubiquitous service coverage.
- The need for affordable end-user equipment and implementation.
- The need for affordable monthly service fees.

Secondly, the research objective is to analyse the current competitive landscape of the satellite industry and to determine the optimal positioning of a potential new provider of digital satellite access services.

### 5.1.1 COMPARATIVE ANALYSES APPROACH

The technology comparative analysis was conducted with respect to the different technology concepts using technical information, as well as by investigating the results of current market deployment that could serve as references. The analysis is conducted to test the 2<sup>nd</sup> research objective and also to gain knowledge and understanding of the following aspects:

- How can specific strengths of one technology be integrated into the network design using another technology?
- What specific elements need to be included in the final network architecture to make the design more robust against competing technology offerings?

The technology comparative study is completed and documented in the following way:

#### **Broadband Technologies Overview**

As an initial reference, the study included all applicable broadband telecommunication technologies to provide a general understanding and context for the comparative analysis. The overview provides references as to why certain technologies are discounted and not considered in more detail during the remainder of this study.

#### **Detail Technology Analyses**

A detailed review and study of the primary broadband technology options were completed to identify the characteristics and the respective prime strengths and weaknesses. This activity includes the study of technology application and implementation characteristics that meets the Africa requirements and, which should be included in the final technical design.

The study is on the following primary broadband architectures:

- ADSL broadband services
- Mobile broadband services
- Satellite broadband services

#### **Global Digital Satellite Access Case Studies**

Case studies of existing international consumer satellite broadband networks are included to provide quantitative and qualitative information as input for the development of the Africa business model.

#### **Related Consumer Technology Services in Africa**

The study includes reference to DStv pay-television consumer services and the expected future satellite deployments to provide further insight into the dynamics of providing technology-based consumer services in the Africa market.

### 5.1.2 DEFINITION OF DIGITAL ACCESS SERVICES

Digital satellite access services are defined as, Internet access services that are provided to the consumer market using satellite broadcast technologies. This service solution distributes, or broadcasts, the Internet access signal from the source directly to the home consumer. The technology is a derivative of the direct-to-home (DTH) satellite television distribution industry, which is widely deployed by Multichoice as the DStv bouquet service throughout Africa.

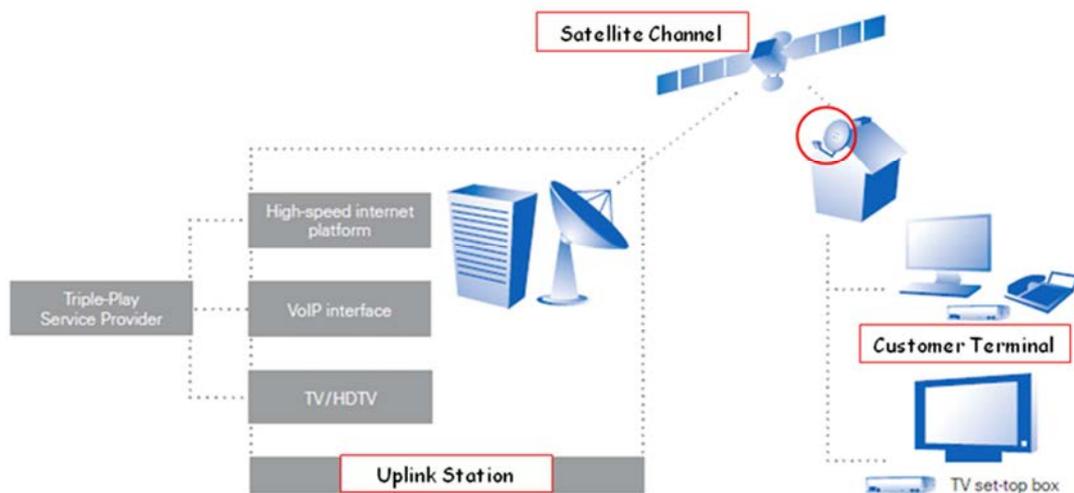


Figure 5-1: Digital Satellite Access network overview

The digital satellite access solution architecture incorporates the following key elements:

#### Uplink Station

The central satellite uplink station provides the gateway and interface between the terrestrial Internet network and the satellite communication network. The uplink station is typically located close to a first tier Internet backbone network and integrates the IP access network with the satellite transmission network.

#### Satellite Distribution Channels

The satellite distribution channel forms the signal transmission medium between the uplink station and the customer terminal equipment. For Internet access services this is a two-way communication channel interconnecting the Internet with the consumer.

#### Consumer Terminal Equipment

The consumer terminal equipment included an outside antenna, receiver and transmitter unit and an indoor modem unit per each consumer home.

### 5.1.3 COMPARATIVE CRITERIA

This review is specifically on positioning the digital satellite access technology service as a solution for consumer broadband services. It is not the focus of this study to provide an in depth technical review and for the purpose of the comparative analyses the following criteria will be considered:

#### **Geographical Communication Coverage**

Key to unlocking the mass consumer market is the capability of the technology to reach the mass consumer market and to do so it must be able to cover wide geographical areas.

#### **Service Price and Affordability**

Service affordability is a dominant factor in providing a solution to the emerging mass Africa market. Affordability of a service is determined by the nominal costs of the service, as well as the product pricing structure. Considering the mobile telephony market, the nominal cost of a call is \$0.20 per minute, which is fair value and not very cheap, while the top-up vouchers are available as from \$5. The affordability to the market is therefore, a function of both the calling rates, as well as the minimum top-up rate.

#### **Implementation Costs and Requirements**

Initial purchasing cost, which includes the equipment cost plus any implementation costs, is a major factor and must be kept to a minimum,

#### **Access Speed**

The technology solution must be able to meet the current broadband access speeds, as well as to increase to higher levels expected to be required in future.

#### **Quality of Service Requirements**

The primary purpose of the solution is to provide broadband Internet access services to the consumer and small office market. This will be reviewed in terms of service access speeds, network performance and expected user experience.

#### **Data usage volumes**

As it is expected, the use of broadband services will grow exponentially, broadband technologies must be able to scale up in order to deliver ever increasing data volumes.

#### **Network loading and congestion**

The ability of broadband networks to provide acceptable levels of service during peak customer demand periods is critical.

#### **Billing Requirements**

A technology solution for the mass consumer market must be able to meet the billing requirements of the consumer market, in terms of flexibility and the option to select incrementally increased service offerings.

**Availability**

Access and availability of the product to the consumer public is a critical element that will determine the viability of the service.

**Net neutrality**

Service providers today have the ability to control the content of broadband access services to give lower or higher priority to some types of content, such as voice traffic or video download data. The manner in which Service Providers apply discretionary rules to the broadband content refers to the issue of net neutrality.

## 5.2 BROADBAND TECHNOLOGIES OVERVIEW

Broadband access services for the consumer market are provided today through a variety of technology options as depicted in the figure below. As not all these technologies are applicable in the Africa context this section provides a brief reference to the status and application of the respective technologies in the current Africa market.

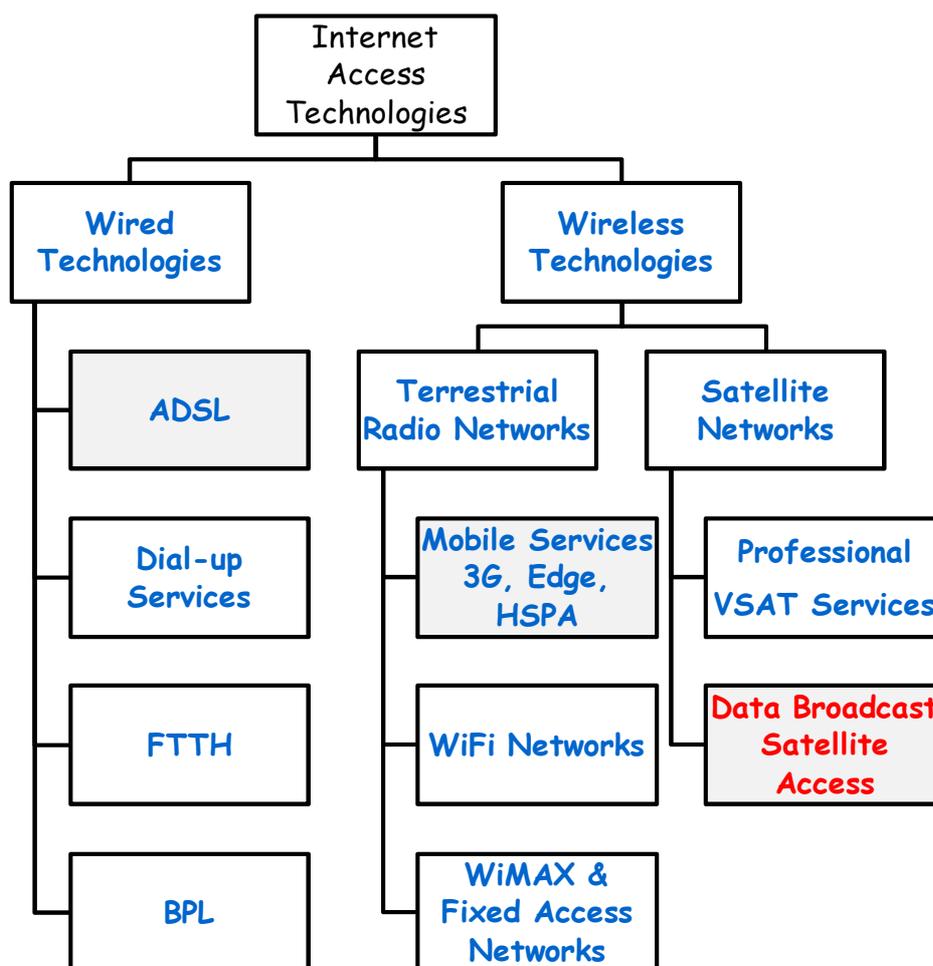


Figure 5-2: Overview of the available technologies to provide broadband services

## 5.2.1 WIRED TECHNOLOGIES

### ADSL

“Analogue Digital Subscriber Line” or ADSL services refer to services that are implemented using existing analogue copper telephone line infrastructure. Digital data transmission equipment is added to the existing copper line networks to provide broadband access services.

ADSL services are widely deployed in South Africa and in some African countries and will be considered in detail in this study.

### Dial-Up Services

“Dial-up services” utilize copper telephone networks and additional data modem devices to provide a data access service on a per call basis. This is one of the very first Internet access methods and is not considered a true broadband option due to limited data rates and is thus not included in the detail study.

### FTTH

“Fiber-to-the-Home” services utilize fiber networks as an access medium directly to the consumer premises. Fiber access networks are the latest access technology and can provide a superior broadband experience.

Some metropolitan area fiber access networks have been deployed in the major cities in South Africa and Africa to provide services to corporate and enterprise customers. Deployment of fiber networks to provide broadband access services to consumers are not considered to be cost effective and therefore not to be a feasible option to provide services to the mass market in Africa.

### Broadband Power line (BPL)

BPL systems allow for high speed data transmission over existing power lines, and do not need a network overlay as they have direct access to the ubiquitous power utility service coverage areas. BPL systems are being promoted as a cost-effective way to service large numbers of subscribers with broadband access.

In a BPL system the data is transmitted over existing power lines as a low voltage, high frequency signal, which is coupled to a high voltage low frequency power signal. The frequency transmission band has been chosen to ensure minimum interference with the existing power signal. Typical data rates in the current trials are 2 to 3 Mbps, but vendors have indicated that commercial systems offering up to 200Mbps could eventually become available. However, there is no clear upgrade path to the higher data rates. Most BPL

systems at present are limited to a range of 1km within the low voltage grid, but some operators are extending this reach into the medium voltage grid (Corning 2005).

Experience has shown that BPL requires a high investment cost, to upgrade the power transmission network and bypass transformers, to support high speed and reliable broadband services. In addition, the frequencies used for BPL often interfere with amateur radio transmission and some BPL trials have consequently suffered considerable opposition.

At present, given the cost and lack of an upgrade path, it seems unlikely that BPL will emerge as a leading broadband technology, but will remain a niche fixed-line broadband option (Buddecom, 2007).

## 5.2.2 WIRELESS TECHNOLOGIES

### **Mobile Broadband Access**

Mobile broadband access services such as 3G, HSDPA and Edge are the dominant access technology in many African markets and are providing an effective broadband access medium to the mass African consumer market.

Mobile broadband access networks do, however, have specific limitations and constraints, which will be discussed in detail in this chapter.

### **WiFi Networks**

“Wireless Fidelity Networks” are widely deployed as a solution to provide services to consumer laptops and smart devices in hotels, shopping complexes and other public areas. Driven by the Intel standard almost all laptop computers and smart phones incorporate WiFi Network access technology as a standard feature. This integration of WiFi access units within most consumer products makes Wi-Fi one of the most widely available broadband access options.

WiFi networks are widely deployed to provide connectivity on a locality basis – i.e. for a specific location such as a hotel, shopping mall, etc. The service is on the convenience and portable consumer market. The technology provides short range connectivity to mobile and roaming subscribers using mobile phones and laptop devices. The short range communication coverage limitation leads to this technology not being ideal for fixed residential connectivity.

### **WiMAX and Fixed Wireless Access Networks**

WiMAX and other fixed wireless access networks have been deployed in Africa in the major cities to provide broadband access services mostly to business and selected high-end residential users. WiMAX networks have the following specific limitations that eliminate this technology as an option to service the mass consumer market in Africa.

### **Communication Range**

WiMax networks operate on frequencies that require line-of-sight signal paths between the base station and the customer terminal. In typical Africa cities this can only be achieved in limited areas and using mast structures at the customer sites. This significantly increases the cost of installation and limits the application of the technology.

### **Low bit rate over long distance**

WiMax technology offers long distance line-of-sight data range of up to 70km and high data bit rates of up to 70Mbps. However, with increased distance range the bit rate will decrease. It should also be noted that specification relates to line-of-sight conditions and that in practical deployments the experience is much less in distance and speed due to terrain obstructions and landscape constraints.

### **Network Capacity Constraint**

Radio access networks are deployed using base stations that are interconnected using fibre or microwave point-to-point links. Base stations are designed and built with a set maximum data throughput capacity and these microwave links interconnecting the base stations are also implemented with set maximum capacity. This results in the network architecture being designed for a total anticipated user data capacity. Should data demand thus rapidly grow more than expected, as is the case for current 3G deployments then the complete network architecture must be re-engineered and most often requires equipment upgrade projects to increase the capacity of the total network.

## **5.2.3 SATELLITE TECHNOLOGIES**

### **Professional VSAT Networks**

Professional VSAT (“Very Small Aperture Terminal”) networks refer to satellite networks that are mainly deployed to provide satellite access services, including broadband access services, to corporate and enterprise customers throughout Africa. In some market this technology is also used to provide broadband consumer services.

The equipment price levels and the access service models currently available, however, prevent these networks from being considered as an option for mass consumer services. This research work is directly driven by the possibility to extend the application of the VSAT technology in order to service the consumer market.

### **Data Broadcast Satellite Access Networks**

Data broadcast satellite access networks refer to VSAT network technology that is specifically developed to enable low-cost manufacturing of the customer terminal equipment, as well as optimized provisioning integrated with a business model that is suitable for the consumer market.

This research work is specifically on the adaptation and implementation of data broadcast technologies to service the Africa consumer.

## 5.3 ADSL BROADBAND SERVICES

### 5.3.1 MARKET PERSPECTIVE

Current fixed line and wireless solutions in rural areas have "largely been limited to the operation and maintenance of telecentres and phoneshops" (Hodge J., 2003). Although Telkom has met its national rollout obligations during its five-year exclusivity period, the trend of increasing access to fixed line telephones is being reversed by rates of disconnection as high as 50-70%' (Bridges, 2002). The main cause of these disconnections has been the issue of affordability and while attempts have been made to ensure affordable access through some form of subsidy (for example government's universal service funds) most people in rural areas still cannot afford the costs of connectivity (Hodge J., 2003). High costs coupled with bandwidth limitations remain the main cause of slow and limiting transmissions, not only in rural and remote areas, but also amongst business and institutional customers.

ADSL terrestrial broadband services are the mainstay product for developed countries in Europe and also for South Africa's metropolitan areas. Where available, it provides the optimum user experience in terms of speed and capacity and is probably the preferred option for most households in urban and metropolitan areas. ADSL services can readily be upgraded to provide data speeds of up to 10Mbps and even beyond, when fiber networks are implemented as the last mile solution.

ADSL services rely on the availability of digital exchange networks and associated subscriber line services to each household. For residential areas where copper infrastructure is available and the exchange networks have been upgraded to digital networks, ADSL will be the service of choice. However, if the service is not currently available it is not viable to provide the infrastructure for most areas in South Africa and for most of Africa. Availability of existing infrastructure is therefore the primary constraint of ADSL networks.

### 5.3.2 TECHNOLOGY CHARACTERISTICS

Delivery of ADSL services requires a single copper pair configuration of a standard voice circuit with an ADSL modem at each end of the line. This creates three information channels – a high speed downstream channel (i.e. from the service provider to the customer), a medium speed upstream channel, and a plain old telephone service (POTS) channel for voice. Data rates depend on several factors including the length of the copper wire, the wire gauge, presence of bridged taps, and cross-coupled interference.

The line performance increases as the line length is reduced, wire gauge increases, bridge taps are eliminated and cross-coupled interference is reduced. In a typical installation the residential or business subscriber PC and modem will be connected to a RJ-11 telephone outlet on the wall. The existing telephone wiring usually carries the ADSL signal to the data modem located on the customer's premises.

## Connection Distance

Typical ADSL implementations are designed to work at loop lengths up to 5km with a downstream speed of 1.5 Mbps and at a duplex speed of 128 Kbps. But other factors in the local loop may interfere with ADSL service. Load coils cause problems, because they are designed to suppress exactly the signal that DSL modems need to transmit, i.e. high-speed data. The effect of a load coil is equivalent to adding about 6km to the line length, making the line unusable for DSL service. In most cases load coils must therefore be identified and removed from lines supporting ADSL (Acterna, 2002).

Bridge taps also interfere with ADSL services because they act as a transmission line stub with adverse effects at high frequency. As a general rule, the length of all bridged taps on the span should total less than 300m, with no single tap exceeding 700m (refer figure 5-3).

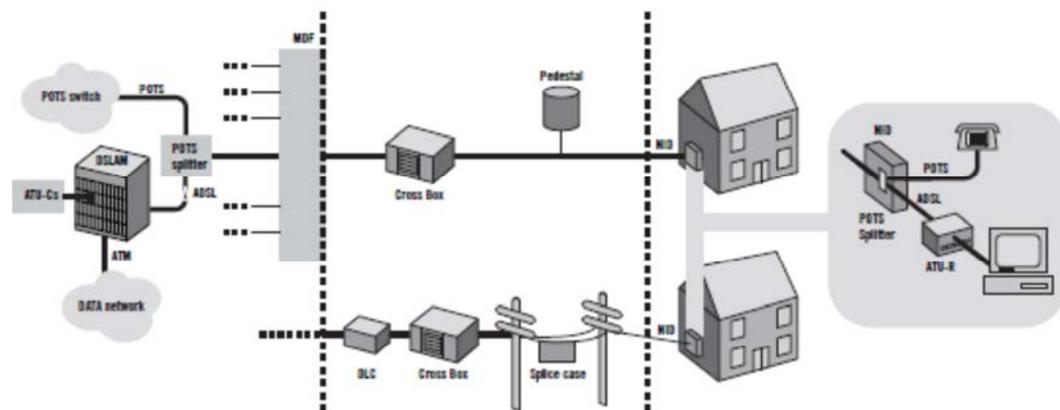


Figure 5-3: ADSL Line implementation diagram

Source: Acterna 2002

## Implementation and Operation

The ongoing implementation and operation of ADSL services within the Africa context are complicated by the following:

### Copper Line Installation

The physical need to install the last mile from the exchange to the residential point requires extensive civil works.

### Copper Line Thefts

The South African market specifically, and the Africa market in general, are plagued by crime syndicates who steal the installed copper lines to earn income from selling the copper on the materials recovery market.

### 5.3.3 ADSL REQUIREMENTS REVIEW

The following table provides a review of ADSL as an access technology against the defined consumer broadband access requirements.

User Requirement	ADSL	
	Description	Rating
<b>Communication Coverage</b>	ADSL services utilises the current copper line networks and the availability and reliability of these in Africa is very limited.	POOR
<b>Service Price</b>	Pricing for a 1Mbps, 5GByte ADSL service in South Africa range from R539 to R722, an average of \$100 per month.	FAIR
<b>Implementation Costs</b>	Deployment of additional copper cable networks in Africa is not feasible. In the high density areas operators implement fibre networks to the business and high-end user markets	POOR
<b>Access Speed</b>	ADSL services are well positioned to deliver broadband services at access speed of up to 4Mbps.	GOOD
<b>Quality of Service Requirements</b>	ADSL services differentiate strongly between local and international content with the associated user implications.	FAIR
<b>Data usage requirements</b>	With fibre networks forming the core of most ADSL networks they are well positioned to deal with data traffic demand increases.	GOOD
<b>Network Loading and congestion</b>	ADSL terrestrial networks with integrated fibre core networks can provide the best possible network resilience against peak traffic demands.	GOOD
<b>Billing Requirements</b>	Public operators traditionally do not engage in usage billing models and still offer broadband access at a fixed rate per month linked to a maximum amount of data usage allowed per month.	GOOD
<b>Net neutrality</b>	The primary income of public operators is still voice based services and hence there is a tendency to degrade the quality of service of Skype and other VoIP data services that compete with analogue voice communications.	POOR

Table 5-1: ADSL Requirement Review

## 5.4 MOBILE BROADBAND SERVICES

### 5.4.1 MARKET PERSPECTIVE

Powerful smartphones, fast networks, compelling applications and user awareness are causing a dramatic surge in the use of mobile-broadband technology. Previously limited to business executives or vertical-market applications, wireless data is now experiencing mass-market adoption. The advantages are obvious – flexible lifestyles, greater productivity, and the addictive sensation of always being connected. This market growth comes at a good time for operators, who are seeing increasing data revenue compensating for declining voice revenue.

Mobile broadband throughout the world is in a ‘delicate’ state. On the one hand, the growth in subscribership has been phenomenal - a *‘mobile miracle’*, as the ITU characterized it in 2008 (ITU, 2008), when mobile broadband subscriptions first exceeded fixed broadband subscriptions globally. The features and capabilities of today’s mobile broadband networks, devices and services are astounding, with the promise of future enhancements even more exciting (Rasavy, 2010).

On the other hand, mobile broadband stands at a potentially perilous time. Today the mobile industry lacks sufficient incremental supply of one of its essential raw materials – frequency spectrum. Based on a review of recent forecasts, one can reasonably draw the conclusion that mobile broadband networks will hit transmission capacity shortages by the middle of this decade, unless steps are taken to secure the additional spectrum needed.

Fortunately, the mobile industry has a long history of driving innovation in radio access technologies, from EDGE through HSPA to LTE, allowing it to utilize spectrum assets as productively as possible. In parallel, the industry also has invested billions in building cell sites to enhance network coverage and capacity. Such steps will continue to be needed, and there is no indication of a slowdown in deployments.

This prominent drive to provide services to Africa will not only drive network deployments, but will create the market appetite for a ubiquitous service, an appetite, which mobile networks will not be able to fully meet. Due to the nature of radio technologies it is not feasible to expect that 3G and broadband services can be made available literally everywhere in Africa. In creating services “gaps” in the market the mobile broadband networks will actually create the need for another service that can provide communication coverage everywhere.

The growing market for broadband services is stimulating a never ending demand for more and more data. It is expected that data usage of 10’s of gigabytes will soon become the norm. The principal architecture of mobile networks are not well positioned to meet this data demand and the network technologies will have to be continuously upgraded and replaced to increase the data capacity. This phenomenon will result in the need for further capital investments, as well as network congestion and the lack of high speed service delivery. Both these aspects indicate that market sectors will not be sufficiently serviced by the mobile networks and that alternative networks will be required.

## 5.4.2 TECHNOLOGY CHARACTERISTICS

### Nominal Capability

The demand for mobile broadband services is driving the continuous development of third-generation (3G) mobile systems, which were intended both to meet the challenge of providing higher-speed data services over the mobile communications network and to further increase radio network capacity. Because it became clear that 3G systems would be unable to cost-effectively keep pace with the exploding demand for mobile broadband multimedia communications services, work on post- 3G mobile standards was started a number of years ago.

The table below provides a summary of the theoretical peak data rates for mobile networks. Although the nominal specifications of mobile broadband networks are adequate for the consumer market demand, the mobile operators are facing significant network growth and congestion challenges to ensure that consumers are offered the benefit of these access speeds (Rasavy, 2010).

Level	Standard	Uplink (bps)	Downlink (bps)
2G	GSM	9.6k	14.5k
2.5G	Edge	384k	513k
3G	UMTS	384k	2.0M
3G+	HSDPA / HSUPA	5.8M	14.4M
3G+	HSPA+	11M	42M
"4G"	LTE	40M	100M

**Table 5-2: Theoretical peak data rates for different mobile technologies**

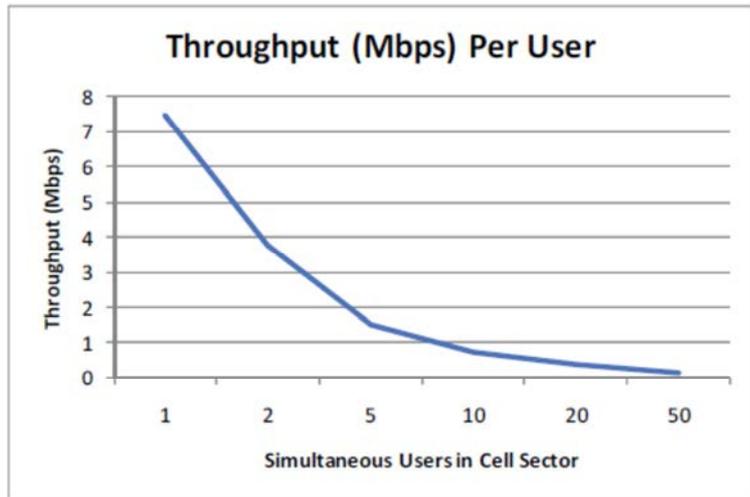
Source: Dialogic 2009

### Network Congestion

Allowing network capacity to saturate is something operators must aggressively avoid. AT&T experienced significant damage to its reputation when widespread use of the iPhone resulted in unreliable user experiences (PC Magazine, 2010). Even after fixing the problem and boosting performance above its competitors, negative perceptions lingered. Users demand not only ubiquitous coverage, but also reliable connectivity - and congested networks are anything but reliable (PC Magazine, 2010).

Consider a scenario of 20 MHz of spectrum allocated to HSPA, as shown in the following figure. The effective throughput per active user depends on the number of simultaneous users in the cell sector. When going from 5 to 10 users, throughput per user falls below 1 Mbps, and thus no longer delivers a true broadband experience. Considering that in the US there are on average 1,000 wireless subscribers per cell site, and considerably more in busy markets, the number of subscribers per cell site can range from between about 10 and 30. Ten active users, constituting 1% to 3% of total subscribers can, however, consume all of

the available bandwidth resources, resulting in unsatisfactory service delivery to the majority of customers (Rasavy, 2010).



**Figure 5-4: Expected data throughput per user decline due to network congestion**  
 Source: Rasavy Oct 2010

To ensure ongoing delivery of a satisfactory broadband user experience mobile network, operators will have to continue to upgrade and expand network infrastructure and find solutions to frequency spectrum and backhaul congestion.

### Distance Degradation



**Figure 5-5: Data rate degradation due to distance**  
 Source: Qualcomm

Signal propagation characteristics and degradation of signal quality through obstructions and buildings lead to a reduction in the net available carrier data throughput rate.

These phenomena further reduce the available network data rates for subscribers who are positioned at the cell edge areas. This is particularly important for user experiences in the rural areas.

### 5.4.3 MOBILE BROADBAND REQUIREMENTS REVIEW

The following table provides a summary of the mobile technology review against the stated requirements for a consumer broadband service.

User Requirement	Mobile Broadband	
	Description	Rating
<b>Communication Coverage</b>	GSM Cellular networks have vast coverage throughout Africa, yet even with these large coverage areas it still does not provide coverage to all of Africa	FAIR
<b>Service Price</b>	Currently mobile networks offer attractive pricing for data services at around \$20 per month. The capability of mobile networks to meet future growth and still maintain profitability is however questioned by various industry analysts.	GOOD
<b>Implementation Costs</b>	Mobile broadband networks require continuous upgrading to base stations and back haul networks to deal with traffic volume increases. This is both time and capital intensive	POOR
<b>Access Speed</b>	Access speed on Mobile broadband networks greatly depends on the range and overall network congestion. Realistically, the average transfer rate will oscillate from 1 to 2 Mbps depending on the quality of the signal and the number of connected users.	FAIR
<b>Quality of Service Requirements</b>	Mobile networks have well developed tools to meet this requirement.	GOOD
<b>Data usage requirements</b>	Mobile networks are expected to become more and more congested as the smartphone users demand more data and higher speeds.	POOR
<b>Network Loading and congestion</b>	Due to the cost implications and limited available operating frequencies mobile networks can not readily be upgraded and network congestion is often experienced.	POOR
<b>Billing Requirements</b>	Globally mobile operators are currently offering usage based services and other advanced packages.	FAIR
<b>Net neutrality</b>	The primary income source for mobile network operators is still voice-based services and thus they are inclined to provide Skype and other VoIP services with a lower priority and poorer quality of service	POOR

**Table 5-3: Mobile technology review against the consumer broadband services requirements**

## 5.5 SATELITE BROADBAND SERVICES

### 5.5.1 MARKET PERSPECTIVE

There are 71 commercial satellites that have been launched with at least partial coverage over Africa. As a rough indicator of total capacity, there are 2,794 transponders with an estimated combined capacity of 149Gbps on the 71 satellites with at least partial coverage over Africa, up from some 964 transponders in 1996.

Of this potential capacity, operators report that the number of transponders, which are configured for use in Africa lies between at least 776 and possibly as high as 1,600. It is extremely difficult to calculate the actual amount of capacity that is available for a variety of reasons, such as the different power of uplink and downlink, different bandwidths, different modulation techniques, and atmospheric conditions. The capacity of each individual link has to be calculated separately. The transponder level does, however, give a rough indicator of the scale of capacity that is available.

The existing satellites above Africa are heavily subscribed to. There is a finite amount of available capacity, and it is increasingly difficult to lease new capacity. One major operator reported that some 60% - 70% of the capacity it has available over the region was sold, another that 65% was sold, and another that 95 – 99% had been sold. These fill rates are higher than for other regions (Balancing-Act, 2010).

The successful application of satellite technology to meet the different connectivity requirements in Africa has been clearly demonstrated. The capability to reach vast areas and provide connectivity to remote locations with the minimum local infrastructure requirements has been most successful to enable the deployment of the mobile networks, corporate data networks and Internet trunk services.

Satellite technology networks are anchored in two principal advantages:

- 1) it provides ubiquitous service throughout the footprint, and
- 2) it is an excellent medium to broadcast content from a single point to thousands of remote sites.

Based on these strengths satellite technology is a very good option to provide broadband networks in Africa.

## 5.5.2 TECHNOLOGY CHARACTERISTICS

GEO stands for Geostationary Earth Orbit. This refers to satellites that are placed in orbit such that they remain stationary relative to a fixed spot on earth. If a satellite is placed at 35,900 km above the earth, its angular velocity is equal to that of the earth, thereby causing it to appear to be over the same point on earth. This allows them to provide constant coverage of the area and eliminate blackout periods of ordinary orbiting satellites, which is good for providing television broadcasting.

### **Operating Frequency Band**

The communication operating frequency channel from the subscriber terminal to the satellite is defined as C-band, Ku-band or Ka-band.

#### **C-band**

C-Band refers to the operating frequency band of 3.7 - 4.2 GHz. Due to the relationship between frequency and energy-distribution, C-band transponders provide large geographical signal coverage footprints and are typically used to service continents and larger areas.

#### **Ku-band Fixed Satellite Service (FSS)**

Ku Band services refer to the operating frequency range of 11.7 - 12.2 GHz. Ku-band FSS transponders provides smaller signal footprints and are mostly used to provide service to smaller regions like Europe and Southern Africa.

#### **Ku-band Broadcasting Satellite Service (BSS)**

The Ku-Band subset of 12.2 - 12.7 GHz is mostly used for broadcast services. Ku-band BSS provides similar coverage areas than FSS frequencies.

### **Coverage Area**

The satellite signal density on the ground is a function of the operating frequency, the geographical region and the maximum transmit power from the satellite. This relationship determines that the lower the operating frequencies the more suitable the transmission is to cover large geographical regions.

### **Latency**

Due to the high altitudes of satellite orbits, the time required for a transmission to navigate a satellite link (more than 550msec from earth station to earth station) cause a delay in data transmission known as latency. This adversely effects data transmission and is compensated for in the ground equipment.

### 5.5.3 SATELLITE REQUIREMENTS REVIEW

The following table provides an overview of the capabilities of satellite technology when evaluated against the broadband user requirements:

User Requirement	Satellite	Rating
<b>Communication Coverage</b>	Satellite is the perfect medium to broadcast the Internet to Africa with 100% signal coverage	GOOD
<b>Service Price</b>	The single source nature of satellite Internet broadcast signals has the result that no income multiplication can be done, as for TV broadcasts, and hence the pricing is for the higher income market	FAIR
<b>Implementation Costs</b>	The network cost required to provide services over the continent is limited to the upgrading of a single earth station and contracting of the applicable satellite capacity	GOOD
<b>Access Speed</b>	All satellite terminals can be configured for maximum network speed which can be 4Mbps or higher	GOOD
<b>Quality of Service Requirements</b>	All the required quality of services can be integrated into the hub network	GOOD
<b>Data usage requirements</b>	The wideband nature of satellite signal carriers of typically 72MHz can deliver up to 140Mbps per channel which can readily meet higher user traffic demands.	FAIR
<b>Network Loading and congestion</b>	Broadband satellite networks are a single point resource with limited options for traffic loading management	POOR
<b>Billing Requirements</b>	Current satellite operators do offer fixed rate packages linked to contended services. It is expected that a "usage-base" model will deliver better user experiences.	GOOD
<b>Net neutrality</b>	Satellite operators have no legacy voice business interests to protect and can ensure 100% net neutrality. At the same time this implies larger business risk as the costs associated with the service must be recovered from data services alone.	GOOD

Table 5-4: Satellite requirements review.

## 5.6 RELATED CONSUMER SERVICES IN AFRICA

The GSM cellular and DStv markets have a number of similarities with Internet broadband services and provide a qualified reference to evaluate the lack of market penetration for broadband Internet access. The key similarities between these markets are as follows;

Terrestrial Network: The GSM cellular service requires large investments to build a terrestrial network of towers and base stations in order to provide communication coverage to the target geographical areas. This is very similar to what is required to provide broadband wireless Internet access services using technologies such as WiMAX and WiFi.

Subscriber Installation: To provide two-way satellite broadband Internet access requires subscriber satellite dish equipment and associated installation very similar to that, which is required for DStv and other satellite TV services.

Target User Group: Both the GSM market and the DStv market include the LSM 8, LSM 9 and LSM 10 user groups within the respective subscriber base. The GSM market also includes the other LSM user groups, while the current DStv service is on only LSM9 and LSM 10. Notably the new licensees within the South African market expect to be focused on servicing LSM 7 and LSM 9.

User Technology Barriers: Both the GSM industry and the DStv industry are based on the most advanced communication technology at the subscriber level as well as for the network. The general perception is that advanced technology cannot be readily implemented in emerging markets or markets with minimum skills in using technology. What the GSM market has proved, is that users of all levels will acquire the required skills in order to use the technology provided that the user experience tangible benefits in doing so and that the user benefits versus cost of usage matches the market's requirements.

Technology Maturity: DStv deploys digital video broadcasting (DVB) satellite technology, which is the same technology used for broadband satellite Internet access services, while the GSM cellular technology is of the most advanced and complex technologies developed to date. This proves that complex and advanced technologies can be successfully deployed and maintained to the mass consumer market and that advanced technologies are not necessarily only for niche market and low-volume deployments.

## 5.7 GLOBAL DIGITAL SATELLITE ACCESS DEPLOYMENTS

This paragraph provides an overview of the international satellite broadband access networks that are currently in service. The review provides insight into their respective operational characteristics and strengths.

### 5.7.1 ASTRA2CONNECT

#### Overview

The European operator SES-Astra's offer, Astra2Connect, was first launched in the German market in March 2007. Astra2Connect operate on Ku-band services using a satellite at 23.5° east and requires a 75-80cm bidirectional satellite dish. Download speeds are available from 256 kbps to 2048 kbps at prices ranging from €20 to €90 a month (€240 – €1080/year) depending on the maximum speed and the service provider.

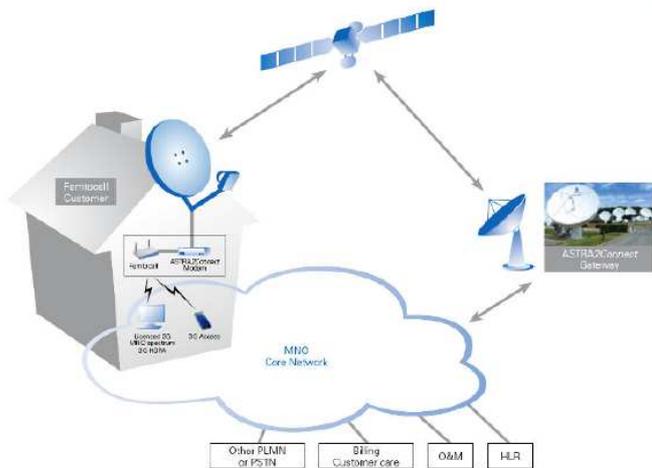


Figure 5-6: Astra2Connect Network Outline

There are three start-up costs to consider: equipment, installation and in some cases, a “set-up” fee. The equipment retails in the price bracket €300 – €400. Some service providers offer hardware rental options and only a few have announced pricing for the 2048 kbps option.

#### Critical Comments

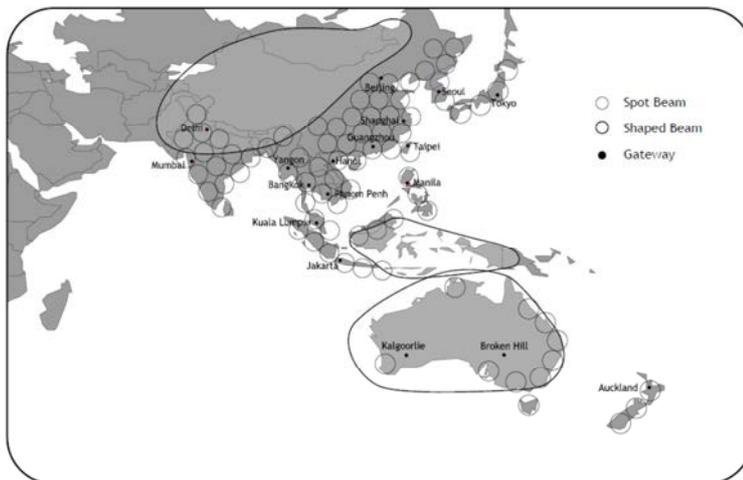
Astra2Connect currently have between 80,000 and 100,000 terminals operating throughout Europe with one service provider active in the East Africa market. The service provides an effective alternative for broadband services with the most negative consumer comments relating to its use of a “Fair Usage Policy”.

The use of a “Fair User Policy” is focused on managing the impact of “power users” during the peak load periods, ensuring good service for those who are “just” browsing web pages or downloading e-mail. However, this creates a negative user experience for the “power users” as corrective actions are applied for a 30-day period leading to much negative criticism.

## 5.7.2 IPSTAR

### Overview

**IPSTAR** provides a large-scale bandwidth platform of satellite-based broadband that can compete effectively with terrestrial broadband solutions. IPSTAR has nearly a quarter of a million user terminals sold with more than 100,000 customers in Australia and New Zealand. The IPSTAR project was created to enable satellite technology to play an important role in the multimedia revolution and the convergence of information and communication technologies.



IPStar is a high-capacity broadband network developed and operated on Ka- and Ku-band satellite channels, using an integrated array of Ka spot beams, as well as Ku regional beams to obtain both the geographical area coverage as well as the network bandwidth capacity.

**Figure 5-7: IPStar signal coverage areas**

Source: [www.ipstar.com](http://www.ipstar.com)

Designed for two-way communications using Ka- and Ku-band services and with a total bandwidth capacity of up to 45 Gbps, Thaicom-4 (IPSTAR) can connect up to 2 million broadband users or 20-30 million mobile subscribers. Customer terminals are Ka-band systems and incorporate an indoor modem and outdoor antenna systems of 0.75 to 1.8-meter diameter.

### Critical Comments

The nature of this technology option implies a requirement for a large number of subscribers from a relatively small geographic area to recover costs, which represents a financial risk for the service provider, as reflected by the following comment: "Our current base case for Thaicom forecast the company to finally be able to report a net profit in (fiscal 2011), a turnaround from 4 consecutive years of normalized net loss," Benchavitvilai said (Satellite TODAY Insider, 02-18-11).

Ka-band network deployments are high-capacity networks for very high density subscriber markets. The financial performance of IPstar clearly illustrate the biggest challenge and risk to the deployment of Ka-band network, i.e., to be able to secure the high number of subscribers within the relative small geographical areas within the business funding constraints.

### 5.7.3 UNITED STATES BASED SERVICES

#### Overview

U.S. Broadband Satellite Subscribers (1Q 2010)	
Service Providers	Subscribers
Hughes	532,000
WildBlue	434,000
Spacenet	100,000
<b>Total</b>	<b>1,062,000</b>

Satellite technology is widely used to provide consumer broadband access services to the US market. The market currently includes 3 major service providers, Hughes, Wildblue and Spacenet, with a total of more than 1 million subscribers (refer to Table 5-5).

**Table 5-5: Broadband consumer satellite subscribers in the USA.**  
Source: Satellite Markets and Research, May 2010

The industry offers a wide range of product offerings from low-cost home services

to higher level business packages. The services definition is based on different access speeds and contention ratios. Refer to Table 5-6.

Satellite Broadband Company / Service Offering	'Up to' Upload Speed	'Up to' Download Speed	Monthly Service Price <sup>1</sup>
<b>HughesNet Offerings<sup>2</sup></b>			
Home	128 Kbps	1.0 Mbps	\$59.99
Pro	200 Kbps	1.2 Mbps	\$69.99
ProPlus	250 Kbps	1.6 Mbps	\$79.99
Elite	300 Kbps	2.0 Mbps	\$119.99
ElitePlus	300 Kbps	3.0 Mbps	\$189.99
Elite Premium	300 Kbps	5.0 Mbps	\$349.99
<b>StarBand Offerings<sup>3</sup></b>			
Nova 1000	128 Kbps	1 Mbps	\$69.99
Nova 1500	256 Kbps	1.5 Mbps	\$99.99
<b>WildBlue Offerings<sup>4</sup></b>			
Value Pak	128 Kbps	512 Kbps	\$49.95
Select Pak	200 Kbps	1.0 Mbps	\$69.95
Pro Pak	256 Kbps	1.5 Mbps	\$79.95
<b>Inmarsat Offerings<sup>5</sup></b>			

**Table 5-6: Current Satellite Broadband Providers / Offerings (As of November 2008)**  
Source: SIA 2010

### Critical Comment

ViaSat, a leading manufacturer of subscriber terminal equipment, is developing the ViaSat-1 system at Ka-Band to deliver even greater bandwidth than the previously mentioned systems. More customers can be served and their data rates are potentially increased relative to the current Ku-Band networks that support more than half of today's subscribers. Multiple spot beams have the technical ability to accomplish this feat; however, obtaining this in practice is dependent on where the subscribers are located within a national footprint.

Ka-band services provide localised high capacity zones and do not have the single nationwide beam produced by the typical Ku-Band satellites. Like the 80/20 rule that applies to revenue/customer performance, it is likely that the vast majority of new customers needed to fill a high capacity satellite, will come from the eastern US and the major metropolitan areas. That leaves the vastness of the plains and western US without a clear market service option.

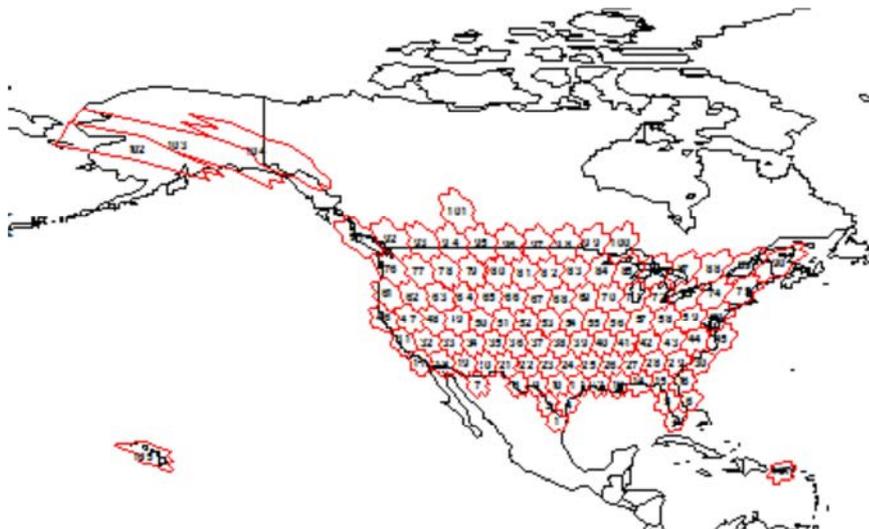


Figure 5-8: Ka-band satellite communication services over America.

Source: SIA 2010

Ka-Band satellites are able to provide more power and flexibility with its unique frequency re-use spot beam system, as illustrated here with Spaceway-3 coverage map of North America.

It is a paradox that the greatest attraction for satellite broadband is in these vast expanses, while customers are clustered in regions heavily served by cable modem and DSL. Consequently, in this scenario satellite broadband must 'steal' terrestrial broadband customers if it wants to move from the current one million to the 10 million projected subscribers for satellite broadband services in the U.S.

This aspect is critical in the selection of Ku-band to provide consumer based services to the Africa market.

## 5.8 SUMMARY

Chapter 5 documents the technology comparative study and concludes section 2, the feasibility study. The technology comparative study provides an overview of all available broadband technologies with a detailed review of ADSL broadband, mobile broadband and satellite broadband services.

### Comparative Study Activities

The technology comparative study on ADSL, mobile and satellite broadband services included the following activities:

- Functional overview of the technology in the context of providing broadband services.
- Current market penetration rates and other market considerations.
- A review of the technology against the listed requirements to provide a broadband service to the Africa market.

### Findings

The research work confirms the following:

- that ADSL service are the most suitable and appropriate technology to provide consumer broadband services where infrastructure is available;
- that due to the lack of availability and implementation requirements ADSL services are not as feasible an option to service the Africa mass consumer market;
- that, in the absence of any other alternative, mobile broadband services are currently the primary option to meet consumer demands for broadband access services;
- that mobile broadband services have inherent limitations that will result in this technology option not being able to meet the expected future demand; and
- that satellite technology is a viable alternative to meet the demands of the current under-serviced broadband market.

#### **Objective 2: Prove that Satellite Technology is a Suitable and Viable option.**

This objective is researched at two levels. Firstly, the research objective is to prove that satellite technology can meet the principal market demand, i.e;

- 1) The need for ubiquitous service coverage.
- 2) The need for affordable end-user equipment and implementation.
- 3) The need for affordable monthly service fees.

Secondly, this research objective is to analyse the current competitive landscape of the satellite industry and to determine the optimal positioning of a potential new provider of digital satellite access services.

#### Finding:

The research demonstrates that satellite technology meets all the requirements and is a viable alternative to provide services to the consumer market for multiple niche and mass market requirements.

## Section 3: Business Innovation

# 6. Business Model Definition

Development of a business model that effectively integrates technology, product and market requirements into a sustainable and profitable business to service the mass broadband Africa market.

*“The strategist seeks opportunities to upset industry equilibrium, pursuing strategies that will allow a business to disrupt the “normal” course of industry events and to forge new industry conditions to the disadvantage of the competitors.”*

Ian C MacMillan

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## 6.1 INTRODUCTION

In order to successfully deliver broadband services to the mass consumer market in Africa the market, technology, product definition, network design and business model requirements must be integrated into a single effective business model that matches the organisational delivery capabilities.

This chapter is the first step in the business definition stage and focuses on the process of defining the most optimum business model and associated business strategy, in the process addressing objective #3. The preferred business model will form the framework for the detailed user billing and business organisational structure studies that will be investigated in chapters 7 and 8.

**Objective 3: Define a Business Model that will enable the supply of data broadcast satellite services to the Africa market on a viable basis**

Define the most suitable business model and strategy to deliver satellite-based data broadcast services to the consumer Africa market and prove that this model is the most suited and viable strategic option.

### 6.1.1 PROCESS OVERVIEW

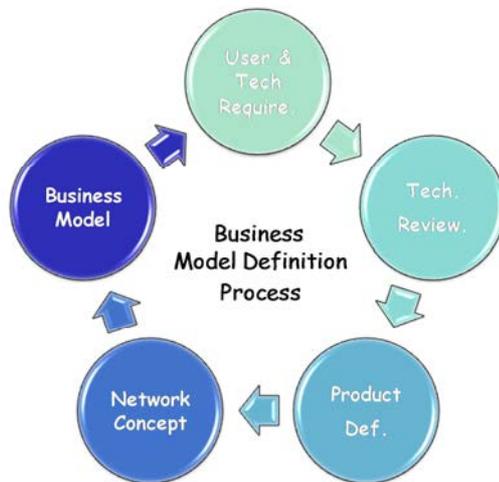


Figure 6-1: Business model definition process for broadband services

The business model formulation process is not a linear step-by-step process. All aspects of the business form an integral part of the business strategy and needs to be considered individually and collectively.

The process is completed in a circular manner with the outputs of the one forming the inputs of the next process. The circular iterative review and definition process is completed once all the business model criteria are met.

The business model integrates all the elements and decisions to provide a quantitative definition of the business strategy.

### 6.1.2 CHAPTER OUTLINE

The research work applicable to the formulation of a business model for the large-scale provision of broadband services in Africa business model is described in the following process:

#### **User and Technology Requirements**

The user and technology requirements that were defined in previous chapters are summarised for ease of reference.

#### **Technology Review**

The technology review was completed in chapter 6 and is only included in the process for completeness.

#### **Product Definition**

The product definition reconciles the relationship between the requirements of the different market sectors and the available service offerings.

#### **Network Concept**

The technical network design is completed, based on the preferred technology, to implement the defined consumer products in order to satisfy the user requirements.

#### **Business Model**

The business model integrates all inputs and outputs and defines the rationale of how business will create, deliver and capture value in providing broadband services to the Africa market.

## 6.2 CONSUMER USER REQUIREMENTS

### 6.2.1 COVERAGE REQUIREMENT

Market reports (BMI Tech, 2010) show that the demand for Internet in Africa will exceed supply in all of the countries and that the increase in market demand applies to all the countries. With a forecasted total number of PC connections for Africa of 20 million by 2014 all of the Africa countries represent the target market. Technologies that provide the most effective communication coverage to the continent will be the best positioned to leverage the pan-Africa demand.

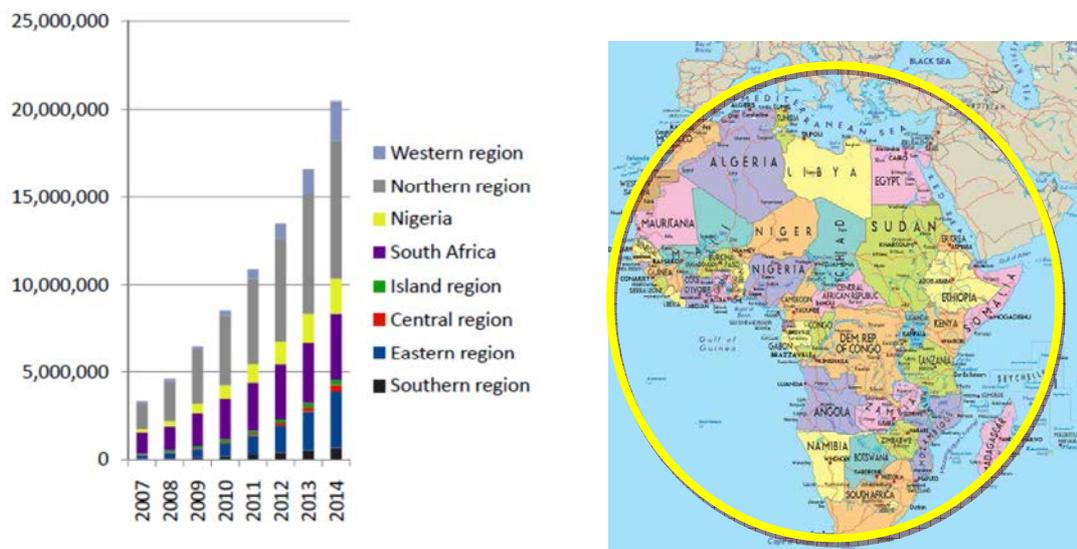


Figure 6-2: Expected PC connections growth and Africa regional market  
Source: BMI TechKnowledge Research 2010

### 6.2.2 NET NEUTRALITY REQUIREMENTS

In January 2011 the USA regulatory body for spectrum allocation, the FCC, determined the criteria that will apply to Broadband Service Providers. Although these guidelines currently only apply to the USA market, it does put forward the criteria that will apply to an open net neutrality service.

The criteria are (FCC, 2010):

- Internet users must have access to all legitimate contents made available on the Open Internet.
- Broadband Service Providers (BSPs), be they telecom network operators, cable operators, ISP's, and/or content providers engaged in the provision of Internet access services, shall not discriminate in transmitting lawful network traffic over an Internet users broadband access service.
- BSPs can develop and deliver new and specialized services (e.g., IPTV and VoIP) on their facilities, as long as they do not negatively impact on the Internet and competition.

- BSPs are allowed to deploy network and bandwidth management techniques that maintain reasonable Internet access quality of service, executed in a competitive, yet non-discriminatory manner.

The challenge posed by the FCC regulation to BSPs, is how to ensure that all subscribers receive their fair share of access bandwidth within the Open Internet framework. Furthermore, any viable network solution needs to be flexible and scalable in its service delivery, offering enhanced user quality of experience (QoE), while improving network utilization efficiency.

Against this background the technology framework for any viable Open Internet policy requires:

- Fairness at All Times for All Users
- Dynamic Adaptability and Optimization
- Consistent Bandwidth Guarantees
- IP Quality of Service (QoS) Enforcement
- Service/Bandwidth Abuse Mitigation

Meeting and exceeding the above objectives would resolve the technical constraints of today's much overstressed Internet, and provide the needed capabilities to handle current and future bandwidth requirements.

### 6.2.3 SMALL BUSINESS REQUIREMENTS

The U.S. Small Business Administration's Office of Advocacy is required to conduct regular studies to explore the ways in which small businesses, access and use high speed Internet services, and to evaluate the importance of broadband speed and pricing for small businesses. In the latest study under Public Law 110-385, Sec.105.1 the Advocacy selected a small business that specializes in this field—Columbia Telecommunications Corporation (CTC)—to conduct their research which yielded the quantified results as described below (Columbia Telecom, 2010 ). Medium and larger businesses require digital and Internet access services that are beyond the definition of broadband services and are thus not further considered within this study.

The results for the small business survey are shown in Table 6-1 and are based on the following assumptions:

- A single broadband subscriber user.
- For downloading small files up to 1 MB, download time of less than 10 seconds is good, 10 to 15 seconds is fair, and more than 15 seconds is not acceptable.
- For downloading small files up to 2 MB, download time less than 20 seconds is good, 20 to 25 seconds is fair, and more than 25 seconds is not acceptable.
- For uploading videos of 1 GB, upload time less than 30 minutes is good, 30 to 90 minutes is fair, and more than 90 minutes is not acceptable.
- For downloading high-definition videos (2 GB), download time less than 10 minutes is good, 10 to 15 minutes is fair, and more than 15 minutes is not acceptable.
- For applications such as videoconferencing and remote server access, no concurrent usage of the same application by the same user will occur.

- Server back-up will normally occur during off-peak times (10 p.m. to 6 a.m.).
- For telemedicine files of up to 160 MB, download time of less than 30 seconds is good, 30 to 60 seconds is fair, and more than 60 seconds is unacceptable to provide effective treatments.

Applications	56 Kbps/ 56 Kbps (Dial-up, maximum speed)	256 Kbps/ 256 Kbps (DSL; Cable)	768 Kbps/ 384 Kbps (DSL; Cable; Satellite)	1 Mbps/ 384 Kbps (DSL; Cable; Satellite)	3 Mbps/ 768 Kbps (DSL; Cable; Satellite)	7 Mbps / 768 Kbps (DSL; Cable; Fiber)	10 Mbps/ 1 Mbps (DSL; Cable; Fiber)	15 Mbps/ 2 Mbps (Cable; Fiber)
Simple text e-mail without attachments (50 KB)	Good	Good	Good	Good	Good	Good	Good	Good
Web browsing	Good	Good	Good	Good	Good	Good	Good	Good
E-mail with large attachments or graphics (500 KB)	Bad	OK	Good	Good	Good	Good	Good	Good
Download small files (e.g., a 50-page text document with limited graphics) (1 MB) <sup>1</sup>	Bad	Bad	OK (11 sec.)	Good (8 sec.)	Good (3 sec.)	Good (2 sec.)	Good (1 sec.)	Good (1 sec.)
Download large files (e.g., a 100-page text document with graphics) (2 MB) <sup>2</sup>	Bad	Bad	OK (21 sec.)	Good (16 sec.)	Good (6 sec.)	Good (3 sec.)	Good (2 sec.)	Good (2 sec.)
Online trading, e-business	Bad	Bad	OK	Good	Good	Good	Good	Good
Online meeting presentation and document sharing	Bad	Bad	OK	Good	Good	Good	Good	Good
Videoconferencing streaming at 384 Kbps (desktop/single user) <sup>3</sup>	Bad	Bad	OK	OK	Good	Good	Good	Good
Third-party hosted applications such as e-mail, data backup <sup>4</sup>	Bad	Bad	OK	OK	OK	Good	Good	Good
Remote server access using VPN client <sup>3</sup>	Bad	Bad	Bad	Bad	OK	OK	OK	OK
Multi-point videoconferencing streaming at 768 Kbps for a group of five to six <sup>3</sup>	Bad	Bad	Bad	Bad	Bad	OK	Good	Good

**Table 6-1: Broadband requirements for small business sector**

Source: Columbia Telecom, 2010

#### 6.2.4 NETWORK TRAFFIC REQUIREMENTS

Subscribers will apply the same set of criteria to assess Internet quality of service, whether it is accessed through wired or wireless media. Similar to the current situation where many subscribers do not differentiate between cable and DSL services, history suggests that subscribers will view all wireless technologies as one. For network operators the situation is very different, as the demand on network resources for different applications greatly differs, e.g. the implication to provide a set quality-of-service requirements for real-time data versus e-mail is very different.

International findings for world-wide data services analysed in a 2010 study (Sandvine, 2010) include the following:

- Social networking services like Facebook continue to be a significant and growing proportion of mobile Internet traffic; in eight months the percentage of mobile traffic in Latin America attributable to social networking almost doubled, and in North America it increased by 33%.
- There is wide variation between the average amount of time per month for which different Internet connections are active; for instance, in North America fixed connections are active for about 3 hours per day, whereas in Asia-Pacific fixed connections are active for 5.5 hours per day.
- Median fixed access data consumption ranged from 4 gigabytes per month in North America to almost 12 gigabytes in Asia Pacific.
- Real-time entertainment (streamed or buffered real time audio and video) is unquestionably the dominant driver of data consumption on fixed and mobile networks worldwide, and is still growing substantially. Up to 43% of total Internet traffic is real-time entertainment, a significant increase from past studies.
- Within the Real-Time Entertainment category, streaming applications that rely on peer-to-peer architectures (sometimes called “peer-casting”; prominent examples include PPStream and PPLive) have achieved worldwide market penetration.

#### Upstream Traffic

Upstream traffic in Europe is shared between three major application categories: Peer-to-peer (P2P) Filesharing, Web Browsing, and Real-Time Entertainment. Upstream traffic drops off rapidly after peaking at 7pm, with the decrease driven mainly by steep declines in Web Browsing, Real-Time Entertainment and Real-Time Communications. The influence of P2P Filesharing can be felt all day long, and it actually increases during the late afternoon and early evening as more peers come online and request content.

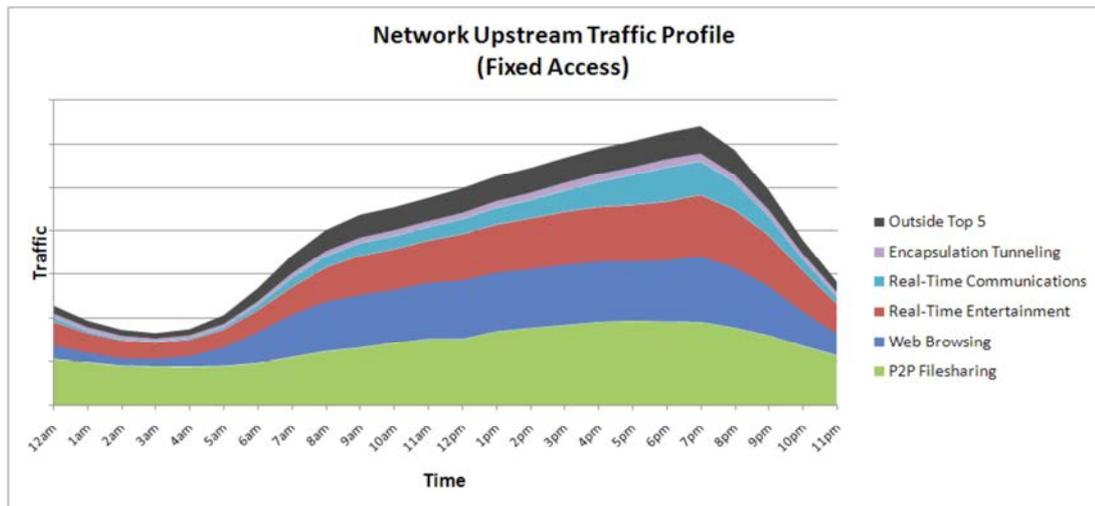


Figure 6-3: Typical Network Upstream Traffic Profile for European Network (Fixed Access)  
Source: Sandvine 2010

### Downstream traffic

In the downstream direction, Web Browsing and Real-Time Entertainment dominate; third place (P2P Filesharing) isn't even close. The peak period bump caused by a mini surge in Real-Time Entertainment traffic is apparent between 6pm and 9pm, while Web Browsing experiences a bump of similar duration but smaller magnitude. Like upstream traffic, downstream traffic drops off very quickly after attaining its peak, and reaches its minimum value at 3am.

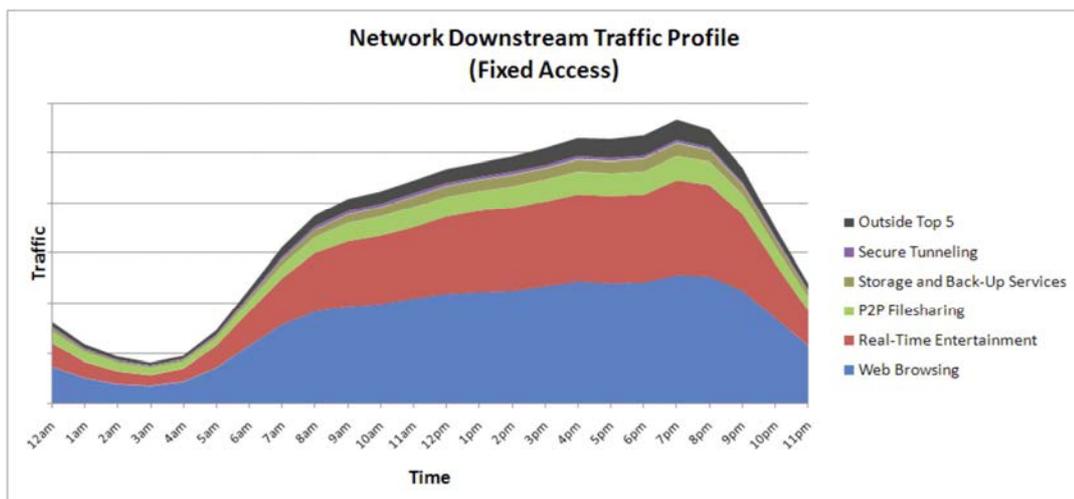
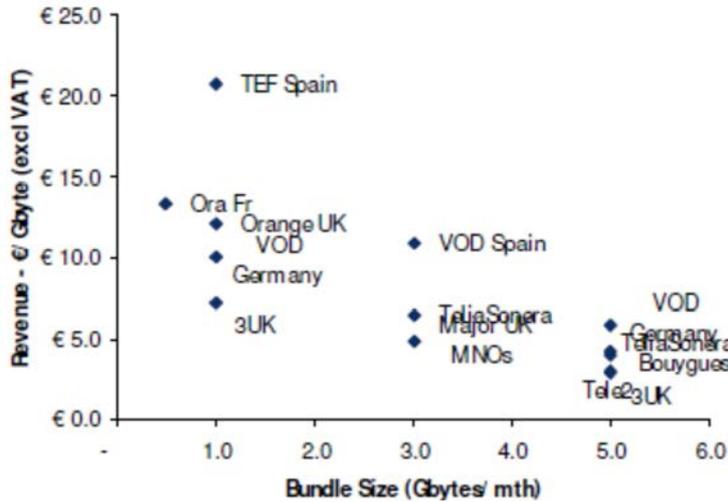


Figure 6-4: Typical Network Downstream Traffic Profile for European Network (Fixed Access)  
Source: Sandvine 2010

### 6.2.5 DATA USAGE REQUIREMENTS

Internet data usage per subscriber is growing rapidly with the current planning to be between 1GByte to 5Gbyte per month per subscriber – as is confirmed by the typical data bundles currently offered by Mobile Data Operators.



**Figure 6-5: Mobile Data Package Bundles**  
 Source: Barclay Capital, 2010

### 6.2.6 BILLING MODEL REQUIREMENTS

To define and quantify the preferred user requirements regarding billing of broadband internet access services it is best to look at research conducted for and to learn from the mobile broadband Internet market. The Mobile broadband market is well developed in terms of user billing methodologies and market adaptation requirements.

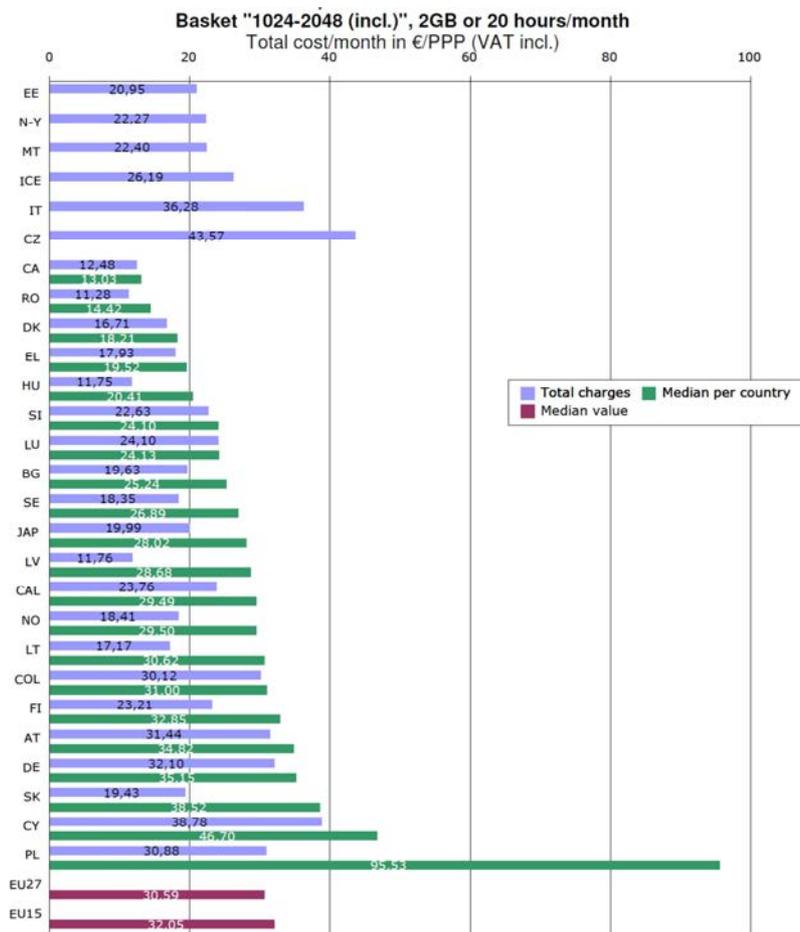
Research done in this area (Volantis, 2010) shows that, prior to the phasing out of flat-rate data packages, these were an attractive proposition for consumers with a staggering 40 per cent of 18 to 24 year olds signed up to a flat-rate data package. Furthermore, just under half (49%) of mobile users across both UK and USA regions said they would be likely to sign-up to such packages if operators made them available.

For operators this evidence presents a dilemma: while they are struggling to provide sustainable bandwidth to accommodate heavy mobile data users, it is clear that those people who already use the mobile internet frequently wish to maintain their level of access, and more consumers wish to increase their level of usage. The idea of pay-as-you-go mobile internet access looks doomed for both UK and US operators, with only two per cent of UK and no US consumers saying they would prefer to pay for each individual time they logged on. Conversely, consumers are prepared to pay for extra data privileges with almost half (47%) of UK mobile phone users and 40 per cent of Americans saying they would happily pay between £3 and £5 / \$5 and \$8 a month extra for flat-rate mobile internet access.

### 6.2.7 PRICE INDICATORS

To determine future price points for the broadband service product, it is more applicable to use European market price indicators, rather than the current pricing for broadband services in Africa. The Africa market is still very much evolving and it can be expected that, while pricing will consolidate and decrease over the next 3 – 5 years in Africa, the European market has already gone through this consolidation and is therefore a good indicator for a long term Africa pricing scenario.

Using the European market as a reference and based on a 2Mbps, 2GByte package, the expected market price is euro30.



**Figure 6-6: European consumer broadband rates for 2009**  
 Source: European Commission BIA Report 2010

## 6.2.8 CONSUMER BEHAVIOR PATTERNS

Research (Sandvine 2009) shows that the industry is in the midst of a massive shift in subscriber behavior from a reliance on “download now, use later” content acquisition to an on-demand mentality where bytes are consumed as they arrive.

Almost two-thirds of all Internet traffic is enjoyed on arrival, including Web Browsing, Real-Time Entertainment, such as video and audio streaming and peercasting applications, Gaming- and Real-Time Communications. Global broadband consumer behaviour patterns show the following notable findings:

### **Not the usual suspects:**

Broad-based adoption of on-demand applications drives peak network utilization globally. Peak-time usage is only slightly influenced by the top network users as measured over the previous month, suggesting that usage management and congestion management are two separate aspects of network management.

### **The network influences subscriber behavior.**

Mature broadband markets have embraced on-demand entertainment applications, while emerging markets still rely on peer-to-peer as the primary source of content.

### **Where do all those YouTube minutes flow?**

On a per-subscriber basis, North Americans consume the most YouTube videos followed closely by subscribers in Africa; but by geography, Europe is the destination for more YouTube minutes than any other region.

### **Storage and Back-Up services are becoming main stream.**

In 2009, networks were transporting almost 56% more data per subscriber to and from storage and back-up services than in 2008, led by one-click download services like Rapidshare and MegaUpload and continuing a trend that first came to prominence in 2010.

### **Are they “game consoles” or “entertainment consoles”?**

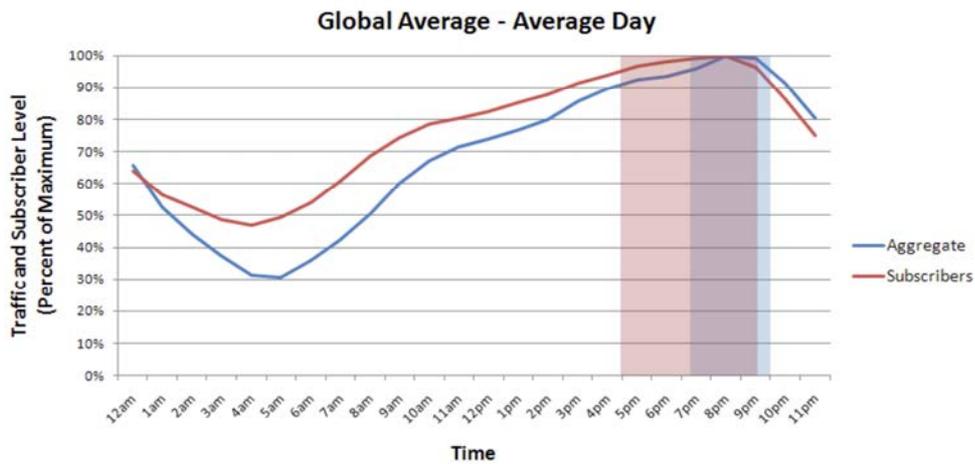
Traffic to and from gaming consoles increased by more than 50% per subscriber. This demonstrates not only the popularity of online gaming, but also the growing use of game consoles as sources of “traditional” entertainment, such as movies and TV shows.

### **Are the P2P wars over?**

BitTorrent has emerged as by far the leading peer-to-peer file sharing network, both in terms of number of users and the total bytes worldwide, although there are still regional variations.

### **At a global level, P2P Filesharing declined by 25 percent as a share of total traffic, to account for just over 20 percent of total bytes.**

However, the decline is not consistent in every region - North America experienced a 20 percent relative decline, while the Caribbean and Latin America actually experienced an increase of more than 30 percent.

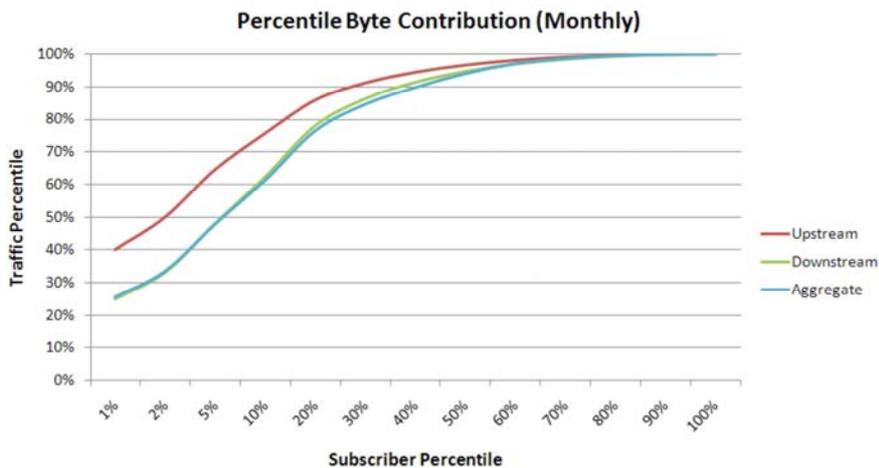


**Figure 6-7: Global subscriber daily usage pattern**  
 Source: Sandvine report, 2010

### 6.2.9 CONSUMER USAGE PROFILE

When subscribers are ranked in order of total consumption and the contribution of each percentage is computed and compared, it becomes apparent that the heaviest network users account for a hugely disproportionate amount of total Internet traffic (Sandvine, 2009).

Over a month, the top 1 percent of subscribers is responsible for 25 percent of total bytes on the network. In the upstream link, the top 1 percent accounts for 40 percent of total bytes, showing an even greater disparity in demand for network resources. Furthermore, the top 20 percent of subscribers account for fully 80 percent of total Internet traffic.



**Figure 6-8: Subscriber demand curve**  
 Sandvine Report, 2010

### 6.2.10 CONSOLIDATED USER REQUIREMENTS

Table 6.2 provides a summary schedule of consumer broadband requirements with a reference to the feasibility of current VSAT models complying with these requirements.

Network Criteria	Requirement	Compliance of the current VSAT Business Models
<b>Communication Coverage</b>	The complete Africa continent represents the target market and ubiquitous services should be available throughout the continent if possible.	Comply. Current VSAT network do cover all of Africa.
<b>Service Price</b>	From European market research the reference target price is based on a 2Mbps data rate, 20Gbyte data usage for 20 hours per month, is \$40 per month.	Non-comply. Current VSAT model is based on access speed and cannot reach these price points.
<b>Net neutrality</b>	Fair Use Technical Framework systems that employ non-invasive dynamic IP Flow-State (IFS) technology must be used to identify and manage Internet traffic in a manner that ensures transparent, equal, non-discriminatory access to online content and facilitates tiered service offerings.	Comply. Current VSAT network are neutral and do not provide any content restrictions.
<b>Access Speed</b>	To provide an acceptable level of access service to the small business market, the Internet access speed must be a minimum of 3Mbps.	Non-comply. High speed services are too expensive using current VSAT networks.
<b>Data Traffic Requirements</b>	The network must provide differential quality-of-service to ensure user satisfaction for real-time traffic and web-browsing applications vs non real-time applications such as email.	Comply. Current VSAT models do include real-time traffic prioritisation.
<b>Data usage requirements</b>	User data usage is currently between 1 and 5Gbyte per month and is expected to grow to 10GByte and more for heavy users. The network must be able to service this demand while maintaining the network data delivery capability.	Non-comply Current models are mainly based on access speed and not on usage.
<b>Network loading and congestion</b>	The network must support a significant differential in overall traffic volumes between the busy-hour period of 18h00 to 22h00 and the off-peak period of 2h00 to 8h00.	Non-comply. Access speed networks do not provide pricing which differentiate on time-of-day usage.
<b>Billing Requirements</b>	The preferred billing platform of future broadband service must find the optimum balance between “flat-rate” and “usage” based billing. Clearly the flat-rate billing is preferred by the users while operators prefer usage-based models.	Non-comply. Current models are mostly flat rate and does not protect against user abuse and over loading.

**Table 6-2: Consumer requirement summary schedule**

## 6.3 PRODUCT DEFINITION

### 6.3.1 PRINCIPAL TECHNOLOGY STRATEGIES

To ensure a long-term sustainable product offering and competitive business position, the principal product strategy must be anchored in the advantages of satellite technology to provide solutions and services that cannot be readily supported by other technologies.

The following table provides a map between the technology characteristic and the preferred associated product strategy. The table also includes a reference to the characteristics of VSAT networks currently available in the industry and the suitability of these VSAT networks compared to the specific requirements.

Principal Technology Characteristic	Product Strategy	Current VSAT network characteristics
<b>Point-to-multipoint.</b> All satellite networks provide connectivity from a central point to thousands of remote sites	<b>Broadcast Service.</b> The holy grail for satellite networks are mass broadcast networks, e.g. digital television broadcast networks. The product strategy must always be on broadcasting of IP-based services such as digital media boards, business video conference broadcasts, etc.	<b>Equipment cost limited.</b> The subscriber terminal cost of current VSAT networks are high and this prevents the deployment of current VSAT networks to service mass broadcast applications.
<b>Ubiquitous Coverage.</b> Satellite networks provide high-level signal coverage over vast areas.	<b>Rural and Nation-wide Services.</b> Typical applications that can be supported are broadband services to rural communities, telemetry and monitoring services to the agricultural industry.	<b>Restricted.</b> The high subscriber terminal cost of VSAT networks limits this application as well.
<b>Asymmetrical Communication.</b> The outbound channel will always support much higher broadband speed than the inbound channel.	<b>IP Distribution Services.</b> Satellite is well suited to applications that require the distribution of files from one location to thousands such as software updates, GIS data, etc.	<b>Comply.</b> Current VSAT networks can be implemented to provide asymmetrical communication services.

**Table 6-3: Principle technology strategy outline**

### 6.3.2 MARKET POSITIONING

Research done for the broadband European market (IDATE, 2009) estimates that in 2008 there were still close to 10 million households in Europe that were not covered by a terrestrial broadband solution network.

After having emerged in North America and Asia during the period 2005, satellite broadband in the Ka-band was introduced in Europe in mid-2007 and, has since proven to be a popular solution for meeting governmental objectives to reduce the digital divide.

For the Africa market the potential for satellite in the short and medium term far exceeds the potential in Europe. What must be recognised is that the broadband Africa market is not a uniform landscape - different countries are in different stages of development and will thus require different product positioning and strategies.

#### **Market 1: Well Developed Markets**

Well developed markets are countries such as South Africa, Nigeria and East Africa countries that already have access to international fiber cables and well developed mobile broadband and ADSL networks. For these markets the focus is on “gap filler” services, i.e. services to smaller areas that are not covered by the terrestrial networks.

These markets are also ready for more advanced IP connectivity applications, such as connectivity for digital media boards, business video broadcasting and point-of-sale applications. In the longer term the convergence of video, voice and data communications, will offer the potential of a partnership strategy with a major DTH platform.

#### **Market 2: Fast Developing Market**

Southern Africa markets, i.e. Botswana, Namibia and Zimbabwe, as well as West Africa markets like Ghana and Ivory Coast are fast developing areas for broadband services. For these markets, satellite broadband still provides a value proposition for large population areas that fall outside the terrestrial networks, as well as to provide trunk services to wireless distribution networks.

Satellite broadband access speeds are generally also higher than terrestrial access in these markets and this can be leveraged to retain some of the high-end user groups. In the medium term it is expected that these markets will develop demand for IP broadcast services and ultimately for triple-play services that will provide broadband services integrated with television channels in partnership with a direct-to-home operators.

### Market 3: Slower Developing Market

The central African markets, i.e. Democratic Republic of Congo, Sudan and Central Africa Republic as well as Angola and Mozambique are countries with vast geographical areas but little infrastructure. For these countries the development of mobile and ADSL broadband networks is slow and mostly limited to the major cities and metropolitan areas.

In these markets the primary strategy is to provide an effective broadband service to the general business and consumer markets not covered by another service network.

### Market Sector Positioning Summary

Table 6.4 provides a summary of the respective market sectors and also includes a reference to the current VSAT services addressing these market sectors.

	Market 1 Well developed broadband market	Market 2 Fast developing market	Market 3 Slower developing market
<b>Countries</b>	South Africa; Nigeria and East Africa	Southern Africa Region and selected West Africa countries.	Central Africa, DRC, Angola and Mozambique
<b>Most suitable initial strategic positioning</b>	<p>“Gap” filler strategy from consumer services.</p> <p>Government digital divide projects.</p> <p>IP broadcast projects such as digital media and video.</p>	<p>Broadband services to higher income market.</p> <p>Schools, clinics leading to reduction of the digital divide</p>	Internet only access provider
<b>Most suitable longer term strategic positioning</b>	Partner with DTH player	<p>IP broadcast services</p> <p>Partner with DTH player</p>	<p>Higher income services</p> <p>IP broadcast services</p> <p>Partner with DTH player</p>
<b>Suitability of current VSAT networks</b>	This market is limited for current VSAT networks due to the high cost of the terminal equipment.	Current VSAT networks can only service the higher income sector of this market which can afford the more expensive terminal cost.	In developing markets current VSAT networks can only service the business and enterprise market sectors.

**Table 6-4: Market and Product positioning matrix**

### 6.3.3 INTERNET ACCESS PRODUCT POSITIONING

The product positioning applicable to Internet access services for broadband applications, as well as for “Internet-of-things” applications, are defined in the following table. Due to established demand broadband access, services will initially be the primary focus of the product with Internet access to equipment and other items to follow as the market develops and matures.

	Broadband Access	The Internet-of-Things
<b>Target Market Segment</b>	Consumers, power-users, small businesses, rural schools.	Consumer and industry.
<b>Service by current VSAT networks</b>	The high subscriber terminal cost of current VSAT networks limits the deployment of this technology as a means to service large scale networks.	
<b>Competitive Advantage</b>	Guaranteed signal coverage throughout target market. The option to structure the product performance to meet different market requirements.	High-speed, high reliability, short bursts IP communications.
<b>Threat</b>	Investment in terrestrial network infrastructure to eventually ensure 100% market geographical signal coverage.	Market still developing
<b>Product definition</b>	Provide two-way Internet access at typically 4Mbps receive and 256kbps transmit speed.	Time-based access product with special options for access at night and other off peak times.
<b>Product pricing</b>	The service will be aimed at the higher LSM categories with a monthly service fee of between R500 to R1000 rand per month.	Pricing based on a “stand-by” service fee with additional rate for actual data usage.
<b>Channel to the market</b>	This product will be offered on a wholesale basis to national and regional Internet Service Providers.	Direct sales to industrial engineering companies who are providing solutions to this market sector.

**Table 6-5: Product positioning for broadband and Internet-of-things market**

### 6.3.4 IP BROADCASTING PRODUCT POSITIONING

IP broadcasting is based on providing IP connectivity from a central location to many remote locations and then broadcasting IP-based content to these remote sites. Applications can include updating content files to digital media boards or broadcasting of business and other closed user group video material, etc.

Content distribution networks will also provide the mechanism for continuous updates of software for user devices. The market for IP broadcasting is still developing and the satellite access product for this market will mostly be deployed in future.

	Content Distribution	Real-time Video Distribution
<b>Target Segment</b>	ICT companies that focus on media distribution applications.	Content industry
<b>Competitive Advantage</b>	<p>The broadcast nature of satellite networks will provide the perfect means to distribute similar content from a single location to hundreds of remote points.</p> <p>Distribution of content can be scheduled to off-peak network periods to provide an attractive distribution rate to customers.</p>	
<b>Entry barriers</b>	Terrestrial networks are not well positioned to distribute large content files from one location to remote sites.	
<b>Current VSAT networks</b>	Current VSAT networks are cost effective for lower quantity higher cost applications and cannot meet mass broadcast deployment requirements.	
<b>Product definition</b>	Content distribution can be offered on a per-week or per-month basis as is required to maintain current content at the remote sites. This service can be billed based on the volume of data distributed or on the duration needed.	Real-time video applications to business customers can be provided on an “ad-hoc” basis for when the service is required. This will be based on the time and the access quality-of-service levels required.
<b>Product pricing</b>	Both these service offerings are new in the market and the product pricing points must still be defined.	
<b>Channel to the market</b>	These access products will be required as part of a wider implementation project and will most often be offered to system integrators and solution providers.	

**Table 6-6: IP broadcasting product positioning**

## 6.4 SATELLITE SYSTEM ENGINEERING

### 6.4.1 SATELLITE NETWORK OVERVIEW

Any satellite-based communication or content distribution network incorporates the following high-level subsystems;



#### Content Source

For broadcast networks this is the video channel content; for corporate networks it can be the head office server; and for broadband services this represents the access to a reliable 1<sup>st</sup> tier Internet service.

#### Satellite Hub Equipment

The hub equipment is specifically determined by the preferred network performance and is manufacturer specific. Satellite network hubs are manufactured by companies such as Gilat, Hughes Networks, iDirect and Newtec. The satellite hub equipment determines the specific functions and features of the satellite communication network and is very specific to the target market.

#### Teleport

The teleport is the physical premises from where the communication channels are sent to the remote sites and received from the remote sites via the satellite. The teleport includes the terrestrial fibre access networks as well as the major earth-station satellite communication antennas.

#### Satellite

The satellite is effectively a signal-relay it receives signals from one source and retransmits these signals to the other source. No signal processing is done in the satellite subsystem. The main selection criteria are 1) the orbital position of the satellite with respect to the target market, and 2) the communication coverage area that is serviced by the particular satellite.

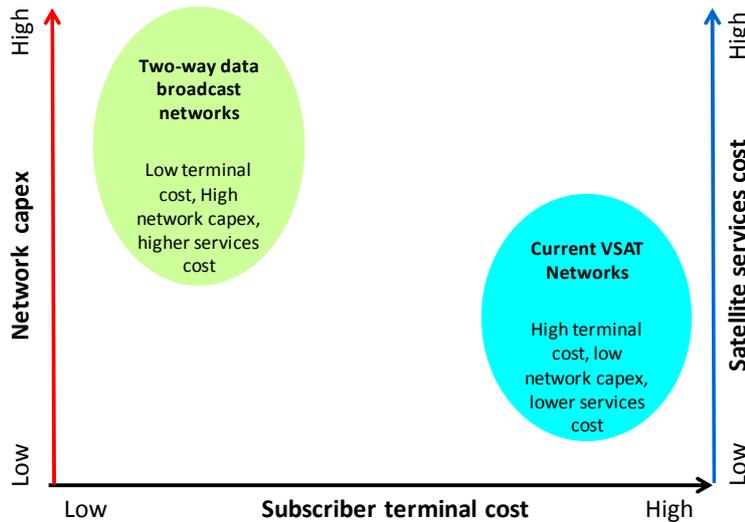
#### User Equipment

User satellite terminals complete the communication chain and communicate to the hub via the satellite channel. User terminals are specific to the hub equipment with very little or no interoperability between manufacturers.

### 6.4.2 NETWORK BUSINESS MODEL CRITERIA

The design of the most suited network technology for implementation of the satellite broadband network is a complex trade-off between network implementation capital costs, the subscriber equipment terminal cost and the influence of the equipment cost on the roll-out rate as well as the net cost of the satellite data transmission channel.

Figure 6.9 provides a graphical perspective of the cost relationships for the current VSAT



networks deployed throughout Africa and the alternative next generation two-way data broadcast networks. The higher cost terminal equipment of current VSAT networks offers more efficient data communication yet lowers the market adoption and increases the subscriber barrier to entry.

**Figure 6-9: Relative relationship between network, terminal and channel costs**

The alternative two-way data broadcast networks provides the advantages of a lower cost subscriber terminal that support mass adoption by the market yet these networks require very high capital investments to implement the core communication network and are less efficient that relates to higher services costs. The high investment cost requirements increase the business risk and the higher services cost require specific billing models to ensure affordable service bundles for subscribers.

In order to effectively service the emerging Africa broadband market a business model must thus be defined that can offer both low-cost subscriber terminals while at the same time minimise the risks associated with high network capital investment expenses. Such a business model must also incorporate a service billing model that can provide an affordable service bundle to subscriber given the higher communication channels costs associated with two-way data broadcast networks.

### 6.4.3 SATELLITE CHANNELS

A satellite channel signal transmission link power analyses, also referred to as, a link power budget, is completed to determine the most suited communication channel carrier specifications, the channel reliability and resource efficiency.

The carrier analysis is done in the forward direction, i.e. from the hub to the remote sites, and in the return direction, i.e. from the remote sites to the hub. The results of the link budget analysis form the basis of all costing and product implementation plans. Refer to appendix D for a detailed link budget calculation.

#### Forward Channel Link Budget

The forward link carrier results are based on a 36MHz DVB-S2 carrier on a saturated 36MHz transponder. The analysis was done for ACM (Adaptive coding and modulation) on the forward link, which ensures that the highest efficiencies are achieved for remote sites in all geographical locations in the footprint and during all weather conditions.

#### Forward Carrier Specifications

Frequency:	Ku-band
Bandwidth:	36MHz
Symbol Rate:	30 Msps
Roll-off:	0.2 spacing between multiple carriers
Pilot Mode:	Active
Possible MODCOD's:	QPSK; 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 8PSK; 3/5, 2/3, 3/4, 5/6, 8/9, 9/10 (MODCOD, modulation codec options)

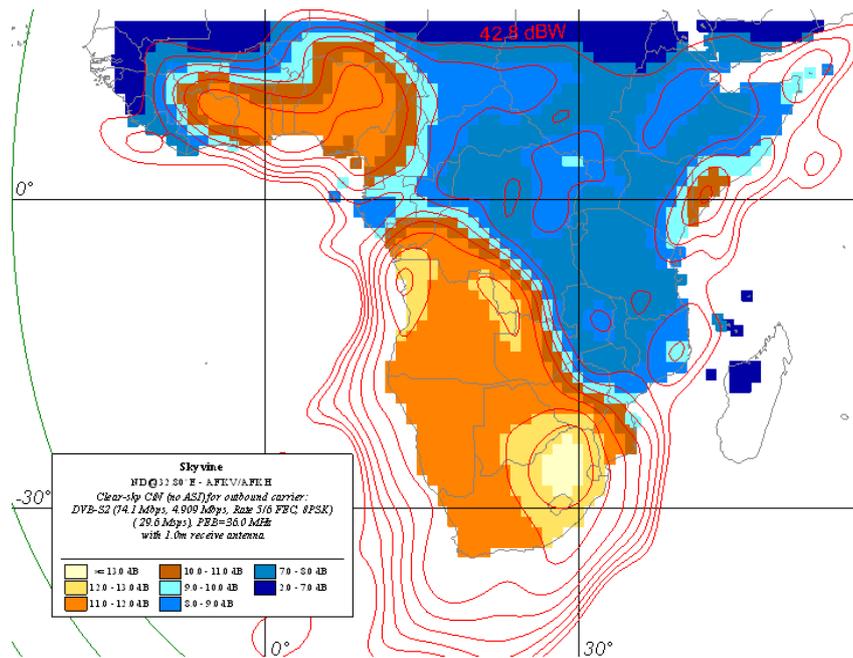
As high order MODCOD's will be used on the downlink, a transponder OBO (output back off) of 1.5dB will be required to ensure that noise is kept at a minimum. This system also deploys Automatic Code Modulation technology which selects the most suites modcod for a specific atmosphere and remote site condition.

#### Return Channel

A carrier multiple distribution analysis was done for each of four different return link carrier types from a remote site, 1m antenna to a 5.6m hub antenna located in Johannesburg, South-Africa. All return carriers use 4CPM (Constant phase modulation) which is a non-linear modulation type.

<b>Carrier Bandwidth</b>	RF channel width	<b>256 kHz</b>	<b>256 kHz</b>	<b>512 kHz</b>	<b>512 kHz</b>
<b>Carrier Type</b>	Codec option	<b>ID 0</b>	<b>ID 1</b>	<b>ID 0</b>	<b>ID 1</b>
<b>Efficiency (bits/Hz)</b>	Data transmission efficiency	0.55	0.71	0.55	0.71
<b>Required Eb/No (dB)</b>	Minimum signal bit level required	3.3	4.5	3.3	4.5
<b>Info rate (kbps)</b>	Usable information data transfer rate	141	182	282	364
<b>Transmit Rate (kbps)</b>	Maximum data transmit rate	178	233	356	467
<b>FEC</b>	Forward error correction code	0.7111	0.7111	0.7111	0.7111
<b>Modulation</b>	Modulation scheme	4CPM	4CPM	4CPM	4CPM

Figure 6.10 and 6.11 provides a graphical representation of the outbound and inbound carrier signal levels as a function of the geographical location.



**Figure 6-10: Clear-Sky analysis for the outbound carrier**

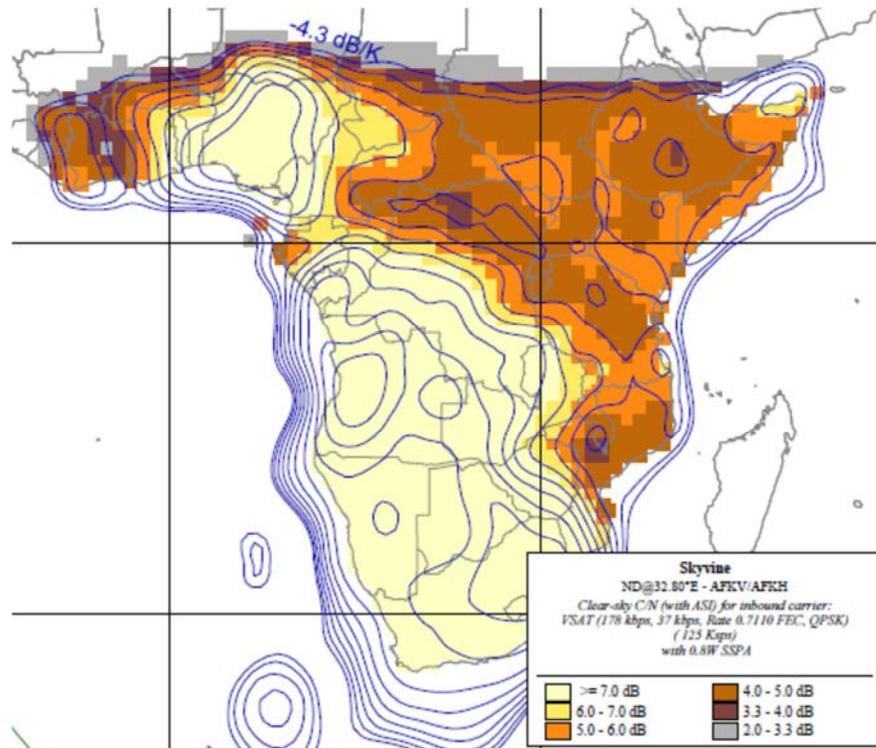


Figure 6-11: Return channel analyses for 256 KHz IDO configuration

## 6.5 BUSINESS MODEL DEFINITION

Having analysed the customer requirements, technology of choice, product definition and network architecture, the next step is to develop the most suitable business model for establishing a satellite data broadcast service.

In terms of the business model definition as applicable to this study the business model defines the following important aspects:

- what specific product will be offered and which market will be targeted;
- which technology solution will be utilised and what the pricing model will be;
- through what type of organisational structure will the service be delivered; and
- what will the requirements be for financial success.

In order to define the most suited business model known processes were considered and used to integrate technology, product development and market strategies into a coherent business strategy.

In particular the business model addresses the creation of value via the fields of service innovation, organisational resources and organisational capabilities by integrating the elements of the STOF model as defined by Bouwman et al, 2008.

As we summarized in Chapter 3 the work of Tidd & Bessant (2009) pointed out that innovation is an iterative and “adaptive” learning process that is completed in a learning loop environment which enables growth and continued learning in the organization. The notion that business model definition should be an “adaptive” and “unpredictable” process to accommodate innovation and flexibility is also confirmed by the work done by Ostwalder and Pigneur. They further stressed that the process must be completed within a “design attitude” that incorporates exploring different concepts in an ad hoc manner and not necessarily in a step-by-step process. (Ostwalder and Pigneur, 2010).

In this thesis we have built upon the above mentioned (and widely accepted) models and methodologies to define an “innovation-loop” business model for providing broadband services to the emerging mass market in Africa. The “innovation-loop” model involves a cyclic process of optimizing business decisions in an iterative way. It provides a structured approach to integrate the various elements and functions into an optimized business model definition.

The business model definition was further expanded by incorporating the work done by Pearce and Robinson (Pearce and Robinson, 1988) which on the development of a strategic management model that incorporates all aspects of a business. Their definition of strategic management incorporates “The set of decisions and actions resulting in the formulation and implementation of strategies designed to achieve the objectives of the organisation”. By integrating this thinking into the “innovation-loop” model the future scenarios and possibilities are also considered.

We concluded our definition of an “innovation-loop” business model by adding the concept of an iterative technology innovation process that integrates the seven different elements as identified by Burgelman *et al* (1996) as well as the strategic business model relationships (Ungerer, 2007). In the process we incorporated the market, technology and product

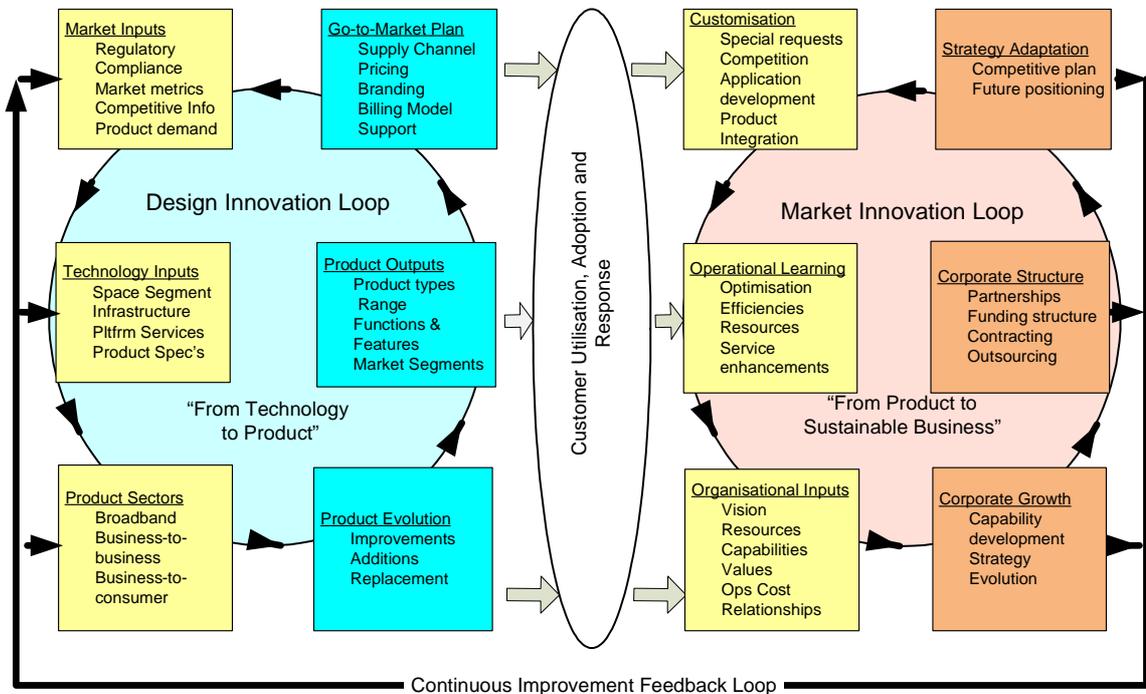
development processes into one coherent business model development process that utilises the best from existing concepts and theories in this field.

In summary it can be stated that we defined the “innovation-loop” business model by expanding on the following known concepts:

- The Service, Technology, Organisation & Finance (STOF) model as defined by Bouwman *et al* (2008).
- The iterative and adaptive learning process behavior of innovation processes as pointed out by Tidd & Bessant (2009).
- The inclusion of all aspects of the business into the strategic modelling as highlighted by Pearce and Robinson (Pearce and Robinson, 1988).
- The concept of “design attitude” that promotes flexible thinking as defined by Ostwalder and Pigneur (Ostwalder and Pigneur, 2010).

6.5.1 **“INNOVATION-LOOP” BUSINESS MODEL DEVELOPMENT**

The “Innovation-loop” process that was followed to develop our proposed business model is depicted in Figure 6-12.



**Figure 6-12: The “Innovation-loop” Business model development process**

This process enables a structured review of all the respective inputs, the internal business criteria and the required outputs to service the market, as well as the applicable feedback loops. The process is briefly described in this paragraph.

**Design Innovation-Loop Process**

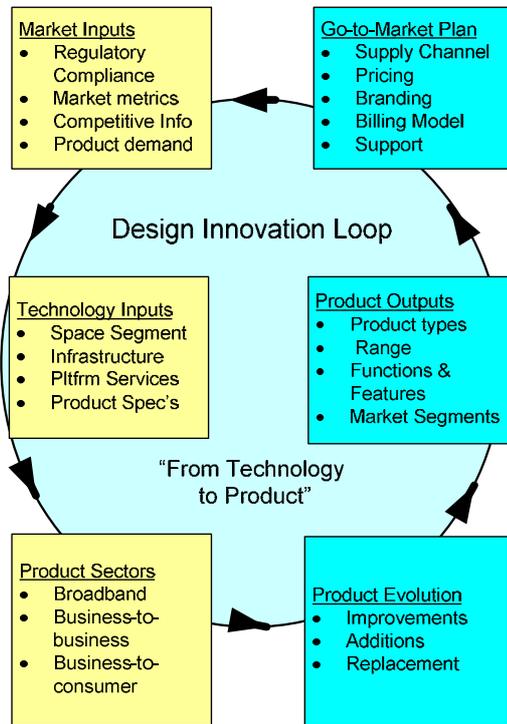
The design innovation loop is focused on the “From-Technology-to-Product” process and is driven by the market, technology and product requirements. The process considers the technical, business and market requirements to define the go-to-market plan, the product outputs and the organisational structure needed to service the market.

**Market Inputs**

Telecommunication regulations, market competitive landscapes, end-user product demand, market volume and demographics are the primary macro environment criteria that determine the scope and possibilities of the business model to be defined. These criteria can be leveraged to create business models that introduce new paradigms and breakthrough products.

**Technology Inputs**

Technology plays the role of an enabler. The specifications and technical capabilities of new



products define the technical limitations of the business model. New technology opens new horizons to develop new products and services – provided that the product can be successfully commercialised. The new low-cost consumer focused satellite terminal integrated with the pan-Africa signal coverage offered by the New Dawn satellite, set the product technical landscape for the new data broadcast product business.

**Product Sectors**

Target market knowledge with detailed definitions of the different market sectors and respective requirements is critical to ensure that the business model to be developed will meet the actual customer requirements. Using general perceptions and broad statistics will lead to a product that is not well suited for the target market without distinct competitive advantages.

**Figure 6-13: Design Innovation Loop Process Diagram**

**Product Outputs**

The product concept is measured against the market and technology input criteria to validate if this product will service the target product sector. Product concepts that are feasible are then applied to define the go-to-market plan. This phase is a critical phase and can incorporate product concept deployments and even customer trial networks, if these are practical options to test a new product concept.

**Go-to-Market plan**

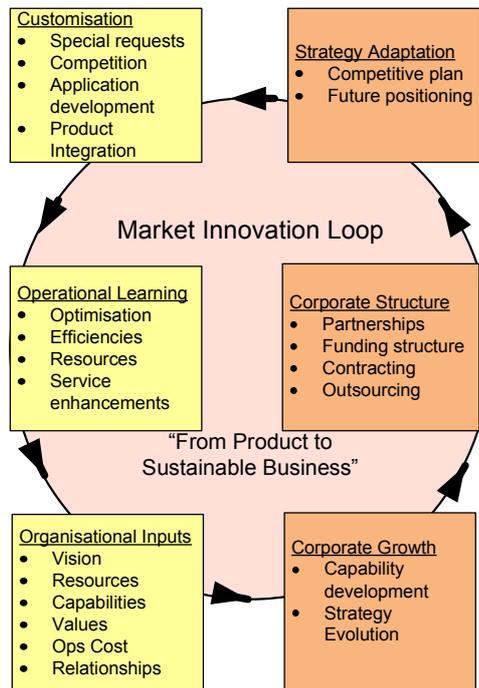
Pricing, branding, distribution channels and billing models all represent criteria that will determine if a product concept can be supplied to the market. A technically impressive

product without the supporting go-to-market plan does not constitute a feasible option on which to base the business model definition.

**Product Evolution**

Continued improvements, adding additional functions and introducing new products are critical to ensure an on-going sustainable business. In the technology environment products needs to be constantly improved or replaced in order to secure sustained market share. In the specific case of satellite services, this requirement is to some extent, mitigated by the fact that satellites and the associated networks are deployed for an expected 15 year life span.

## Market Innovation-Loop Process



**Figure 6-14: Market Innovation-Loop Process Diagram**

The market innovation loop is focused on receiving feedback from the market and adapting the applicable business parameters in order to ensure on-going alignment between the business strategy and market requirements

The market loop is depicted in figure 6-15 and incorporates the activities and processes that are focused on the “Product-to-sustainable business” phase.

### Customisation

Customisation and product evolution are two very critical steps in the business model development cycle. These interactive processes must ensure that the product maintains its competitive advantage. The drive towards self-help portals, and towards customised products that are built based on a single individual’s requirements are indicative of the importance of this element.

### Operational learning

A great product that is in high demand requires ongoing operational learning to ensure efficient delivery and support of the product. The operational requirements of the potential new product must be planned for in the business model and will drive aspects such as remote support requirements and the skills and know-how required to support the product.

### Organisational Inputs

The business model development process must be completed within the broader organisational landscape of the company. New business models that are not aligned with the company vision, resources, capabilities, values and cost limitations will not materialise

and must be redefined. A product concept that requires the organisation structure to be changed must be carefully considered, as this could either be the product that unlocks a completely new future for the organisation or it may be a product that will drain the resources of the company.

### Corporate Structure

Different products and different business strategies require different corporate structures in terms of industry supply relationships, distribution channels, resource contracting options and funding requirements. The focus is on defining a business model that meets the market demand while still being compatible with the current corporate structure or with a structure that can be established.

### **Corporate Growth**

Business model evolution is one of the most effective options to propel companies into new markets using new products and technologies. While this is true, the reverse is equally valid as new business models can lead to the demise of great companies. For this reason the business model must be defined to be feasible within the current company capabilities or alternatively specific steps must be included in the business model definition phase to establish the corporate growth that will be required for successful execution.

### **Strategy Adaptation**

Markets, regulations, industries and technologies represent changing elements of the macro environment of the business. The challenge is to maintain the strategic direction in order to drive business growth while at the same time being sufficiently flexible to accommodate the challenges of a changing environment. For this purpose the business model development process must include a review of the current competitive plan and future positioning.

## **6.5.2 EXISTING BUSINESS MODELS**

To the uninformed observer it may appear as if satellite based Internet services are well established and freely available to the mass market in Africa. The brief description below of existing case studies provides evidence of the limitations inherent to existing service offerings and of the need for a different approach to effectively service the mass Internet market in this region.

### **The current African VSAT market**

Between 2003 and 2006, Canada's International Development Research Centre (IDRC) joined forces with the British government's CATIA (Catalysing Access to ICTs in Africa) initiative to support research of the VSAT market (IRDC, 2007).

They found that the challenges to widespread deployment of VSAT services include the shortage of trained local technicians to install and maintain thousands of terminals, the need to power this equipment from alternative electricity sources in remote rural areas, and the problem of collecting service fees from people in those areas.

These constraints are fundamental to the current VSAT business models deployed in Africa as it restricts the deployment of VSAT services to the business and government markets. It also provides the motivation and principle justification why a new and different technology and business model option must be defined to service the mass Africa market.

The business model developed through this study has resolved all of the constraints identified above, namely:

- a. The technology deployed by the two-way data broadcast networks significantly simplifies the field installation requirements and the terminals can be installed using DStv and other DTH-networks installation teams. Following the success of DStv and other TV networks in Africa there is a large network of installation teams in Africa offering these minimum skill levels.

- b. The power consumption of the data broadcast technologies has been optimized to such an extent that these terminals can be effectively operated using solar power systems. This characteristic enables the deployment of these terminals in areas with no, or unreliable, grid power supply.
- c. The problem of collecting subscriber revenue is also elegantly addressed by this study through the development of an applicable broadband billing model which not only resolves the revenue collection challenge but also makes the product more affordable to service a wider market sector. The billing model developed in this study is the key to economically service the mass consumer market and is expected to enable the deployment of data broadcast networks throughout Africa.

### **International Data Broadcast Model**

Astra2Connect is a subsidiary of SES Astra and a European based service provider that operates a data broadcast business model. Astra2Connect currently provides services to an average of 80,000 users, using a service infrastructure of multiple hub networks and related satellite communication bandwidth.

Through close co-operation and personal visits to the Astra2Connect facility in Luxemburg, the author obtained access to information and operational data of the Astra2Connect services. The investment required to service the European market was \$5M in network infrastructure while the satellite capacity services were provided to Astra2Connect by its holding company SES Astra.

Operation started in 2005 and currently the network is servicing an estimated 80,000 users throughout Europe. The total operating financial investment to establish the Astra2Connect services is estimated to be more than \$20M with trading profitability reached by 2008 at a subscriber base of 40,000. The initial operating funding was provided by Astra2Connect's holding company SES Astra who also allowed Astra2Connect to use satellite capacity on very favourable financial terms.

The Astra2Connect case study outlines;-

- a) the large investments required to establish a data broadcast service.
- b) the large number of subscribers required to secure the financial return.
- c) the need to service a market that can meet these requirements in a 3 year time frame in order to provide the required business investment confidence.

While this model proved to be viable within the European market and with the active support of an established parent company, the same conditions are not satisfied for a service offered to the African market and by a service provider that must independently operate such a service on a financially viable basis. It therefore reconfirms the need for an alternative approach to achieve success in providing such services to the mass African market.

During 2012 Yahsat, a Middle-East operator, launched the YahClick service which is a similar service as the Astra2Connect services and which is based on the data broadcast business model. The Yahclick service has strong similarities to the Astra2Connect services: it also

involves a large investment in infrastructure made by a satellite network operator; furthermore the infrastructure investment is located outside of Africa and focuses primarily on the Middle-East market rather than Africa.

Both the Astra2Connect and the Yahclick services confirmed that the industry has not yet found a suitable business model to establish a data broadcast service in Africa for Africa and which offers an acceptable risk profile that balances the market potential with the investment risk profile.

### **Critical Review of Existing Business Models**

The following table provides a critical evaluation of the current business models in terms of the key requirements to service the mass consumer Africa market. This provides an overview and understanding of the constraints of the current business models to service the Africa market, and thus the need to develop an alternative business model.

In chapter 9 we develop a quantified business model simulator; we will apply this simulator to further quantify the constraints of the current VSAT business models in the context of servicing the Africa market as well as to provide quantified scenarios to demonstrate the limitations of the current models.

Key Requirements	VSAT Business Models	Intl' Data Broadcast Models
Consumer requirements	Par 6.2.10 provides a summary that outlines the limitations of the current models w.r.t. the consumer requirements.	The data broadcast models comply with most of the consumer user requirements; in this case the issue is that the investment viability of these models for Africa is not good enough to justify its deployment.
Product definition	The relatively high subscriber terminal implementation costs for current VSAT network is a strong inhibitor for mass deployment of VSAT networks to service large scale applications in Africa.	Intl' data broadcast networks can be an effective solution to provide standard Internet access services to the mass market.  However many applications, e.g. distance learning and telemedicine, require localized content uplink facilities; as a result these applications cannot be serviced by the data broadcast networks located in Europe and elsewhere.
Satellite system engineering	The satellite systems engineering for VSAT networks in Africa are constrained by the financial potential of the business which lead to the networks not being able to contract bulk satellite capacity in order to get the critical mass and the price	The data broadcast business models does provide the financial viability to contract for large scale satellite services as is required to get to an acceptable product pricing structure.  In this scenario the constraint lies in the fact that these models currently utilizes

	economies required.  This leads to higher input costs scenarios and higher user service fees.	satellites that are not optimum for Africa and thus cannot effectively provide services to the total target Pan-Africa market.
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### 6.5.3 CURRENT INDUSTRY DILEMMA

The opportunity to provide satellite data broadcast services to the emerging Africa market has been confirmed and satellite data broadcast networks are proven to be a suitable technology to implement the solution. However, analysis of the current business strategies of ISP's operating in Africa and using VSAT based product offerings, have indicated that the risk-return balance is not acceptable and that these models will require too high investment levels against minimal return potential to service the mass data broadcast market.

The data broadcast services that are currently provided in Europe can provide a reference for a possible deployment in Africa. When analyzing the European business model, the investment required vs. the expected return is acceptable given the stable and low risk socioeconomic conditions associated with the European market. Within the Africa market context data broadcast services are not yet provided; it would appear that the combination of a substantially higher required investment, uncertain market take-up and the African socio-economic risks poses too high a business risk to deploy the current European data broadcast models.

#### **Business Model Dilemma**

To establish a data broadcast network for Africa, the current ISP models do not provide sufficient financial returns, and the European business model requires an unacceptably high combination of investment and risk to be viable within the emerging Africa market.

The question then is: which business model, if any, can be applied to provide data broadcast services to the Africa market at an acceptable financial return, as well as risk-reward ratio.

The resolution of this dilemma forms the pivotal focus point for the definition of a business model and business strategy that can be applied to successfully establish a satellite data broadcast network for Africa.

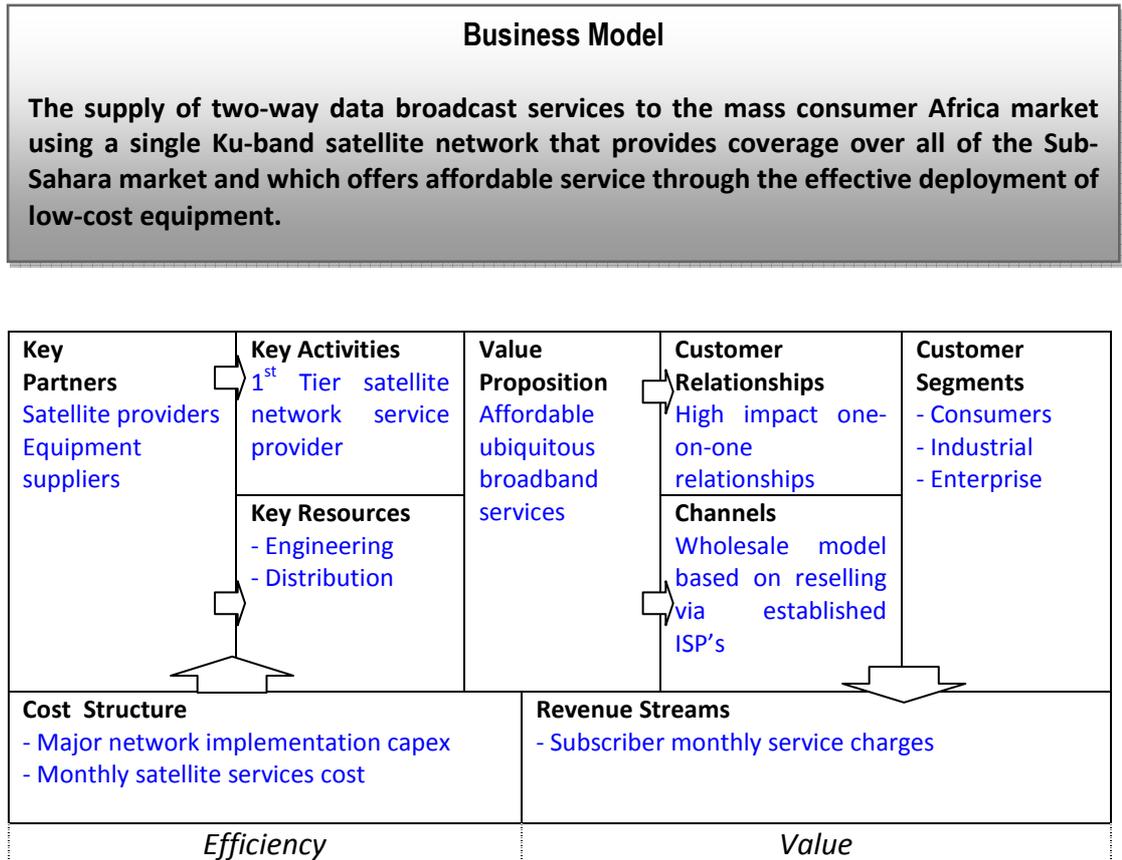
Within this study the concept of a "business model" refers to the integrated business structure and business strategy that defines:

"What technology to be applied to provide what product to which market using what billing structure and payment terms and requiring how much financial and organisational resources?"

**6.5.4 THE BUSINESS MODEL**

Using the business model canvas framework defined by Osterwalder and Pigneur (2010) we can document the preferred business model to provide broadband services to the mass Africa market (see Figure 6.15).

The proposed business model is also summarized as follows;



**Figure 6-15: Canvas of the Proposed Broadband Business Model**  
 Source: Framework provided by Osterwalder & Pigneur 2010

However, the proposed business model incorporates the following two principal business constraints which must be overcome in order to facilitate feasible implementation:

**Alternative Billing Model**

We must define an innovative alternative billing model that will transpose the relatively expensive satellite communication access channels into affordable subscriber's services.

The alternative billing model must have the potential to unlock the broadband Africa market in similar manner that the pre-pay per-minute model opened the mass consumer market for the cellular industry.

### **Organisational structure**

We must find a suitable organisational structure and investment framework that can be leveraged to reach a more acceptable investment-vs.-risk balance for implementation of the two-way broadcast data network. The current investment models deployed by either the datacast networks in Europe or the VSAT industry in Africa pose an unacceptable high risk-vs-reward ratio.

## 6.6 SUMMARY

Chapter 6 documents the business model formulation process and forms the first phase of the business definition process. Formulation of the business model is an iterative process that involves considering and reviewing each of the different elements individually and collectively until the outcome of the overall business strategy is practically and financially feasible.

Chapter 6 also identifies the two principal elements that must be resolved in order to ensure feasible implementation of the business model, namely definition of a suitable service billing model that realise provisioning of affordable services and the definition of a suitable organisational structure that provide an acceptable balance between investment funding requirement and market development risks. Chapter 7 and 8 continues the research work in order to address these two principal pre-conditions in order to define a feasible scenario of the business model.

### **Objective 3: Define a Business Model that will enable the supply of broadband satellite services to the Africa market on a viable basis**

Define the most suitable business strategy to deliver satellite-based broadband services to the consumer Africa market and prove that this strategy is the most suited and viable strategic option.

#### Finding:

The business model was defined, this included selection of the primary target market, of the technology platform, as well as of end-user equipment. It also defines the critical requirements for the technology platform, billing model and organisational structure in order to successfully implement the business model for the Africa market.

## Section 3: Business Innovation

# 7. Billing Model Innovation

Definition of the most suited Internet billing model through the integration of user preferences, business drivers and technology capabilities.

*"Just as energy is the basis of life itself,  
and ideas the source of innovation,  
so is innovation the vital spark of all human change,  
improvement and progress"*  
Ted Levitt

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## 7.1 INTRODUCTION

*"Mobile operators who rely on flat-rate plans for mobile data services need to rethink their strategy. As mobile data reaches mass markets and bandwidth demands grow, the flat rate model will break because it doesn't connect revenue with the high cost of delivering bandwidth across an expensive radio access network."*

*Technology Research Institute (TRI, 2009)*

Chapter 7 is the second chapter in Section 3: Business Definition, and focuses on the research work required to define the optimum billing model that can be leveraged to provide high-value satellite broadband services at affordable rates to the mass consumer market.

The chapter addresses Objective #4 and the research work leads to a completely new and unique billing concept.

### **Objective 4: Define the preferred billing model**

Through applied research and market pilot projects this study defines and tests different billing models. The optimum billing model is then defined through the successful adaptation by the market, as well as financial benefits offered to users and providers.

### 7.1.1 THE NEED FOR BILLING MODEL INNOVATION

The need to define the optimum billing model for data access services is most pressing in the mobile industry yet equally critical for providing a consumer Internet access product.

This chapter outlines the current network practices, user preferences and technology considerations that lead to the definition of a completely new and innovative *matrix* billing model. Through application of the *matrix* billing model Internet broadband services can be offered at an optimum balance between user quality-of-service requirements and network resources.

The **Matrix** billing model is an innovative and creative mechanism to implement a billing algorithm for Internet broadband services, while maintaining the optimum balance between the user preferences and network resources.

The **Matrix** billing model is fully scalable and enables dynamic mass customisation of broadband services by different user groups.

### 7.1.2 OUTLINE OF THE CHAPTER

The billing model innovation research work and findings are presented in the following framework:

#### **User Habits and Preferences**

Broadband consumer usage patterns are analysed and investigated in order to define the precise terms and conditions applicable to these services.

#### **Network Characteristics**

The network characteristic, or technology “behaviour”, is analysed in parallel with the user behaviour in order to define the specific strengths and weaknesses of the network architecture.

#### **Business Drivers**

Thirdly, the business drivers, or business “behaviour”, is studied to identify the critical business requirements, which the billing model must support in order to ensure a sustainable business.

#### **The Matrix Billing Model**

The three sets of input requirements are then integrated into a single billing model that provides the optimum balance between the respective criteria.

### 7.1.3 THE BILLING DILEMMA

Perhaps the best way to understand the pricing and control problem faced by broadband access networks is to look at how other industries have solved similar problems. The hotel, cruise ship, and airline industries, for example, are similar to the telecoms industry because they all sell a perishable service. You have a once-of opportunity to sell access to a certain hotel room, airline seat, ship cabin, or bandwidth capacity on a particular day. Yesterday's capacity is gone forever.

To adapt to this reality, the airline industry has built some very sophisticated pricing and aircraft scheduling systems. In fact, the price you pay for an airline ticket goes up or down based on the availability of facilities: the number of seats left on the flight that you are booking and the number of aircraft available to fly. Here's the key: for the British Airways pricing system to be effective, it needs to be *airline seat-reactive*. It needs to automatically adjust prices or capacity for a certain destination. For example, if 90% of the seats for morning flights from Heathrow to Charles De Gaulle airport are sold 3 weeks in advance, the price of tickets on that flight needs to be raised immediately, or an additional plane (or capacity) needs to be scheduled in.

The figure below illustrates the basic challenge of developing a bandwidth-reactive system; the need to successfully balance the conflicting forces of charging and policy.

#### The Charging vs Policy Seesaw

To provide a sustainable and profitable Internet access service, two opposing forces within the network architecture must be balanced: charging and policy. Charging's role is to maximize revenue. Policy's job is to reduce network costs by managing bandwidth.



In broadband data networks, the trigger for action is either an abundance or lack of bandwidth for a particular user, application or portion of the network. An advanced charging and control system reacts in real-time to bandwidth availability, being able to either reduce or increase bandwidth for particular users as directed by policy.

Problems occur when one side of the seesaw has too much weight. When charging is too strong, revenues grow, but the network now needs to support too many users, degrading QoS and the customer experience. When policy is over-emphasized, high QoS is offered, but revenue suffers and the operator earns a poor return on its network investment.

**7.1.4 BILLING OBJECTIVE**

The key objective of a balanced billing model is that it will put user-sensitive and bandwidth-reactive principles into practice. In this scenario it is possible to provide a personalised service to small groups of users and give them treatment packages and *ad hoc* offers unique to their special needs. At the same time network engineers appreciate the system’s ability to control bandwidth and QoS at a granular level.

Figure 7-1 below illustrates the key problem that needs to be solved: allocating limited bandwidth to users with different usage needs and of different revenue value to the operator. The figure compares the “cost of delivery” of various usage scenarios to their actual “value to the operator”. For example, a consultant checking his Blackberry for emails (in lower right quadrant) is a relatively low cost network activity, however, because the consultant is a business user, he’s paying a premium and so the operator is probably earning a good margin on this usage.

Instead of proposing a handful of flat rate plans, it is now possible to offer dozens of “lifestyle plans” that are fine-tuned to attract various subscriber types. In turn, those plans not only fit the subscriber’s usage profile, but are designed to subtly influence behavior to better manage bandwidth costs. Lifestyle plans can also provide a variety of QoS levels. For certain subscribers, you could guarantee high QoS for email and low bandwidth applications, but provide a relatively slow speed for file-sharing, gaming or other high-end applications.

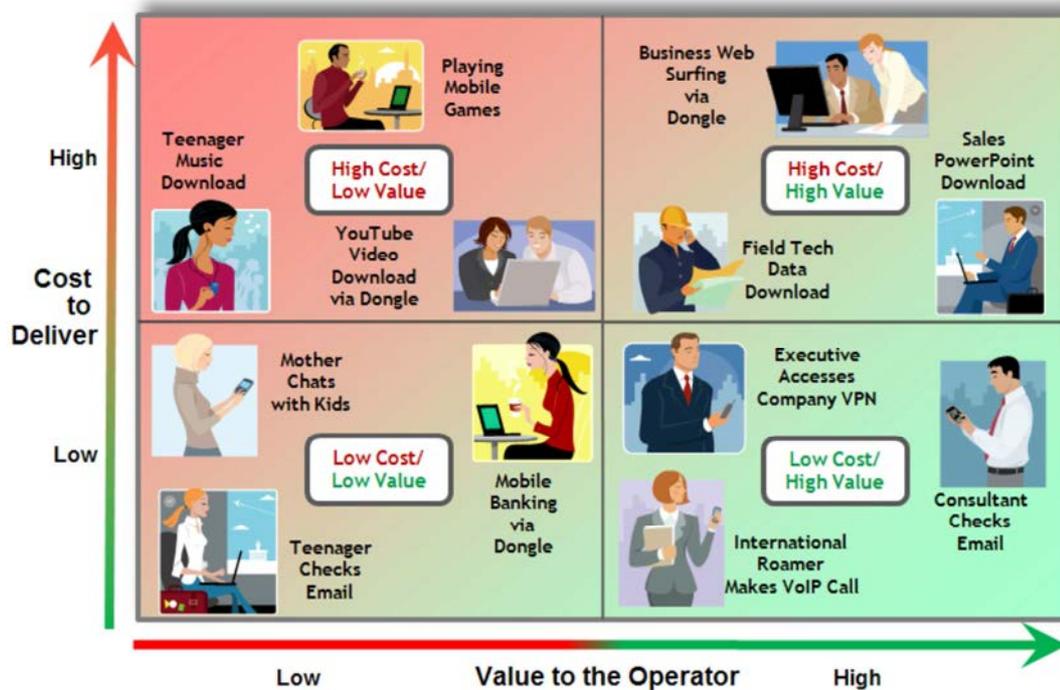


Figure 7-1: Cost-to-deliver versus Operator-value diagram

## 7.2 USER HABITS AND PREFERENCES

### 7.2.1 THE 80-20 RULE

Subscriber data usage statistics follow the Pareto principle (also known as the 80-20 rule) which states that, for many events, roughly 80% of the effects come from 20% of the causes (Pareto, 1971). For broadband services this correlate with the fact that 80% of the data usage is generated by 20% of the users. In some cases this can be extreme with 1% of the users generating 40% of the upstream traffic as is the case for the North American fixed usages statistics in 2010 (Sandvine, 2010).

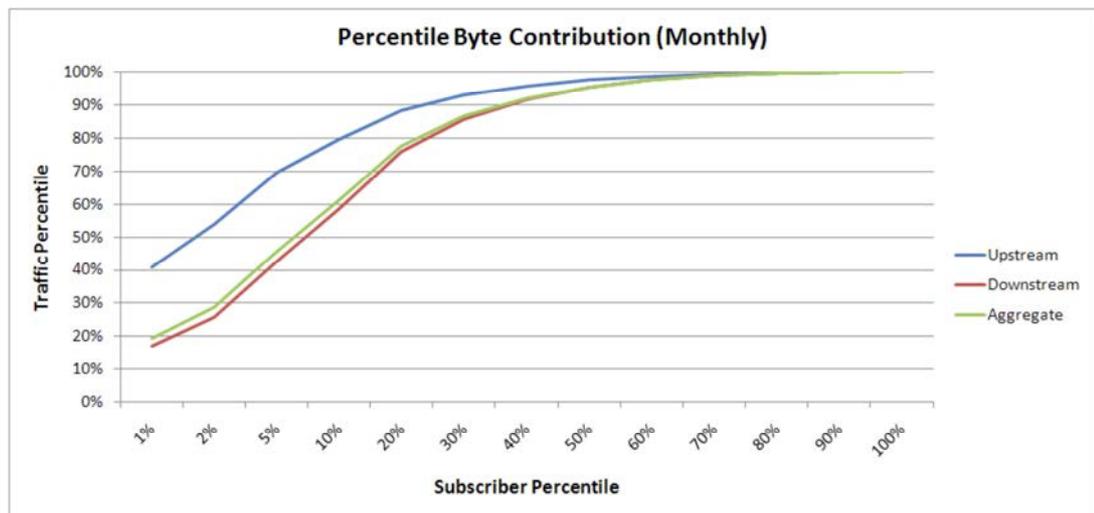


Figure 7-2: North America - Percentile Byte Contribution (Monthly, Fixed Access)  
Source: Sandvine, 2010

### 7.2.2 TYPICAL DATA USAGE PER MONTH

The most applicable billing model is determined by the volume and type of user data. Network resources and service costs greatly vary for example between basic email services and video feeds.

On average, usage is between 2GByte to 5Gbyte per month; the user data usage for different user habits is displayed in Table 7-1. For certain data services this can increase to 10GByte or even more (Articlesbase, 2009).

The volume of data used has a direct influence on the actual network resources consumed to deliver the service. The usage factor should thus be closely integrated into the billing model to ensure that the business model will remain viable as usage levels increase.

User Type	Usage volume
<b>Basic Browsing and Emailing</b>	This is a basic service and normally does not require usage based billing <i>Estimated usage allowance required = 1GB to 2GB per month</i>
<b>Online Radio and TV Catch-up</b>	With the increase in popularity of YouTube and BBC's iPlayer, there has been a corresponding increase in the amount of video watching online. Typically when using iPlayer, probably between 200-500MB of bandwidth is used per programme, depending on the length of the programme. <i>Estimated usage allowance required = 5GB per month for 1 programme per week.</i>
<b>Downloading music and films</b>	For users that want to download MP3's frequently from sites such as iTunes or Amazon, the recommended minimum is 10GB of usage to enable continued surfing and watching online content while simultaneously downloading music files. <i>Estimated usage allowance required = 10GB per month minimum</i>
<b>Peer-to-peer</b>	If you are likely to share large files through network services such as Peer-to-peer (p2p) or Bittorrent, you fall into a heavy downloader category and should definitely consider comparing unlimited broadband deals, which offer not only an unlimited usage, but a lenient fair/acceptable use policy. <i>Estimated usage allowance required = Unlimited</i>
<b>Skype and VoIP</b>	24 hours of talk-time on VoIP phone uses approximately 2.4GB. <i>Estimated usage allowance required = 5GB minimum per month.</i>

**Table 7-1: Data volumes relating to different user services**

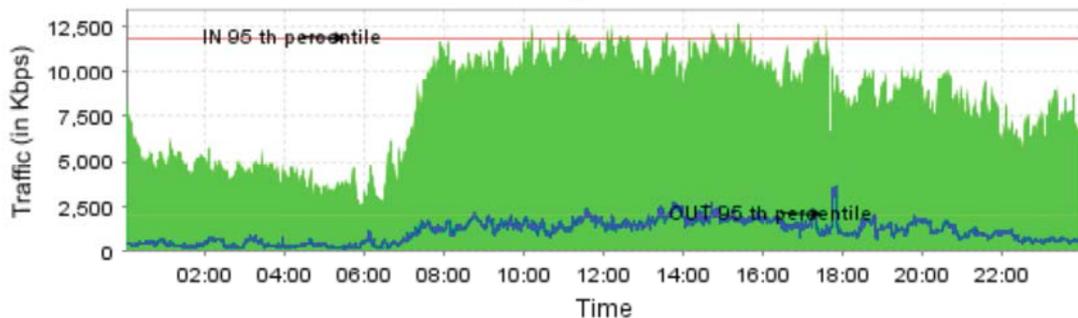
### 7.2.3 USER BUSY-HOUR PERIOD

The satellite access network provides an “always-on” service with connectivity services available to all locations 24 hours per day.

The typical user access data for subscribers in the Africa market over a 24 hour period reflects a busy-hour period of 13 hours from 7h00 to 20h00 with the minimum traffic period from 2h00 to 7h00.

The net effect of the 24 hour network availability vs. the market demand of 13 hours effectively means that the network capacity during the night is not used. This effect has the implications that the business revenue must be generated during the market busy-hour period, while the network cost element spans a 24 hour cycle.

Network billing models should thus stimulate user habits and patterns that promote usage in off-peak hours and optimize usage during the peak hours.



**Figure 7-3: User busy-hour pattern**  
Source: [www.qkon.com](http://www.qkon.com)

## 7.2.4 BILLING PREFERENCES

Research done as early as 2000 identified the preferences that customers show towards dynamic tariff schemes. Within the INDEX, CATI, and M3I projects it has turned out that transparency and predictability of charges are of major importance to the Internet customer (CACTI).

For billing models that implement flexible costing structures it is of paramount importance to provide user feedback and transparency with regards to the status of the accounting. This has been confirmed by the specific target market research, as well as during most of the discussions with potential service providers and end-users.

## 7.3 NETWORK CHARACTERISTIC

The satellite broadband access network has some very specific performance characteristics that must be considered when defining the most suited billing model. These relate to the costing and data rate parameters of the outbound and inbound data transmission channels.

### 7.3.1 TRANSMISSION EFFICIENCY

#### **Outbound Channel**

The outbound channel (from the hub to the remotes) is a single saturated high powered DVB-S2 carrier operating at 70Mbps through a 36MHz channel. The channel transmission efficiency for different modulation codec options has an average efficiency of 1.94bits / Hz.

The outbound channel is considered very efficient and offer up to 99Mbps using a 36MHz RF channel, thus translating into a lower cost per bit for delivery of user data than the inbound channel.

## **Inbound Channel**

The inbound channel (from the remote to the hub) is operating from the smaller (1m) antenna system and lower powered (800mW) terminals and is thus limited in the possible communication channel efficiencies.

The communication channel modulation types and efficiencies that can be supported by the network provide an average efficiency of 63%. The efficiency range from 0.55bits/Hz to 0.71bits/Hz which is inefficient compared to the outbound channel and will lead to higher cost per bit levels.

## **Inbound Power Limitation**

The inbound communication channels that provide communication from the small 1m, 800mW remote terminal to the hub is power limited and constrained to a maximum data transmission rate of 256kbps. The network architecture will be designed to provide multiple of inroute channels as is required to provide the total transmission capacity for the return link communication.

## **Billing influence of network transmission**

The combined effects of the channel efficiencies and the return link power limitation is that the network will deliver outbound data services from the hub to the remote more cost effectively than the inbound channels. The net effect is that the billing model should be able to differentiate between the outbound and inbound data flows and apply different costing structures to the respective data paths.

### **7.3.2 DATA QUALITY-OF-SERVICE**

Traffic Shaping or Quality of Service (QoS) management is the ability of the network to use queuing to provide preferential treatment to certain classes of traffic. Bandwidth management equipment features ensure on-time delivery of time-critical information through specific port assignments, priorities and policies that can be assigned at the database-level, guaranteeing QoS for critical applications.

For applications delivered over satellite networks, each application may have different delivery requirements, and business conditions may determine that certain priority levels are given to specific types of traffic. Network administrators use QoS to support diverse applications over satellite links to ensure each application receives the appropriate level of service when competing for limited satellite link bandwidth.

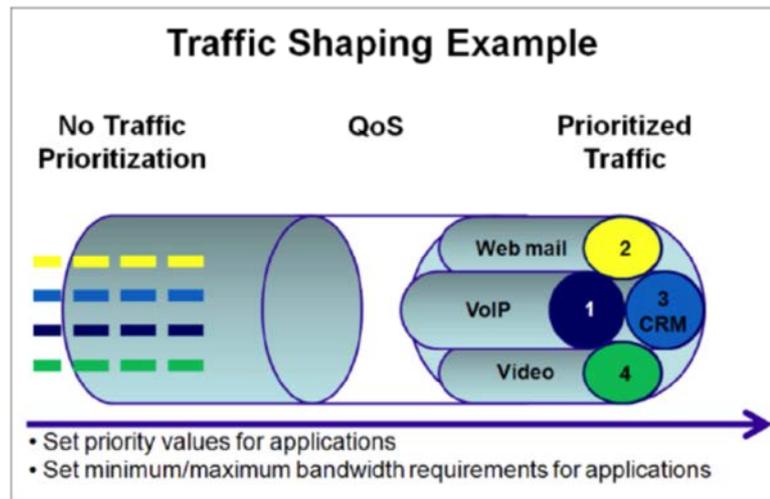


Figure 7-4: Traffic Shaping allows classification of traffic to improve application performance over satellite links.

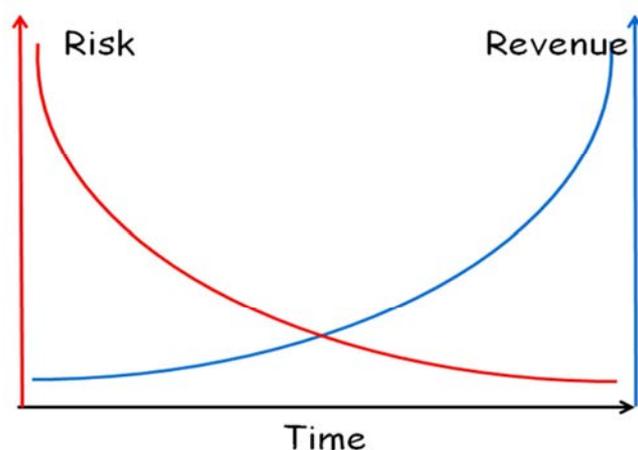
Source: Comtech EFDData, 2011

## 7.4 BUSINESS DRIVERS

The billing model needs to be sensitive to the critical business requirements and must structure the customer billing models in-line with the principal business objectives and drivers. These business drivers are mostly determined by the business case for the initial period after launching the service and by the minimum requirements to ensure successful business establishment.

### 7.4.1 RISK AND REVENUE BALANCE

The risk and revenue business driver requirements are different for different stages of the business life cycle. During the initial phase the business risk is high and the product billing drivers must thus be to minimize the risk rather than maximizing profits. Once the market is established, the focus can change to adopt more aggressive product pricing policies that maximize the revenue potential.



### **Initial Period**

It is critical that a minimum revenue base be established as soon as possible, which can be applied to recover the initial set-up cost. During the initial stage, the implementation of the customer sites will also be a limiting factor, adding to the requirements to introduce a minimum fee per terminal per month. The early stage market strategy should therefore be to recruit customers that can afford a certain minimum monthly fee, rather than recruiting customers that prefer to buy in very small increments.

### **Established Phase**

Once the business is established with a large subscriber base the billing model can be adjusted to increase revenue and profit margins. This can be done by grooming the platform to introduce various product options that offer lower monthly fee options, at an increased margin.

## **7.4.2 PREPAY SUBSCRIPTIONS**

Prepay models have proved very effective to provide telecommunication services in Africa. For this model, the balance between risk and cash is in the interest of both the service provider and the customers. For the end-user there is no risk of incurring excessive costs and hence unforeseen payment liabilities, while for the service provider the revenue collection is done in advance with no risk of bad debts.

### **Advantages of Prepay Broadband Services**

A prepay policy provides the following advantages as applicable to the provisioning of broadband services;

- The service can be offered to subscribers at small incremental payment units, thus making the service more accessible and affordable.
- Subscribers can very closely manage their expenditure and prevent incurring unexpected expenses.

### **Disadvantages of Prepay Broadband Services**

Possibly the only limitation of prepay services is that business subscribers prefer to pay a fixed monthly amount and that this market sector would require a special product or billing process.

### 7.4.3 CHANNEL TO THE MARKET

The product pricing structure and implementation thereof in the billing model must accommodate the interests of all the following parties that will collaborate to offer the services to the market:

**Service Providers**

The product will be offered to the market through an in-direct channel via national and regional ISP's.

**Regulatory Partners**

In selected countries the business will include cooperation with other 3<sup>rd</sup> parties who comply with the local telecommunication regulations.

**Resellers**

It is expected that the major ISP's will service the market through a network of smaller ISP's throughout the region.

**End-User**

The consumer end-user payments must be offered through on-line credit card payment mechanism or other suitable payment structures for consumers in Africa.

## 7.5 REQUIREMENTS SUMMARY

The optimum broadband access billing model needs to provide the optimum balance between the respective user, technology and business requirements. Table 7-2 summaries the billing requirements with respect to user behavior patterns, table 7-3 the requirements resulting from the network transmission characteristics and table 7-4 the business related requirements.

NETWORK REQUIREMENTS	Billing Model Criteria and Implications
Channel efficiencies	The billing model must differentiate between the outbound and inbound traffic to account for the different transmission efficiencies.
Inbound limitation	The billing model must be able to compensate for the limited data rate of the inbound channel.
Quality-of-service	The billing model must be able to cost different data streams differently depending on the specific service profile, etc. data, video or real-time voice services.

**Table 7-2: Network characteristic requirements**

USER REQUIREMENTS	Billing Model Criteria and Implication
80-20 Rule of heavy users	Billing model must differentiate between heavy users and provide for resource allocation and charging metrics accordingly.
Usage per month	Average data usages per subscriber are between 2G and 5G bytes per month with extreme usage of 5T bytes. The billing model must be “usage-sensitive”.
Busy-Hour period	Within a 24-hour day it is expected to have a 13-hour busy period, a 5-hour medium and 4-hour low traffic period. The billing model should integrate relevant time zone parameters to implement a “time-sensitive” billing solution.
Billing preferences	Most consumer users prefer a fixed-rate per-month billing model. The billing model must provide a balance between the need for usage billing and the customer expectations for fixed price.
Customisation	End-users want to have specific control over expenses and transparency with regards to billing methodologies.
Data type and quality-of-service	Users expect real-time data for video and live streaming applications to have the minimum quality-of-service level to ensure acceptable experience levels.

**Table 7-3: Summary of user behavior requirements**

BUSINESS REQUIREMENTS	Billing Model Criteria and Implications
Risk and revenue	The billing model must be able to initially implement products with higher monthly rates, possibly at lower margins, and later change to products with lower monthly rates at higher margins.
Prepay collections	The model must support prepay collection mechanisms throughout Africa, these should be both payment via credit cards as well as by customer vouchers.
Market channel	The billing model must satisfy the minimum criteria of all stakeholders forming part of the “channel-structure”, including distributors, service providers, resellers and end-users.

**Table 7-4: Business requirements**

## 7.6 THE MATRIX BILLING MODEL

### 7.6.1 DESCRIPTION

The matrix model was developed based on the respective input requirements and is the optimum balance between the subscriber preferences and the service provider interests.

To the best knowledge of the research team, as well as industry partners and customer groups that were interviewed, this billing model offers a unique value proposition and has not been implemented in this format in the satellite broadband industry yet.

The matrix billing model is based on the following principles:

#### **Nominal Product Definition and Cost**

The nominal product is defined and a rate is calculated according to the input costs and the standard financial margin policy. For this specific case study the nominal product definition was a fixed base service fee of \$75, which includes 1Gbyte of data and \$50 per 1Gbyte top-up data units.

#### **Weighted Pricing Metrics**

Critical service metrics were identified and based on these different pricing factors that allocated based on pre-defined statistics and user patterns. These pricing metrics can be changed to accommodate changing user behaviour patterns.

The initial pricing metrics selected for implementation are:

- Access speed (normalised and set to 1)
- Data usage
- Time of day
- Type of data
- User type (not configured)

#### **Usage Rate Calculation**

The actual billing usage rate is then calculated on a “per-Gbyte” usage level as a function of the nominal cost to provide the additional service and the respective metrics. The final rate calculation is:-

Usage rate = (base cost per Gbyte) \* (Usage Factor)

Usage factor = (access speed) \*(data usage) \* (time of day parameter) \*(type of data parameter)

Note: The usage price factor is only applied to the top-up usage volumes

Note: Refer to table 7-5 for the specific matrix parameters.

According to this billing model the rate for a businessman downloading email during business hours, will be more on a per-GByte basis than for a student doing research work late at night.

**7.6.2 THE MATRIX INPUT VALUES**

In chapter 9 the matrix billing model is fully integrated into the business model simulator – refer to the Appendix for the detail schedules.

In order to illustrate the practical application of the matrix billing model, the data as represented in Tables 7-5 and 7-6 was applied to calculate the rates for the SkyeVine business project. The billing model forms the basis of the SkyeVine business case and has proven to be very successful during the initial business trials (SkyeVine, 2010).

The element costing and pricing data is calculated using a 2Mbps receive carrier and the actual input cost data applicable to the SkyeVine business case.

A. Element Costing & Pricing			
<b>Product</b>			
Data rate	2048	kbps	
Utilisation	0.0051	Mbps / Gbyte	
<b>Cost Elements</b>	<b>Cost /mnt</b>	<b>Selling</b>	
Site fee	\$7.50		
1 Gbyte	\$21.45	\$50	
Base service	\$28.95	\$75	

Table 7-5: Matrix model input costing parameters

B. Service Profile Metrics									
Access Speed		Gbytes		Time of Day		Type of Data		User Type	
2048	1	0	1.0	05h - 8h	1	email	1.2	Not configured	
2048	1	1	0.9	08h - 18h	1.5	Browsing	0.9		
2048	1	2	0.8	18h - 22h	0.8	Social media	1.4		
2048	1	4	0.6	22 - 01h	0.5	Downloads	0.9		
2048	1	10	0.5	01h - 05h	0.3	Games	2.0		
				Week-ends	N/A				

Table 7-6: Pricing metrics and price weighted factors

### 7.6.3 SUBSCRIBER REVENUE SCENARIOS

The fundamental difference between the matrix billing model and existing billing models applied in the broadband market is the fact that users will be enabled to adapt their usage patterns to determine the effective cost of the service. When applying the matrix billing model, different subscriber behaviour patterns will result in different usage revenue rates. This will allow users to budget and plan their behaviour according to their budget requirements; for example, a student might select to do research work at night, during which time a 30% factor applies (i.e. usage rates at night are 30% of peak rates).

Table 7-7 provides examples of different subscriber price packages based on the different user patterns. The different price package examples are as follows:

**Base service**

The base service applies to all subscribers and is a monthly subscription fee that includes 1Gbyte of data at a firm rate of \$75 per subscriber per month.

**Business User**

The business user profile has a usage of 2GByte of additional data for mostly email traffic between the hours of 8h00 to 18h00. The pricing factor for the top-up services is 1.4 with a rate of \$144.

**Socialite**

For the socialite using 3GByte of additional Facebook and other social media applications data between 18h00 and 22h00, the total pricing factor is 0.7 resulting in a rate of \$101.

Note: The calculated examples are an over simplification. It uses one type of data per user per period. In reality the model will calculate the applicable rate for each 100Mbytes used.

C. Subscriber Revenue Examples											
	<u>Access</u>		<u>Add</u>		<u>Time</u>		<u>Type</u>		<u>Factor</u>	<u>Mnthly Fee</u>	<u>Dist</u>
	<u>Speed</u>		<u>Gbytes</u>								
<b>Base service</b>	2048	1	0	1.0	08h - 18h	1.5	Browsing	0.9	1.4	<b>\$75</b>	
<b>"Top-up" Services</b>											
Business User	2048	1	2	0.8	08h - 18h	1.5	email	1.2	1.4	<b>\$144</b>	5%
Hard Core	2048	1	5	0.5	22 - 01h	0.5	Games	2.0	0.5	<b>\$125</b>	5%
Socialite	2048	1	3	0.6	18h - 22h	0.8	Social media	1.4	0.7	<b>\$101</b>	40%
Student	2048	1	1	1.0	18h - 22h	0.8	Browsing	0.9	0.7	<b>\$36</b>	20%
Budget user	2048	1	2	1.0	01h - 05h	0.3	Browsing	0.9	0.3	<b>\$27</b>	30%
									ARPU	<b>\$144</b>	<b>OK</b>
									Aver Gbyte / user	<b>3.35</b>	
									Aver \$/Gbyte	<b>\$43</b>	<b>OK</b>

**Table 7-7: Subscriber revenue examples based on different behavior patterns.**

## 7.7 SUMMARY

Chapter 7 summarizes the outcome of the billing model research work and innovation works. The innovation process is depicted in Figure 7-5. The billing model is defined based on the inputs and requirements from the user behavior studies, the network performance analyses and the business model drivers.

The research work led to the definition of the **matrix billing model** that is a unique billing concept.

The matrix billing model provides the optimum balance between user preferences, network limitations and business case requirements.

The model offers a mechanism to offer high-value satellite based broadband services to the mass consumer market at affordable service charges.

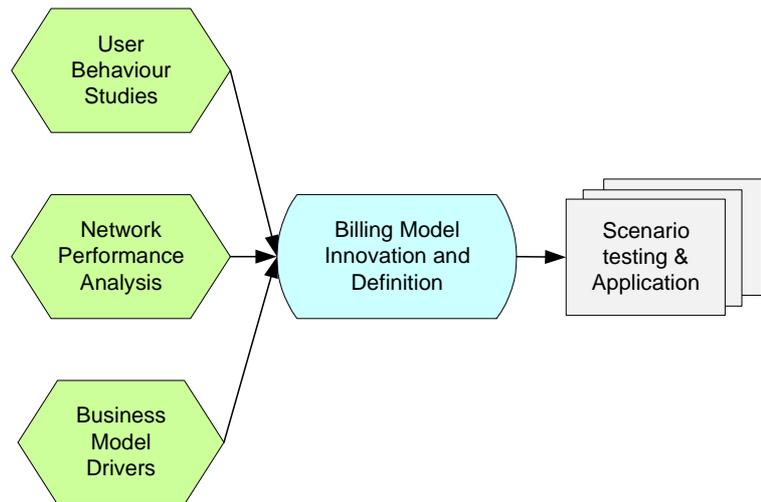


Figure 7-5: Billing model innovation process

The billing model was tested through market research and was found to be most effective and acceptable by both Internet Service Providers and the market. The billing model is currently being implemented for the SkyeVine business case.

### Objective 4: Define the preferred billing model

Through applied research and market pilot projects this study defines and tests different billing models. The optimum billing model is then defined through the successful adaptation by the market, as well as financial benefits offered to users and providers.

#### Finding:

The research work led to the definition of a unique billing matrix concept that enables the supply of high-value services to the mass consumer market at affordable rates. The research outcome provides conclusive information of the need for a billing model and defines an alternative billing model concept.

## Section 3: Business Innovation

# 8. Organisational Structure Innovation

**Definition of the optimum balance between risk, investment and delivery capability through organisational structure innovation.**

*“To exist is to change,  
to change is to mature,  
to mature is to go on creating oneself endlessly”*  
Hendry Bergson French Philosopher

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## 8.1 INTRODUCTION

This chapter focuses on the last and most critical pillar of the business requirements that is required for the effective delivery of an advanced technology solution to the emerging Africa market – i.e. finding the organisational structure that best meets the delicate and nervous balance between risk, investment and delivery capability.

This chapter documents the thought processes that led to the establishment of an innovative organisational structure that can unlock the market and ensure the required investment funding, while limiting risk to the founders and also limiting demands on scarce resources.

The applicable research work and results focus on objective #5 and proves that organisational innovation can provide a new impetus and enabling power to the supply of technology-based services to the emerging Africa market.

**Objective 5: Prove that business structure innovation can effectively leverage resources, reduce investment and reduce risk.**

The scale of the financial and resource investment required to implement the initial satellite-based data broadcast service, given the uncertain nature of this emerging market, requires a customized organisational structure to minimise the risk and maximise resource utilisation.

## Research Work Outline

We start off by defining the organisational requirements that are required to implement the business strategy as previously formulated. Based on these requirements three possible organisational structures are identified: a vertically integrated business structure, the addition of new functions to an existing vertical structure and a symbiotic structure based on cooperation between distinct entities.

The resource and funding implications of these options are then analysed and evaluated using the relative difference between the financial requirements of the different models to provide a qualitative evaluation. In chapter 9 we also evaluate the different organizational scenarios using the business model simulator to obtain a quantitative evaluation of the different organization options.

## 8.2 ORGANISATIONAL STRUCTURE REQUIREMENTS

### 8.2.1 BUSINESS OBJECTIVE

An organisational structure needs to be developed to implement and underwrite the execution of the following business definition:

**Business Definition:**  
**Design, Operate, Supply and Support a Satellite Data Broadcast Service to the mass consumer market in Africa.**

The business is defined as a 1<sup>st</sup> tier Service Provider of a consumer data broadcast access services to the Pan-Africa market, operating from a single satellite network infrastructure. The broadband service will be supplied on a wholesale basis to national and regional ISP's who will provide the service to the consumer user market.

## 8.2.2 ORGANISATIONAL REQUIREMENTS

The organisational requirements that will apply to the qualitative evaluation are listed in table 8.1 and also applied in Chapter 9 to perform the quantitative evaluation.

Requirements	Description
Minimise Investment	The risks associated with the emerging Africa market necessitates a strictly conservative approach that minimise the initial investment required.
Risk Adverse	The business should be established in such a way that it is tolerant against possible political instability in some Africa countries.
Competitive Baseline	The cost associated with the organisational structure forms a significant part of the final subscriber monthly cost component. The organisational structure must thus be defined to also ensure a minimum cost requirement to ensure the most cost effective subscriber service rates.
Platform design and implementation	The organisation must have the required satellite system engineering skills to complete the platform design and implementation activities.
Operational and support services.	The business must have the engineering resources and capability to provide the on-going platform operational services that includes second line support services to the ISP's.
Equipment distribution.	The business must be able to procure and distribute the end-user equipment terminals and make it available to the mass market.
Customer equipment implementation	The business must have the resources and capability to perform the end-user equipment implementation tasks.
Marketing and sales reach	The business must be able to access and service the market in all the targeted Africa countries and will require sales presences in the respective countries.
Scalability	The business potential is estimated to be between 5,000 and 30,000 subscribers and the business must be able to effectively scale its operations as required to service the market demand.
Regulatory compliance	The provision of telecommunication services is regulated and will require the applicable governmental approvals.

**Table 8-1: Organisational requirements**

### 8.3 NEW VERTICALLY INTEGRATED SCENARIO

In this scenario the data broadcast service for the emerging Africa market is implemented in a new start-up organisation that is established according to a vertically integrated model.

**New Vertical Scenario**  
The new data broadcast service product is implemented within a new start-up company that is established according to a vertically integrated organisational model.

#### 8.3.1 VERTICALLY INTEGRATED STRUCTURE DEFINITION

The vertical functional model uses a hierarchical structure with a strong concept of subordination; it encompasses management span of control, reporting relationships and a centralized management staff that are responsible for decision-making.

A vertically integrated structure incorporates all the organisational functions and infrastructure into a single corporate organisation. In a vertically integrated organisational structure all decision making is delegated from the Managing Director (MD), or Chief Executive Officer (CEO), position down to the second layer of management and further into the organisation.

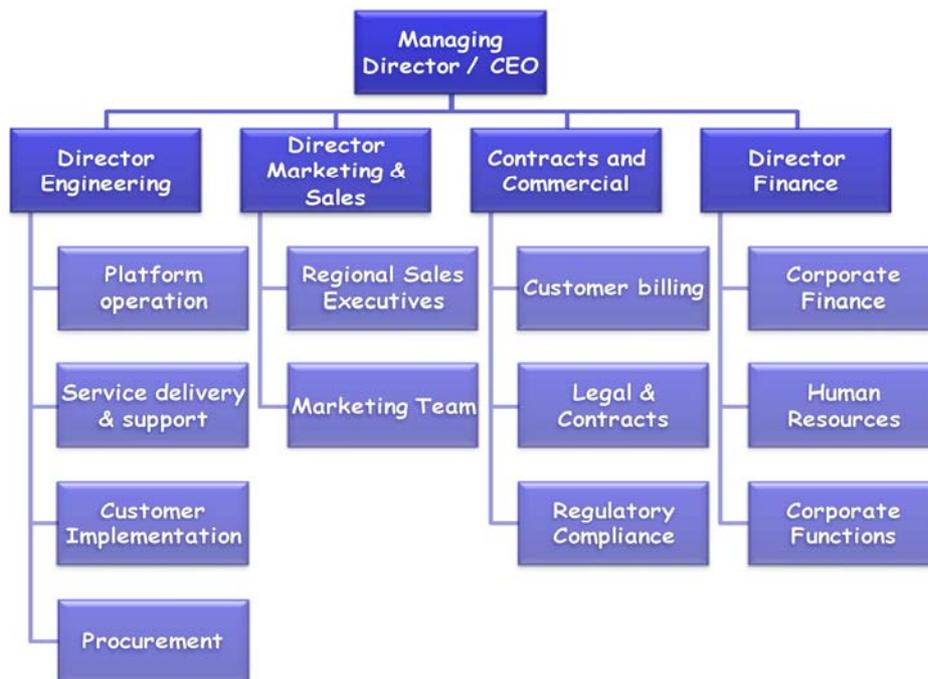


Figure 8-1: Typical vertical organisational structure required by a broadband service provider

### 8.3.2 “NEW-VERTICAL” SCENARIO REVIEW

The “new-vertical” scenario requires the establishment of a new company with a vertical structure that incorporates all of the functions required to operate the business. To establish such an organisation and then offer the new service to the market from this company will require the following actions with associated implications:

#### **Financial Implications**

The financial considerations are mainly around the total funding requirements and the source of funding. The feasibility of securing the required funding is the fundamental requirement to the successful establishment of the new operation.

#### **Funding required**

All tasks must be established in the company and funding will be required for equipment investments, recruitment of skills and resources, marketing and sales, as well as engineering operational capabilities.

#### **Source of funding**

Funding must be sourced externally from venture capitalists or from equity shareholder partners. This will imply that the founders will at least partially lose control over their own venture, as investors may tend to interfere in business decisions.

#### **Financial risks**

The new company will have no existing internal resources or other activities that can be leveraged to limit the funding required for the new initiative. Should the new venture not succeed the implications are that a substantial portion of this investment funding will be lost.

#### **Implementation Capability**

The success of the company will be determined by its capability to reach and secure the market and to deliver the service. These objectives are determined by the business strategy, while it depends on the caliber and capabilities of the management and technical teams.

#### **Management Risk**

Deploying a new service into a new market can already be regarded as a high-risk venture, regardless of the amount of upfront research to address uncertainties. Doing this forms a new and unproven business organisation, with an unproven management team that will imply stacking risk upon risk, making it even more difficult to predict the outcome.

### **Skills and Resources**

After funding, the next biggest challenge is to secure the business and engineering skills required to execute the business plan. The current skills limitation in the market, added to the high level of technical and service complexity, makes this a significant challenge.

### **Marketing and Sales**

The new company brand will have to be established in the market and market acceptance of the company brand and product must be secured.

## **8.4 EXISTING VERTICAL STRUCTURE SCENARIO**

To implement a business model for a completely new service that is on a new market from within an existing organisational structure, has some specific advantages and disadvantages. In such a scenario, the new business initiative is added to the current business functions to be executed from within the organisation, thus integrating all new business functions vertically into the company.

For this study, a large listed organisation is taken as reference. This is done in order to provide some insight into the feasibility of executing new innovative projects in large organisations.

### **Existing Vertical Scenario**

The new broadband service product is implemented within an existing large organisation with all functional elements of the new business vertically integrated into the organisational model.

### **8.4.1 EXISTING ORGANISATIONAL INTEGRATION OPTIONS**

In order to implement a new service of any significant magnitude in an existing organisation will require some changes and growth in the organisation. Most of the organisational functions will be impacted and various options are available to complete the integration.

A detailed study of the possible organisational impact and implications of such an integration, falls outside the scope of this study. For this study it is sufficient to realize that such integration will have various complexities that can sufficiently be illustrated by just considering two of the possible organisational structures i.e. project-based structure or matrix-based structure.

## Functional Option

When following a functional integration option the new business activities are allocated to a new team within a new vertical reporting structure. All functions relating to the new business will be reporting to a single manager (Director: New Projects) who will be responsible to the Managing Director for the success of the project.

### Advantages

Within a functional integrated option the complete team is only tasked with the single new project objective which provides good focus and dedication to ensure the success of the project. This option also provides management the option to carefully select the team that is best qualified for this specific project.

### Disadvantages

To establish a specific team for the new project requires recruitment of specific resources which increases the funding requirements that can also be limited by the availability of appropriate skills. Even if the team is recruited from within the organisation, replacements must be found for the internal positions.

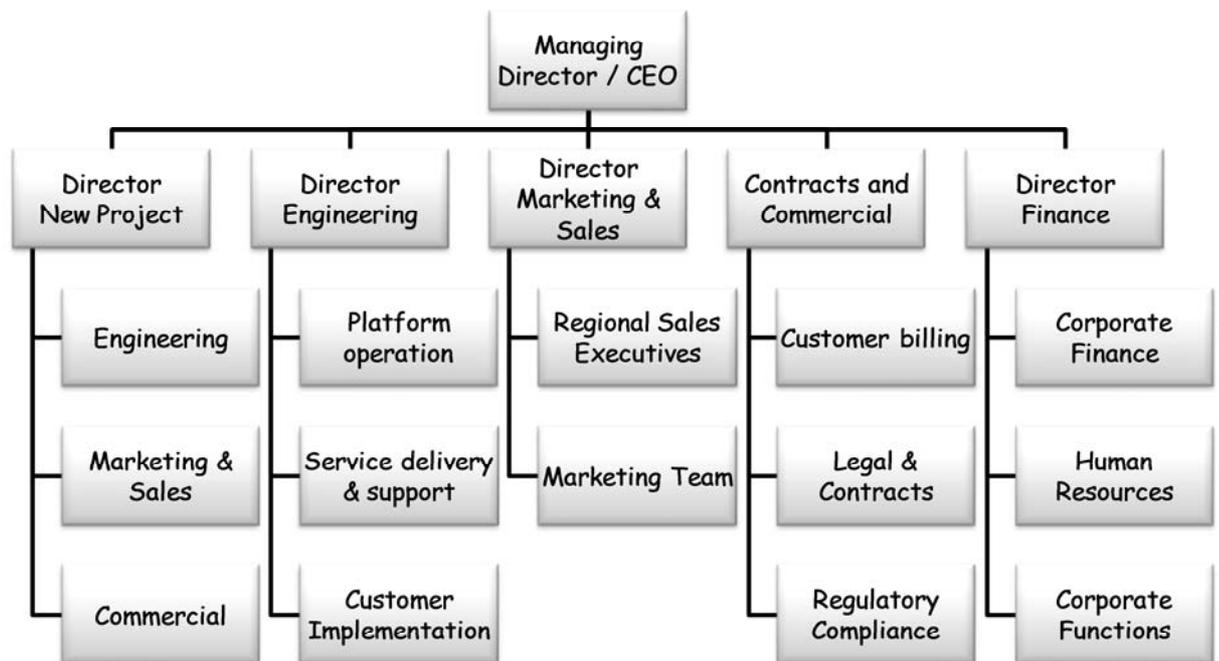


Figure 8-2: Vertical organisational structure with functional project team

## Matrix Option

Implementing the new project within an existing organisation can also be done using a matrix model, which adds new responsibilities to each of the existing functional areas. Responsibilities of the new project can be centralized under a single management function and additional staff may also be recruited within the respective functional areas.

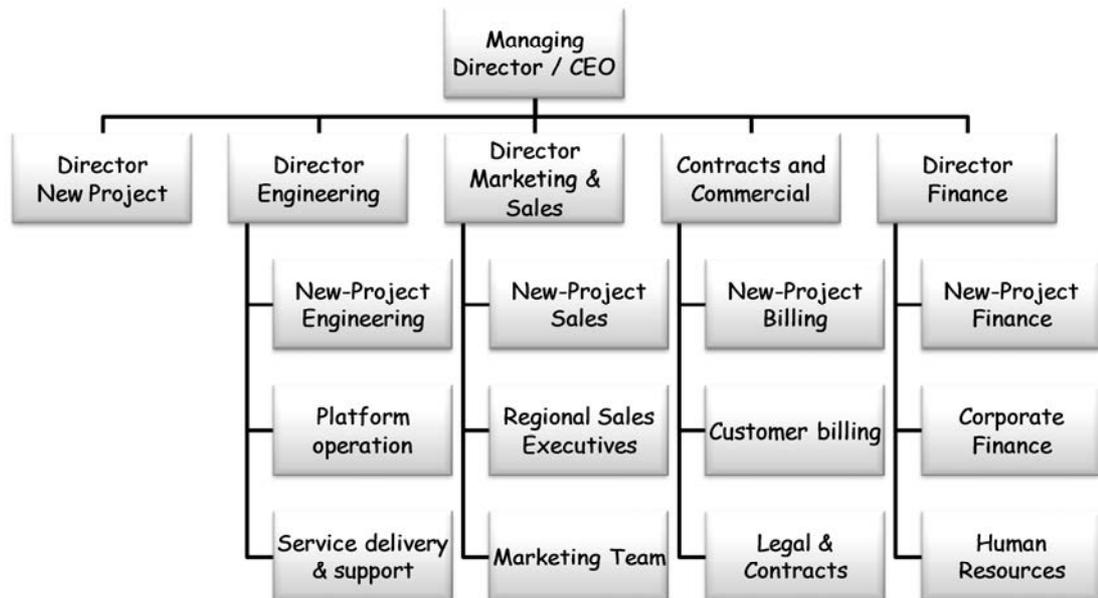


Figure 8-3: Vertical organisational structure with matrix project team

### Advantages

An integrated matrix option mostly leverages existing skills and expertise in the organisation that provides the new project with depth and experience. This option can also be implemented without the need to recruit a new team first.

### Disadvantages

Within the matrix option most team members in the organisation will have multiple tasks and responsibilities, which dilute the focus on the new project. Reporting and control of the team is also more complicated, since team members have to report to the functional manager, as well as the project manager.

## 8.4.2 “EXISTING VERTICAL” SCENARIO REVIEW

Adding a new project to an existing vertically integrated organisation brings forward a number of issues typical to large organisational operations. Some of these dynamics are positive and some are counterproductive to the implementation of a new business initiative.

### **Financial Implications**

#### **Funding Required**

The funding requirement will be larger when implementing the new project as a new functional group, with less funding required when implementing the new project in a matrix model. Both will require less funding compared to a new business organisation.

#### **Source of Funding**

An established company can source funding from its internal operations, or from raising capital from the market through listing of shares, or from financial institutions through loan funding. The existing financial status of the company will largely determine the implications of such fundraising in terms of risk and possible loss of management control.

### **Implementation Capability**

The capability of large organisations to implement a new project for a new market is characterized by the following:

#### **Lack of Innovation**

Large organisations are usually focused on providing safe returns for shareholders. The internal structures and management culture are therefore often anti-innovative plans. The organisational culture of large organisations therefore, does not provide a favourable environment for innovation and new risk prone projects.

#### **Lack of Focus**

New smaller projects do not get the focus and support needed to ensure success. This may result in support teams not walking the “extra mile” to keep new customers happy, specifically should there initially be teething problems regarding the deployment of the new service.

#### **Skills and Resources**

Large organisations have the resources to implement new projects, yet often lack the specific skills and innovative approach to implement new projects for new markets.

#### **Marketing and Sales**

If the new project is in line with the current branding and market positioning then this can readily be added to the portfolio; if this is not the case, the probability to successfully add the new project to the business will be much less.

## 8.5 SYMBIOTIC STRUCTURE SCENARIO

### 8.5.1 DEFINITION OF A SYMBIOTIC RELATIONSHIP

#### **In Nature**

A symbiotic relationship is a relationship between two entities that is mutually beneficial for the participants in the relationship. Thus, there is a positive-sum gain from cooperation. This is a term commonly used in biology to explain the relationship between two entities that need each other to survive and prosper.

The bumblebee and the flower would be an example. The bumblebee extracts the flower's pollen for protein and its nectar for energy. The bumblebee, while collecting these resources, inadvertently brushes pollen from one flower to another to enabling the flower's reproduction process to begin. The bumblebee needs the flower to survive; similarly the flower needs the bumblebee to survive.

These are positive sum relationships. Other relationships in biology, especially with respect to the food chain, are not so forgiving, being a zero sum relationship, where one player clearly benefits from the other (typically consumes the other). In this type of relationship, it is still essential that both players (as species not individuals) survive, or the dominant player will lose its food supply, and therefore become extinct. If the foxes kill all the chickens, the foxes die, as they lose their source of survival. If the predator kills all its prey, the predator will eventually also die.

#### **In a Business Relationship**

One can observe a symbiotic relationship between Venture Capitalists and Entrepreneurs. Venture Capitalists need early stage investment opportunities. These are provided by entrepreneurs. Entrepreneurs need investment capital to develop their ideas; these are provided by the Venture Capital community. Thus both industries benefit from each other's participation, a positive sum game. It is important that each keeps this in perspective: if one industry tries to exert additional pressure (prisoner's dilemma!) they may be better off in the short term, but the long term survival of the relationship would be put at risk if it meant that the other player may not survive or lose interest in continuing the relationship.

## 8.5.2 THE SYMBIOTIC ORGANISATIONAL STRUCTURE

In the context of this research study a symbiotic organisation structure is centered on the 1<sup>st</sup> tier network operator and the respective mutual beneficial relationships with its principal suppliers.

### Symbiotic Relationship Principle

A symbiotic principle exists between the 1<sup>st</sup> tier service provider who is the customer of its respective suppliers, while the suppliers form the business partners of the service provider, to whom they provide various services and even funding on favourable supply terms.

This relationship can be depicted in Figure 8-5.

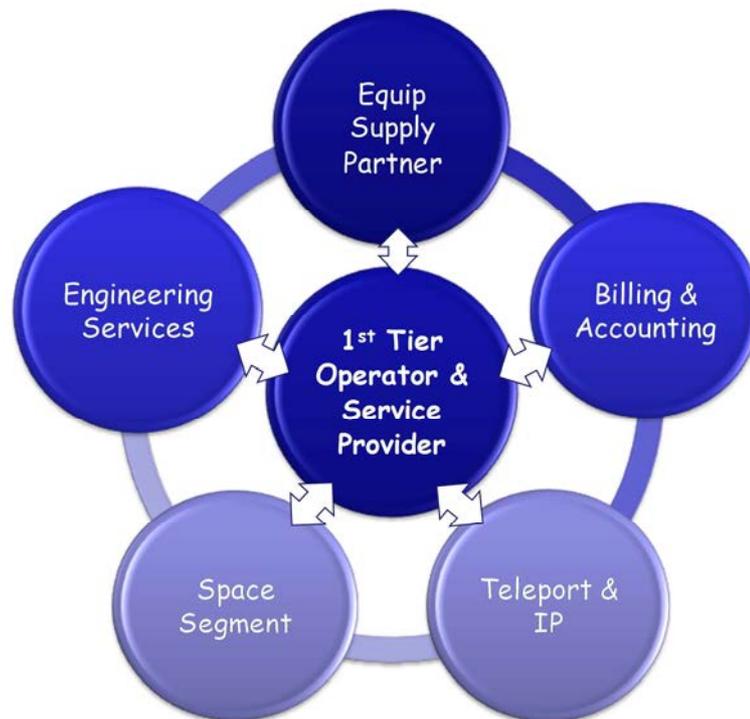


Figure 8-4: Symbiotic organisational principle

### Secondary Symbiotic Relationships

Business cooperation and mutually beneficial relationships can also exist between some or all of the suppliers. This provides further business synergy within the group of companies and forms a secondary level of symbiotic relationships.

## 8.6 SELECTING THE PREFERRED STRUCTURE

### 8.6.1 QUALITATIVE REVIEW

This section provides a qualitative review of the considerations impacting the choice between different organizational structures and outlines the criteria for selecting the symbiotic structure as the preferred model for the establishment of a new consumer based broadband product for the emerging Africa market.

In chapter 9 we complete a quantitative analysis of different organizational options with the application of the business model simulator and confirms that the symbiotic structure provides the most feasible scenario for establishing a data broadcast service for the emerging Africa market.

#### **Minimise Investment**

The symbiotic structure requires external funding for its operations, which forms the core of the business, but only takes responsibility for the management of the 1<sup>st</sup> tier operation, while the respective supporting business activities are funded within the partner organisations. This model therefore distributes the requirement for funding between a number of established players which greatly increases the feasibility of the project and reduces the funding requirements of the newly established entity.

The symbiotic structure provides the most effective mechanism to leverage the financial resources of the partner companies and requires the lowest direct venture funding.

#### **Risk**

Through the joint collaboration of all the resources available in the partner organizations the symbiotic structure minimizes the investment required and maximizes the business capabilities and market penetration footprint. Together these factors address the most critical uncertainties during the initial establishment phase and greatly reduce the business risks.

However, the symbiotic structure has some very specific risks that need to be noted and carefully managed in order to ensure the long-term success of the partnership. These are:

Alignment of Mutual Interest: The alignment of the mutual business interests of all the partners need to be respected and maintained. Should the partners develop counter constructive or competitive business strategies, the relationships will have to be reviewed and adjusted to avoid conflicts of interest. The fundamental principle is that all partners should benefit from the symbiotic consortium.

Value Definition: Since the business activities are distributed through the respective partner organisations the business value that each partner is entitled to cannot easily be quantified using traditional accounting methodologies. This could create some limitations should the shareholders in the symbiotic organisation plan to unlock wealth through an equity sale transaction, as the value of the symbiotic organisation as an independent entity may not be simple to calculate.

### **Skills and Resources**

The availability in the open market of the specialized engineering, business management and sales executive expertise required to make a success of this business is very limited. The principal rationale for the formation of a symbiotic structure lies in the capability to leverage scarce skills and resources that are available from different organisations. Through their cooperative nature it is possible to build a very competent team with the minimum recruitment or employment complications, and without having to carry the full-time cost of such an experienced team from the outset.

### **Marketing and Sales**

The marketing and sales effort within a symbiotic structure consists of the core focus of the symbiotic organisation to establish and build the brand, while all the business partners drive the respective sales efforts, using their existing contacts in this industry.

Through the business and industry network of its partners, it will have a wide reach into the market, which will greatly accelerate the growth of its initial market footprint. This capability linked with the existing customer relationships of the partners will decrease the initial market resistance for the new product and support market adoption.

### **Break-even Subscriber Quantities**

The low investment funding required, plus the reduced resource levels required to be allocated to the SkyeVine project, enables the business to break even on much lower subscriber numbers compared to the case for an independent service provider.

## **8.6.2 CASE STUDY OF SYMBIOTIC STRUCTURE**

The symbiotic organisational structure can be illustrated through considering the SkyeVine reference case study. SkyeVine is a new business project that is specifically on providing consumer broadband services to the emerging Africa market. The needs and challenges of the SkyeVine business project provide the quantitative background of this research work.

The SkyeVine business was formed following a symbiotic business structure that elegantly integrates the mutual interests of the respective business players. Each business partner has a specific contribution to ensure the success of the SkyeVine business case, while at the same time benefitting from the results of the SkyeVine business.



**Figure 8-5: SkyeVine business organisational structure**

The SkyeVine symbiotic group includes equity partners and operational partners.

### **Equity Partners**

The equity partners are core to the new business and are contributing to the initial investment capital required. Both equity partners have principle business interests in SkyeVine and view the SkyeVine business operation as strategic to their respective businesses.

### **Q-KON**

Q-KON is a system engineering company that provides telecommunication services to Service Providers in the African market. Q-KON has more than 10 years of experience in the operation of satellite based Internet access services, and is currently operating various platforms, which are on the business and enterprise markets.

SkyeVine will obtain all satellite platform engineering services, business services and sales account development services from Q-KON. These services will be provided to SkyeVine on the basis of an outsourced services contract for which, the applicable remuneration will be accumulated in an investment account. Only once the SkyeVine business case has been proven, will Q-KON receive monthly payments for its services.

### **Ellies Holdings**

Ellies Holdings is a publicly listed organisation that currently supplies and distributes consumer household hardware items, as well as satellite television equipment to the mass market in Southern Africa. Ellies has well established distribution channels and retail points to supply equipment to the mass consumer market in South Africa and southern Africa.

Ellies will supply and distribute the subscriber terminal equipment for SkyeVine directly to the consumer market. Ellies will earn revenue directly from the consumer market for the supply of terminal equipment and has agreed to make the initial cash investment needed to launch the SkyeVine operation.

## **Operational Partners**

### **Tradepage**

The customer accounting and billing services are done in accordance with a SkyeVine proprietary billing model which will be implemented by Tradepage. Tradepage is an established ISP who has both the software development capabilities, as well as access to the small and medium business customer markets.

Tradepage will be contracted by SkyeVine to implement the customer billing and customer account management systems, while Tradepage will also act as a reseller of SkyeVine's services to the market. The Tradepage services and expertise will be contracted through a long-term contract that includes a fixed monthly retainer element and a performance based "per-site" element.

### **Intelsat**

Intelsat is an international organisation that operates the largest global fleet of commercial telecommunication satellites. Intelsat will provide SkyeVine with satellite communication services on its newly launched New Dawn satellite that has been specifically designed and developed to service the Africa market.

The space segment service will be contracted from Intelsat over a five year period and in return Intelsat will provide the capital funding required procuring and implementing the first VSAT hub in order to establish the broadband service.

### **Business Connexion**

Business Connexion provides information technology services and solutions to the business and enterprise sector in South Africa, Mozambique, Zambia and Tanzania. Business Connexion's capabilities include a level 4 data centre and hosting facility located in Midrand, as well as multiple fibre access trunks to 1<sup>st</sup> tier national and international Internet access services.

Business Connexion will be providing the investment required to extend its current data centre facilities to include a satellite teleport and uplink facility for SkyeVine. In return SkyeVine will contract the Internet access and hub hosting services from Business Connexion.

## 8.7 SUMMARY

The organisational structure is the last and critical pillar in the business definition stage. The research work focused on defining the optimum structure for establishing the business to provide mass consumer services to the Africa market. In this chapter we evaluated the different organisational structures in a qualitative manner. In chapter 9 the different organisational models will be evaluated in a quantitative manner using the business model simulator.

The research work considered three possible organisational structures: a new vertically integrated structure, an existing vertical structure that is expanded, and a symbiotic structure based on cooperation between business partners.

The results of the qualitative analysis are that the symbiotic organisational structure is the preferred option. It offers an acceptable level of risk exposure and a limited requirement for funding, while creating a strong organisational delivery capability and a team with proven expertise.

The symbiotic organisational structure is a new alternative for this industry and is not part of classical organisational structure options. A symbiotic structure for satellite-based data broadcast service delivery into Africa has been defined as a result of the research innovation and insight of this study. This proposed structure offers significant benefits in reduced funding requirements and reducing the corporate risk and exposure, while at the same time increasing the probability of success by involving established players with many years of experience in this industry.

**Objective 5: Prove that business structure innovation can effectively leverage resources, reduce investment and reduce risk.**

Statement

The scale of the financial and resource investment required to implement the initial satellite-based data broadcast service, given the uncertain nature of this emerging market, requires a customized organisational structure to minimise the risk and maximise resource utilisation.

Finding:

The research work proved that the traditional vertical organisational structures require too high financial investments with implied high new business risks. The study led to the definition of an alternative symbiotic structure that requires less funding and offers an acceptable risk profile, while at the same time creating a very strong delivery capability and human resource expertise team.

## Section 4: Business Model Simulation

# 9. A Quantitative Business Model Simulator

Definition of a mathematical business model simulator to analyse different business strategies and options using quantified technology, financial and market parameters.

*"The route to a simple solution is usually extraordinary"*  
Business Connexion

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### 9.1 INTRODUCTION

This chapter documents the framework and methodology that was used for the creation of a simulated mathematical model that predicts expected business behaviour for different sets of decision options. This was achieved through the quantification of all important technology, market and business parameters and the integration of the relationships between these parameters into a comprehensive model that enables the quantified simulation of different scenarios.

The chapter documents the research work that is on the sixth and last research objective. The research work proves that the business can be effectively modelled to analyse various possible business strategies using quantified input parameters. Refer to Appendix A for details schedules of the business model simulator.

#### **Objective 6: Prove that the business can be modelled and simulated**

Through this part of the research work it is shown that it is possible to construct a mathematical business model simulator that accurately analyses different business scenarios. It is done through the integration of quantified market, technology and financial parameters, and that this can serve as a valuable support tool to enable improved decision making, while minimizing the risk of non-viable physical deployments.

### 9.1.1 DEVELOPMENT OF A QUANTIFIED BUSINESS MODEL SIMULATOR

In the preceding chapters the most important factors impacting on the success of a satellite broadband service provider focusing on the African market were discussed in detail. It is clear that there are a multiplicity of factors to take into account, that the impact of the respective factors are not independent of each other and that it will be difficult, if not impossible, to make optimal choices if these factors are considered in isolation.

One possibility to determine the combined effect of different impacting factors would be to physically deploy a service into the target market, to experiment with different business model options and to observe and evaluate the resulting behavior under each set of conditions that should be considered. This approach would however be impractical, firstly due to the large costs involved in the deployment of such a service, and secondly due to the long time period that may be required to exhaustively consider all available options in practice. The available technology platforms and the underlying nature of the market under investigation are in fact likely to change materially during the course of conducting such a set of experiments.

The only viable approach left to the research to scientifically consider the impact of the identified set of factors in order to support good business decisions is to construct a mathematical model that can be used to simulate the expected behavior of the market and of the proposed service provider under different sets of conditions. Such a model would allow the researcher to conduct a set of simulated experiments that will reflect the impact of each factor, the interaction between different factors and the performance that can reasonably be expected under different conditions and for different management options.

The value of the results to be generated using such a simulated model will obviously depend on the accuracy and reliability of the model that is implemented. The quality of the model will have to be verified through logical reasoning, ensuring that each important factor impacting on market and business behavior is accurately incorporated in the model. The model will furthermore have to be validated against existing case studies in this industry, by investigating the business models and strategies employed by existing players, in each case quantifying the respective input factors forming part of the model, and by comparing the practically observed behavior and performance of such players against the performance as predicted by the simulator. Such case studies can furthermore be used to calibrate the model against reality in order to increase its accuracy and reliability.

Against this background a complete mathematical business model simulator for a satellite based broadband service provider in the African marketplace was constructed through an integrated and interlinked spreadsheet structure. The mathematical business model is a quantified simulation that enables the evaluation of various business and technical implementation scenarios. The mathematical business model simulator provides a mechanism that enables management and system engineers to evaluate different business, product and technology options. It integrates the system engineering parameters, the product definition, the market demand and adoption as well as the required financial investment and expected return on investment.

### 9.1.2 RESEARCH REFERENCE

The research work to achieve the objective and to prove that the business can be effectively modeled was completed by using two current business model options as reference scenarios and to evaluate the options applicable to the establishment of a symbiotic structured business model. The research work sourced, identified and quantified all the applicable inputs parameters and business relationships in order to build an effective model to simulate various possible business scenarios.

The business model was developed using a series of integrated spreadsheets that calculated the different business and technical relationships. The applicable data, algorithms and interrelated relationships were derived from the results of intensive interaction with current leading industry players, as well as satellite system engineering teams.

#### **Simulator Validation**

The business model simulator was validated by applying the following two relevant, but very different, business model scenarios and by reviewing the predicted outcomes against the current realities in this industry.

#### **VSAT Business model**

Research was conducted to define the parameters and business drivers for the VSAT business model that is currently applied by ISP's in the industry and then applying these to the business model simulator. The research data was obtained through interviews with the industry, market research (refer to chapter 3) and by using known Q-KON business outcomes as a cross reference for comparison purposes.

#### **European Data broadcast model**

Astra2Connect operates the largest European data broadcast platform and detailed research work was conducted with the Astra2Connect team over a period of 2 years. The research work included several visits to the Astra2Connect Luxemburg facilities, as well as visits by the key Astra2Connect team members to South Africa.

#### **Simulator Application**

SkyeVine is a privately owned company that was formed with the sole objective to provide mass consumer broadband services to the emerging Africa market.



The SkyeVine business establishment requirements and business model have been integrated through this research project to allow the formulation of the research objectives and to provide the research validation environment. The business model has been applied to various relevant business scenarios for SkyeVine. Refer to [www.skyevine.co.za](http://www.skyevine.co.za) for more background on its business activities.

### 9.1.3 METHODOLOGY TO VERIFY AND VALIDATE THE MODEL

#### **Step 1: Build and verify the model**

A quantitative business model simulator was built through modelling of all the technical, commercial and marketing business relationships in terms of mathematical equations, as well as through the research work to define and quantify the respective input parameters.

The model was implemented through a series of spreadsheet calculations that capture the different algorithms and relationships that are discussed in more detail in the rest of this chapter.

The correctness of the implementation was verified by performing reality checks on all of the spreadsheet outcomes and by reviewing the changes in outcomes as the values of different input parameters was changed. Incorrect implementation of the underlying relationships could be detected by identifying unrealistic trends in quantified operational and financial outcomes.

#### **Step 2: Validation of the business model simulator**

The simulator was optimized through applying existing business model scenarios and comparing the simulated outcomes to actual known data. This was done using researched data, as well as data that was available in the public domain. In cases where the business model incorporates sensitive financial and business data and where these could not be obtained for the existing businesses, typical industry reference data was used for comparison purposes.

#### **Step 3: Apply the model**

Once the model was developed, verified and validated, the third step was to apply the model to provide predicted output data that could be used to address different business questions and evaluate options. In particular, the model was applied to support and validate decisions regarding the following business considerations:

##### **Evaluate the existing business models**

The business model simulator was applied to analyse the existing VSAT business model that is currently being used in the industry. The

##### **Calculated scenarios of a potential new business model**

- 1) Prediction of the business revenue potential to secure investors;
- 2) Selection of the most suited satellite scenario in terms of availability and cost;
- 3) Evaluation of the impact of different equipment types;
- 4) Optimisation of the matrix billing model.

## 9.2 OVERVIEW OF THE MODEL STRUCTURE

### 9.2.1 DIAGRAMMATIC REPRESENTATION

The various market, financial and technical dimensions were integrated into a mathematical model that is implemented using integrated spreadsheets that is depicted in Figure 9-1.

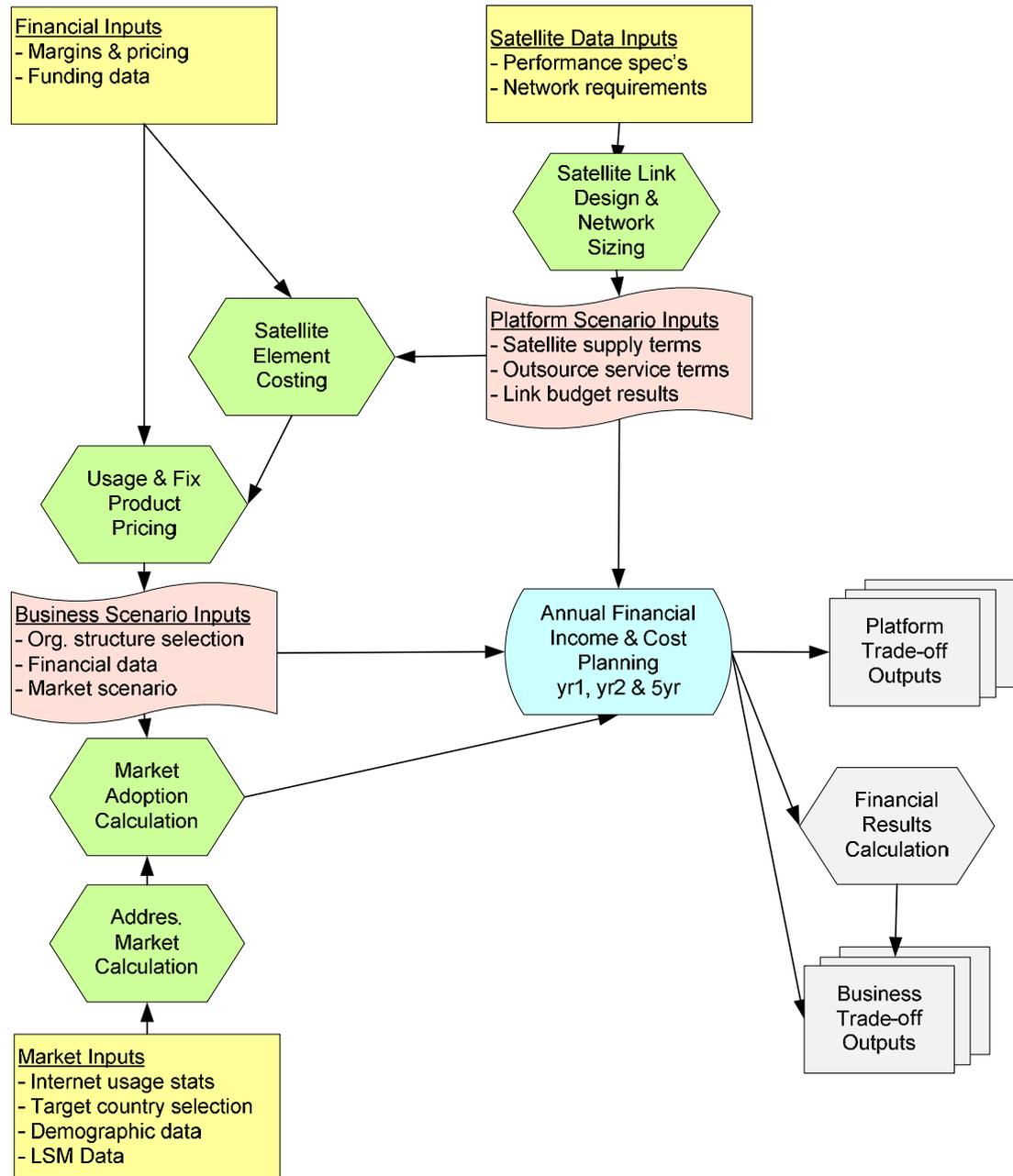


Figure 9-1: Diagrammatic representation of the mathematical business model simulator.

## 9.2.2 INPUT DATA

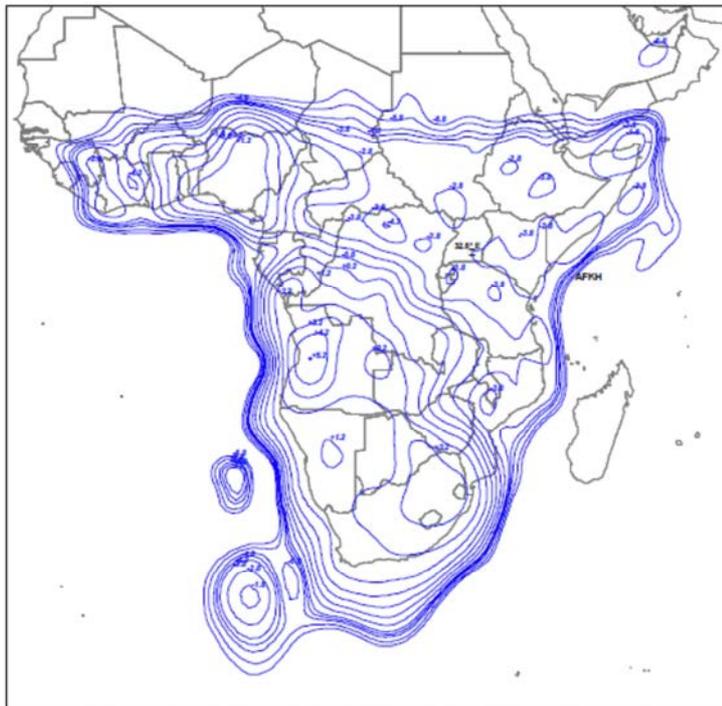
The business model is primarily driven from three sets of input data, which collectively defines the business perimeter and framework. The input data sets are indicated as yellow square processes and are the satellite, financial and market input data sets.

**Satellite Data Inputs**  
- Performance spec's  
- Network requirements

### Satellite Inputs

The satellite signal specifications are defined for outbound and inbound signal paths (as defined from the hub station) and are functions of the geographical signal levels, i.e. the signal coverage map.

The satellite data is typically obtained from the satellite operator and the most critical data is the receive sensitivity and transmit power levels as a function of geographical coverage.



The transmit power levels is defined to as the downlink, and is measured in Effective Isotropic Radiated Power (EIRP) values of typically 40 to 52dBW. The receive signal sensitivity is defined as the uplink and specifies the sensitivity of the satellite that is defined in G/T values of typically -5.8 to +5dB/Kelvin.

Figure 9-2: Uplink Ku-band signal coverage map for the New Dawn satellite.

### Financial Input Data

The financial input schedule defines the financial input data and reflects the applicable financial environment. The financial input data remains constant for all the scenarios and defines the following input data fields:

- rate-of-exchange values;
- product pricing rules for wholesale and retail margins;
- equipment, shipping and clearance costs;
- capital hub equipment implementation costs;
- applicable interests rates for loan and overdraft facilities;
- dividend percentage policy.

## Market Input Data

The market input data is captured in the following series of schedules that in combination define the macro market landscape:

### Country selection

Countries are selected to be included as part of the target market based on the satellite signal coverage maps and the existing equipment distribution capability available in each respective country.

### Market demographics

For each target country the following statistical data is obtained and incorporated in the model:

- population;
- major cities with population data;
- calculation of the non-urban (rural) population;
- number of broadband subscribers;
- number of DStv subscribers;

### Living Standard Measurement (LSM) Data

The following data is compiled for each different LSM group for both South Africa and Africa and these data points are used as inputs to calculate the size of the expected addressable market:

- LSM group;
- % of households for a specific LSM group;
- % of households in non-urban areas;
- Primary and secondary market size estimates;

## 9.2.3 CALCULATED DATA

The model uses the input data fields from various sources to calculate specific parameters that are used within the business model scenarios. Data calculation processes are represented by green hexagon icons and include the following:-



## Satellite Link Design and Network Sizing

The objectives, inputs, process and outputs of the satellite link design and network sizing calculations are summarised in the following tables. This represents the steps for calculating the link parameters for a specific location.

Through computerised algorithms the link parameters are calculated for hundreds of location positions throughout the satellite signal footprint and the results are presented in graphical format as shown in figures 6.10 and 6.11. For the purpose of the business model simulator results the average values of these calculations in a given geographical area is used.

<b>Satellite Link and Network Sizing:- Objectives, Inputs, Outputs &amp; Process</b>	
<b>Objective:</b>	Calculate & optimise the platform sizing dimensions for the services i.t.o. <ol style="list-style-type: none"> <li>a. Space segment requirements for specific service profiles</li> <li>b. Total number of subscribers for allocated space segment</li> <li>c. Estimated cost per service</li> </ol>
<b>Inputs:</b>	<ol style="list-style-type: none"> <li>a. Service Profile definition i.t.o. max Tx/Rx rates, contention &amp; subscriber quantities</li> <li>b. Total available space segment &amp; transmission profile plus IP data estimate</li> <li>c. Enter Zone, Site and Carrier data for clear sky &amp; rain conditions</li> </ol>
<b>Outputs:</b>	<ol style="list-style-type: none"> <li>a. Optimum platform bandwidth utilisation &amp; space segment requirements</li> <li>b. Expected total number of sustainable subscribers</li> <li>c. Cost per profile</li> </ol>
<b>Process:</b>	<ol style="list-style-type: none"> <li>Step 1: Calculate the average expected forward IP data rate and spectrum efficiency</li> <li>Step 2: Calculate the total number of sustainable users based on the defined service profile &amp; subscriber distribution</li> <li>Step 3: Calculate the required return capacity as per the defined service profiles and distribution</li> <li>Step 4: Summarise hub sizing i.t.o. Mbps and related MHz for forward &amp; return channels</li> <li>Step 5: Calculate the cost per service profile</li> </ol>

**Table 9-1: Satellite link and network sizing summary**

**Step 1: Calculate FORWARD channel IP Throughput & Efficiency**

Average FW IP rate = FW rate for clear sky condition + FW rate for rain condition  
 = ( FW Mbps Clear sky \* % total network) + (FW Mbps Rain \* % rain)

FW Efficiency = (FW Eff Clear \* 90%) + (FW Eff Rain \* 10%) / (% clear + % rain)

Outputs

Total average IP throughput expected for Outbound (Mbps)

Total average IP efficiency (bits / Hz)

**Step 2: Calculate total number of sustainable subscribers**

Average data rate per profile = FW peak data rate / contention \* % distribution of this profile

Total subscribers = Total average Mbps / Average kbps per subscriber

Bandwidth (MHz) per Profile = Aver profile data rate (kbps) / Total Aver data rate (kbps) \*

Total Bandwidth (MHz)

Output

Total number of subscribers that can be supported

**Step 3: Calculate required RTN bandwidth**

Required RTN bandwidth = Qnty subs \* Peak rate / Contention

Average data rate per profile = Peak rate \* Profile distribution % / Contention

Total Return data rate (Mbps) = Sum (Required RTN (kbps) per profiles) / 1024

Average IP Efficiency = Clear sky Efficiency \* % days applicable + Rain efficiency \* % days applicable

Total Return MHz = Total Rtn Mbps / Aver Efficiency

MHz per profile = Aver kbps per profile / Total Aver per profile \* Total Rtn MHz

Outputs

Total RTN Mbps

Aver RTN Efficiency

Total RTN MHz

**Step 4: Sizing Of Hub**

Hub specification is determined by max FW and RTN Mbps requirements

**Table 9-2: Satellite link and network sizing calculation steps and calculation references**

## Satellite Element Costing

The satellite element costing process calculates the cost of the basic satellite element in terms of \$/kbps, which can then be used to calculate the cost and price of the respective access products.

The element costing is calculated as follows:

- a) Total costs = space segment + engineering services + infrastructure costs.
- b) The total available Mbps for receive and transmit carriers, calculated using link budget algorithms.
- c) Average \$/kbps = (total contract value) / (total available kbps).

For the New Dawn scenario the input data is as follows:

- Receive channel capacity: 70Mbps
- Transmit channel capacity: 10Mbps
- Receive channel : \$2.81 / kbps
- Transmit channel: \$5.23 / kbps
- Platform average: \$3.11 / kbps

## Usage and Fixed Product Pricing

The end-user product options and pricing are calculated based on input data from the satellite element costing field and financial input data.

### Fixed-rate Product Costing

The “fixed”-rate products provide Internet access services at a fixed monthly rate for a given service profile. The product definition and costing algorithm is as follows:

$$\begin{aligned}\text{Service rate} &= ((\text{Tx data rate} * \$/\text{kbps}) + (\text{Rx data rate} * \$/\text{kbps})) / \text{Service contention.} \\ \text{Eg. Service rate for 256kbps Tx data rate / 4Mbps Rx data rate service} \\ &= ((256 \text{ kbps} * \$5.23 / \text{ kbps}) + (4096 \text{ kbps} * \$2.81 / \text{ kbps})) / 40 \\ &= \$321\end{aligned}$$

### Usage-based Product Costing

For products that are based on the data “usage” the costing is a function of a GByte unit that is calculated by defining a “busy-hour” period of 15 hours and then calculating the cost of one GByte unit using a reference signal carrier of 256kbps transmit and 4096kbps receive.

For example:

$$\text{Cost of reference carrier} = ((256 * 5.23) + (4096 * 2.81)) = \$12,848$$

$$\text{Total traffic bytes / ref carrier} = \text{Rx carrier} / 8 * 60\text{sec}/\text{min} * 60\text{min}/\text{hr} * 15\text{hrs}/\text{day} * 30 \text{ days}/\text{month}$$

$$\text{Cost per traffic byte} = \text{Cost of reference carrier} / (\text{Total traffic bytes} / \text{ref carrier}) = \$16 / \text{GByte}$$

### Addressable Market

This process calculates the addressable market size based on available data for the broadband and DStv markets in the same geographical areas.

#### As a function of current Broadband Subscribers

Based on the known broadband subscriber statistics the addressable market for the satellite access service can be calculated as follows:

To illustrate these calculations the input data for Botswana is used as example:

- Current broadband subscribers = 48,486
- Average broadband subscription = \$65 / month
- Average subscriber equipment cost = \$250
- Percentage of population that is non-urban = 40%

Through application of the price-elasticity-demand relationship and a PED factor of -1.25 for services and -1.05 for equipment, the addressable market for a satellite access service with an ARPU of \$130 and an equipment cost of \$905 can be calculated as follows, using the formula derived in section 4.6.1:

$$Q_{d2} = kP_2^{E_d} = Q_{d1} \left( \frac{P_2}{P_1} \right)^{E_d}$$

Addressable market for rural Botswana (derived from current broadband subscribers):

Market size adjusted for higher ARPU =  $48,486 * (130 / 65)^{-1.25} = 20,386$

Market size in non-urban areas =  $20,386 * 40\% = 8,154$

Market size adjusted for higher equipment price =  $8,154 * (905/250)^{-1.05} = 2,112$

#### As a function of DStv Subscribers

The addressable market can also be calculated when applying the same methodology and using the following current DStv subscribers' data as reference;

E.g. Input data for Botswana:

DStv subscribers = 20,243

DStv ARPU = \$100 / month

DStv equipment cost = \$400

Percentage non-urban subscribers = 40%

Addressable market for rural Botswana (derived from DStv subscribers):

Market size adjusted for higher ARPU =  $20,243 * (130 / 100)^{-1.25} = 14,583$

Market size in non-urban areas =  $14,583 * 40\% = 5,833$

Market size adjusted for higher equipment price =  $5,833 * (905/400)^{-1.05} = 2,475$

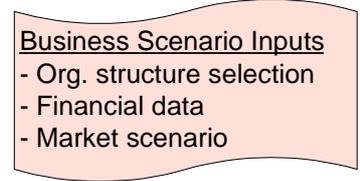
### Market Adoption

The market adoption for different product and business scenarios is calculated using past European growth numbers as a reference and adjusting this data for the Africa scenario to provide a quantified reference for the expected market penetration based on different product pricing policies.

The price-elasticity-of-demand function is applied as described above to calculate the expected market adoption for the different product options.

#### 9.2.4 SCENARIO INPUT DATA

The scenario input data schedules enable the selection of different input data sets depending on the specific scenario under investigation. The scenario input processes are depicted in a pink flow-rectangle and the following two processes are integrated into the model:-



**Business Scenario Inputs**

- Org. structure selection
- Financial data
- Market scenario

### Platform Scenario Input Data

The platform scenario input schedule integrates different input data sets for each of the different platform scenarios under consideration. Each column represents a different satellite platform scenario and the respective design and platform parameters are captured in the data fields.

The following scenarios are included in the process:

- Different satellite scenarios for Astra4A, Astra4Ai, T11N, Amos5 Ku3 Europe hub, Amos5 Ku3 Africa hub, NewDawn 3<sup>rd</sup> party teleport and NewDawn own teleport;
- Different organisational structure scenarios for NewDawn new-vertical and New-Dawn existing vertical structures;
- A scenario based on the use of professional level equipment.

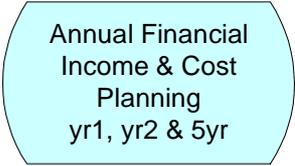
### Business Scenario Input Data

The business scenario input schedules capture the input data sets to evaluate the impact of the different business scenarios. The business scenario input data incorporates the following business aspects:

- a symbiotic organisational structure;
- a new-vertical organisational structure ;
- conservative market penetration;
- aggressive market penetration;
- usage based billing;
- fixed product billing.

### 9.2.5 ANNUAL INCOME AND COST SCHEDULE

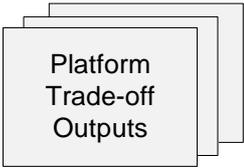
The income, expenditures, gross profit and net profit data is generated in the annual income and cost schedule. The data is generated for year 1, year 2 and for a 5 year term. The process is illustrated with a light blue rounded rectangle.



Annual Financial  
Income & Cost  
Planning  
yr1, yr2 & 5yr

### 9.2.6 SCENARIO OUTPUT DATA

The output data for the different business and platform scenarios is captured in the output scenario schedule for the platform, business and financial.



Platform  
Trade-off  
Outputs

#### **Platform Scenario Output Data**

The platform scenario output process captures the output data for the different platform scenarios to enable a direct comparison between the different platform evaluation options.

#### **Financial Performance Data**

The financial performance data schedules calculate the corporate income statement, cash flow and balance sheet data.

#### **Business Scenario Output Data**

The output data for the respective business scenarios is captured for consideration and trade-off analysis in the business scenario output data schedule.

## 9.3 VALIDATION OF THE BUSINESS MODEL SIMULATOR

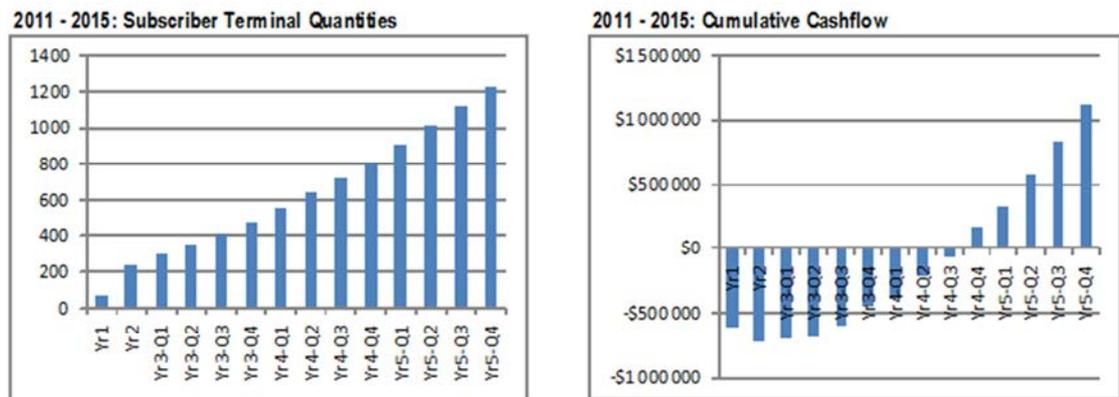
The business model simulator can be validated by using the simulator to predict the market size and financial return results for two known reference cases: the VSAT business model as currently used by industry and the European data broadcast model.

The current VSAT network model was used as a reference case study in order to evaluate the business simulator, comparing its outputs to actual historical results that have been achieved in this industry and calibrating the simulator to produce realistic results by adjusting the required parameter values.

In the same way the available data for the European data broadcast model was applied to validate the business model simulator within a different market sector. In both cases data was used that is within the public domain or that represents typical data values applicable to these industries.

### 9.3.1 VSAT BUSINESS MODEL

#### Summary Outcome



**Figure 9-3: Simulated results for the current VSAT business model**

The quantified business model simulator provided a valid estimate of the current business scenario. When the predicted results (1223 terminals in 5 years and an average ARPU of \$250) are compared with the actual data of VSAT based ISP's operating in Africa (DCC 2100, DoPC 3000, Linkserve 1000, Q-KON 900), it is clear that the predicted sales figure falls within the range of current sales figures achieved by existing competitors in this market (Comsys 2010) that have been operational for a period of 5 years.

The above predicted cash flow results also correlates with the actual data of a typical satellite platform product operated by Q-KON which provides a net income of \$30,000 per month, (or \$360,000 per annum) once the platform has been developed and was fully operational. The simulation model reached these cash flow levels after just more than 4 years of operation, which is very similar to the period of time that has elapsed since Q-KON launched its VSAT service.

## Simulator Adjustment

In order to obtain the above figure it is important to note that one significant adjustment had to be made to the PED value. When applying a PED value of -1.25 to both the equipment and services in order to calculate the addressable market for the current VSAT business model and using the DStv and broadband subscriber figures as a reference, then the outcome is not realistic as the sales figures were too low compared to actual results achieved by current market players – refer figure 9.4.

This deviation between actual and predicted figures can at least partially be explained by taking into account that the current VSAT service offering is aimed primarily at the professional and business markets. It would therefore not be entirely realistic to assume that the market adoption rates for this market can be directly deducted using the consumer DStv and broadband market statistics as a reference.

In order to compensate for this mismatch a PED factor of -1.05 for the subscriber equipment was introduced and this provided realistic results – refer figure 9.4. The correctness of the implementation was verified by performing reality checks on all of the spreadsheet outcomes and by reviewing the changes in outcomes as the values of different input parameters was changed. Incorrect implementation of the underlying relationships could be detected by identifying unrealistic trends in quantified operational and financial outcomes.

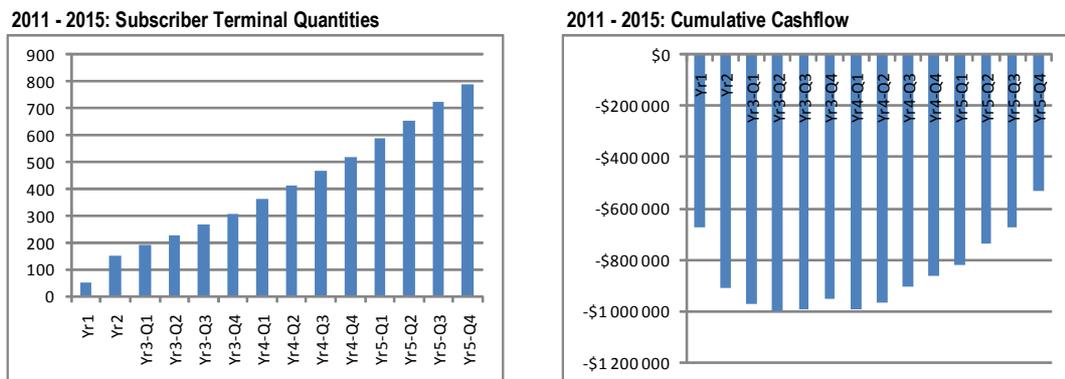


Figure 9-4: Simulated data for the VSAT business model with no PED factor correction.

### 9.3.2 CURRENT EUROPEAN DATA BROADCAST MODEL

The business model simulator was further validated through application of the current European data broadcast business model that allowed the simulator to be tested in a different market sector and for a different product sector.

#### Input Data

The input data required to apply the Astra2Connect European data broadcast model to the simulator was obtained from product information and pricing data available in the public domain, as well as from information obtained during one-on-one meetings with the Astra2Connect team in Luxemburg.

Table 9-3 provides an overview of the parameters that defines the European business model and the primary differences between the Africa market and the European market.

Input Parameter	Value	Comment
Satellite utilisation	33%	The satellite servicing the European market offers increased power levels and more concentrated signal beams which enable higher efficiencies and lower utilisation values.
Equipment cost	\$524	The subscriber terminal equipment is manufactured in Europe with lower logistics costs resulting in a lower end-user equipment price.
Hub implementation cost	\$800,000	The hub equipment is manufactured in Europe that leads to a lower hub implementation cost.

**Table 9-3: Input data review for European data broadcast scenario**

#### Simulated Results

The simulated results for the current Astra2Connect European data broadcast model are depicted in figure 9.5. The results shows an accumulated subscriber terminal quantity of 120,000 terminals over 5 years against the current actual value of 100,000 after 5 years which is a good predicted value.

The specific financial status of the Astra2Connect operations was kept confidential and no actual data are available to evaluate the predicted financial data. However, during the meetings and discussions held in Luxemburg it was noted that the typical turn-around cycle for this business is 4 to 5 years and the predicted results (achieving positive cumulative cash flows by Q4 of year 5) correspond with this value.

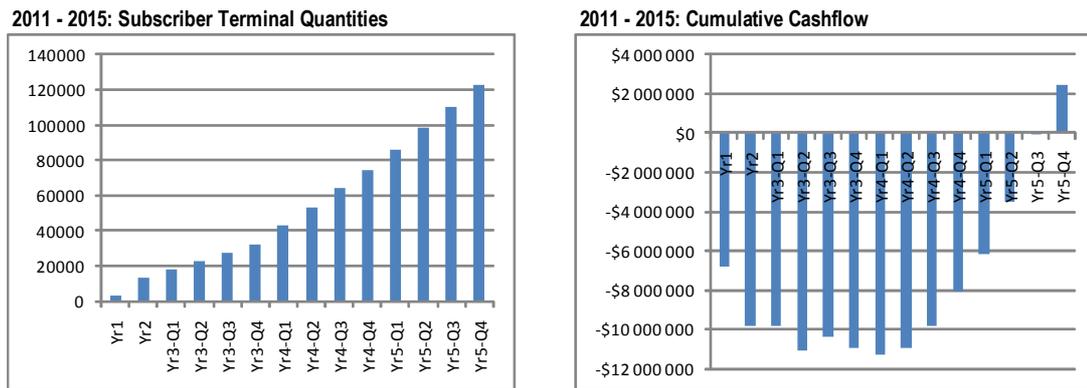


Figure 9-5: Simulated output data for the European data broadcast model

## Review

In order to apply the European data broadcast model the business model simulator had to be adjusted in the following areas:

- a) The methodology to apply the current broadband subscriber and DStv subscriber data to calculate the expected addressable market and the associated PED factors do not apply in the European context and was excluded from the simulator. The simulator for the European scenario therefore, does not include a market size prediction estimation but rather a prediction of expected results based on a known market size– which is what is required in order to validate the model. The business model simulator was thus validated against the actual market penetration data and not against an addressable predicted market estimate.
- b) The product bouquet for the European market is different than for the Africa market and this data were added to the simulator. In Europe the service is mostly applied for domestic purposes with very little business application, whereas in Africa the expected used profiles will include a much stronger focus on the business user with limited consumer users.

### 9.3.3 CONCLUSION OF THE BUSINESS MODEL SIMULATOR VALIDATION

The business model simulator was applied to two existing scenarios in the satellite broadband industry: the current VSAT business model as used in Africa and the current European data broadcast scenario. In both scenarios the simulator provided a good estimate of the potential number of subscriber units, as well as of the predicted financial performance.

Although the financial status could not be directly evaluated against actual data, the predicted subscriber quantities are typical of the current values and it can thus be stated that the business simulator provides a valid estimation of the complex satellite service business model domain.

## 9.4 APPLICATION OF THE BUSINESS MODEL SIMULATOR

Having validated the business model simulator in the previous section, the following sections demonstrate the application of the simulator to analyze different typical decision scenarios by comparing alternative outcomes that result from important business decisions.

The first application of the business model simulator involved the quantified evaluation of two existing business models currently being applied in the satellite broadband industry:

- The VSAT business model used to serve the business and enterprise markets in Africa;
- The European data broadcast business model.

Both of these business models were critically evaluated in chapter 6, but without the benefit of verifying the validity of the respective qualitative arguments through a quantitative analysis. The uncertainty about the viability of applying either of the two competing models to the Africa consumer market is based on the reality that the target markets served by those models differ fundamentally from the Africa consumer market. Section 9.5 will use the simulator to address the question whether any of the existing satellite broadband business models will prove to be viable in rural Africa.

The second application of the business model simulator involves a detailed scenario analysis to investigate each of the important aspects that were identified through the work in the previous chapters to be critical to the success of a satellite broadband service provider to the Africa consumer market. This scenario analysis must firstly confirm if the differentiated business model, compared to the above existing business models, will indeed result in a higher level of performance. Secondly it will be used to optimize some of the critical business decisions to be taken, including the best satellite option, the choice of equipment, the pricing structure and billing model, as well as the organizational structure.

Through the above process we will not only illustrate the practical value of the simulator, but also generate useful information regarding optimal choices in the establishment of a business operation in this industry. As the underlying business model and the supporting simulator are very generic in nature, this scenario analysis creates new knowledge for the satellite broadband industry that has general applicability for new markets with limited access to alternative broadband services.

## 9.5 QUANTITATIVE TRADE-OFF

### 9.5.1 FINANCIAL INPUT DATA

Business Parameter	Simbiotic Business Structure	New-Vertical Business Structure
	Conservative Market	Conservative Market
	Usage Billing	Usage Billing
<b>Sale of Equipment</b>	0	1
<b>Company Structure Influence</b>		
Operating cost	\$40 000	\$145 000
CAPEX, fix property	\$0	\$0
CAPEX, Equipment	\$0	\$3 640 806
CAPEX, Operations	\$0	\$212 500
<b>Market Influence</b>		
Market penetration factor	1	1
% market share Yr1	0.5%	0.5%
Yr2	1.5%	1.5%
Yr3	3.0%	3.0%
Yr4	5.0%	5.0%
Yr5	8.0%	8.0%
<b>Billing Model Influence</b>		
ARPU yr1	\$130	\$130
ARPU yr2	\$129	\$129
ARPU yr3	\$127	\$127
ARPU yr4	\$126	\$126
ARPU yr5	\$125	\$125
ARPU Mbps yr1	0.0167	0.0167
yr2	0.0184	0.0184
yr3	0.0202	0.0202
yr4	0.0222	0.0222
yr5	0.0244	0.0244

**Table 9-4: Financial input data to perform organisational trade-off**

Table 9-4 outlines the respective financial parameters applicable to a symbiotic organisational structure and to establish a new integrated structure. The market and billing model data are the same for both scenarios and do not affect the organisational structure review.

9.5.2 OUTPUT DATA

Business Parameters	Symbiotic Organisation	Vertical Integrated Company
	Conservative Market	Conservative Market
	Usage Billing	Usage Billing
<b>Funding</b>		
Max funding required	\$1 388 889	\$6 019 417
Yr5 return	\$32 009 732	\$22 633 316
<b>Summary Financial Indicators</b>		
Time to break-even	2	3
Time to positive cashflow	1	4
Maximum negative cash flow	\$633 111	-\$4 630 528
Maximum shareholder risk	\$1 388 889	\$6 019 417
Return on Investment	79%	77%
Internal rate of return	143%	130%
Net present value	\$4 622 193	\$4 234 415
<b>Annual cashflow as a function of time</b>		
Yr 1:2011	-\$755 778	-\$2 166 111
Yr 2:2012	\$1 839 345	\$1 245 271
Yr 3: 2013	\$6 206 737	\$6 513 252
Yr 4: 2014	\$11 495 752	\$12 186 783
Yr 5: 2015	\$20 667 398	\$23 495 217
<b>Profit (loss) as a function of time</b>		
Yr 1:2011	-\$883 358	-\$2 914 019
Yr 2:2012	\$1 245 008	-\$64 614
Yr 3: 2013	\$3 541 497	\$4 248 103
Yr 4: 2014	\$8 192 656	\$8 344 407
Yr 5: 2015	\$12 286 032	\$13 398 520
<b>Return on investment</b>		
Yr 1:2011	-63.6%	-209.8%
Yr 2:2012	246.3%	4.2%
Yr 3: 2013	202.3%	-267.2%
Yr 4: 2014	154.8%	313.9%
Yr 5: 2015	91.1%	121.8%

Table 9-5: Financial Output Data Schedule

Table 9-5 summarises the quantitative evaluation of a symbiotic vs. a vertically integrated organisational structure while keeping all other scenario parameters constant. The vertically integrated organisation requires significantly more funding with lower returns over the initial 3 year period. Over longer periods the vertically integrated model offers improved results, but given the high investment required and initial losses this option is associated with much higher risk levels.

## 9.6 EVALUATION OF EXISTING BUSINESS MODELS

Currently, the following two alternative technology options are available for consideration to provide satellite based broadband services to the Africa market:-

- The VSAT approach used by various ISP's to provide services into Africa and elsewhere;
- The data broadcast approach used by amongst others Astra2Connect to provide services into Europe.

Each of these two approaches implies an associated business model that is dictated by the capabilities and constraints of the respective technology options. The feasibility of either of these business models to provide data broadcast services into Africa can be evaluated using the quantified business model simulator. The simulator quantifies the expected market adoption rates, the network capacity to be deployed, the resulting funding requirements and the expected return on investment to provide a firm reference for evaluation of the viability of the respective business model options.

### 9.6.1 EXISTING VSAT BUSINESS MODEL EVALUATION

Very Small Aperture Terminal (VSAT) systems are widely deployed throughout Africa to provide Internet access and data connectivity services to the business and enterprise markets. These VSAT networks are implemented using high cost professional customer terminal equipment that must be installed by qualified field engineers and which provides services at a relative high subscriber cost per month.

#### **Input Data**

Using publicly available data, and complementing this with typical cost estimates applicable to a VSAT service provider business model, it is possible to evaluate the business models currently employed by existing service providers in this industry as an option to service the mass consumer market. The Balancing Act 2010 VSAT market report (Balancing Act, 2010) was used as a reference to define the following input data for the current VSAT service provider market based on current industry averages:

- Customer equipment price: \$2,853 excluding shipment, clearance and installation.
- Services pricing model: These models work on a fix-rate for a defined access transmit and receive data rate at a given contention ratio. For the purposes of the simulation a service of 128kbps transmit rate / 2048kbps receive rate at a 1:60 contention was applied. Note that this specification is far less than the expected 256kbps by 4096kbps access service profile for consumer broadband services.
- Network implementation capital expenses: \$520,000.

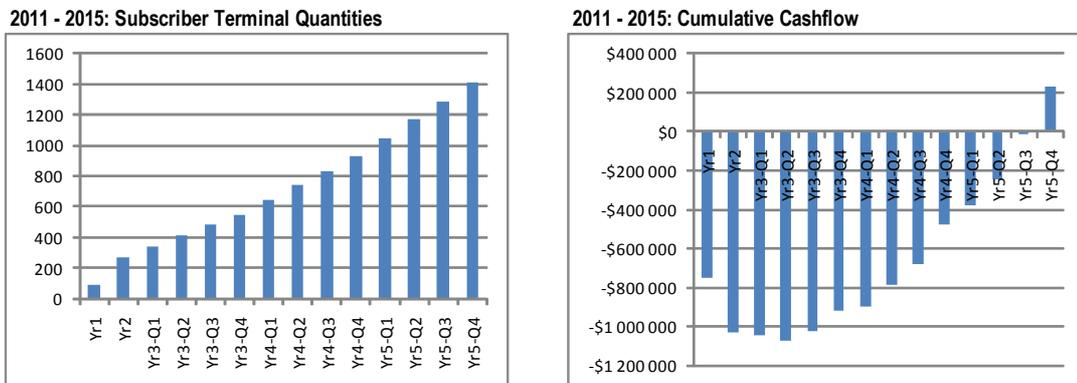
### Simulated Outcome

The quantified business model simulator was used to evaluate the feasibility of applying the current VSAT business model to provide data broadcast services to the Africa consumer market. The simulation yields a total of 1410 subscribers over 5 years and requires \$1,054,419 funding and with a net return of \$239,890 over 5 years.

The critical output data is summarised in table 9.6.

Current VSAT Business Model considered as an option to service the low-end market		
Business Parameter	Predicted Value	Comment
ARPU	\$309	In order to service the low-cost data broadcast market the current VSAT services must be operated at a contention of 1:60. This is a very high contention for current VSAT networks and is not recommended while a lower contention will further increase the already high ARPU rate and decrease sales.
Addressable market	23,785	This is the expected addressable market for the given ARPU and equipment price of \$2853.
Market Adoption	1400 yr5	Total number of subscribers in year 5, this is determined by the ARPU and equip. price

**Table 9-6: Simulated output data for current VSAT business model**



**Figure 9-6: ISP financial summary data for operating a VSAT network to service the low-cost market**

## VSAT Business Model Review

When evaluating the current VSAT business models as an option to meet the demands of future data broadcast services the outcome shows a very high investment required as reflected by the negative cumulative cash flows, even after 5 years of operation. This is furthermore accompanied by relatively small market adoption, leading to negative net returns over 5 years.

Furthermore, the service profile selected is a 128kbps transmit by 1024kbps receive data rate service with a 1:60 contention ratio. This service was selected in order to maximize the data rate and minimise the service cost. However, a service cost of \$309 is still very high and not close to the target rate of \$100 for the mass market while the contention of 60 is extremely high for current VSAT networks and very near to the design limitation which cannot be supported by the current VSAT technologies.

Added to this is the underlying associated risk of establishing a major new business operation in Africa with marginal profitability prospects at best – against this background it becomes clear why the current VSAT business model and architecture is not being used to service the mass consumer data broadcast market.

### 9.6.2 EUROPEAN DATA BROADCAST OPTION

The second alternative is to apply the current European data broadcast business model to service the emerging Africa market. To analyse this scenario we consider Astra2Connect, a European based network operator that provides data broadcast service to the European consumer market ([www.astra2connect.com](http://www.astra2connect.com)) on a wholesale basis to 1<sup>st</sup> tier ISP's. The service is deployed to complement ADSL services with a current estimated subscriber base of 100,000 terminals. Astra2Connect operates a vertically integrated organisation from its teleport facilities in Luxemburg and offers the market both fixed and usage based billing options.

The purpose of this evaluation is to consider the application of a vertically integrated data broadcast business model as deployed in Europe and to evaluate this as an option to provide low-cost consumer services to the Africa market.

For this reason the business model simulation is applied using Africa market and business landscape input data, combined with product data as offered by Astra2Connect in Europe.

#### Input Data

The following input data were obtained from market sources and general industry references:

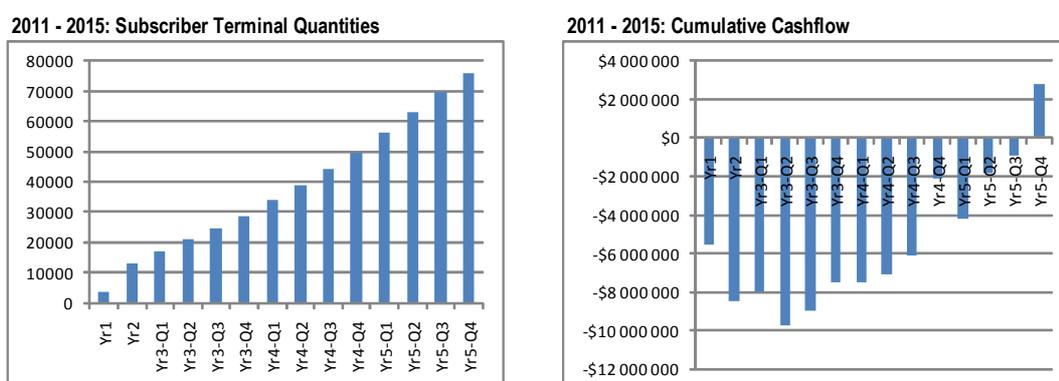
- a. Equipment price: \$905
- b. Service price: \$130
- c. Africa network implementation cost: \$3,853,306. In order to use technology that support low-cost self-installed customer terminal equipment, the technology in the central hub equipment is much more advanced and thus the investment in the central hub network are much more than the current VSAT network equivalent.

## Simulated Outcome

Applying the known data of the existing European data broadcast network to the Africa market scenario, yields an expected subscriber base of 76,111 subscribers with a total funding requirement of \$9.7M and a cumulative cash flow yield of \$2.8M over 5 years.

Current VSAT Business Model applied to provide low-cost Data Broadcast Services		
Business Parameter	Predicted Value	Comment
ARPU	\$130	The European model includes a “usage-based” billing option that can be applied to offer a service at \$130.
Addressable market	241,964	For the given ARPU and equipment price of \$905 the expected addressable market is calculated.
Market Adoption	76,505 yr5	This is determined by the ARPU and equipment price and shows the rapid nature of customer acceptance

**Table 9-7: Simulated output data for the European data broadcast model applied in the Africa market**



**Figure 9-7: Simulator results for applying the existing European data broadcast operation to the Africa market.**

## European Business Model Review

A critical review of the European data broadcast operator applied to the Africa market yields the following:

This scenario predicts a total captured market of 76,111 subscribers over 5 years. When considering that the current European subscriber base is 100,000 and that the European market has well developed alternative connectivity solutions, then this estimate is possible, given the vast Africa market and the very limited terrestrial connectivity.

For a vertically integrated business model the simulator calculates an expected total funding required of \$9.7M, which given the stability of the European market is an acceptable investment required for the potential cumulative net cash flow of \$2.8M over 5 years. However, with the uncertainties of the Africa market and the political instability in many African countries, the risk associated with such an investment is beyond the appetite of most investors.

### 9.6.3 BUSINESS PARAMETER ANALYSIS

Using the business model simulator the current Africa VSAT and European data broadcast business models were evaluated as options to implement data broadcast services for the Africa market. Although the detailed interrelationships between the various parameters are complex it is possible to deduce the principal drivers of the business model as:- the consumer equipment price, the required average revenue per subscriber (ARPU) and the initial investment required to build the network.

It should be noted that it is the relative relationships between these parameters that are critical and not the absolute value of these parameters. The important element is that the relationships between these parameters must result in attractive returns for a specific target market to ensure a successful and sustainable business. Table 9-5 below provides a summary based on which the alternative options can be compared.

<b>Business Model</b>	<b>ARPU</b>	<b>Equip Cost</b>	<b>Comment</b>
Current VSAT Model	High	High	<ul style="list-style-type: none"> <li>- This scenario is focused on the business market</li> <li>- High ARPU is earned from the business customer</li> <li>- The high equipment cost is acceptable</li> <li>- The market adoption quantities are low</li> <li>- Lower quantities and higher ARPU leads to acceptable revenue</li> <li>- This is current VSAT business model employed by ISP's.</li> </ul>
VSAT model employed as Datacast option	Low	High	<ul style="list-style-type: none"> <li>- The ARPU is decreased to access the broader consumer market</li> <li>- Lower ARPU will result in higher sales volumes</li> <li>- The equipment price is maintained thus the market adoption is still limited</li> <li>- Low ARPU plus limited sales volumes leads to low revenue generation</li> <li>- This scenario is not financially feasible</li> </ul>
Existing European model considered for Africa market	Low	Low	<ul style="list-style-type: none"> <li>- Low ARPU plus low equipment price will lead to maximum market adoption</li> <li>- High market adoption plus low ARPU will generate good revenue</li> <li>- The initial investment required to implement this network is significant</li> <li>- The financial returns are good and the model is financially feasible</li> <li>- The investment required combined with the risk associated with an unproven market is the critical element that scares off investors</li> </ul>
Niche market scenario	High	Low	<ul style="list-style-type: none"> <li>- Low equipment cost will lead to high market adoption with the market niches that can afford the monthly fees</li> <li>- High ARPU plus high niche market adoption will lead to high profitability</li> <li>- This scenario will apply in specific unique niche markets only</li> </ul>

**Table 9-8: Summary of business model evaluation considerations**

## 9.7 AFRICA TWO-WAY DATA BROADCAST SCENARIO ANALYSIS

In this section we perform a quantitative investigation into the most critical issues impacting on the success of a satellite broadband service for the Africa consumer market. The qualitative arguments put forward in earlier chapters are tested based on business performance figures generated by the validated business model simulator. In the process optimal decision choices are identified based on the expected levels of market penetration and the associated financial performance that will result from those decisions.

### 9.7.1 ORGANISATIONAL STRUCTURE AND BILLING MODEL

#### Business Query

As for any business operation the required operational funding can only be secured from potential investors and equity partners, if realistic and credible estimates are available for the revenue potential of the business, as well as the funding required to unlock this potential. From the earlier investigations into this industry it is clear that two primary business choices have a significant impact on both of these criteria: the organisational structure, as well as the billing model. These estimates must be available for both conservative and aggressive market situations.

**Business query:**

**Quantify the revenue potential & funding requirements**

Calculate the revenue potential and the maximum funding required to establish a satellite broadband operation in the African market, and determine what organisational structure and billing model offers the optimum scenario.

#### Scenarios

Based on the above discussion we include three variable elements in the current scenario analysis:

- a) The first element addresses the issue of choice of organisational structure. The two general options that are compared are a vertically integrated structure (which is currently the business model most commonly employed in the satellite broadband industry) and a symbiotic (vertically disaggregated) structure based on cooperation between independent business entities, each playing a specialist role (refer to chapter 8).

- b) The second element addresses the billing model that can be either a usage-based matrix model as discussed earlier in this chapter, or it can be a fixed subscription based model.
- c) The third element considers the business outcome for either conservative or aggressive market conditions; this will indicate if choices regarding the other two elements will be robust under different business conditions.

Collectively the three principal elements offer eight possible scenarios for business, see Table 9-9.

Option	Organisational Structure	Market Penetration	Billing Model
1	Symbiotic	Conservative	Usage based
2	Symbiotic	Conservative	Fixed
3	Symbiotic	Aggressive	Usage based
4	Symbiotic	Aggressive	Fixed
5	Vertical	Conservative	Usage based
6	Vertical	Conservative	Fixed
7	Vertical	Aggressive	Usage based
8	Vertical	Aggressive	Fixed

**Table 9-9: Revenue and Funding scenario input data schedule**

### Scenario Outcome Data

The eight different business scenarios were analysed using the business model simulator and table 9-8 details the outcome data.

### Considerations & Decisions

There are two principal elements to be reviewed, relating to the two aspects over which the business has full control: a) the organisational structure and b) the billing model. These two elements will be discussed separately. The conservative and aggressive market scenarios provide additional information regarding the robustness of the selection of an alternative under different business conditions; as it cannot be assumed that business conditions will be favourable, the outcome for a decision must prove to be financially viable under both sets of market conditions.

#### Organisational Structure

The classical vertically integrated organisational structure requires more funding as completely new distribution and support capacity must be established. Most of these investments are avoided in the case of the symbiotic structure. The returns are initially lower for the vertical structure compared to the symbiotic structure, due to the larger

investment. While the returns by year 5 overtakes the returns on the symbiotic structure, with a slightly higher net present value (using a 40% discount rate to reflect the relatively high risks associated with a new start-up) is it achieved at much higher levels of risk. This is reflected by the initial negative cash flows and the longer period till break-even is achieved. Refer to chapter 8 for a detailed discussion.

**Billing Model**

The matrix usage-based billing model provides a more affordable option to the market and yields better financial results. Even assuming the same number of subscribers (which could possibly be higher for usage based billing given the increased flexibility offered to customers) overall revenues and profits are higher for usage based billing, resulting in a more attractive return on investment and NPV. More detail is provided in chapter 7.

Business Parameters	Symbiotic Organisation				New-Vertical Integrated Company			
	Conserv. Market		Agressive Market		Conserv. Market		Agressive Market	
	Usage Billing	Fix Billing	Usage Billing	Fix Billing	Usage Billing	Fix Billing	Usage Billing	Fix Billing
ARPU Yr1	\$130	\$189	\$130	\$189	\$130	\$189	\$130	\$189
<b>Funding</b>								
Max funding required	\$1 388 889	\$1 388 889	\$1 388 889	\$1 388 889	\$6 019 417	\$7 388 245	\$6 276 640	\$6 257 322
Yr5 return	\$32 009 732	\$16 878 611	\$88 078 755	\$45 195 704	\$22 633 316	\$7 502 195	\$78 702 339	\$35 819 288
<b>Market Indicators</b>								
Subscribers Yr1	2 632	1 418	9 367	3 214	2 632	1 418	9 367	3 214
Yr2	6 532	3 649	17 167	7 676	6 532	3 649	17 167	7 676
Yr3	14 274	11 391	32 651	23 160	14 274	11 391	32 651	23 160
Yr4	24 795	21 912	53 694	44 203	24 795	21 912	53 694	44 203
Yr5	41 272	38 389	86 647	77 156	41 272	38 389	86 647	77 156
<b>Summary Financial Indicators</b>								
Maximum negative cash flow	\$633 111	\$563 989	\$526 221	\$416 867	-\$4 630 528	-\$5 999 356	-\$4 887 751	-\$4 868 433
Maximum shareholder risk	\$1 388 889	\$1 388 889	\$1 388 889	\$1 388 889	\$6 019 417	\$7 388 245	\$6 276 640	\$6 257 322
Return on Investment	79%	63%	116%	94%	77%	57%	120%	98%
Internal rate of return	143%	102%	305%	186%	130%	96%	322%	187%
Net present value	\$4 622 193	\$2 434 516	\$13 903 573	\$7 363 654	\$4 234 415	\$1 981 542	\$15 122 706	\$8 275 318
<b>Annual cashflow as a function of time</b>								
Yr 1:2011	-\$755 778	-\$824 900	-\$862 668	-\$972 022	-\$2 166 111	-\$2 170 897	-\$2 423 335	-\$2 404 017
Yr 2:2012	\$1 839 345	\$304 065	\$9 284 569	\$2 670 830	\$1 245 271	-\$854 158	\$9 455 984	\$1 866 385
Yr 3: 2013	\$6 206 737	\$4 471 620	\$19 299 087	\$11 044 126	\$6 513 252	\$4 575 010	\$21 410 046	\$13 065 307
Yr 4: 2014	\$11 495 752	\$5 239 663	\$25 724 724	\$14 149 139	\$12 186 783	\$5 711 317	\$28 845 312	\$17 269 727
Yr 5: 2015	\$20 667 398	\$13 617 282	\$47 443 898	\$29 507 884	\$23 495 217	\$16 104 397	\$55 030 864	\$37 094 850
<b>Profit (loss) as a function of time</b>								
Yr 1:2011	-\$883 358	-\$941 415	-\$1 043 528	-\$1 104 612	-\$2 914 019	-\$2 972 076	-\$3 074 189	-\$3 135 273
Yr 2:2012	\$1 245 008	\$11 408	\$5 813 785	\$1 821 852	-\$64 614	-\$2 040 268	\$6 190 665	\$767 256
Yr 3: 2013	\$3 541 497	\$2 815 315	\$11 569 649	\$6 457 942	\$4 248 103	\$2 972 945	\$12 642 735	\$8 248 715
Yr 4: 2014	\$8 192 656	\$5 152 949	\$19 252 312	\$12 327 497	\$8 344 407	\$5 722 206	\$21 214 794	\$14 273 741
Yr 5: 2015	\$12 286 032	\$7 609 933	\$28 657 690	\$16 893 521	\$13 398 520	\$8 349 614	\$32 596 472	\$20 815 695
<b>Return on investment</b>								
Yr 1:2011	-63.6%	-67.8%	-75.1%	-79.5%	-209.8%	-214.0%	-221.3%	-225.7%
Yr 2:2012	246.3%	2.5%	1683.4%	640.9%	4.2%	128.9%	-367.3%	-43.9%
Yr 3: 2013	202.3%	613.5%	187.8%	306.6%	-267.2%	-82.0%	280.6%	-842.5%
Yr 4: 2014	154.8%	157.4%	108.6%	143.9%	313.9%	-879.6%	123.7%	196.3%
Yr 5: 2015	91.1%	90.3%	77.5%	80.9%	121.8%	164.6%	85.0%	96.6%

**Table 9-10: Organisational scenario planning outcome schedule**

## 9.7.2 SATELLITE SCENARIO ANALYSES

### Business Query

The preferred business plan option is based on the provisioning of Internet access services using a satellite communication medium. The selection of the preferred satellite is fundamental to the business as it influences almost all business parameters, such as revenue, cost, target market, infrastructure requirements etc. In order to illustrate the impact of choice of satellite on the expected business performance, as well as to demonstrate the use of the business model simulator to evaluate different alternatives, the study considers the options that are typically available.

As a particular case study we consider the SkyeVine business plan which was initially based on the Astra4A satellite that is operated by the European based SES-Astra group that provides connectivity between Europe and Africa. All the SkyeVine business parameters were planned using the Astra4A satellite and the commercial terms offered by SES-Astra. During the final contract closure negotiations a final agreement could not be reached and both parties mutually decided not to continue with the contract.

This represented a major disruptive event for the SkyeVine business and alternative satellite options had to be considered rapidly. Different satellite scenarios offer different options with regards to satellite signal specifications, target coverage areas, commercial terms, service availability dates, etc. and all these terms impact the business plan.

Based on this scenario the simulator was applied to address the following business query:

#### **Business query: Evaluate different satellite scenarios**

The impact of different satellite scenarios on all the business plan criteria must be quantified to enable selection of the satellite scenario that still meets the business funding requirements.

## Input Data

In order to evaluate the business impact of the different satellite scenarios, the following input data needs to be incorporated into the model for all the different scenarios. The available satellite scenarios had different service start dates that also had to be incorporated.

Type of Input Data	Data Fields
<b>Satellite supply terms</b>	Service availability date; contract deposit; rate for outbound channel; rate for inbound channel; available contract capacity ramp terms; minimum capacity that can be contracted.
<b>Teleport uplink terms</b>	Rate for satellite RF uplink and IP termination services
<b>Hub operation and platform services</b>	Capital cost for the 1 <sup>st</sup> network hub, cost for next hubs, engineering services rates for the hub operation, site activation and support services, rates for accounting and billing services.
<b>Link budget analysis data</b>	Link and network design data for the outbound and inbound channels including MHz and Mbps efficiencies and cost per Mbps.
<b>Implementation plan data</b>	Data applicable to the implementation i.e. service start date, number of initial sites and roll-out growth rate

**Table 9-11: Satellite scenario input data**

## Critical Considerations

At the time when a new satellite scenario had to be selected for SkyeVine, the initial investor funding was already secured and the start-up business was already formed and operational. At that stage it was not possible any more to select the best possible outcome based on the satellite link viewed in isolation, as a number of other business commitments have already been made.

The model therefore had to be applied to find the optimal satellite scenario that best fitted the existing business constraints. At that time the most restrictive business constraints were:

### **Maximum Available Funding**

The initial funding available to start the business was limited to R10 million and hence the scenario had to be defined not to exceed this amount.

### **Time-to-market**

The broadband market was rapidly developing and the time-to-market was critical to have first starter benefits.

### **Addressable Market**

In order to minimise the business development risk the product must be available to as large a geographical market as possible.

### **Satellite Scenario Outcome Data**

The business model was applied to analyse nine possible satellite scenarios of which seven are included in the next table, and of which three most feasible options will be discussed. The other satellite scenarios do not provide feasible business model outcomes for the business criteria under consideration.

#### **Astra4A Base-Case**

This scenario was the basis of the original plan and is included as reference for evaluation.

#### **New-Dawn**

The New-Dawn satellite provides Africa-to-Africa connectivity and requires teleport services in South Africa. Two scenarios were considered: a scenario based on building SkyeVine's own teleport and a scenario based on using a 3<sup>rd</sup> party teleport.

Offsetting the additional cost, required to build SkyeVine's own teleport and required an increase in sales from 2385 units for year 1 to 3223 units, in order to meet the other business criteria.

#### **Amos5**

Two scenarios for the Amos5 satellite were considered: one for a hub located in Europe and one for a hub located in South Africa. The Amos5 satellite launch date was scheduled for Qtr3 2011 and both these scenarios would require a very fast sales growth rate of more than 200% p.a. in order to secure the required revenue within the funding limitation. The fast growth rate is required to ensure a high growth in subscriber revenue to compensate for the additional expenses incurred due to the delay in the satellite launch program.

Satellite Financial Trade-off	Current Data	Astra4A Base-case	NewDawn SA Own Teleport	NewDawn SA 3rd Party Teleport	NewDawn & T11N	NewDawn & Astra4i	Amos5 Ku3 Europe Hub	Amos5 Ku3 Africa Hub
<b>Business Elements</b>								
Hub services		ABBS Rental	Own	Own	ABBS rental	ABBS Rental	ABBS Rental	Own
Teleport services		ABBS Rental	Own	3rd Party	ABBS rental	ABBS Rental	ABBS Rental	Own
Primary Satellite	NewDawn Symbiotic	Astra4A Bcase	NewDawn Own	NewDawn @3rd	NewDawn A-A	NewDawn A-A	Amos5 Eur-Afr	Amos5 Afr-Afr
Interrim Satellite	None	-	None	None	T11N	Astra4Ai	None	None
<b>Year 1</b>								
Prim-Sat Subs	2632	4251	3223	2385	2390	2390	1500	2538
Prim-Sat growth rate	160%	125%	150%	140%	130%	130%	200%	250%
Inter-Sat Subs	0	0	0	0	0	0	0	0
Total subscribers	2632	4251	3223	2385	2390	2390	1500	2538
Accum total	-\$1 424 979	-\$1 248 646	-\$1 309 272	-\$1 473 095	-\$1 494 453	-\$1 538 626	-\$923 136	-\$1 129 466
<b>Year 2</b>								
Sub growth /mnth	50	50	50	50	50	50	50	50
Total Subscribers	6532	8151	7123	6285	6290	6290	5400	6438
Max funding	-\$1 616 456	-\$1 172 931	-\$1 191 398	-\$1 441 890	-\$1 459 738	-\$1 503 911	-\$1 249 317	-\$1 325 272
	-R 12 123 417	-R 8 796 984	-R 8 935 488	-R 10 814 177	-R 10 948 033	-R 11 279 332	-R 9 369 880	-R 9 939 540
<b>Year 5</b>								
Total subscribers	41272	27951	26923	26085	26090	26090	25200	26238
Xpdrs	18	8	8	8	8	8	8	8
Acc nett income	\$18 879 658	\$68 292 549	\$68 575 394	\$64 306 418	\$62 686 129	\$62 641 956	\$56 395 474	\$65 205 978

**Table 9-12: Satellite Scenario Output Data Table**

## Recommendation

The New-Dawn satellite scenario with teleport and hub infrastructure owned by SkyeVine was recommended based on the following considerations:

### Time-to-market

New-Dawn was scheduled for launch at the end of April 2011 and would have been ready for commercial services by 1 July 2011. This would have only resulted in a net delay of three months, with reference to the original Astra4A service launch date.

### Funding Requirement

The business can still be established within the available funding limit without being dependent upon unrealistic sales targets.

### Addressable Market

New-Dawn provides adequate signal coverage over most of the sub-Saharan region to enable service delivery to most of the original addressable markets.

### 9.7.3 EQUIPMENT SCENARIO ANALYSES

#### Business Query

The SkyeVine satellite-based broadband service is implemented using a subscriber terminal that incorporates a satellite modem, transmitter and receiver modules. The subscriber terminal is connected, via the satellite communication channel, to the central network hub equipment that is located at the uplink station, to implement the communication channel.

Subscriber terminal equipment is designed for different market sectors. Different terminal types are available for the mass consumer, professional or enterprise markets. Satellite terminals focusing on the consumer market are low-cost, self-installed units with basic IP communication capabilities while terminals for the professional market are higher cost terminals with more advanced specifications.

The SkyeVine business plan is on providing services to the mass Africa consumer market and in the initial business planning the service was based on the consumer terminal equipment manufactured by Newtec. The Newtec equipment is widely used in Europe on the Astra4A satellites and offered a proven solution for the Africa SkyeVine business plan.

When the Astra4A satellite could no longer be considered for use by SkyeVine, it also provided SkyeVine with an opportunity to reconsider the selection of the Newtec equipment for the Africa consumer market. Alternative equipment options were offered to SkyeVine by competing vendors; one particular product manufactured by Gilat was offered at very attractive commercial terms.

#### **Business query: Optimise the subscriber terminal equipment selection**

Analyse and quantify the business impact of and draw a comparison between deploying consumer or professional equipment terminals and make a recommendation regarding the preferred equipment type for the SkyeVine business plan.

#### Critical Considerations

The research work focused on applying the SkyeVine business model to simulate different business outcomes based on the deployment of either consumer or professional equipment types. The analysis focused on quantifying the effect of different equipment types on the market adoption, sales revenue and funding requirements.

Determining the impact of different equipment types for the SkyeVine business plan is driven by consideration of the following aspects:

### Subscriber Terminal Equipment Cost

For the consumer market the initial purchase price of the equipment has a significant impact on market adoption and subscriber numbers. The professional equipment product is 50% more expensive than the consumer terminal and the impact of the expected lower levels of initial product adoption due, to a higher equipment price must be quantified and reviewed.

### Subscriber Implementation

Satellite subscriber terminal equipment requires the physical installation of a dish antenna structure for each subscriber. The technical and physical implications of the installation process can significantly increase the total initial cost of service provisioning. The consumer terminal is designed as a “self-install” unit to be installed by the consumer, whereas the professional terminal requires the on-site services of a satellite field engineer.

### Network Hub Equipment Cost

The establishment cost of the network hub is a function of the specific equipment manufacturing type and impacts on the capital expenditure budget. The capital cost for the consumer network is almost twice as much compared to the cost for the professional product and the effect of this must be carefully analysed.

## Input Data

For the Africa market the possible satellite equipment manufacturers have focused on different market sectors. Satellite terminals for the consumer market are manufactured by Newtec and terminals for the professional market are manufactured by Gilat. There are other manufacturers, e.g. Viasat, Hughes etc., who offer terminals for the consumer market; however, these options require very high subscriber numbers to justify the initial investment in hub and platform establishment equipment. For this reason only the Newtec and Gilat options were formally evaluated.

Input values for the two equipment manufacturing options for the Africa market are as follows:

Type of Input Data	Consumer Product	Professional Product
<b>Manufacturer</b>	Newtec	Gilat
<b>Product Name</b>	Sat3Play	SkyEdgell
<b>Subscriber terminal equipment cost</b>	\$426	\$650
<b>Subscriber terminal implementation cost</b>	\$80	\$160
<b>Network hub equipment cost</b>	\$750,000	\$450,000

Table 9-13: Equipment manufacturer option input data

## Scenario Outcome Data

The output data for the most critical parameters are listed in the table below. The following observations are noted:

### Subscriber Quantities

The nominal value of the subscriber quantities required to achieve positive monthly cashflow and to recover the total investment is very similar for the consumer and professional products. This is expected, since the monthly subscriber revenue for the service is kept the same for both options.

### Time to recover investment

The biggest influence of the more expensive subscriber terminal cost is the expected delay in subscriber sales using the professional version, owing to the higher equipment cost. This delayed subscriber growth effectively doubles both the time to achieve positive cash flow, as well as the time to recover the full investment.

Output Data Field	Consumer Product	Professional Product
Maximum funding required	\$1,424,979	\$2,130,136
Months to turn cash positive	6 months	15 months
Subscribers quantity required to turn cashflow positive	2,632	2,446
Months to recover investment	Yr3, Qtr3	Yr4, Qtr2
Subscriber quantity required to recover investment	10,403	10,545

**Table 9-14: Outcome of the professional vs. consumer equipment analyses**

## Recommendation

Based on these quantified business scenario results, the decision to select the consumer product was clear to all stakeholders.

## 9.8 SUMMARY

Chapter 9 concludes the research activities. The chapter documents the outcome of the quantified business model simulator development process that addresses objective #6. The business model simulator is completed as an integrated mathematical model, and is implemented in a spreadsheet format (refer to the Appendix A for a printed copy of selected modules of the model).

The business model simulator is designed to support the business strategy development process and captures the respective relationships between the various business processes and functions. The development of the business model simulator incorporates the following research activities:

- investigation into and definition of the respective business, technology and market input parameters;
- the definition and development of the billing model, organisational structure and technology network solution that form the anchor business elements;
- definition of the respective mathematical relationships to model the business strategy and business functions;
- calculation of the various business outcome scenarios based on different input data sets, to enable decision making regarding the investment required, the best organisational structure, the preferred billing model, the preferred satellite platform and the choice of subscriber terminal equipment.

### **Objective 6: Prove that the business can be modelled and simulated**

Through this part of the research work it is shown that it is possible to construct a simulated mathematical model that accurately analyses different business scenarios through the integration of quantified market, technology and financial parameters. It is furthermore demonstrated that this can serve as a valuable support tool to enable improved decision making, while minimizing the risk of non-viable physical deployments.

#### Finding:

The research work demonstrated that it is possible to develop a business model simulator that integrates innovation in billing model and organisational structure definition and that effectively models the business strategy. The business model was successfully applied to analyse various business scenarios applicable to the SkyeVine commercial business environment, to enable decisions regarding strategic aspects of the business.

## Section 4: Business Model Simulation

# 10. Summary and Conclusions

An overview of the research objectives, activities, process and outcomes with specific reference to innovation and new knowledge obtained.

*"The only limits are, as always, those of vision".*  
James Broughton

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### 10.1 RESEARCH OBJECTIVE

The objective of the research work was to develop a **scalable business model for mass customization of broadband services in the emerging Africa market.**

The business model is needed in order to provide a quantitative environment for evaluating various business concepts and strategy options applicable to providing broadband services to the mass consumer market.

#### Principal Research Problem

This research work is focused on answering the following principal questions:

"Is there an addressable consumer broadband market in Africa that can be effectively serviced using a satellite-based access network?"

If this is the case, then:-

- 1) What is the size and specific characteristics of the market?
- 2) What is the satellite network architecture that will meet the requirements of the implied broadband service offering?
- 3) What is the business structure that can effectively integrate technology, market and product dimensions into a viable business operation?
- 4) What billing model will be the most effective with respect to monthly revenue versus subscriber quantities?
- 5) What organisational structure will offer the most efficient and lowest risk operating model?
- 6) Can the business be modelled to evaluate different architectural, financial and market scenarios in order to select the optimum implementation strategy?

## 10.2 FIELD OF KNOWLEDGE CONTRIBUTION

The field of contribution of this research study was outlined in detail in chapter 2. This research work extends across the intersection points of various classical fields and was intended to create new knowledge in a specific practical application domain rather than extending the depth of the academic knowledge fields from which it borrowed its core ideas.

The study focused on the integration of the knowledge domains of business management theories, satellite systems engineering, market demand prediction, billing models for Internet services and organisational structure selection. Knowledge from these fields was integrated to construct a business model that would be suitable for the successful deployment of broadband Internet services for the African consumer market. Refer to Figure 10-1 for a diagrammatic overview of the knowledge domains relevant for this study.

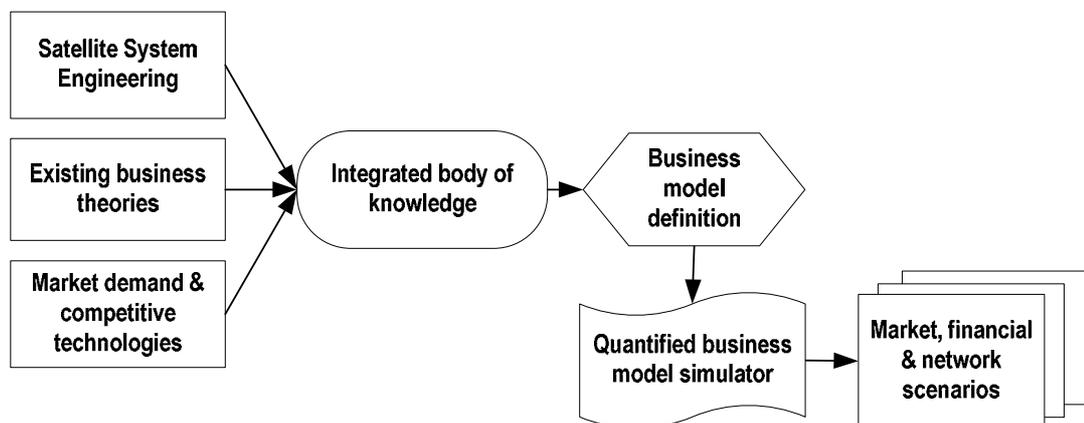


Figure 10-1: Overview of the knowledge domain of this research study.

The research work provides a quantitative and qualitative outcome that integrates the relationships between satellite systems engineering, business model theories, market demand prediction and technology based service deployment.

Studying these intersection points not only allows for the evaluation and optimum definition of a scalable business model for the mass customization of broadband services in the emerging Africa market, it also provides new understanding of the relationships between engineering decisions, technology options and viable business models.

The study incorporates the definition, implementation, validation and practical demonstration of a quantitative business model simulator that can be used to evaluate specific engineering, technology and market scenario decisions by calculating and qualifying expected business outcomes.

## 10.4 ACTIVITIES AND PROCESS REVIEW

The study and associated research work incorporated the following activities and processes that were documented in the respective chapters:

### **Section 1: Reference Knowledge**

Section 1 provides the reference framework and background for the research study and includes chapters 1, 2 and 3.

#### **Chapter 1: Introduction**

Chapter 1 provides the background and motivation for this research work and outlines the process applicable to the development of a data broadcast business model for the mass Africa consumer market.

#### **Chapter 2: Definition of Research Contribution**

The specific research framework, areas and objectives are defined in chapter 2 and form the framework within which the research work was conducted.

#### **Chapter 3: Literature Study**

A detailed literature study was completed to obtain a sound reference of the current knowledge base in this field of study. The literature study included references on current business and management theories, the Africa broadband environment, the mobile broadband industry, the ADSL broadband industry and case studies of current international IP data cast satellite broadband services.

### **Section 2: Business Feasibility Study**

In section 2 the principal business feasibility aspects i.e. the market demand and the technology analysis are researched and evaluated. The outcome of this section provides the basis for definition of the business model.

#### **Chapter 4: Market Demand Analysis**

The research work proved that there is a large under-serviced broadband consumer market in Africa and that this market cannot be serviced by the current ADSL and mobile broadband services.

#### **Chapter 5: Technology Comparative Analysis**

A technology comparative study was conducted to identify and confirm that satellite technology can meet the business requirements and to define the key characteristics of the network solution.

### **Section 3: Business Innovation**

The core business processes are defined in section 3; these are the business model and strategy, the billing model as well as the organisational structural definition.

#### **Chapter 6: Business Model Definition**

The market demand and technology solution served as inputs to the definition of the most effective and optimum business model to service a mass consumer market in the risk sensitive Africa market.

#### **Chapter 7: Billing Model Innovation**

The most suitable billing model was developed in order to offer a high-value satellite based service to the mass consumer market in an affordable manner.

#### **Chapter 8: Organisational Structure Innovation**

In chapter 8 a viable organisational structure was developed to provide the enabling platform in terms of financial, technical and engineering resources to implement the mass consumer broadband service and unlock the emerging Africa market.

### **Section 4: Modeling & Results**

The quantitative business model simulator is described in chapter 9 and the research is summarized in chapter 10.

#### **Chapter 9: Quantitative Business Model Simulator**

A quantitative business model simulator was developed that integrates all the business parameters and business interrelationships to enable effective scenario planning and the evaluation of different alternatives.

#### **Chapter 10: Summary and Conclusion**

The principal processes and contributions are summarised in chapter 10.

## 10.5 BUSINESS FEASIBILITY OUTCOMES

### 10.5.1 MARKET DEMAND ANALYSES

Through a systematical process the potential broadband market in Africa was quantified and satellite technology was validated as a feasible option to service the under-serviced areas. The process and outcomes are summarized in table 10-1 below.

Market Research Area	Activity	Outcome
<b>Research Area 1</b> External environment	Confirms that the market is deregulated and has strategic support from governments in Africa and that it is considered to be a principal development objective.	<b>Outcome 1</b> Broadband services are a necessity and essential for future economic development.
<b>Research Area 2</b> Market Demand and Affordability	Quantify the size of the addressable market in terms of number of prospective customers and income levels. Demonstrate that there is a large medium income group that can afford satellite services.	<b>Outcome 2</b> There is a large current and future demand for consumer broadband services in Africa.
<b>Research Areas 3</b> Competing broadband services	Document the competing service types, signal coverage and limitations of the current ADSL and mobile broadband services.	<b>Outcome 3</b> Mobile and ADSL broadband services cannot meet the market demand.
<b>Research Area 4</b> Quantify the Addressable Market	Quantify the addressable market for satellite services in terms of projected number of customers, revenues and profits.	<b>Outcome 4</b> There is a sustainable market that need and can afford satellite broadband services.
<b>Research Area 5</b> Market Sectors Analysis	Review and qualify the different Internet applications including consumer broadband services that can best be serviced by satellite access networks.	<b>Outcome 5</b> Satellite networks can effectively service various broadband market sectors.
<b>Research Area 6</b> Satellite related technical services	Review international satellite broadband networks and pay-TV networks.	<b>Outcome 6</b> Consumer based satellite services are technically feasible for Africa.

**Table 10-1: Market research and quantification process outline**

## 10.5.2 TECHNOLOGY COMPARATIVE ANALYSES

Given that the research work confirmed the market demand for broadband services, the next step was to define the most suitable technology required to meet the demand.

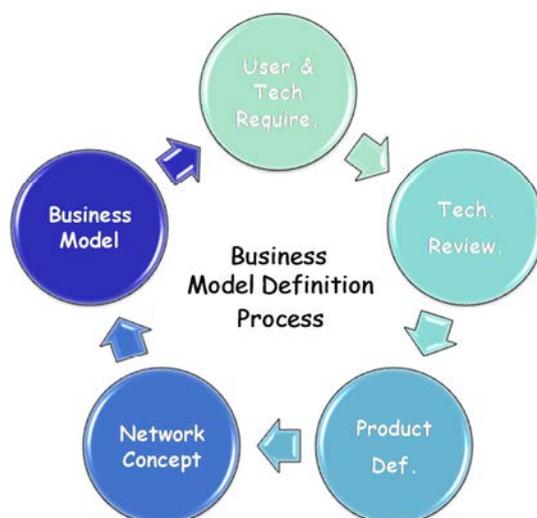
The research work included a brief review of all the available technologies with an in depth analysis of ADSL wired services and 3G mobile wireless services. The research work considered both the Africa landscape scenario, as well as applicable international case studies.

The research work confirms the following:

- that ADSL services are the most suitable and appropriate technology to provide consumer broadband services where infrastructure is available;
- that due to the lack of availability and implementation requirements ADSL services are not feasible as an option to service the Africa mass consumer market;
- that, in the absence of any other alternative, mobile broadband services are currently the primary option to meet consumer demand for broadband access services;
- that mobile broadband services have inherent limitations that will result in this technology option not being able to meet the expected future demand;
- that satellite technology is a viable alternative to meet the demands of the current under-served broadband market; and
- that satellite technology broadband networks are successfully operated in Europe and America.

## 10.6 BUSINESS MODEL SIMULATOR DEFINITION

The definition of the most suitable business model is completed by following an iterative process that we call the innovation-loop model. This process includes the consideration of the user requirements, the available technology options, possible product definition and network concept design options.



Different business scenarios were evaluated in order to define the most feasible strategy. The business feasibility was measured against the capability to unlock the mass consumer market, while at the same time minimising investment funding requirements and business risks.

Figure 10-2: The business innovation-loop model and process

The business model definition process was successfully applied to evaluate different possible business model options that were evaluated and quantified using the business model simulator. A review of the critical considerations is provided in the following paragraphs.

### 10.6.1 **REQUIREMENT: TARGET MARKET SECTOR**

The above process was applied to determine what target market sector in terms of ARPU and subscriber quantities will provide the optimum business results. High subscriber volumes at low ARPU levels of \$100, lower subscriber quantities at an ARPU of \$130 and high ARPU subscribers at \$250 associated with lower subscriber numbers were considered.

The business model yields that the \$130 ARPU level is the optimum point for the initial roll-out phase leading to lower ARPU levels after the critical mass is secured.

The process confirmed that the initial business strategy must be to service the requirements of the professional-consumer market sector that can afford an ARPU of \$130 and an equipment cost of \$500.

### 10.6.2 **TECHNOLOGY: SATELLITE SELECTION**

Signal coverage area, availability, data transmission efficiencies, operating frequencies, commercial terms and future growth, are all aspects that influence the selection of the most suited operating satellite.

#### **Satellite operating: Band, Ku-band vs. Ka-band**

Telecommunication satellites operate on different frequency bands and these frequency bands determine the geographical signal coverage and the data transmission capabilities. In the international market the initial network deployments in the past were on Ku-band frequencies, while the planned networks in the future will be Ka-band networks.

The influence of Ku- vs. Ka-bands was investigated and the business implications determined using the quantified business model. This analysis clearly showed that the expected subscriber densities within the Africa market is well suited for the Ku-band satellites and that Ka-band satellite services are more suited for the high subscriber density markets of Europe and America.

#### **Satellite Selection**

To determine the most suited Ku-band satellite the process was applied to all the available Ku-band satellite options. The business model quantified the effect of different efficiencies and configurations in order to select the most suited satellite.

### 10.6.3 PROFESIONAL VS CONSUMER EQUIPMENT SELECTION

Satellite subscriber terminal equipment is manufactured with functions and features that are focused on specific user market sectors. The prime equipment options for the Africa market have different subscriber focus areas. The one terminal is more focused on the professional market and offers higher functionality at a higher price point. The other manufacturer offers equipment with less functionality and is focused on the consumer market with a lower equipment terminal price.

Since the equipment price directly influences the subscriber sales quantities and thus the potential revenue, it is a critical consideration for the business. The study applied the business strategy process and business model simulations to the different equipment types and could clearly show the respective implications.

## 10.7 INNOVATION OUTCOMES

This research work has stimulated creative thinking and business process engineering that led to three specific innovation outcomes.

### 10.7.1 THE MATRIX BILLING MODEL

The first business engineering innovation was the development of the matrix billing model.

Billing models are defined as the products of functions, pricing and financial terms for providing a service to the market. The pre-pay billing model for mobile services was developed in South Africa and was the principal element that enabled the massive growth of mobile services in Africa.

In order to provide broadband services to the mass consumer market in Africa it was necessary to define the most suitable billing model. The required billing model must enable the provisioning of high-value satellite based broadband access services in an affordable manner to the mass market.

The matrix billing model was defined to integrate conflicting Internet usage behavior requirements, technology network requirements and business requirements into an optimal pricing structure. The matrix billing model provides differentiated pricing with respect to the volume, time-of-use and type of data and allows users to customize their product billing structure.

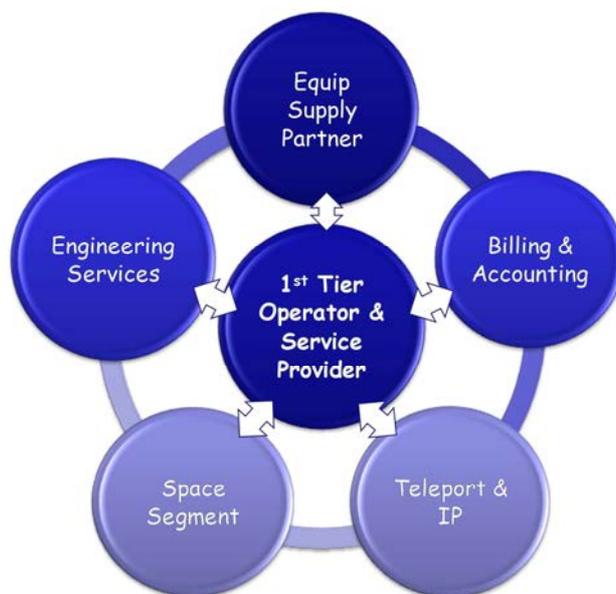
The matrix billing model is defined to enable further customisation in future to include even more pricing input parameters.

### 10.7.2 THE SYMBIOTIC ORGANISATIONAL STRUCTURE

Effective implementation, delivery and support of the service are determined by the organisational capability that is a function of the organisational structure.

An organisational structure determines the business delivery capability that is defined by the initial venture funding requirements, the engineering and business team capability and the market delivery and support resources.

Minimising the initial funding requirements, while still mobilizing the engineering, marketing and service delivery capabilities required to deliver the product to the market, demands some very specific and unique organisational structure concepts. A symbiotic organisational structure that involves cooperation between a number of established market players, each with a specialist role in the value chain, has proven to be the optimal choice.

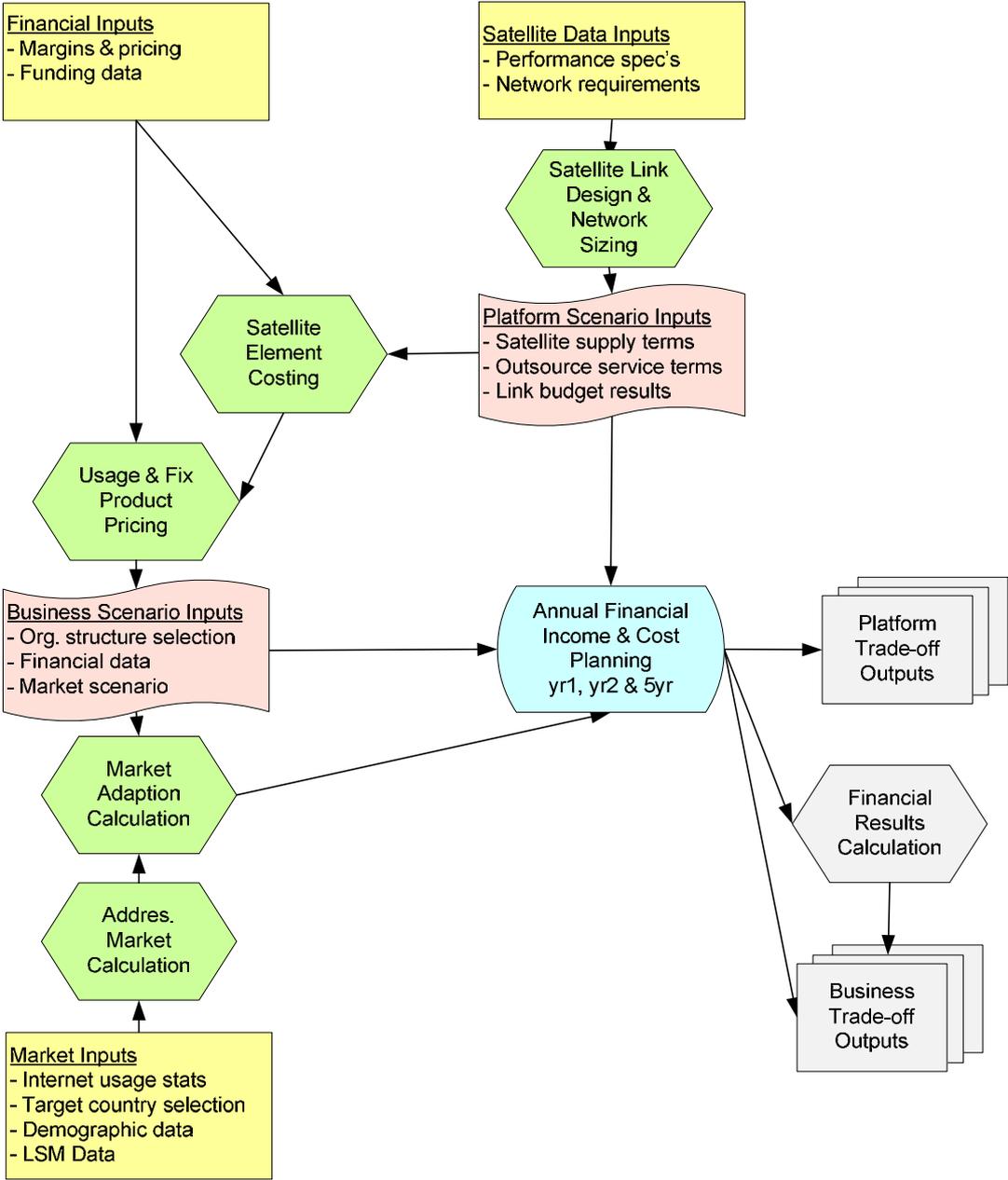


Definition of such a symbiotic organisational structure offers a unique value proposition for accessing the high risk emerging Africa market environment. The formulation and definition of the symbiotic organisational structure flows directly from the research work and represents a new contribution in this field.

Figure 10-3: A symbiotic organisational structure applied to the SkyeVine case study.

**10.7.3 A QUANTITATIVE AND INTEGRATED BUSINESS MODEL SIMULATOR**

The research work includes the definition of a mathematical model that integrates the business, technology and engineering dimensions of the business to provide a quantitative outcome for different business scenarios.



**Figure 10-4: Outline of quantitative business model**

The definition and application of financial business models are common in the industry in general. What is of specific value in the model proposed by this research work is the integration of the satellite engineering design elements, billing model options, market characteristics and the symbiotic organisational structure.

## 10.8 RESEARCH OBJECTIVES OUTCOMES

The research work to define a scalable business model for mass consumer broadband services in the emerging Africa market was structured around six research objectives that formed the anchor pillars of the study.

These six research objective, and the respective outcomes, are as follows:

### **Objective 1: Proof of the market**

#### **Statement**

Broadband Internet access is no longer a pure luxury and there is a substantial underserved mass consumer market demand throughout Africa, both in urban and rural areas. This market sector cannot effectively be serviced by the current 3G and ADSL services and the need exists for an alternative technology solution.

#### **Outcome**

The research work conducted has clearly identified:

- a. That there is a significant under-serviced market sector – defined as the service gap - and that the demand for broadband services in Africa is growing.
- b. That very limited ADSL infrastructure is available throughout Africa and that the available infrastructure is not meeting the demand.
- c. That mobile 3G services are currently the most effective option to provide broadband services, yet these services have two principal constraints. Firstly the network communication coverage area is not ubiquitous and large service-gaps exist and secondly, the technology has some fundamental capacity limitations that prevent the large scale deployment of data services to the mass market.

**Objective 2:  
Prove that Satellite Technology is feasible**

**Statement**

The key to unlock the consumer broadband Internet market in Africa lies in the ability to meet the following principal requirements:

- a. The need for ubiquitous service coverage;
- b. The need for affordable end-user equipment and implementation;
- c. The need for affordable monthly service fees.

The question is whether these requirements can be met using a satellite access technology network.

**Outcome**

The research work clearly demonstrated that satellite technology is very well suited to provide services over a very large geographical area such as Africa. The research also found that the point-to-multipoint nature of satellite technology is well suited for the delivery of broadcast services, such as Internet access services.

**Objective 3:  
A Business Strategy can be defined that will lead to a viable operation providing broadband satellite service to the Africa market**

**Statement**

Define the most suitable business strategy to deliver satellite-based broadband services to the consumer Africa market and prove that this strategy is the most suited and viable strategic option.

**Outcome**

The research work defined the iterative process that integrates the various business processes that collectively defines the business strategy. The business strategy was evaluated through a quantified business model that was used to analyse various alternative business options. Several of the options simulated through this model provided proof that a viable service can be delivered within the Africa broadband market.

**Objective 4:  
Billing model innovation can make satellite services affordable****Statement**

To unlock the emerging Africa market product offerings must be widely available and must be structured in affordable units. This applies equally to clothing and household products, as to technology based service products, such as broadband Internet services.

**Outcome**

The research led to a breakthrough in the billing of broadband services and a new matrix billing model was developed. This new billing model provides a mechanism to offer broadband services to the mass market in an affordable manner. Integrating this new matrix billing model with satellite technology creates a consumer broadband service that is both affordable and available throughout Africa.

Affordability and availability are the two principal conditions to provide services to the mass consumer market in Africa. By the integration of satellite technology with the matrix billing model, the study offers a new alternative for the mass broadband market in Africa.

**Objective 5:  
Prove that business structure innovation can effectively leverage resources, reduce investment and reduce risk.****Statement**

The scale of the financial and resource investment required to implement the initial satellite-based broadband service, given the uncertain nature of this emerging market, requires a customized organisational structure to minimise the risk and maximise resource utilisation.

**Outcome**

A new organisational structure was defined that offers increased organisational capability, lower investment funding and stronger market penetration. This symbiotic organisational structure is a breakthrough in business models and has previously been leveraged to address the specific risks and demands of the Africa broadband Internet market.

**Objective 6:  
Prove that the business can be modeled****Statement**

It is possible to construct a mathematical simulator that effectively analyses different business scenarios through the integration of quantified market, technology and financial parameters.

**Outcome**

The different dimensions and relationships of all the business activities were very successfully integrated into a quantified business model. The business model was used to analyse various business scenarios that considered different options during the business strategy definition process. Using this quantified model it was possible to select the most optimal set of business decision options, taking into account the impact of all of the major factors impacting the business.

## 10.9 FURTHER RESEARCH WORK

The study was focused on the definition of a **scalable business model for mass customization of broadband services in the emerging Africa market**. The research focused specifically on the broadband market sector that can be serviced by satellite technology and provides a departure point for the following future research opportunities:

**Matrix Billing Model Expansion**

This research work addressed all aspects of the complete business model, i.e. market analysis, technology analysis, business strategy, billing model and organisational structure. Further research can be conducted to evaluate the matrix model in more depth and to define the respective matrix factors and the limitations and boundaries of these factors.

**Wireless Technology**

It will be most valuable to consider the outcome of this study in the context of the wireless Wi-Fi hotspot access services industry. WiFi access networks are expected to provide services to the mass market in built-up metropolitan areas and this industry should benefit from both the matrix billing model, as well as the symbiotic organisational structure.

**Business Model Application**

The business model provides a quantitative relationship between technology, engineering and business outcomes that may be able to contribute in other technology fields within the emerging Africa market. Future research can be conducted to determine the suitability and general validity of the model for other technologies, such as fibre network deployments and wireless network deployments.

## 10.10 CONCLUSION

This research journey started from the initial question “Is there a viable market for broadband services in Africa?” and concluded, after conducting a complete and comprehensive study, that a viable market indeed exists. This study quantifies and qualifies the market, technology, organisational and financial requirements of a business that want to provide services to this industry.

The research work covers a very wide field and has contributed towards the growing understanding of the complexities in the domain where technology meets the Africa market. The study provides insight into methodologies to quantify the market and to develop technology solutions specifically focused on the Africa market, as well as business model strategies for developing business opportunities based on these technologies.

Five significant research contributions are made:

### **Development of an integrated Innovation-Loop model**

The existing approaches of Burgelman and others to develop new business strategies were integrated into a consolidated approach that takes into account all of the major market, organisational, financial and technology issues. It was shown that an iterative approach is essential to arrive at an optimal set of choices, given the interactive nature of all of the critical factors impacting on the type of business under consideration.

### **Quantification of an unknown market**

An innovative approach was used to accurately quantify the unknown market for broadband services in the un-serviced rural areas of Africa. This was achieved by applying the concept of price elasticity of demand to the currently serviced urban markets and by using the LSM stratification of consumer groups, in both urban and rural areas, to arrive at a motivated figure for the expected size of the previously un-gauged rural Africa market.

### **Definition of the matrix billing model**

The matrix billing model proposes a completely new and innovative mechanism to provide Internet access services to the consumer market in an affordable and practical manner. The matrix billing model is a new paradigm in the provisioning of Internet access services and is expected to become the reference and guide for future billing practises.

### **Definition of a symbiotic organisational structure**

The third contribution is in the field of organisational structure and defines a symbiotic organisational structure. The symbiotic organisational structure provides significant benefits and advantages to address the risks and investment requirements applicable to the Africa market. The structure increases organisational capability, decreases investment funding requirement and expands the initial market footprint. This results in a set of practical benefits that have not been realised before by any other organisational structure in the Africa broadband market.

**Design of a quantified business model simulator**

The primary knowledge contribution of the study is the integration of the interrelationships of the various knowledge fields that forms the framework of a broadband service provider business model.

This contribution is consolidated in the definition and formulation of a quantified mathematical business model simulator that incorporates the integrated business rules and relationships between satellite system engineering, broadband technologies, market dynamics and business strategies.

The business model simulator provides a quantified methodology to effectively evaluate different business model strategies for implementation of a satellite based broadband service in Africa. The business model simulator was validated based on existing case studies and was then applied to optimise the strategy decisions for a new service provider in this sector.

In summary it can be stated that all of the research objectives were achieved and that it was proven that two-way satellite data broadcast services can help to close the digital divide that still separates rural Africa from the developed world.

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# Appendix A: Business Model Schedules

## Introduction

The quantified business model simulator was created as a series of mathematical models and algorithms that were implemented in an interlinked spreadsheet structure. The complete integrated mathematical model comprises a set of 35 interlinked and integrated sheets and 100 printed pages.

Due to the extent of the simulation model it is not practical to include a complete copy of the model in this document. Appendix A provides copies of only the most important schedules of the business model. Other schedules are included in the text of the thesis in the applicable chapters.

The following list provides an outline of business model schedules.

### Outline of Business Model Schedules

1. Summary Schedule (included in appendix A)
2. Graphic representation (included in appendix A)
3. Business scenario output schedule (included in appendix A)
4. Business scenario input schedule (included in appendix A)
5. Platform scenario output schedule (included in appendix A)
6. Platform scenario input schedule (Included in appendix A)
7. Financial inputs
8. Balance sheet
9. Cash flow schedule
10. Income statement
11. 5 Year Revenue plan
12. Year 2 revenue plan
13. Year 1 revenue plan
14. Equipment pricing
15. Usage based product pricing calculation
16. Fixed product pricing calculation
17. Interim satellite costing
18. Primary satellite costing
19. Symbiotic structure costing
20. New-vertical structure costing
21. Existing vertical structure costing
22. Country roll-out plans
23. Satellite competitive product analyses
24. Broadband competitive product analysis
25. Market adaptation calculations

26. Market size calculations
27. LSM data processing
28. Market questionnaire
29. Demographic data
30. Country selection
31. Internet statistics
32. Uplink business case
33. Technology overview
34. Funding requirement source information
35. Equipment pricing trade-off information

## Summary Schedule

Current Scenario		Primary Satellite: <b>ND Own Sym Cons. Equip</b>		Interim Satellite: <b>None</b>	
Business Scenario: <b>Symbiotic, Conserv, Use</b>					
	2011	2012	2013	2014	2015
<b>Total subscribers numbers</b>	600	4 200	11 400	25 800	43 800
Subscriber growth / mnth	100	300	600	1 200	1 500
<b>Space Segment</b>					
Outbound, Europe-to-Africa [MHz]	36.0	72.0	144.0	324.0	576.0
Inbound, Africa-to-Europe [MHz]	18.0	36.0	72.0	162.0	288.0
<b>Sales Revenue</b>	<b>\$273 000</b>	<b>\$3 938 220</b>	<b>\$13 301 917</b>	<b>\$30 878 795</b>	<b>\$55 520 528</b>
Average revenue per user per month	\$38	\$78	\$97	\$100	\$106
<b>Costs</b>	<b>\$1 944 050</b>	<b>\$3 683 950</b>	<b>\$8 521 300</b>	<b>\$21 129 580</b>	<b>\$36 885 256</b>
<b>Gross profit</b>	<b>-\$1 671 050</b>	<b>\$254 270</b>	<b>\$4 780 617</b>	<b>\$9 749 215</b>	<b>\$18 635 272</b>
Deposits	\$318 600	\$318 600	\$637 200	\$1 593 000	\$2 230 200
Opex	\$960 000	\$1 152 000	\$1 382 400	\$1 658 880	\$1 990 656
<b>Net Profit</b>	<b>-\$2 949 650</b>	<b>-\$1 216 330</b>	<b>\$2 761 017</b>	<b>\$6 497 335</b>	<b>\$14 414 416</b>
Acc Nett		-\$1 216 330	\$1 544 687	\$8 042 023	\$22 456 439

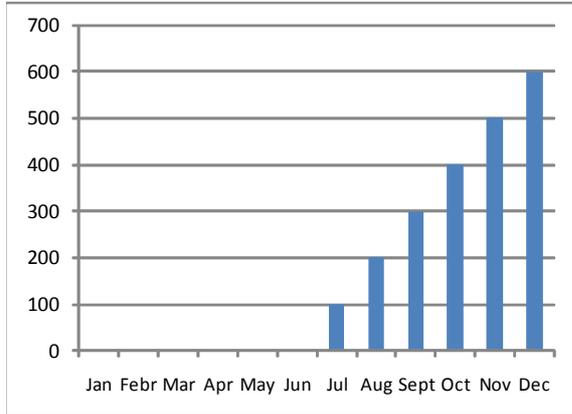
Table A-1: Business Summary Schedule

Field	Note
<b>Current Scenario</b>	Indicates the input data selected for the primary satellite, interim satellite and business scenarios.
<b>Primary Satellite:</b>	ND Own Sym Cons. Equip: New Dawn satellite, Symbiotic structure, Consumer equip.
<b>Business Scenario:</b>	Symbiotic, Conserv, Use: Symbiotic structure, Conservative market, Usage billing.
<b>Subscribers</b>	List the total aggregated subscriber quantity at the end of the year. Also list the average subscriber growth per month for each year.
<b>Sales Revenue</b>	List the forecasted sales revenue and the calculated subscriber ARPU given the total subscriber quantity at the end of the year.
<b>Cost</b>	Details the total operational costs per year
<b>Gross profit</b>	Calculates the expected gross profit excluding deposits and operational costs (opex)
<b>Net profit</b>	Total organisational net profit

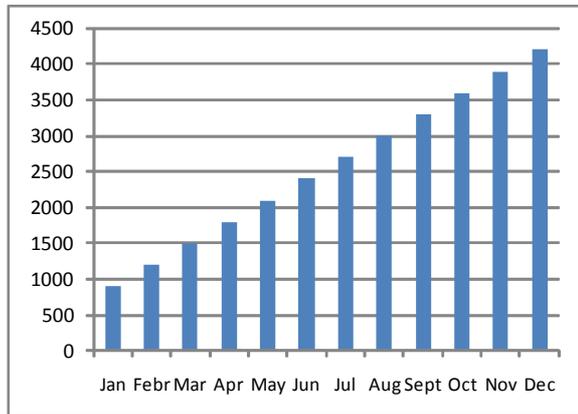
Graphic Representation

Current Scenario      Primary Satellite: **ND Own Sym Cons. Equip**      Interrim Satellite: **None**  
Business Scenario: **Symbiotic, Conserv, Use**

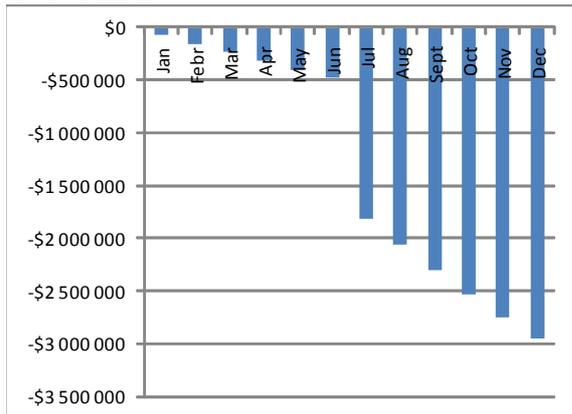
2011: Subscriber Terminal Quantities



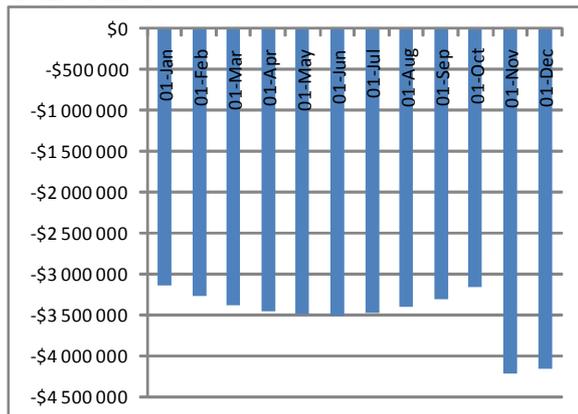
2012: Subscriber Terminal Quantities



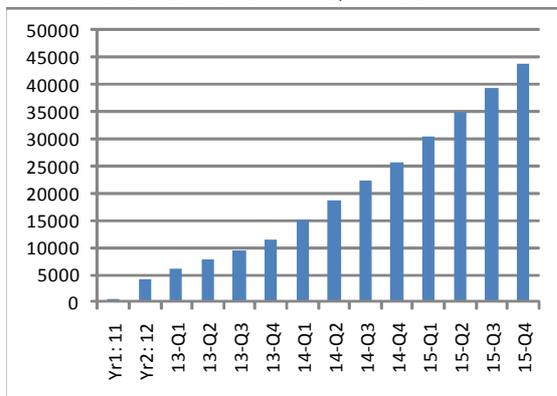
2011: Cashflow



2012: Cashflow



2011 - 2015: Subscriber Terminal Quantities



2011 - 2015: Cumulative Cashflow

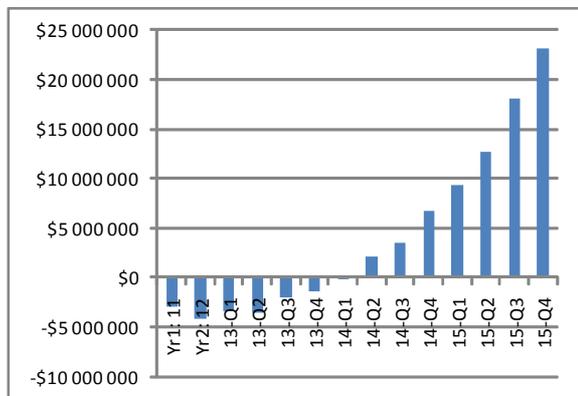


Table A-2: Graphic representation

**Business Scenario Input Data Schedule: Symbiotic Option**

Business Parameter	Current Scenario Input Data	Symbiotic Structure			
		Conservative Market		Agressive Market	
		Usage Billing	Fix Billing	Usage Billing	Fix Billing
	Symbiotic, Conserv, Use	Symbiotic, Conserv, Use	Symbiotic, Conserv, Fix	Symbiotic, Aggres, Use	Symbiotic, Aggres, Fix
<b>Sale of Equipment</b>	0	0	0	0	0
<b>Subscriber terminal cost</b>	\$905	\$905	\$905	\$905	\$905
<b>Company Structure Influence</b>					
Operating cost	\$80 000	\$80 000	\$80 000	\$80 000	\$80 000
CAPEX, fix property	\$0	\$0	\$0	\$0	\$0
CAPEX, Operations	\$0	\$0	\$0	\$0	\$0
<b>Market Influence</b>					
Market penetration factor	1	1	0.56	2	1.11
% marketshare Yr1	2.0%	2.0%	2.0%	4.0%	4.0%
Yr2	4.0%	4.0%	4.0%	8.0%	8.0%
Yr3	6.0%	6.0%	6.0%	12.0%	12.0%
Yr4	8.0%	8.0%	8.0%	16.0%	16.0%
Yr5	10.0%	10.0%	10.0%	20.0%	20.0%
<b>Billing Model Influence</b>					
ARPU yr1	\$130	\$130	\$192	\$130	\$192
ARPU yr2	\$129	\$129	\$173	\$129	\$173
ARPU yr3	\$127	\$127	\$156	\$127	\$156
ARPU yr4	\$126	\$126	\$140	\$126	\$140
ARPU yr5	\$125	\$125	\$126	\$125	\$126
ARPU Mbps yr1	0.0167	0.0167	0.029	0.0167	0.029
yr2	0.0184	0.0184	0.029	0.0184	0.029
yr3	0.0202	0.0202	0.029	0.0202	0.029
yr4	0.0222	0.0222	0.029	0.0222	0.029
yr5	0.0244	0.0244	0.029	0.0244	0.029

Table A-3(a): Business Scenario Input Data Schedule: Symbiotic Option

**Business Scenario Input Data Schedule: Vertically Integrated Option**

Business Parameter	Current Scenario Input Data	New-Vertical Business Structure			
		Conservative Market		Aggressive Market	
		Usage Billing	Fix Billing	Usage Billing	Fix Billing
	<b>Symbiotic, Conserv, Use</b>	<b>New-Vertical, Conserv, Use</b>	<b>New-Vertical, Conserv, Fix</b>	<b>New-Vertical, Aggres, Use</b>	<b>New-Vertical, Aggres, Fix</b>
<b>Sale of Equipment</b>	0	1	1	1	1
<b>Subscriber terminal cost</b>	\$905	\$905	\$905	\$905	\$905
<b>Company Structure Influence</b>					
Operating cost	\$80 000	\$145 000	\$145 000	\$145 000	\$145 000
CAPEX, fix property	\$0	\$0	\$0	\$0	\$0
CAPEX, Operations	\$0	\$212 500	\$212 500	\$212 500	\$212 500
<b>Market Influence</b>					
Market penetration factor	1	1	0.56	2	1.11
% market share Yr1	2.0%	2.0%	2.0%	4.0%	4.0%
Yr2	4.0%	4.0%	4.0%	8.0%	8.0%
Yr3	6.0%	6.0%	6.0%	12.0%	12.0%
Yr4	8.0%	8.0%	8.0%	16.0%	16.0%
Yr5	10.0%	10.0%	10.0%	20.0%	20.0%
<b>Billing Model Influence</b>					
ARPU yr1	\$130	\$130	\$192	\$130	\$192
ARPU yr2	\$129	\$129	\$173	\$129	\$173
ARPU yr3	\$127	\$127	\$156	\$127	\$156
ARPU yr4	\$126	\$126	\$140	\$126	\$140
ARPU yr5	\$125	\$125	\$126	\$125	\$126
ARPU Mbps yr1	0.0167	0.0167	0.029	0.0167	0.029
yr2	0.0184	0.0184	0.029	0.0184	0.029
yr3	0.0202	0.0202	0.029	0.0202	0.029
yr4	0.0222	0.0222	0.029	0.0222	0.029
yr5	0.0244	0.0244	0.029	0.0244	0.029

**Table A-3(b): Business Data Input Data Schedule: Vertical option**

**Business Scenario Output Data Schedule**

Business Parameters	Current Data	Symbiotic Organisation				New-Vertical Integrated Company			
		Conserv. Market		Agressive Market		Conserv. Market		Agressive Market	
		Usage Billing	Fix Billing	Usage Billing	Fix Billing	Usage Billing	Fix Billing	Usage Billing	Fix Billing
<b>Current Scenarion</b>									
Satellite Scenario	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip	ND Own Sym Cons. Equip
Business Scenario	New-Vertical, Aggres, Fix	Symbiotic, Conserv, Use	Symbiotic, Conserv, Fix	Symbiotic, Aggres, Use	Symbiotic, Aggres, Fix	New-Vertical, Conserv, Use	New-Vertical, Conserv, Fix	New-Vertical, Aggres, Use	New-Vertical, Aggres, Fix
ARPU Yr1	\$192	\$130	\$192	\$130	\$192	\$130	\$192	\$130	\$192
Equipment Cost	\$905	\$905	\$905	\$905	\$905	\$905	\$905	\$905	\$905
<b>Funding</b>									
Max funding required	\$3 263 718	\$2 854 269	\$2 251 555	\$1 597 031	\$1 622 694	\$3 371 419	\$3 334 039	\$3 420 190	\$3 263 718
Yr5 return	\$33 108 656	\$23 156 325	\$16 286 447	\$88 922 010	\$41 592 080	\$17 351 877	\$10 481 999	\$80 438 586	\$33 108 656
<b>Market Indicators</b>									
Subscribers Yr1	1 799	600	600	2 935	1 799	600	600	2 935	1 799
Yr2	9 284	4 200	4 200	15 145	9 284	4 200	4 200	15 145	9 284
Yr3	20 727	11 400	11 400	33 813	20 727	11 400	11 400	33 813	20 727
Yr4	36 272	25 800	25 532	59 173	36 272	25 800	25 532	59 173	36 272
Yr5	56 063	43 800	43 524	91 460	56 063	43 800	43 524	91 460	56 063
<b>Summary Financial Indicators</b>									
Maximum negative cash flow	-\$1 874 829	-\$1 465 380	-\$862 666	-\$208 142	-\$233 805	-\$1 982 530	-\$1 945 150	-\$2 031 301	-\$1 874 829
Maximum shareholder risk	\$3 263 718	\$2 854 269	\$2 251 555	\$1 597 031	\$1 622 694	\$3 371 419	\$3 334 039	\$3 420 190	\$3 263 718
Return on Investment	105%	70%	63%	117%	89%	90%	85%	135%	105%
Internal rate of return	266%	114%	102%	267%	184%	157%	155%	406%	266%
Net present value	\$10 740 391	\$3 235 348	\$2 420 453	\$13 726 166	\$6 555 030	\$6 358 377	\$5 595 775	\$21 417 792	\$10 740 391
<b>Annual cashflow as a function of time</b>									
Yr 1:2011	-\$3 051 218	-\$2 240 150	-\$2 202 770	-\$1 597 031	-\$1 622 694	-\$3 158 919	-\$3 121 539	-\$3 207 690	-\$3 051 218
Yr 2:2012	\$5 958 871	-\$520 480	\$40 742	\$5 505 827	\$3 026 122	\$546 627	\$1 107 849	\$11 153 421	\$5 958 871
Yr 3: 2013	\$16 469 072	\$4 173 717	\$3 993 957	\$18 806 058	\$11 027 138	\$7 265 210	\$7 095 780	\$28 720 409	\$16 469 072
Yr 4: 2014	\$20 960 857	\$7 476 715	\$5 315 674	\$28 310 926	\$13 183 035	\$14 974 568	\$12 644 054	\$42 243 396	\$20 960 857
Yr 5: 2015	\$35 621 003	\$21 111 772	\$15 751 414	\$51 284 465	\$24 546 836	\$31 731 506	\$26 350 559	\$70 843 399	\$35 621 003
<b>Profit (loss) as a function of time</b>									
Yr 1:2011	-\$2 934 176	-\$2 348 150	-\$2 310 770	-\$1 745 894	-\$1 751 676	-\$3 170 650	-\$3 133 270	-\$2 928 394	-\$2 934 176
Yr 2:2012	\$4 750 953	-\$991 369	-\$426 035	\$3 656 804	\$2 189 305	\$264 546	\$829 880	\$8 210 576	\$4 750 953
Yr 3: 2013	\$10 157 052	\$3 237 025	\$2 988 198	\$11 123 468	\$6 427 217	\$5 405 961	\$5 101 051	\$17 939 572	\$10 157 052
Yr 4: 2014	\$16 226 605	\$6 415 115	\$5 490 361	\$21 135 755	\$10 897 410	\$11 613 792	\$10 597 512	\$30 709 419	\$16 226 605
Yr 5: 2015	\$21 247 095	\$12 197 725	\$8 690 281	\$30 843 997	\$14 265 314	\$18 881 589	\$15 355 251	\$43 293 017	\$21 247 095
<b>Return on investment</b>									
Yr 1:2011	-211.3%	-169.1%	-166.4%	-125.7%	-126.1%	-228.3%	-225.6%	-210.8%	-211.3%
Yr 2:2012	-307.4%	103.3%	46.2%	-1024.3%	-603.5%	-14.8%	-47.6%	-533.3%	-307.4%
Yr 3: 2013	316.8%	-165.9%	-221.7%	337.1%	351.9%	-356.3%	-557.8%	268.9%	316.8%
Yr 4: 2014	121.4%	498.7%	334.7%	146.5%	132.0%	298.7%	253.1%	124.8%	121.4%
Yr 5: 2015	71.8%	158.4%	121.9%	86.7%	74.5%	121.8%	103.9%	78.3%	71.8%

Table A-4: Business Scenario Output Data Schedule

Satellite Platform Scenario Input Data Schedule (A)

Scenario	Current Input Data Primary Sat	Current Input Data Interrim Sat	Satellite Scenario Considerations					
			Based on consumer equipment and a symbiotic business structure					
			Astra4A Base-case	Astra4Ai	T11N	Amos5 Ku3 Eur Hub	NewDawn 3rd Party Teleport	NewDawn Own Symbiotic
<b>Space Segment Terms</b>	ND Own Sim Pro.Equip	None	Astra4A Bcase	Astra4Ai	T11N	Amos5 Eur-Afr	NewDawn @3rd	ND Own Sim Cons. Equip
Available	01 May 2011	-	Jan 2011	Immediate	Immediate	Sep 2011	01 May 2011	01 May 2011
Contract Deposit (mnths)	2			1		2	2	2
MHx / transponder	36		36	36	36	36	36	36
OUTbound \$/MHz	\$2 950	\$4 200	\$3 681	\$3 240	\$4 200	\$3 200	\$2 950	\$2 950
INbound \$/MHz	\$2 950	\$4 200	\$2 222	\$2 222	\$4 200	\$3 200	\$2 950	\$2 950
Ramp Terms, Qtr1	100%		0%	-		0%	100%	100%
Qtr2	100%		100%	-		50%	100%	100%
Qtr3	100%		100%	-		100%	100%	100%
Qtr4	100%		100%	-		100%	100%	100%
Min Contract OUTbnd		5		10	5			
Min Contract Inbnd		2		5	2			
<b>Teleport Uplink Terms</b>								
Teleport \$/MHz	\$500	\$0	\$0	\$0	\$0	\$0	\$1 000	\$500
IP Access \$/Mbps	\$500	\$0	\$0	\$0	\$0	\$0	\$500	\$500
<b>Hub Operation and Platform Services</b>								
1st Hub Capex	-\$300 000	\$0	\$260 000	\$0	\$0	\$260 000	\$0	\$0
Next Hub Capex	\$450 000	\$0	\$0	\$0	\$0	\$750 000	\$750 000	\$750 000
Hub operation yr 1/ mnth	\$16 250	\$0	\$0	\$0	\$0	\$0	\$16 250	\$16 250
Hub operation >yr2 / mnth	\$16 250	\$0	\$32 500	\$0	\$0	\$32 500	\$16 250	\$16 250
Hub Site Services \$/sub/mnth	\$5	\$10	\$10	\$10	\$10	\$10	\$5	\$5
Billing Services \$/mnth	\$20 833	\$0	\$20 833	\$0	\$0	\$20 833	\$20 833	\$20 833
Billing Services \$/sub/mnth	\$1.50	\$1.50	\$1.50	\$1.50	\$1.50	\$1.5	\$1.50	\$1.50
Pltfrm Eng Services \$/kbps								
Pltfrm Eng Services \$/sub/mnth	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00

Table A-6(a): Satellite Input Schedule Section A.

**Satellite Platform Scenario Input Data Schedule (B)**

Scenario	Current Input Data Primary Sat	Current Input Data Interrim Sat	Satellite Scenario Considerations					
			Based on consumer equipment and a symbiotic business structure					
			Astra4A Base-case	Astra4Ai	T11N	Amos5 Ku3 Eur Hub	NewDawn 3rd Party Teleport	NewDawn Own Symbiotic
<b>Link Budget Analyses</b>								
Outbound								
MHz	36	36	36	10	36	36	36	36
Mbps	70	36	70	10	36	75	70	70
Utilisation	51%	100%	51%	100%	100%	48%	51%	51%
\$/Mbps	\$1 517	\$4 200	\$1 893	\$3 240	\$4 200	\$1 536	\$1 517	\$1 517
Inbound:								
MHz	18	18	18	5	18	18	18	18
Carrier kHz	615	256	256	256	256	512	512	512
kbps	680	141	141	141	141	282	282	282
Total Mbps	19	10	10	3	10	10	10	10
Utilisation	93%	182%	182%	182%	182%	182%	182%	182%
\$/Mbps	\$2 732	\$7 626	\$4 034	\$4 034	\$7 626	\$5 810	\$5 356	\$5 356
<b>Implementation plan</b>								
Prim-Sat Service Start	7		2	5		9	7	7
Prime-Sat Start Sites	100		100	50		100	100	100
Prime-Sat Yr1 Growth Rate	50%		25%			100%	40%	60%
Yr2 Growth / mnth	50		50			50	50	50
Inter-Sat Service Start		3		3	3			
Inter-Sat Start Sites		0		10	10			
Inter-Sat Yr1 Growth		0%		110%	110%			
Penetration Equip. price Factor	1.0		1	1	1	1	1	1
ARPU adjustment factor	1.0		1	1	1	1	1	1

**Table A-6(B): Satellite Platform Scenario Input Data Schedule (B)**

## Appendix B: Target Market Research

### Introduction

The market research included an effort that was addressed to 100 potential Service Providers and Resellers in the Africa market. The target group was selected based on established relationships between these parties and Q-KON, as well as through a prequalification process to confirm their interest to become possible Service Providers for the SkyeVine product.

### Results

Seventy percent of the questionnaires were received back and were consolidated into a single data response schedule that incorporate the statistical average of all the responses integrated to provide the market data for the pan-Africa market.

### Addressable Market

SkyeVine Satellite Consumer Broadband Service	Answers				
1 If we accept that the number of subscribers are determined by the price of the service, then for your market please indicate the total expected sales at each given price point	\$50	\$75	\$100	\$125	\$150
Please insert expected market size for each price level	200 000	100 000	40 000	20 000	10 000
2 Please give us your best estimate for product sales over a 5 year period based on a retail rate of \$100 / mnth	Year 1	Year 2	Year 3	Year 4	Year 5
Quote expected sales per year	8 000	10 000	8 000	6 000	4 000
3 Planning of the service uptake during the first year is critical to the long term business success. Please provide an indication of the quantities your market will require during the different initial stages	Demo & testing	Qtr1	Qtr2	Qtr3	Qtr4
Indicated expected sales per period	600	1 400	2 000	2 000	2 000

Estimates for the addressable market vary throughout the region and also between Service providers within the same region. The general consensus was that there is a large untapped and under-served market for broadband satellite services. Since there is currently not a similar product in the market, the market is unqualified and hence there is uncertainty amongst the general industry about exactly how big the market is.

## Business Model and Billing

SkyeVine Satellite Consumer Broadband Service	Answers				
4 Please rate the impact each business element will have on the initial product sales (1 = no significant impact, 5 = major impact)	Equip Cost	Equip logistics & instal.	Competitive satellite services	Competitive 3G & Mobile services	Lack of market demand
Please indicate on a scale of 1 to 5	5	3	4	4	2
5 What billing model do you believe does the market prefer. Flat rate billing linked to access speeds and contention or usage based billing. (You can mark more than one.)	Flat Rate linked to speed & content.	Usage plus linked to speed	Usage only	Usage linked to type of data	Usage linked to type of data & QoS
Please marked the likely option (s)		x			
6 SkyeVine will incorporate advance billing technology that will allow you to bill in many flexible ways. Eg it can be possible to bill for video download at night differently than for email data during the day. Do you believe the market is ready for such advance billing	No	May be	Yes, now in 2011	Yes, in 2012	Yes, In future
Please mark the option			x		
7 At an average speed of 4Mbps / 256kbps, how much do you estimate would a typical consumer use during one month.	1GByte	2GByte	3GByte	5GByte	10GByte
Please mark the option		x	x		
8 To provide satellite broadband services to the market requires the implementation of a customer terminal at each house. For your business, please select your preference how to do the equipment supply and installations	Supply the equip. and do the installation	Supply the equip. and subcontract the installation work		Do not get involved in the equip supply or installation work, provide services only	
		x			

With regards to the business model and billing model scenarios Service Providers responded much more coherently, with the majority Service Providers confirming the critical business parameters, i.e.:

- That the equipment price and logistic costs to the consumer is critical.
- That the service is supplementary to 3G and ADSL and should not be positioned as a competing option.
- That the market is ready for an advanced matrix billing model.
- That the general usage is between 2 and 3 GByte per subscriber per month.
- That most Service Providers would prefer the equipment to be supplied and supported directly through a retail channel.

## Appendix C: Demand Models for Access Network

Reference	Description	Demand function	Interpretation
Hou, J <i>et al.</i> 2002	Congestion control based on pricing in hard-capacity cellular networks	$D = e^{-(p/p_0-1)2}$	Demand in terms of percentage of user ( $D$ ) who will accept price $p$ given normal price $p_0$
Wang, Q. <i>et al.</i> 2007	Network pricing and admission control for public safety and commercial services	$D = k_1 - k_2p$	User demand in terms of arrival rate ( $D$ ) is a linear function of price with parameters $k_1$ and $k_2$
Lee, J.W <i>et al</i> 2005.	Utility maximization-based power allocation in CDMA wireless networks	$D = \max_q (U(\gamma(q)) - pq)$	Power demand ( $D$ ) is a solution of transmit power $q$ based on net utility maximization, where $U(\cdot)$ is a utility function of SIR $\gamma$
Badia, L. <i>et al.</i> 2006	Revenue maximization in multimedia WLANs	$D = 1 - e^{-kum/pn}$	User demand ( $D$ ) to accept a service is a function of rate utility $u$ and price $p$ , where $k$ , $m$ , and $n$ are model parameters
Saraydar, C.U. <i>et al.</i> 2001	Non-cooperative game formulation for distributed power control and pricing in CDMA networks	$D = \max_q U(\mathbf{q}) - pq$	Transmit power demand ( $D$ ) is a solution of net utility maximization, where $U$ is the utility function of transmit power vector $\mathbf{q}$
Sun, J. <i>et al.</i> 2006	Wireless channel allocation based on second-price auction algorithm	$D_i = E(X_i   p_i \geq p)$	Payoff or throughput demand ( $D_i$ ) depends on expected channel quality $X_i$ and is a function of all prices
Gandhi, S <i>et al.</i> 2007	General framework for wireless spectrum auction	Piecewise linear price-demand (e.g., $D = (B - p)/A$ )	Spectrum demand ( $D$ ) is a linear function of price $p_i$
Xing, Y. <i>et al.</i> 2007	Pricing in competitive spectrum market with multiple sellers	$U = \sigma(q - q') + (1 - \sigma)(p' - p)$	A user demands spectrum if utility $U$ is maximized where $q$ and $p$ denote the quality and price whose lower bound and upper bound are $q'$ and $p'$ , respectively; $\sigma$ is a model parameter which lies between 0 and 1
Zhang 2005	Bearer service allocation and pricing in heterogeneous wireless networks	$D = Ap^{-\epsilon}$	Bandwidth demand $D$ is controlled by price elasticity $\epsilon$ and demand potential $A$
Chan, H. <i>et al.</i> 2005	Utility-based network selection for heterogeneous wireless networks	$D = \max_r N(U(r) - pr)$	Bandwidth demand $D$ is a solution $r$ of user revenue maximization gained from utility function $U(r)$ under $N$ active users

## Appendix D: Satellite Link Budget Calculation

### Introduction

Satellite communication channels require precise calculation of the power requirements and signals receive levels in order to ensure reliable end-to-end communication. This process is done through completion of a link budget calculation as defined in paragraph 3.6.2.

This appendix details an example of one of the many link budgets calculated to determine the final system engineering results as described in par 6.4. The example relates to the calculation of the outbound carrier with the teleport facility in Johannesburg and the remote site also in Johannesburg.

Service Name	JHB FL 36Mhz Transponder 4K
Coverage	AFR-EUR
Uplink earth station	Johannesburg, South Africa
Downlink earth station	Johannesburg, South Africa
Satellite name	NewDawn

Link Input Parameters	Up	Down	Units
Site latitude	26.18S	26.18S	degrees
Site longitude	28.07E	28.07E	degrees
Site altitude	1.752	0	km
Frequency	14.065	11.015	GHz
Polarization	Vertical	Horizontal	
Rain model	ITU (49.9)	ITU (49.9)	(mm/h or zone)
Availability (average year)	99.85	99.6	%
Antenna aperture	6.5	1	metres
Antenna efficiency / gain	+57.3	+41.1	% (+ prefix dBi)
Coupling loss	1.3	0.1	dB
Antenna tracking / mispoint error	0.3	0.5	dB
LNB noise figure / temp		1	dB (+ prefix K)
Antenna noise		41.5	K
Adjacent carrier interference	27	27	dB
Adjacent satellite interference	24	20	dB
Cross polarization interference	23	23	dB
Uplink station HPA output back-off	3		dB
Number of carriers / HPA	1		
HPA C/IM (up)	50		dB
Uplink power control	0		dB
Uplink filter truncation loss	0		dB
Required HPA power capability	MAX		W

Satellite Input Parameters	Value	Units
Satellite longitude	33E	degrees
Transponder type	TWTA	
Receive G/T	3.2	dB/K
Saturation flux density	-88.5	dBW/m2
Satellite attenuator pad	0	dB
Satellite ALC	0	dB
EIRP (saturation)	49.8	dBW
Transponder bandwidth	36	MHz
Input back off total	3.3	dB
Output back off total	1.5	dB
Intermodulation interference	19	dB
Number of transponder carriers	AUTO	

Carrier/Link Input Parameters	Value	Units
Modulation	8-PSK	
Required bit error rate performance	10 <sup>-4</sup>	
Required Eb/No without FEC coding	11.72	dB
Required Eb/No with FEC coding	5.24	dB
Information rate	62.155	Mbps
Overhead	5.1	%
FEC code rate	0.7258	
Spreading gain	0	dB
Reed Solomon code	1	
(1 + Roll off factor)	1.2	
Carrier spacing factor	1.2	
Bandwidth allocation step size	0.000001	MHz
System margin	1	dB

## Satellite Link Budget Calculation

Calculations at Saturation	Value			Units
Gain 1m <sup>2</sup>	44.42			dB/m <sup>2</sup>
Uplink C/No	98.88			dB.Hz
Downlink C/No	93.30			dB.Hz
Total C/No	92.24			dB.Hz
Uplink EIRP for saturation	74.23			dBW
General Calculations	Up	Down	Units	
Elevation	58.92	58.92	degrees	
True azimuth	11.06	11.06	degrees	
Compass bearing	29.80	29.80	degrees	
Path distance to satellite	36571.24	36571.24	km	
Propagation time delay	0.121988	0.121988	seconds	
Antenna efficiency	58.51	96.69	%	
Antenna gain	57.30	41.10	dBi	
Availability (average year)	99.85	99.6	%	
Link downtime (average year)	13.149	35.064	hours	
Availability (worst month)	99.453	98.716	%	
Link downtime (worst month)	3.997	9.382	hours	
Spectral power density	-61.14	-26.47	dBW/Hz	
Uplink Calculation	Clear	Rain Up	Rain Dn	Units
Uplink transmit EIRP	70.93	70.93	70.93	dBW
Transponder input back-off (total)	3.30	3.30	3.30	dB
Input back-off per carrier	3.30	5.62	3.30	dB
Mispoint loss	0.30	0.30	0.30	dB
Free space loss	206.67	206.67	206.67	dB
Atmospheric absorption	0.07	0.07	0.07	dB
Tropospheric scintillation fading	0.11	0.11	0.11	dB
Atmospheric losses total	0.18	0.18	0.18	dB
Total path loss (excluding rain)	206.85	206.85	206.85	dB
Rain attenuation	0.00	2.32	0.00	dB
Uplink power control	0.00	0.00	0.00	dB
Uncompensated rain fade	0.00	2.32	0.00	dB
C/No (thermal)	95.58	93.26	95.58	dB.Hz
C/N (thermal)	20.02	17.70	20.02	dB
C/ACI	27.00	24.68	27.00	dB
C/ASI	24.00	21.68	24.00	dB
C/XPI	23.00	20.68	23.00	dB
C/IM	50.00	50.00	50.00	dB
Eb/(No+Io)	14.20	11.88	14.20	dB
Downlink Calculation	Clear	Rain Up	Rain Dn	Units
Satellite EIRP total	49.80	49.80	49.80	dBW
Transponder output back-off (total)	1.50	1.50	1.50	dB
Output back-off per carrier	1.50	3.82	1.50	dB
Satellite EIRP per carrier	48.30	45.98	48.30	dBW
Mispoint loss	0.50	0.50	0.50	dB
Free space loss	204.55	204.55	204.55	dB
Atmospheric absorption	0.06	0.06	0.06	dB
Tropospheric scintillation fading	0.12	0.12	0.12	dB
Atmospheric losses total	0.18	0.18	0.18	dB
Total path loss (excluding rain)	204.73	204.73	204.73	dB
Rain attenuation	0.00	0.00	0.95	dB
Noise increase due to precipitation	0.00	0.00	1.57	dB
Downlink degradation (DND)	0.00	0.00	2.52	dB
Total system noise	122.24	122.24	175.35	K
Figure of merit (G/T)	19.63	19.63	18.06	dB/K
C/No (thermal)	91.80	89.48	89.28	dB.Hz
C/N (thermal)	16.23	13.91	13.72	dB
C/ACI	27.00	24.68	27.00	dB
C/ASI	20.00	17.68	20.00	dB
C/XPI	23.00	20.68	23.00	dB

## Satellite Link Budget Calculation

C/IM	19.00	16.68	19.00	dB
Eb/(No+lo)	10.14	7.82	8.83	dB
<b>Totals per Carrier (End-to-End)</b>	<b>Clear</b>	<b>Rain Up</b>	<b>Rain Dn</b>	<b>Units</b>
C/No (thermal)	90.28	87.96	88.36	dB.Hz
C/N (thermal)	14.72	12.40	12.80	dB
C/ACI	23.99	21.67	23.99	dB
C/ASI	18.54	16.23	18.54	dB
C/XPI	19.99	17.67	19.99	dB
C/IM	19.00	16.68	19.00	dB
C/(No+lo)	86.85	84.53	85.88	dB.Hz
C/(N+l)	11.29	8.97	10.31	dB
Eb/(No+lo)	8.70	6.38	7.72	dB
System margin	1.00	1.00	1.00	dB
Net Eb/(No+lo)	7.70	5.38	6.72	dB
Required Eb/(No+lo)	5.24	5.24	5.24	dB
Excess margin	2.46	0.14	1.48	dB
<b>Earth Station Power Requirements</b>	<b>Value</b>			<b>Units</b>
EIRP per carrier	70.93			dBW
Antenna gain	57.30			dBi
Antenna feed flange power per carrier	13.63			dBW
Uplink power control	0.00			dB
HPA output back off	3.00			dB
Waveguide loss	1.3			dB
Filter truncation loss	0			dB
Number of HPA carriers	1			
Total HPA power required	17.9346			dBW
Required HPA power capability	62.1521			W
Spectral power density	-61.14			dBW/Hz
<b>Space Segment Utilization</b>	<b>Value</b>			<b>Units</b>
Overall link availability	99.451			%
Information rate (inc overhead)	65.3249			Mbps
Transmit rate	90.0040			Mbps
Symbol rate	30.0013			Mbaud
Occupied bandwidth	36.0016			MHz
Noise bandwidth	75.56			dB.Hz
Minimum allocated bandwidth required	36.0016			MHz
Allocated transponder bandwidth	36.0016			MHz
Percentage transponder bandwidth used	100.00			%
Used transponder power	48.30			dBW
Percentage transponder power used	100.00			%
Max carriers by transponder bandwidth	1.00			
Max carriers by transponder power	1.00			
Max transponder carriers limited by:-	Bandwidth			[1.00]

## Appendix E: Published Article

Abstract of Article as published in Proceedings of the 2nd International Conference on Applied Informatics and Computing Theory 2011, Prague, Czech Republic, September 26-28, 2011, pp. 178-185.

# Broadband Internet access for rural Africa: finding a viable model

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**Abstract**—While cellular communications have grown exponentially in Africa over the last 10 years, many parts of rural Africa still lack access to broadband Internet services. The question is posed whether this market can be serviced on a financially viable basis using existing broadband technology. To answer this question and determine how this can be done most effectively require an in-depth understanding of the interplay between market, product, technology and financial issues. This paper describes an interlinked model that allows simulation of the relationships between the critical set of market, product, technology and financial variables impacting of the delivery of broadband service to rural Africa. It motivates the use of satellite communications as the most suitable alternative for this market, and continues to identify and compare the available satellite platforms that can be used as basis for broadband access to rural areas. Based on current communication costs and available data rates, as well as typical needs from Internet users, a satellite based broadband service offering is defined that would be cost-effective within the African context. It is then shown that an innovative billing model would be critical to the successful launching of such a service, as has been the case with cellular telephony service offerings in Africa. The paper concludes by presenting a business case for the deployment of satellite based broadband services in order to assist rural Africa in becoming part of the mainstream global economy.

**Keywords**— billing models, broadband Internet, digital divide, rural Africa, satellite communications.

### I. INTRODUCTION

Africa's rapid adoption of the mobile phone is quickly closing the digital divide between developed and developing nations for voice services. Rural Africa has however been largely left behind in the shift to ubiquitous broadband Internet, partly because existing telecommunications infrastructure is overburdened by the need for voice services, and partly because those services barely cover urban areas. There are two reasons why the subscriber growth rate of broadband connectivity in Sub-Saharan Africa is so low: prices are very high and availability is limited. The average retail price for basic broadband in Sub-Saharan Africa in 2010 was US\$190 per month, compared with US\$6 -US\$44 per month in India. Typical prices for entry level broadband

services in Europe average around US\$40 per month, falling as low as US\$12 per month in some European countries [1]. Fundamental to the efforts to close this aspect of the "digital divide" is the need to provide a ubiquitous access network that will enable distribution of broadband services to anywhere and anytime throughout Africa on a basis that can be afforded by the rural market. This is a very relevant issue, given the importance of Internet access to function as part of the global economy [2].

To the best of the authors' knowledge no academic study has however been conducted to determine if a broadband service to rural Africa will be a viable operation without the need of cross-subsidization from more established services offered to urban markets. The next obvious research question to address is which existing technology platform to be used to provide such a service most effectively (with ADSL, GSM and satellite the most likely candidates). Should this question be answered satisfactorily one would be lead to address more detailed issues, e.g. how a billing model should be constructed to successfully launch a broadband service in a market with limited affordability.

Against the above background this paper firstly investigates the availability, affordability and market penetration of current broadband services in Africa. We assess the limitations and constraints of currently available ADSL and mobile 3G broadband technologies to determine if these technologies will be able to meet future demands for consumer broadband services in Africa. We then analyze current satellite television broadcast solutions and the synergies thereof with possible consumer broadband services. The technology study furthermore quantifies the potential advantages of using satellite technology to implement a mass consumer broadband service in Africa, based on the ubiquitous nature and rapid deployment capabilities of satellite access networks.

While satellite networks can technically reach all corners of the globe the issue still remains whether the commercialization of a satellite based broadband service for the mass consumer market will prove to be viable in Africa. The difficulty in answering this question lies in the fact that market size, revenue per customer, cost of service delivery, design of the product-service offering, required data delivery capacity and network architectural design are all interlinked – none of these important factors to assess the viability of a broadband internet service to rural Africa can be quantified in isolation.

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To illustrate this dilemma: it is widely accepted that the size of any market is dependent on the relationship between price and perceived value, i.e. by the way the product-service combination is packaged. The rate of adoption of a new technology concept is furthermore impacted by the associated billing model - the success of the mobile telephony prepay model and of pay-TV subscription services have demonstrated that the business model for the commercialization of technology solutions is critical to ensure mass adoption. Offering optimally packaged broadband services however requires specific minimum volumes of scale, and this critical mass differs between different technology platforms. Optimal pricing of the offering will have to strike a balance between the conflicting objectives of maximizing market uptake and maximizing cost recovery per customer. The billing model will furthermore influence not only the rate of market uptake but also the balance between upfront investment and downstream cost recovery - in the case of cellular telephony in Africa the operators largely subsidized handsets in order to accelerate market adoption, which required substantial upfront investments but proved to be very successful as market uptake exploded beyond all initial expectations.

The question is whether a similar approach will prove to be viable for broadband Internet, and if yes, what the most appropriate strategy would be to unlock this latent market potential while controlling financial risk to the service provider under conditions of uncertainty in untested markets.

This paper addresses the above problem by designing an interlinked simulation model that includes the complete set of relationships between those variables that significantly impact a business operation providing broadband services to the currently under-served market in Africa. In order to evaluate various alternatives regarding price, product definition and selected target market an accurate mathematical model is developed to simulate the various business outcomes as function of a set of input parameters. Using this model it is demonstrated that different decision-making options can be compared on a quantified basis through scenario analysis, in the process quantifying not only expected market uptake for specific service offerings but also assessing the impact of technology platform selections in terms of revenues, profits and required financial investments.

The paper is structured as follows: In section II we develop a model to quantify the under-served market in Africa for broadband Internet access as function of price and structuring of the service offering. Historic data on related technology markets in Africa, including the adoption rates for PCs, ADSL, mobile telephony and pay-TV is combined with a price elasticity of demand model to produce an estimate of the expected market size for different scenarios.

Section III provides an overview of existing broadband offerings and compares competing technology platforms in terms of functionality and cost. We then motivate the use of satellite communications as the most suitable alternative for this market, and proceed to identify and compare the available

satellite platforms that can be used as basis for broadband access to rural areas.

In section IV a satellite based broadband service offering is defined that will be cost-effective within the African context, based on current communication costs and available data rates, as well as typical needs from Internet users. Section V describes the most appropriate design of the technology platform to find an optimal balance between the expected needs of the market in terms of data capacity, the delivery capability of the satellite transponders and the resulting upward and downward link rates.

In section VI we investigate the possibilities for billing model innovation by defining a new billing structure for broadband services that provides end-users with the capability to adapt their broadband usage patterns to meet their budget constraints. It is shown that this approach has the potential to set a completely new paradigm for users regarding their ability to influence the cost of the service, which has proven to be critical to the success of mobile telephony in Africa.

In section VII a scenario analysis is performed to illustrate how the integrated business model can support decision making against different sets of input data. We investigate the interaction between technology options and other factors that will impact on a successful business strategy for satellite based broadband access, including market risk and funding requirements.

The paper concludes by presenting a business case for the deployment of satellite based broadband services in rural Africa. We highlight the critical technology factors that differentiate the various broadband options for rural Africa, as well as the business issues that will impact on the eventual successful deployment of such services in order to assist rural Africa in becoming part of the mainstream global economy.

## II. QUANTIFICATION OF THE UNDER-SERVED MARKET FOR BROADBAND INTERNET ACCESS IN AFRICA

The first issue to address is whether a significant under-served market really exists for broadband Internet services in Africa<sup>1</sup>. This was investigated at different levels in a recent study [3], and only the main findings will be reported in this paper.

While some progress has been made at institutional level, only a few African countries have a modern institutional framework that governs the regulatory aspects of the telecommunication sector [3]. As a result the majority of African countries still only have a partially deregulated market. The private sector has proved to be willing to invest significantly into mainly cellular communications infrastructure, resulting in a 10 fold increase in the number of cellular subscribers in the last 5 years [4].

The average Africa Internet access market penetration is still only 6.7% against a world average of 24.9% [5]. What is however of particular importance is the fact that Africa currently has the fastest growing telecommunications market:

- Internet users in Africa are growing at an annual rate of 30.6% compared to the World average of 17.0% [6].
- Mobile cellular subscriptions in Africa grew by 47%, compared with the average world growth of 23% [7].

These statistics provides an indication of the demand, affordability, growth and potential of providing telecommunication services to the emerging Africa market. Market reports [8] show that, in all of the countries included in the studies, market demand is increasing and the demand for Internet in Africa will exceed supply. The forecasted total number of PC connections for Africa is 20 million by 2014. Technologies that provide the most effective communication coverage to the continent will be the best positioned to leverage this pan-Africa demand.

In [3] the estimated under-serviced market in rural Africa is quantified through the following approach: Firstly the current figures for penetration of Internet in urban areas as well as the average cost of Internet service offerings were extracted from market research studies. The relative size of urban versus rural populations, as well as the distribution of the urban and rural populations amongst so-called Living Standard Measure or LSM categories were then determined from historic references [9]. By combining these statistics with a price elasticity-of-demand model [3] the expected size of the rural market in 16 target countries was estimated for different pricing levels of a broadband service. This analysis produced a figure of between 10 and 12 million end-users that will be able to afford such a service at typical broadband rates but who currently cannot access any of the existing services [3]. In subsequent sections these figures for estimated under-serviced market size will be combined with results from the technology and product-service offering studies to assess the viability of offering a commercial broadband service.

### III. COMPARISON OF TECHNOLOGY PLATFORMS

The key to unlock the consumer broadband Internet market in Africa lies in the ability to meet the following principal requirements:

- The need for ubiquitous service coverage;
- the need for affordable end-user equipment and implementation; and
- the need for affordable monthly service charges.

The question is: can these requirements be effectively met for the currently under-serviced market, and if yes, by which technology platform?

In this paper we compare three alternative broadband access technologies: ADSL, mobile (cellular) and satellite. As the latter option for Internet access is less known compared to ADSL and cellular, a brief description of satellite Internet architectures will first be provided.

Direct-to-Home-Internet (DTHi) access services is defined as Internet access services that are provided to the consumer market using satellite broadcast technologies [10]. The DTHi service solution broadcasts directly to the home consumer, as shown in figure 1 below.

The DTHi solution architecture incorporates the following key elements:

- *Uplink Station*

The central satellite uplink station provides the gateway and interface between the terrestrial Internet network and the satellite communication network. The uplink station is typically located close to a first tier Internet backbone network and integrates the IP access network with the satellite transmission network.

- *Satellite Distribution Channels*

The satellite distribution channel forms the signal transmission medium between the uplink station and the customer terminal equipment. For Internet access services this is a two-way communication channel interconnecting the Internet with the consumer.

- *Consumer Terminal Equipment*

The consumer terminal equipment includes an outside antenna, receiver and transmitter unit and an indoor modem unit per each consumer home.



Figure 1 Direct-to-Home Internet (DTHi) network overview

For the purpose of the comparative technology platform analysis the following criteria will be considered:

- (1) *Geographical Communication Coverage*

Key to unlocking the mass consumer market is the capability of the technology to reach the mass consumer market and to do so it must be able to cover wide geographical areas. ADSL services utilises the current copper line networks and the availability and reliability of these in Africa is very limited. GSM Cellular networks have vast coverage throughout Africa, yet even with these large coverage areas it still does not provide coverage to most of rural Africa. Satellite by contrast is the perfect medium to broadcast the Internet to Africa with 100% signal coverage.

- (2) *Service Price and Affordability*

Service affordability is a dominant factor in providing a solution to the emerging mass Africa market. Affordability of a service is determined by the nominal costs of the service as well as the product pricing structure. Considering the mobile telephony market in Africa, the nominal cost of a call is \$0.20 per minute, which is fair value and not very cheap, while the top-up vouchers are available as from \$5. The affordability to the market is therefore a function of both the call rates as well

as the minimum top-up rate. Pricing for a 1Mbps, 5GByte ADSL service in South Africa averages \$100 per month.

Currently mobile networks offer attractive pricing for data services at around \$20 per month. The capability of mobile networks to meet future growth and still maintain profitability is however questioned by various industry analysts [11]. The single source nature of satellite Internet broadcast signals has the result that no income multiplication can be done, as for TV broadcasts, and hence the pricing is for the higher income market.

### (3) *Implementation Costs and Requirements*

Initial purchasing cost, which includes equipment cost plus any implementation costs, is a major factor and must be kept to a minimum. The large scale deployment of additional copper cable networks for ADSL in Africa is not feasible, partly as a result of high levels of copper theft. In high density areas operators implement fibre networks to business and high-end consumer markets. Mobile broadband networks require continuous upgrading to base stations and back haul networks to deal with traffic volume increases. This is both time and capital intensive. For satellite the network cost required to provide services over the continent is limited to the upgrading of a single earth station and contracting of the applicable satellite capacity.

### (4) *Access Speed*

The technology solution must be able to meet the current broadband access speeds as well as to increase to higher levels expected to be required in future. ADSL services are well positioned to deliver broadband services at access speeds of up to 4Mbps. Access speed on Mobile broadband networks greatly depends on the range and overall network congestion. Realistically, the average transfer rate will vary from 1 to 2 Mbps depending on the quality of the signal and the number of connected users. All satellite terminals can be configured for maximum network speed which can be 4Mbps or higher.

### (5) *Quality of Service Requirements*

The primary purpose of the proposed solution is to provide broadband Internet access services to the consumer and small office market. This will be reviewed in terms of service access speeds, network performance and expected user experience. ADSL services differentiate strongly between local and international content with the associated user implications. Mobile networks have well developed tools to meet QoS requirement. For satellite all the required quality of services can be integrated into the hub network.

### (6) *Data usage volumes*

As it is expected that the use of broadband services will grow exponentially, broadband technologies must be able to scale up in order to deliver ever increasing data volumes. With fibre networks forming the core of most ADSL networks they are well positioned to deal with data traffic demand increases. Mobile networks are however expected to become more and more congested as smartphone users demand more data at higher speeds. The wideband nature of satellite signal carriers

of typically 72MHz can deliver up to 140Mbps per channel which can readily meet higher user traffic demands

### (7) *Network loading and congestion*

The ability of broadband networks to provide acceptable levels of service during peak customer demand periods is critical. ADSL terrestrial networks with integrated fibre core networks can provide the best possible network resilience against peak traffic demands. Due to the cost implications and limited available operating frequencies mobile networks can not readily be upgraded and network congestion is often experienced. Broadband satellite networks are a single point resource with limited options for traffic loading management.

### (8) *Billing Requirements*

A technology solution for the mass consumer market must be able to meet the billing requirements of the consumer market in terms of flexibility and the option to select incrementally increased service offerings. Public operators offering ADSL traditionally do not engage in usage billing models and still offer broadband access at a fixed rate per month linked to a maximum amount of data usage allowed per month. Globally mobile operators are currently offering usage based services and other advanced packages. Current satellite operators typically offer fixed rate packages linked to contended services. It is expected that a "usage-base" model will deliver better user experiences.

### (9) *Net neutrality*

Service providers today have the ability to control the content of broadband access services to give lower or higher priority to some types of content such as voice traffic or video download data. The manner in which service providers apply discretionary rules to the broadband content refers to the issue of net neutrality. The primary income of public operators offering ADSL is still voice based services and hence there is a tendency to degrade the quality of service of Skype and other VoIP data services that compete with analogue voice communications. The primary income source for mobile network operators is also voice-based services and thus they are similarly inclined to provide Skype and other VoIP services with a lower priority and poorer quality of service. Satellite operators have no legacy voice business interests to protect and can ensure 100% net neutrality.

### (10) *Availability*

Access and availability of the product to the consumer public is a critical element that will determine the viability of the service. While ADSL is in the best position to handle increasing data volumes where it is available, the simple fact is that ADSL is unlikely to be an available option for the bulk of Africa's rural population for several decades to come. Mobile Internet is available over a more extensive range, but where it is deployed the tendency is for voice communications to use the bulk of available capacity. It would therefore seem that, although it is currently still the most expensive option, satellite may in fact be the only option for a significant portion of the African population for the foreseeable future.

The above comparison confirms the following:

- that ADSL services are the most suitable and appropriate technology to provide consumer broadband services where landline infrastructure is available;
- that due to the lack of availability and implementation requirements ADSL services are not a feasible as an option to service the complete Africa mass consumer market;
- that, in the absence of ADSL as alternative, mobile broadband services is the next option to consider for meeting consumer demand for broadband access services;
- that mobile broadband services have inherent bandwidth and cost of infrastructure limitations that will result in this technology option not being able to meet the expected future demand in Africa; and
- that satellite technology, while still being too expensive for the lower income categories, is the only remaining viable alternative to meet the demands of the currently under-served broadband market in Africa.

#### IV. DEFINITION OF AN AFFORDABLE PRODUCT SERVICE OFFERING

In the previous section we established the fact that for a large portion of the African population satellite is currently the only viable alternative for broadband Internet access, even though it may not be an ideal option taking into account cost considerations. The next challenge is to define a product service offering that can be supported by currently available technology and that will prove to be affordable to a sufficient portion of the target market to make such a service viable in the short to medium term.

Currently there are already 71 satellites with at least partial coverage over Africa, operating approximately 2,794 transponders providing substantial communication capacity for this market. A recent study showed that these transponders are running at between 60 and 99 % of full capacity, providing proof that even without an optimally packaged broadband service there is already significant demand from Africa for satellite based services [12].

A further selection to make is the type of satellite band to use, with a choice between C-band (3.7-4.2 GHz), Ku-band (11.7-12.7 GHz) or Ka-band (26.5-40 GHz). The optimal choice is dictated by the expected subscriber density: while Ku-band transponders cover a significant portion of a continent, with data rate capacity of around 1-2 Gbps, Ka-band transponders cover only a relatively small area (typically one large metropolitan area) while offering data rate capacity of around 45 Gbps. Ka-band will thus be the technology of choice for geographies with very high subscriber densities (typically as would be the case for South-East Asia or the coastlines of the USA), while Ku-band will be the optimal choice for the much lower expected densities in rural Africa.

Assuming a minimum monthly fee of around \$100, the proposed service will be targeted primarily at more affluent individuals and small to medium sized business. Based on a recent study [13] the needs of the small business of the future, including video-conferencing and third-party hosted

applications, will require at least a combination of 1Mbps downlink and 256 kbps uplink at the lower end, going up to a combination of 15 Mbps and 2 Mbps respectively.

In the case of consumer clients the dominant driver of data consumption for Internet traffic is real-time entertainment with social networking in the second place [13]. Within these categories streaming applications that rely on peer-to-peer architectures (sometimes called "peer-casting") have achieved worldwide market penetration.

Regarding data usage, the current offerings of mobile service providers indicate that typical requirements range from 1Gbyte to 5 Gbyte per subscriber per month.

A major challenge in all Internet markets is the fact that usage tend to be very dependent on time-of-day, as shown in figure 2 below, with real-time entertainment causing a significant peak in data consumption during the period 6pm to 9pm.

In summary, the type of broadband service to be incorporated into the simulation model will be based on the selection of the most suitable Ku-band satellite, offering a combination of down- and uplinks starting at 1 Mbps and 256 kbps, combined with total monthly data usage of at least 1 Gbyte, and with the option to offer time-of-use based pricing in order to help manage peaks in demand.

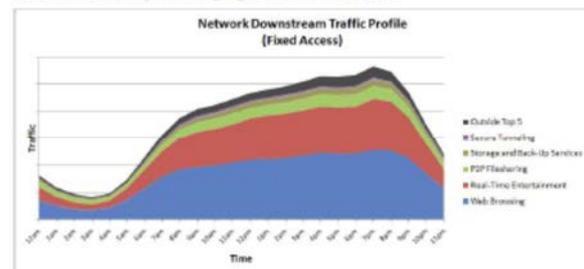


Figure 2 Typical Network Downstream Traffic Profile for European Network [13]

#### V. TECHNOLOGY NETWORK DESIGN

Selection of the most suitable equipment for implementation of the satellite broadband network is a complex trade-off between upfront capital outlay, the influence of the consumer equipment cost on the rate of market adoption as well as the minimum cost of the satellite data transmission channel. Higher cost terminal equipment offers more efficient data communication and increase the barrier to entry yet lowers the rate of market adoption.

The most critical parameters when selecting between equipment alternatives include the cost of hub equipment (which will increase initial capital outlay and hence increase upfront risk and time to breakeven) and cost of terminal equipment (which will increase customer capital outlay and therefore influence rate of market adoption and thus increase the funding required to sustain the operation until break-even is achieved). The data rates that the satellite can handle for both the downlink and the uplink, and how this compares with aggregated customer demand, will determine the number of

customers that can be accommodated per transponder as well as the quality of Internet experience that will be offered.

In order to determine which of several available satellite platforms will be the optimal choice for a broadband service into Africa a simulated study was performed which is described in detail in [3]; only a summary of the approach that was followed and the results obtained are given in this paper. One of the critical elements of this simulation is the so-called link budget, which matches the satellite transponder capacity in both directions with the aggregated needs of Internet customers, allowing the estimation of the maximum number of customers that can be serviced by one transponder. A satellite channel signal transmission link power analyses, also referred to as a link power budget, was hence completed to determine the most suited communication channel carrier specifications, the channel reliability and resource efficiency.

The carrier analysis was done in the forward direction, i.e. from the hub to the remote sites, and in the return direction, i.e. from the remote sites to the hub. The results of the link budget analysis were used as basis for comparing several alternative satellite options.

The forward link carrier results were based on a 36MHz DVB-S2 carrier on a saturated 36MHz transponder. The customer platform incorporates ACM (adaptive coding and modulation) on the forward link which ensures that the highest efficiencies are achieved for remote sites in all geographical locations in the footprint and during all weather conditions.

Similarly a carrier multiple distribution analysis was done for each of four different return link carrier types from a remote site 1m antenna to a 5.6m hub antenna located in Johannesburg, South-Africa. All return carriers use 4CPM (constant phase modulation) which is a non-linear modulation type and yield an efficiency of between 55% and 71%.

The above approach with the described set of assumptions was used to simulate a typical business operation offering such a service to the African continent. The results of the simulation in terms of utilization of available capacity, number of customers that can be accommodated and resulting business performance are summarized in the table below:

Table 1 Review of alternative satellite equipment options

Satellite Characteristics Analyses	New Dawn	Amos5
Time to market	3 months	9 months
Addressable market	Sub-Sahara Africa	Southern Africa
Terminal sales growth rate required to turn-around the business with available funding	150%	200%
Equipment Characteristic Analyses	Newtec	Gilat
Hub capex equipment	\$750,000	\$450,000
Remote terminal equipment	\$450	\$650
Equipment implementation cost	\$80	\$160
Inbound carrier utilization	182%	93%
Effective 4Mbps inbound service cost	\$5,356	\$2,732
Maximum funding required	\$1,507,572	\$2,352,870
Time to cash positive	6 months	18 months
Number of consumers per transponder, year 1	2632	1154

The significant difference in time to positive cash flow results from the higher remote terminal equipment cost for the 2<sup>nd</sup> option, resulting in slower expected market adoption rates. The simulation demonstrated that the choice between different available satellite platforms, that on paper appear to offer rather similar functionality, can make the difference between a time to positive cash flow of either 6 or 18 months[3]. In practice this can effectively be the difference between success and failure for the underlying business operation.

## VI. THE ROLE OF BILLING MODELS

A good billing model will enable fast market adoption by striking an optimal balance between the value offered to customers and the cost to deliver that value. To provide a sustainable and profitable Internet access service, two opposing forces within the network architecture must be balanced: charging rates and policy.

The role of charging rates is to maximize revenue. Policy's job is to reduce network costs by managing bandwidth. In broadband data networks, the trigger for action is either an abundance or lack of bandwidth for a particular user, application or portion of the network. An advanced charging and control system reacts in real-time to bandwidth availability, being able to either reduce or increase bandwidth for particular users as directed by policy.

Problems occur when one of these factors has too much weight. When emphasis is on low charging rates revenues will grow, but the network will need to support too many users, degrading QoS and the customer experience. When quality policy is over-emphasized, high QoS is offered, but revenue suffers and the operator earns a poor return on its network investment.

The satellite broadband access network has some very specific performance characteristics that must be considered when defining the most suited billing model. These relate to the costing and data rate parameters of the outbound and inbound channels.

- *Outbound Channel:* The outbound channel (from the hub to the remotes) is a single saturated high powered DVB-S2 carrier operating at 70Mbps through a 36MHz channel. The channel transmission efficiency for different modulation codec options is detailed in table 2 and has an average efficiency of 1.94bits/Hz. The outbound channel is considered very efficient and offers up to 99Mbps using a 36MHz RF channel thus translating into a lower cost per bit for delivery of user data than the inbound channel.
- *Inbound Channel:* The inbound channel (from the remote to the hub) is operating from the smaller (1m) antenna system and lower powered (800mW) terminals and is thus limited in the possible communication channel efficiencies. The communication channel modulation types and efficiencies that can be supported by the network provide an average efficiency of 63%. The efficiency range from 0.55bits/Hz to 0.71bits/Hz which is inefficient compared to the outbound channel and will lead to higher cost per bit levels.

- *Inbound Power Limitation:* The inbound communication channels that provide communication from the small 1m, 800mW remote terminal to the hub is power limited and constrained to a maximum data transmission rate of 256kbps. The network architecture will be designed to provide multiple of in-route channels as is required to provide the total transmission capacity for the return link communication.
- *Billing influence of network transmission:* The combined effects of the channel efficiencies and the return link power limitation is that the network will deliver outbound data services from the hub to the remote more cost effectively than the inbound channels. The net effect is that the billing model should be able to differentiate between the outbound and inbound data flows and apply different costing structures to the respective data paths.

The eventual billing model that is used should reflect at least the following factors that contribute towards the cost of providing the service:

- Access speed;
- Monthly data usage;
- Time-of-day of usage;
- Type of data.

For the simulation studies the following weightings were used to convert the different factors into one monthly fee (assuming a standard downlink access speed of 2Mbps):

Table 2 Price weighting factors for usage based billing

Gbytes	Wght	Time of Day	Wght	Type of Data	Wght
0	1.0	05h - 8h	1	email	1.2
1	0.9	08h - 18h	1.5	Browsing	0.9
2	0.8	18h - 22h	0.8	Social media	1.4
4	0.6	22 - 01h	0.5	Downloads	0.9
10	0.5	01h - 05h	0.3	Games	2.0

In order to assess the applicability of the model it was applied to three typical end-user scenarios and the expected monthly costs were calculated:

*Base service:* The base service applies to all subscribers and is a monthly subscription fee that includes 1Gbyte of data at a fixed rate of \$75 per subscriber per month.

*Business User:* The business user profile has a usage of 2GByte of additional data for mostly email traffic between the hours of 8h00 to 18h00. The pricing factor for the top-up services is 1.4 with a rate of \$144.

*Socialite:* For the socialite using 3GByte of additional Facebook and other social media applications data between 18h00 and 22h00 the total pricing factor is 0.7 resulting in a rate of \$101.

This costing model was tested against a selected group of ISPs operating within different African countries, and in general the feedback was favorable, indicating that this model

will allow customers to effectively match the cost of the service with the value that is delivered.

## VII. SCENARIO ANALYSIS

A quantitative business model was developed in Excel for typical business scenarios faced by a business operation providing satellite broadband services into Africa. This included the modelling of the important business relationships as well as the quantification of the respective input parameters. Once the model was constructed, the second step was to apply the model to provide output data for different business decisions and options that had to be considered. In particular the model was applied to support and validate decisions regarding the following business considerations:

- 1) Selection of the most suited satellite scenario in terms of availability and cost: The inputs used for this analysis were satellite supply terms, teleport uplink terms, cost for hub platform and operation, link budget analysis and implementation costs.
- 2) Evaluation of the impact of different remote terminal equipment types (consumer or professional version): inputs include terminal equipment and implementation costs and network hub equipment cost.
- 3) Simulation of different pricing and billing models: usage based billing based on the input data in table 2 above was compared against fixed rate billing.

For each of the above options the projected risks and returns were quantified in terms of sales revenue potential, time to positive cash flow, expected profit over 5 years and required financial investment. To make the scenario analysis more representative for uncertain market conditions, it was repeated for both a conservative and an aggressive market scenario, allowing market share after 5 years to range from 8% to 25%.

A summary of the findings is provided in Table 3 below; in [3] the outcome of this scenario analysis is described in more detail.

Table 3 Summarized outcome of scenario analysis

Scenario	Option 1	Option 2
<u>Satellite Selection:</u>	<u>New Dawn</u>	<u>Amos 5</u>
Time to market:	3 months	9 months
Sales rate required:	150%	200%
Subscribers yr1:	3223	1500
Addressable market:	Sub-Sahara Africa	Southern Africa
<u>Equipment Selection:</u>	<u>Consumer</u>	<u>Professional</u>
Max funding:	\$1.4M	\$2.1M
Months to cash positive:	6 months	15 months
Market penetration:	Nominal	Less 48%
<u>Billing Model Selection:</u>	<u>Usage billing</u>	<u>Fixed billing</u>
5yr Return:	\$32M	\$16M
Yr1 Subscribers:	2632	1418

The scenario analysis firstly provides proof that a satellite platform can be used to provide broadband services into Africa at monthly rates that will attract a sufficiently large market to make such a service a viable operation, without having to subsidize such an operation from the returns generated in more established markets (as is most likely the case for most satellite based services currently offered into Africa).

Secondly it can be stated that a usage-based billing model not only provides a more affordable option to the market but also yields better financial results. Even assuming the same number of subscribers (which could possibly be higher for usage based billing given the increased flexibility offered to customers) overall revenues and profits are higher for usage based billing, resulting in a more attractive return on investment and NPV (net present value).

The consumer version of end-user terminal equipment is expected to provide more attractive results compared to the professional version, mostly due to lower upfront cost to end-users that will result in faster market adoption.

As far as the satellite platform selection is concerned the New-Dawn satellite operated by Newtec produced the most favourable results, as its combination of up- and downlink data rates, combined with supply terms, better matches expected market demand for data capacity compared to those of competing platforms.

#### VIII. SUMMARY AND CONCLUSIONS

This research work adds knowledge and insight to the field of applied business strategy as applicable to providing advanced technology-based services for emerging markets. The research work is specifically focused on the case for providing broadband services into rural Africa and proposes a new billing model for satellite based broadband services.

The research work conducted clearly identified that there is a significant under-served market sector in Africa and that the demand for broadband services is growing. It furthermore showed that very limited ADSL infrastructure is available throughout Africa and that the available infrastructure is not meeting the demand. While mobile 3G services are currently the most effective option to provide broadband services, these services have two principal constraints. Firstly the network communication coverage area is not ubiquitous and large service-gaps exist and secondly the technology has some fundamental capacity limitations that prevent the large scale deployment of data services to the mass market.

The research work clearly demonstrated that satellite technology is very well suited to provide services over a very large geographical area such as rural Africa. The research also found that the point-to-multipoint nature of satellite technology is well suited for the delivery of broadcast services such as Internet access services.

Affordability and availability are the two principle conditions to provide services to the mass consumer market in

Africa. The research proposes a new usage-based billing model to offer broadband services to the under-served market in an affordable manner. Integrating the proposed billing model with satellite technology will enable the creation of a broadband service that will be available throughout Africa, that will be affordable to the institutional, small business and higher end consumer markets, and that can be operated on a financially viable basis. The integration of satellite technology with the usage-based billing model therefore offers a new alternative for the mass broadband market in Africa.

In order to verify and validate the results of this study the different factors and inter-relationships for the operations of a broadband service provider were integrated into a quantified business model. The business model was used to analyze various business scenarios, considering different options during the business strategy definition process. Using this quantified model it was possible to recommend the most optimal set of business decision options, taking into account the impact of all of the major factors impacting such a business.

Future work in this field will involve the testing of the model that was presented here in practical conditions. The research team intends to closely work with commercial operators in this industry to verify whether the simulated results of this study can be achieved in practice, in the proposing validating the research approach that was followed.

In conclusion it can be stated that the provision of broadband services to rural Africa has been theoretically proven to be a viable business proposition, combining existing satellite platforms with a suitable business strategy. It is hoped that the results of this work will make a useful contribution towards closing the remaining digital divide for rural Africa, helping these impoverished areas to participate on a more equal basis in the global economy.

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