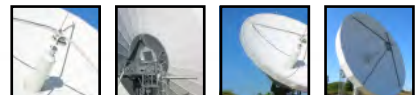
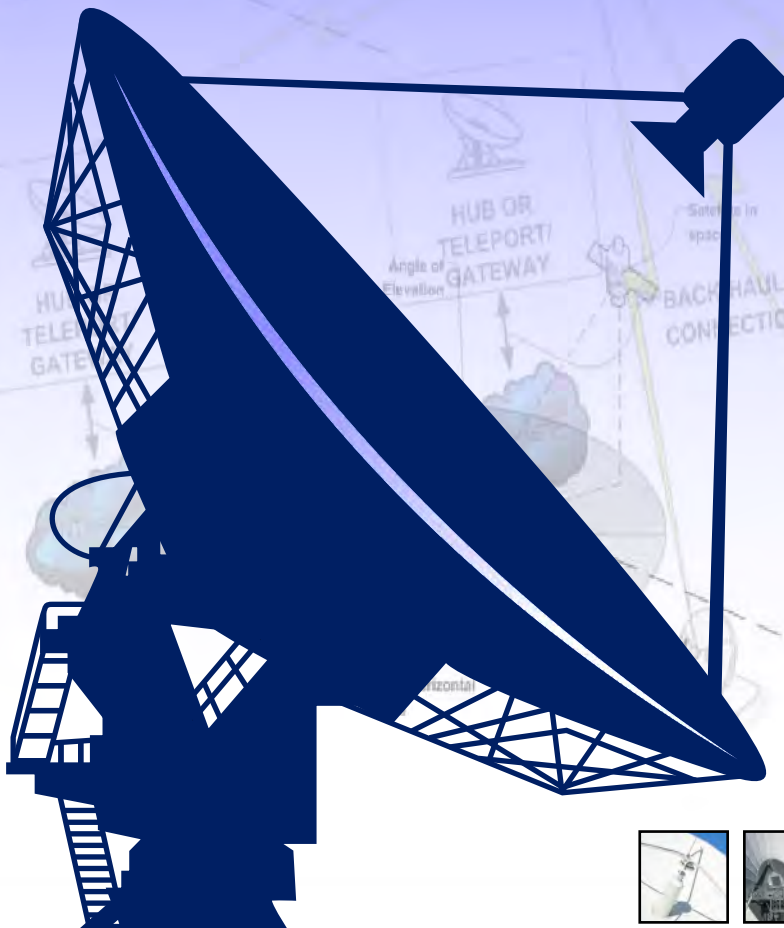


The VSAT BUYER'S GUIDE

A GUIDE TO SELECTING, PROCURING AND IMPLEMENTING
VSAT TECHNOLOGIES FOR DEVELOPING COUNTRIES



ALEX TWINOMUGISHA AND SANDRA ALUOCH



The **International Development Research Centre (IDRC)** is a public corporation created by the Parliament of Canada to help researchers and communities in developing countries in the developing world find solutions to their social, economic, and environmental problems. IDRC connects people, institutions and ideas to ensure that the results of research it supports and the knowledge that research generates are shared equitably among its partners, North and South.


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Preface

What steps do organisations and individuals take when faced with the prospect of buying a VSAT- a parabolic dish and associated electronic equipment used to send and receive information via a satellite? How do they select VSAT equipment and service options and arrive at the final choice? What factors should be considered in buying VSAT equipment and services and what should be avoided? What should one do after installation and when the VSAT system is not performing as anticipated?

An internet search for answers to these questions will yield very little- strange in itself, given the propensity of the Internet to seemingly host every nugget of information ever produced. There are also many books on satellite communications, VSAT systems and procurement strategies, but none that specifically address how to efficiently acquire VSAT systems and the issues to consider in the complex decision making process leading to the acquisition in a non-technical way. We have experienced this unsettling situation first hand, as we have, between us, undertaken over four successful international competitive bids for VSATs for organizations with a pan-African reach in the last 5 years.

This lack of information was also clearly evident to a wider group of players, comprising of international organizations and African universities, with whom we were involved in tackling issues of lowering VSAT bandwidth prices for African universities in 2004. As a direct result, and with the support of IDRC's Connectivity Africa Program staff, the journey to develop this Guide began.

This Guide therefore attempts to fill the information void and to answer the questions posed above. The Guide discusses VSAT technologies and procurement strategies, in what we hope is a non-technical and easy-to-understand manner. It describes a step by step process to assist you to obtain the most appropriate and cost effective VSAT solution. However, the Guide does not make recommendations of any particular VSAT technology, equipment or supplier. It will only assist you in making the right choices and arriving at the right decision.



Who should read this Guide?

This VSAT Guide is primarily meant for persons with the authority to make final decisions, or those who make recommendations to final decision makers, on selecting and buying technologies. The Guide is meant to provide insights and strategies for purchasing VSAT systems and services with the hope that there will be efficiency and economy in the acquisition process, and that, ultimately, the technology will fulfil the desired objectives and offer a real return on investment. These strategies and insights can also be applied to the purchase of other complex information technologies.

The Guide is not an engineering text on satellite and VSAT technologies and is not intended to make you, the reader, an expert in this field. Neither is it for field technicians to be used for monitoring, trouble shooting, servicing, maintaining and repairing equipment. However, technology experts and field technicians can benefit from the Guide by gaining a deeper understanding of the processes associated with selecting, acquiring and maintaining VSAT systems. This understanding may help maximize the return on any VSAT investment made.

The Guide is mainly targeted at the social and economic development sectors. However, the strategies, processes and recommendations presented here can be applied to any industry across the board.

How to use the Guide

The Guide is written in a style that seeks to directly address and appeal to the target audience, i.e. a group or individuals appointed to purchase the VSAT system. As such, the constant use of “you” is deliberate and refers to the technology manager, other decision makers or indeed a group or committee formed to purchase a VSAT system for the organisation.

The Guide is written in a practical, and what we hope is an easy-to-follow manner. We hope it will be used as a reference tool in the planning and procurement process, alongside other resources utilised in arriving at a final decision in purchasing a VSAT solution.

This Guide does not have to be read from beginning to end. It is structured so that users can skip directly to the sections in which they are interested. However, we recommend that you peruse all the sections to familiarize yourself with the Guide's structure and its components. This may provide insights into areas that you may not otherwise have considered in the procurement process, and also assist you in determining, overall, how it can best suit your needs.



What is presented in the Guide

The Guide is divided into three broad parts, each with a number of sub-sections.

Part 1 presents an overview of VSAT technologies

Part 2 details the processes involved in purchasing VSAT systems from start to finish, presented in a sequential order;

Part 3 consists of a number of appendices offering contact details for the case studies listed in The Guide, information on suppliers, trainers and training programs, books and links to online link budget calculators. It closes with a glossary of all the major terms and concepts of satellite communication technology used in this Guide.

Extracts from the case studies are interspersed throughout the Guide to lay emphasis on the point being made and to provide empirical examples of how organisations have addressed the issues involved in buying a VSAT.

This Guide draws from the authors' own relevant practical experiences, and from carefully selected case studies that highlight the views and experiences of both suppliers and service providers and therefore might not offer in-depth scope on all the issues involved in purchasing VSAT systems for all possible situations. The Guide is therefore an assembly of proven best practices and practical advice rather than the advancement of a theoretical framework.

A note on terminology

We must point out the recurring confusion over the term “bandwidth” as applied to VSAT systems. As our technical reviewer repeatedly pointed out, “The term bandwidth means different things to different persons. This Guide uses the term generally to describe data rates or the “speed” of your connection and capacity. The satellite industry uses the terms strictly according to its technical meaning, which is the difference between the upper and lower frequencies of an analogue channel. Satellite operators sell their space segment (see glossary) in terms of the bandwidth consumed by a carrier, measured in Hertz. There is no single fixed relationship between bandwidth and capacity or data rate. Each VSAT network design has a different relationship.” In other words, 1 Mbps does not always equal to 1 Mega Hertz. Where the term *bandwidth* is correctly used, it is highlighted in *italics*.



Acknowledgements

This Guide was made possible through support from the International Development Research Centre (IDRC) of Canada. The work was carried out under contract from IDRC by Mr. Alex Twinomugisha as the lead contractor, developer and writer of the Guide and Ms. Sandra Aluoch as the principal collaborator responsible for sourcing information on case studies and providing overall support in developing the Guide.

We wish to sincerely thank all those who in one way or another have helped with the development of this VSAT Buyers Guide. Special recognition goes to Mr Geoff Daniell, who reviewed the technical details in the Guide, Mr. Russell Southwood who provided overall editorial guidance to us and Mr. Mike Jensen who reviewed and provided comments throughout the development of the Guide.

We would also like to thank all the organisations, service providers and suppliers and their staff who took the time to provide information for the case studies and to discuss issues related to purchasing VSAT systems. Their experiences provide a wealth of practical knowledge for other organisations intending to procure VSATs in the future.

We reserve the last word of thanks for the staff of IDRC who commissioned and subsequently reviewed this Guide and provided valuable advice throughout its development, especially Ms. Edith Ofwona Adera and Mr. Steve Song. We are also indebted to the staff of the IDRC Regional Office in Nairobi, notably Ms. Gladys Githaiga, for all the administrative help and support they provided to us.

And lastly, any omissions, ambiguities or misrepresentations are unintentional and we apologise for them.

Alex Twinomugisha
Sandra Aluoch

November 2005

This Guide expresses the views of the authors and does not in anyway seek to express or represent the views of any one provider or organisation.



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Introduction

The Internet is a global network of computers connected to one another that enables and supports hitherto unprecedented communication, collaboration and access to information anywhere, anytime and increasingly on any computing or communication device. In the last 10 years or so it has evolved from a tool and network used by a few technical experts to become a crucial and fundamental part of citizens' everyday life, in both the most and least developed countries. It has spawned and supported innovative and revolutionary advances in education, research, health, good governance, banking and finance and other social and commercial sectors. It has changed the way business is done globally and transformed information, its creation and access to it, into a strategic resource and one of the most important competitive advantages an individual, a company, society or nation can have in the new knowledge economy.

To harness its potential and partake of the consequent benefits and competitive advantage, however, requires that one become "connected" to the network. And therein lies the catch: while rich developed countries had existing widespread telecommunication systems that were ready to enable, support and further drive access to the Internet, the under-developed nations such as those in sub-Saharan Africa had severely limited, unreliable and inadequate telecommunication systems. This has therefore meant that these under-developed countries have largely lost out on the potential benefits of the Internet, further widening the gap between poor and rich nations. This phenomenon is usually referred to as the "digital divide".

VSAT still remains the most viable connectivity solution in rural and upcountry locations¹

While there is no doubt that the digital divide is more a symptom than a cause of under development, its continued existence spells further trouble for the under-developed nations and their communities. Part of the solution lies in enabling "access" - the physical connection - as well as the financially sustainable means to connect. With the telecommunications infrastructure necessary to provide the physical connection in these countries often severely limited in geographical coverage, unreliable and expensive where it exists, the most economical solution in the short and medium term lies with the use of satellite systems and more specifically Very Small Aperture Terminals, or VSATs.



VSATs are parabolic dishes together with electronic equipment, used to transmit and receive information, in the form of voice, video or data via a satellite in space. Because they rely on the satellite in space to make the connection among two or more locations, VSAT systems bypass the terrestrial telecommunications infrastructure to provide direct connection to the international telecommunications network and to the Internet. They offer the ability to connect urban and remote areas without incurring huge upfront capital investments, and can claim the additional advantage of very fast turn-around times for installation. In conjunction with, say, wireless terrestrial systems, they can be used to provide coverage over large areas at a fraction of the cost and time it would take to roll out the more traditional wired telecommunication networks. However, even with these advantages, VSATs remain a short term solution which can be used to jump-start access: medium to long term solutions consist of developing competitive and efficient intra- and inter-national terrestrial networks capable of providing very high data transfer speeds at a fraction of the cost of VSAT system, albeit with huge upfront capital outlays.

“The USA has amongst the best terrestrial infrastructure available, yet accounts for almost 60% of the VSATs sold worldwide, so terrestrial networks should not impact the VSAT market as long as the VSATs address the applications for which they are best suited”²

Even though satellite telecommunications systems have been around for about three decades, they were the preserve of large telecommunication companies (usually state owned monopolies). VSATs, using low cost satellite terminals, have come into their own as a mainstream commercially available connectivity solution only in the last 5 to 10 years. However, the spread and adoption of VSATs, despite their acknowledged potential, has been hindered by two major factors: heavily regulated telecommunications regimes and a lack of competition in the global satellite industry. The former made it virtually impossible to install and operate a VSAT system while the latter, where regulation allowed, made it possible only for the richest private sector companies or international organizations with the ability to make the large scale financial investment required.

Recently, increasing liberalization and deregulation of the telecommunications sector in most of Africa, and on the global scene, has seen a significant increase in the number of satellite providers leading to steep competition that is driving down prices and improving the quality of services. Technological advances are also being realized that make it possible to offer more cost-effective VSAT solutions. These factors have led to a prevalence of VSAT systems and their recognition as a feasible option to provide access cost-effectively in the short term.



Governments, community organizations, educational and public health institutions and other public sector institutions, as well as the private sector, are increasingly buying VSAT systems and services.

However buying a VSAT system involves considering a complex mosaic of technologies, services and equipment, far beyond the comprehension of the average buyer. This is not made any easier by the lack of openly available information to enable buyers to make an informed purchase decision and to help determine whether they are getting value for their money. As a reviewer³ of this Guide noted, *“those selling VSAT connectivity have only themselves to blame.... African companies and NGOs have been ill-served by those selling VSAT bandwidth as all too often they do not clarify what they are selling and why it costs what it does... there has been too little effort put in educating potential buyers.”* For example, it is not unusual to find two institutions procuring exactly the same amount of bandwidth, equipment and after sales services from the same provider, in the same country, but paying vastly different amounts. While providers have, in some cases, valid technical, marketing and economic reasons for situations of this sort, which are undoubtedly complex, the problem is exacerbated by a distinct lack of knowledge on what is exactly being bought. As a result, VSAT providers are often, unfairly in many cases, viewed as being unscrupulous in their dealings.

This Guide has been developed to address this information “gap”. It is targeted at the less resourced public and community development sectors and it aims not only to empower but to enlighten buyers of VSAT systems. The Guide provides detailed information about available technologies, and proffers step by step practical guidelines that purchasers can adopt to ensure that they obtain the most economical and efficient VSAT system to suit their particular needs. It addresses the challenges organizations are likely to face when procuring VSAT systems, and provides a variety of solutions. While this Guide is focused on VSAT systems, it does not set out to promote their use. On the contrary, it is strongly advised that the VSAT buying decision should carefully consider the buyer’s overall needs and any alternative connectivity options that may also be feasible. VSATs are not a panacea to all the connectivity challenges in least developed countries. This “one size fits all” thinking has proved a costly mistake to many, as is evidenced by the landscape in Africa, with its decoration of non-functional satellite dishes.



PART 1

**VSAT
TECHNOLOGY
PRIMER**





This section of the Guide is not meant to make you a VSAT engineer or an expert in satellite technology. It aims to explain how VSATs work and to shed light on some of the terms and acronyms that your technical staff or those smart-talking salesmen are likely to use to dazzle, impress or confuse you! After reading this section, we hope you will be more able to confidently engage in and follow any conversation on satellite and VSAT technologies.

Overview

Traditionally, satellite dishes measured over 5 meters in diameter, were accompanied by complex electronic equipment, cost a small fortune and were used only by large telecommunications companies. With technological advancements in the satellite industry, it became possible to use smaller and cheaper dishes, which were named VSATs. VSATs are a relatively new phenomenon and have been around for about 15 years now.

Contrary to popular belief, the term VSAT encompasses both receive-only systems such as those used for satellite TV or cable broadcast service, and interactive systems that have the capability to transmit and receive, such as those used for Internet access. The term is mainly used in connection with interactive systems thus fuelling the confusion.

The VSAT sends and receives information, in the form of signals, to and from the satellite. Signals to and from the satellite are said to form “Links”. Sending signals from the VSAT to the satellite is referred to as “uplinking” and forms the “uplink”. Corollary, receiving signals from the satellite is referred to as “downlinking” and forms the “downlink”.

The satellite receives signals, amplifies and retransmits them back to earth. As a consequence, satellites are often referred to as “repeaters in the sky” or “bent pipes”. For illustration, consider making a telephone call from Burundi to Senegal using a VSAT. The call from Burundi is beamed up by a VSAT to a satellite in the sky, which in turn beams it to another VSAT in Senegal (see Figure 1). As the two parties in Burundi and Senegal converse, the signals carrying their voices will be beamed up and down by the respective VSATs. Similarly for internet access, information requested from a user’s computer is beamed up by one VSAT to a satellite which in turn beams down the information request to another VSAT connected to the Internet. The requested information from the internet is sent back the same way via the satellite.

A more detailed explanation of how the various pieces of VSAT equipment work is provided later in Part 1 of the Guide.

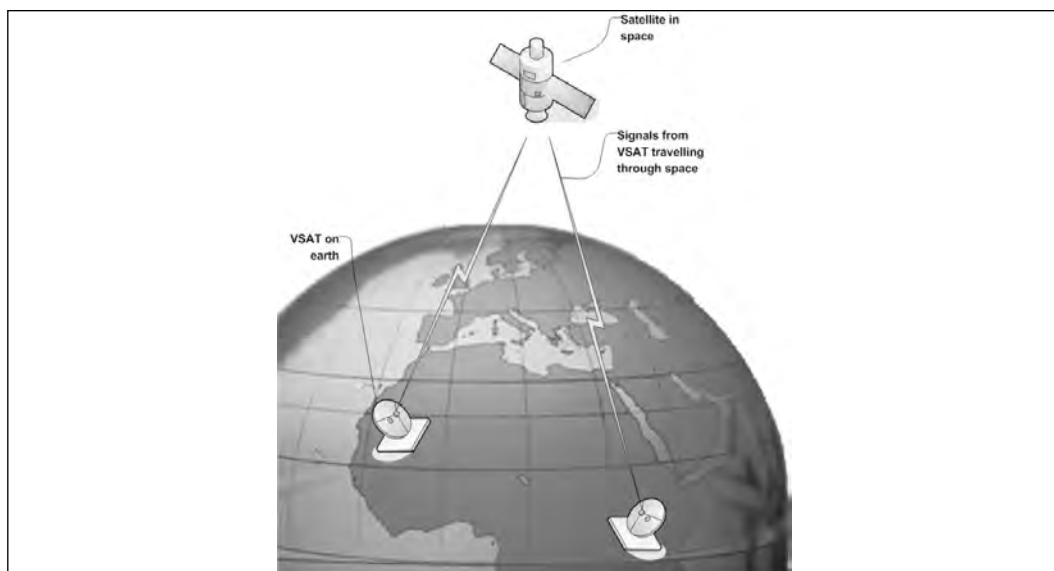


Figure 1- Illustration of a VSAT and connection to the Satellite

Satellites and how they work

Satellites are commissioned and run by Satellite Operators. The major Satellite Operators include Intelsat, New Skies Satellites, SES-Americom/Panamsat, Eutelsat and Arabsat. Satellites are given alpha numeric identifiers by their operators for example, New Skies Satellite's NSS 7, Intelsat's 10-02 and Panamsat's Pas 1R.

Satellites are launched from earth using rockets, just like the space shuttle, and placed in an orbit around the earth. Communication satellites are placed in special circular orbits called geosynchronous orbits. In this orbit, a satellite will orbit the earth in 24 hours, the same time it takes the earth to complete one revolution about its axis. If the satellite is placed in an orbit precisely over the equator, the satellite will appear to be stationary in space when viewed from any point on earth. The orbit is then known as the geostationary orbit or Clarke Orbit, named after Arthur C Clarke, who first described the properties of such an orbit. This "stationary" property makes geostationary satellites useful for communication purposes as they enable one to have the VSAT dish fixed on earth and always pointed in the same direction. Otherwise, VSAT dishes would have to be movable to keep track of the satellite's movement in space! We should at this point mention that sometimes, VSAT dishes have to be moveable and track a satellite's movement in space. This happens in the special case of the Inclined Orbit, discussed a little later on in Part 1 of the Guide.



The satellite stays in orbit and does not fall back to earth because of the effect of centrifugal⁴ forces as it revolves around the earth. The satellite in space also experiences other forces, such as gravitational pull from the sun, that tend to draw the satellite out of its orbit. This effect is countered by equipping satellites with small rockets which are periodically “fired” and burn a special propellant to produce gases. The gases expelled move the satellite just like a balloon filled with air will move if some of the air is expelled, in line with Newton’s third law (for every force, there is an equal and opposite force). These movements are small but help to keep the satellite on course in the orbit.

Inclined Orbits

The propellant used by the rockets for course correction last 10 -15 years and determines the “useful” life of the satellite. Once the propellant is used up, the rockets can no longer be fired to return the satellite to its regular course and the satellite slowly drifts off course. Towards the end of the useful life of the satellite, Satellite Operators may prolong the life of the satellite by conserving the propellant and deliberately allowing the satellite to slowly drift off course. For geostationary orbits, the satellite’s orbit changes from a circle in the same plane as the equator to an ellipse inclined to the plane of the earth’s equator and moving along a widening figure 8-like path within the orbit along a north-south axis. The satellite is thus said to be in “inclined orbit.”

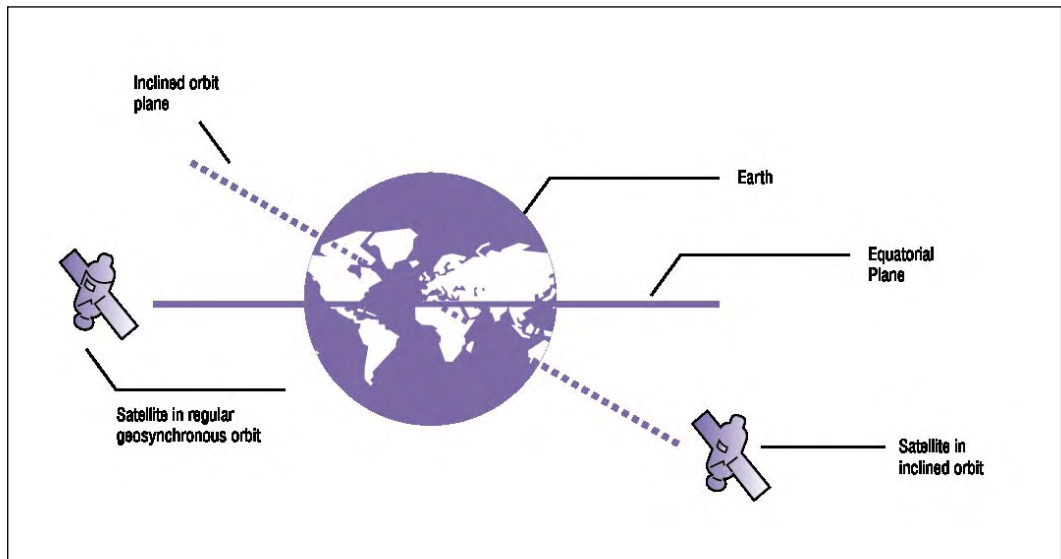


Figure 2- Illustration of an inclined orbit



The satellite in inclined orbit can still be used for communications provided that the dish on earth is movable and can track the irregular movement of the satellite. This can be accomplished by equipping the dish with an automatic tracking system that steers the dish and keeps it aligned with the satellite.

Satellite Beams

Signals sent down to earth from the satellite are said to form a “beam” like the light beam of a torch. Satellites are said to “illuminate” an area on earth with their beams. The area covered by the satellite beam is called its “foot print”. As can be clearly illustrated with a torch in a dark room, the larger the floor area covered, the less bright the illumination on the floor is. The same happens with satellite beams, with the brightness or intensity analogous to the satellite’s power (technically referred to as the Effective Isotropic Radiated Power or EIRP). Thus the larger the beam, the less power is generally available within the beam. There are four types of beams differentiated by size of the area covered and therefore the power they are able to deliver. In order of area covered, they are global beams which are the largest, hemi beams, zonal beams and spot beams which are the smallest. It follows then that spot beams are more powerful than global beams. The downside of course is that the spot beam covers a smaller surface of the earth, which can be present a problem if you want to connect two places far apart from each other using a single beam. Satellite operators usually provide maps showing the beam coverage and strength of the satellites power within the beam. These maps are referred to as contour maps and an example is shown in Figure 3.



Figure 3- Satellite contour map [source- Panamsat: Pas I R- C band Beam]⁵



As you might notice from the contour map in Figure 3, not all locations in the beam coverage receive the same power. Some areas even within the same beam will receive higher satellite power and may enable the use of smaller dishes for the same uses as those areas located within the lower power portions of the beam.

Frequency Bands

Signals to and from the satellite are in form of radio frequency waves which are a sub-set of the electromagnetic frequency spectrum. These signals are identified by the range of frequencies they occupy, referred to as the frequency band.

These ranges of frequencies which make up the “band” are designated by letters for easy identification. There are three main frequency bands used for satellite communications: C band, Ku band and Ka band. The particular range of frequencies and letter designations of each band are determined and allocated by the International Telecommunications Union or ITU.

The frequency bands differ by frequency and the coverage of their beams, with C band having the lowest frequency and largest beam coverage and Ka Band the highest frequency and lowest beam coverage. As we noted above, the larger the beam coverage, the lower the satellite power delivered. As a consequence of this relationship between beam coverage and satellite power, C band has the lowest power and Ka band the highest power. Satellite signals are also affected by rainfall, the degree of effect depending on the frequency band. This is explained in detail farther on in this section. The differences are captured in Table 1.

Band	Frequency in GHz	Area covered by beams (footprint)	Power delivered	Effect of rainfall
C Band	3 to 7	Large	Low	Minimal
Ku Band	10 to 18	Medium	Medium	Moderate
Ka Band	18 to 31	Small	High	Severe

Table 1: C, Ku and Ka bands compared

Traditionally, C Band was used predominantly but this is changing as C band systems are increasingly eclipsed by the higher frequency Ku band, and more recently, Ka band, which use even higher frequencies and require smaller dishes⁶. At the moment, Ka band is not available in Africa, probably because Ka band beams cover a very small area, usually a single city, and therefore are unlikely to be economical for small markets in the developing world.



The Effect of Rainfall on VSATs

If you have watched a television program delivered by satellite cable TV, you will notice that the picture tends to “freeze” and “streak” across the screen when it is rainy or cloudy. This is the effect of rainfall on satellite signals as they pass through the atmosphere. The higher the frequency of the signal, the more likely it is to get degraded or technically speaking “attenuated.” Thus C band is less affected by rain while Ka band is severely affected by rain. To explain this phenomenon, we shall need to revisit the mechanics of electromagnetic waves.

The fundamental equation for electromagnetic waves is

$$c = f\lambda$$

Where c is speed of light, which is a constant, f is the frequency of the signal and λ (called Lambda) is the wavelength of the signal. The wavelength is the distance between two successive points of the wave. Remember our signals to and from the satellite are in the form of electromagnetic waves. For satellite signals, the wavelength is in millimetres.

Now consider a rain drop, which is almost spherical in shape. If the wavelength of a signal is larger than the size of the raindrop, the signal is not affected as it moves through the rain drop. If, however, the wavelength of the signal is equal to or about the same size as the raindrop, then the signal could get reflected, refracted or even absorbed as it goes through the raindrop. Now remember there are billions of raindrops in the atmosphere when it rains (and some even in the form of moisture when it is not raining) and you get an idea of the severe distortion of the signal as it moves through all these raindrops, especially if their wavelength is about the same as the size of the raindrops.

Now remember that the shorter the wavelength, the higher the frequency through their inverse relationship, and you can now fathom why higher frequency bands such as Ku band and Ka band are likely to be more affected by rainfall than the lower frequency C band. This effect of rain is also referred to as “rain fade”.



Common uses of VSATs

VSAT systems can be used for a variety of applications that include but are not limited to:

- General Internet access; to provide internet-based services to places where the local telecom company infrastructure is non-existent, very expensive or unreliable. For example, VSATs have been used successfully in remote Telecenter projects.
- Distance Education (e-Learning); to enable courses conducted in one location to be transmitted to several other locations in real or delayed time, through videoconferencing or video broadcasting. VSATs are also used to provide Internet access for remote distance education “support centres” or “learning centres” and for e-learning.
- Telemedicine; to provide video, voice and/or images from remote health outposts, clinics and centres to a major hospital or health centre for analysis and to allow feedback from experts and consultants that are unable to travel to these outposts or remote health centres.
- Telephony; to connect towns and villages, located long distances from the major cities, to the national telephone grid cost effectively.
- Videoconferencing; live two-way video communications among two or more locations either lacking any (high-speed) terrestrial telecommunications network or where this network is low speed and unreliable.
- Banking; VSATs are used in banking for a variety of applications, but most commonly to link remote bank branches, Automatic Teller Machines (ATMs) and Points of Sale (POS) to the bank’s main branch or electronic clearing network.
- Virtual Private Networks (VPNS): Many companies have numerous branch offices spread across diverse locations which are often most effectively connected to headquarters via a VSAT network.
- Media – these are usually mobile VSATs installed on a van and used to track media events that require high coverage (for example, global meetings, war or sports), that are either broadcasted live or relayed to television networks. This is often called Satellite News Gathering or SNG.



VSATs and how they work

A VSAT is composed of a dish, technically referred to as an antenna, and a receive-transmit assembly, called a feed assembly, attached to the dish. This feed assembly is connected via one or two cables referred to as an Inter Facility Link (IFL) to electronic equipment (In Door Unit or IDU) that processes the information (voice, video or data) received or for transmission. This equipment is illustrated in Figure 4.

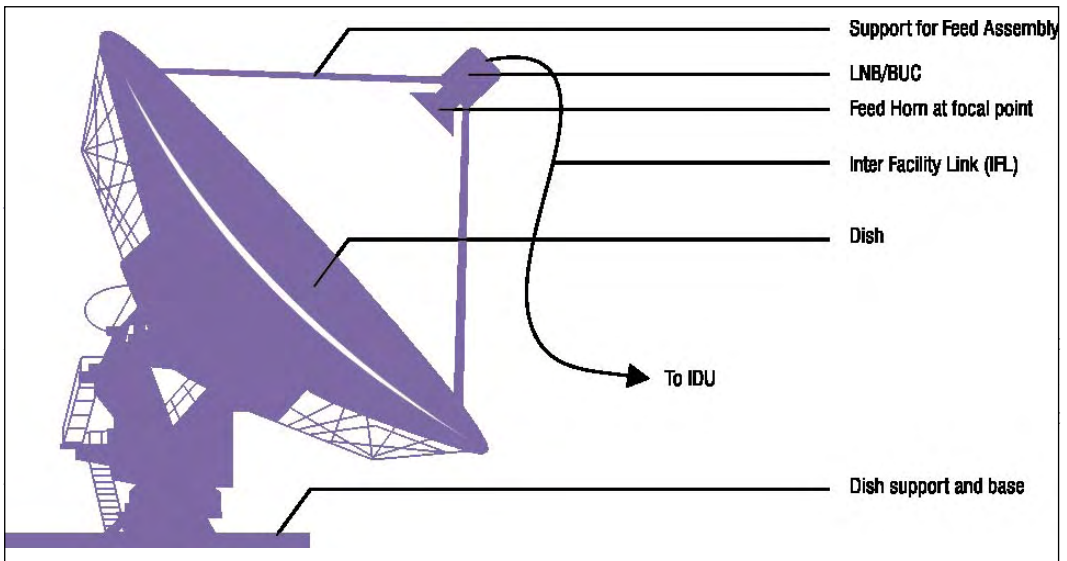


Figure 4- VSAT station

The dish receives and transmits signals, after reflecting and concentrating them, from and to satellites that are about 36 000 kilometres above the earth. The parabolic shape of the dish has special reflective properties that enable it to concentrate and focus signals to a single point, called the focal point. The reflective properties of the dish are illustrated in Figure 5.

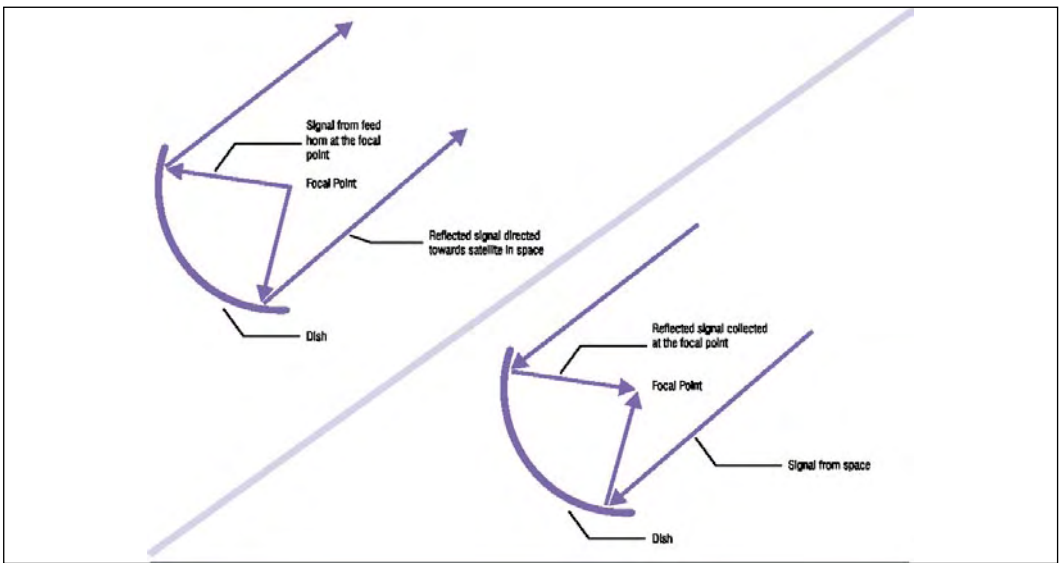


Figure 5- Reflection of receive and transmit signals

The feed assembly is placed at the focal point and consists of a feed horn, Ortho Mode Transducer (OMT), a Transmitter Reject Filter, Low Noise Block (LNB) and Block Up Converter (BUC), as shown in Figure 6.

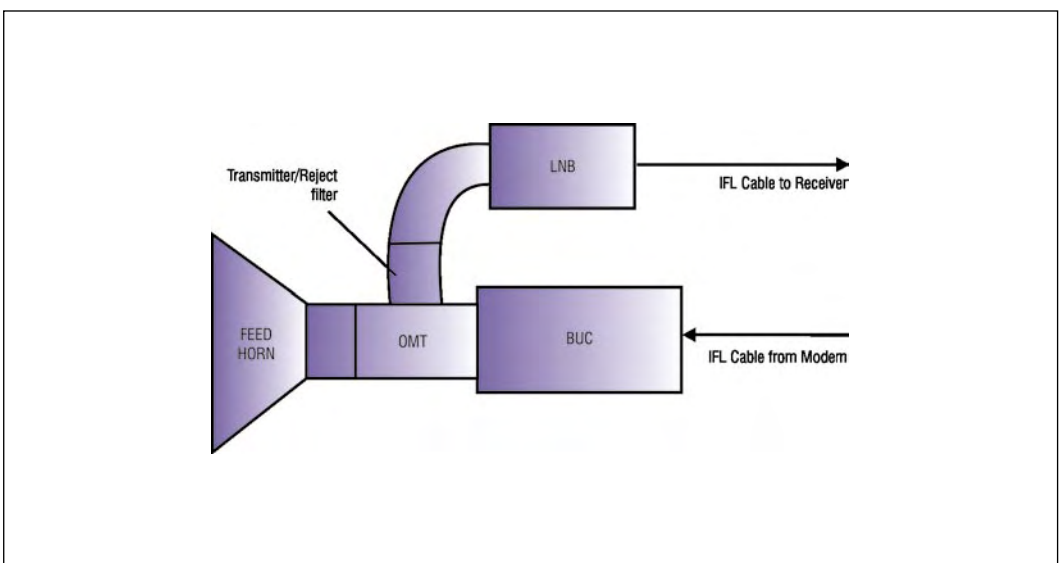


Figure 6 - Feed assembly

The signals from the satellite, reflected by the dish and converging at the feed horn, are weak and barely detectable after traversing thousands of miles in space. The signals will also have



picked up other extraneous signals, referred to as “noise”, as they traverse the atmosphere. The feed horn collects the weak reflected signals and passes them on to the LNB.

The LNB functions are twofold: to amplify or boost the weak received signals without amplifying the noise signals (hence the “low noise” part of LNB) and to convert the high frequencies of the signals into lower frequencies, a process called down converting, for conveyance to the IDU through the IFL Cable.

The IFL Cable is a regular co-axial cable. It conveys the down converted signals from the LNB to the IDU and from the IDU to the BUC. If the high frequencies were conveyed without down conversion, they would require the use of expensive and sophisticated wave guides (hollow metallic conduits) for conveyance. Down converted, the lower frequencies, on the other hand can be conveyed using cheaper co-axial cables.

In the case of receive-only VSATs, the IDU consists of a receiver (also known as a demodulator) whereas in the case of interactive systems it consists of both a receiver or demodulator and modulator. Sometimes, the demodulator and modulator are combined in the same box referred to as a modem. In receive mode, the receiver processes the signal and outputs useable information, data, video or voice, which can be passed on to the appropriate device connected to the receiver. For example, if the VSAT system is for internet access, a router, network switch or computer could be connected to the receiver.

In the transmission mode, the information is fed into the modulator, which mixes the information with a carrier signal through a process called modulation. The modulator then outputs the modulated signal to the BUC via the IFL coaxial cable. The BUC amplifies and increases the frequency of the signal and then feeds it to the feed horn. The feed horn then disperses the signal onto the dish, which reflects the signal, in a focused beam towards the satellite (see Figure 5).

The LNB and BUC are separated by the Ortho Mode Transducer (OMT) and the Transmit Reject filter which ensure that signals received and transmitted do not mix up and interfere with each other.

Figure 7 illustrates the process described above and how the various pieces of VSAT equipment fit and work together.

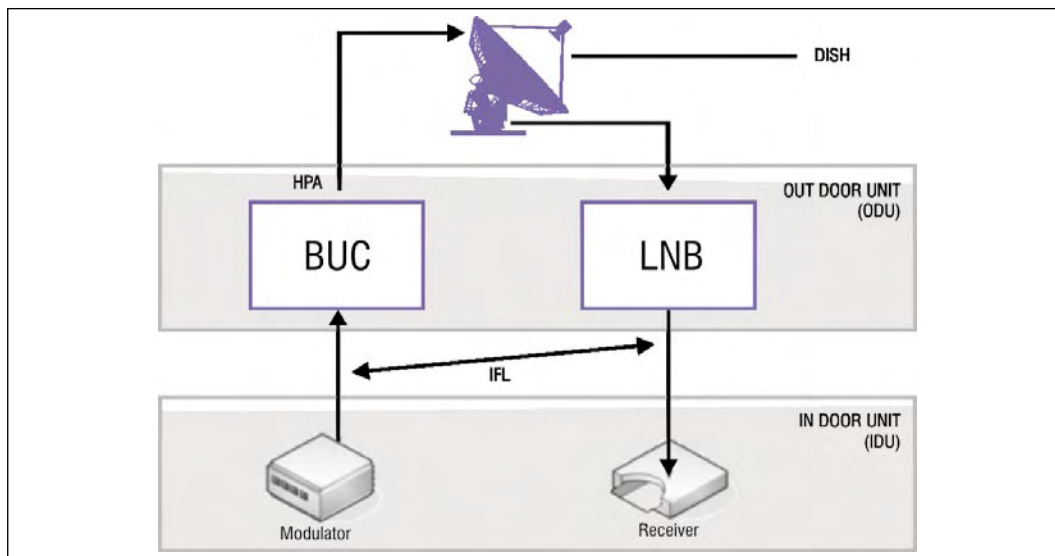


Figure 7- VSAT ODU and IDU

Look Angles, Elevation and Azimuth

VSATs require a direct clear and unobstructed view (also called line of sight) of the satellite in space. The dish must therefore be “pointed” directly and accurately at the right satellite to enable reception or transmission. The precise direction in which to point the antenna is determined by two parameters called “look angles.” These are the angle of elevation and the azimuth angle and are illustrated in Figure 8.

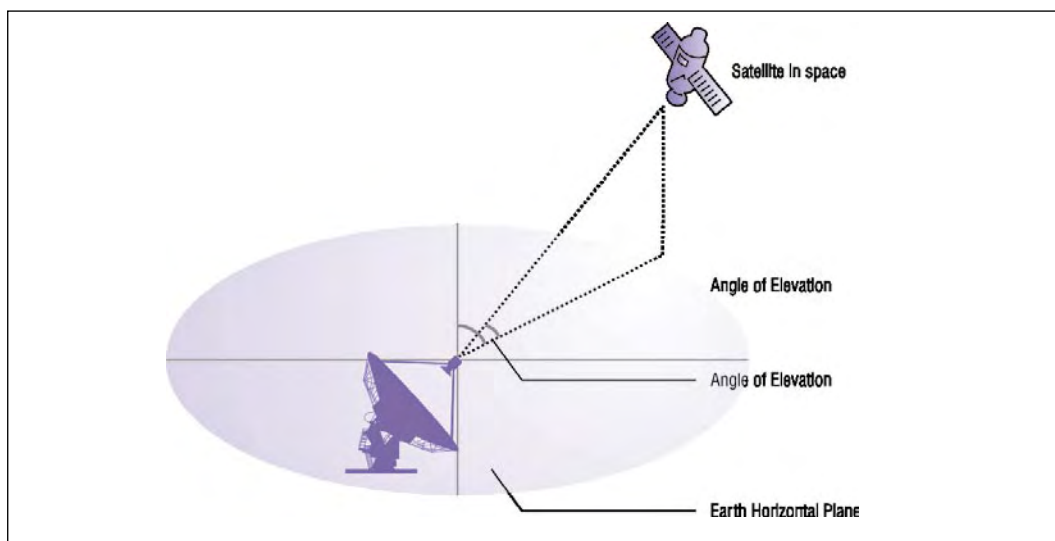


Figure 8 - Elevation and Azimuth angles



These angles are critical when installing the VSAT. The process by which the dish is pointed with the right elevation and azimuth is referred to as “alignment”. Low elevation angles of less than 10 degrees can cause problems with VSAT systems because the low elevation:

- Makes it difficult to clear buildings, plants or other objects for an unobstructed view of the satellite.
- Makes it more likely that the dish will pick up noise and electrical interference generated by the earth since it will be pointing almost into the ground.
- Increases the length of the path to the satellite. Signals to and from the satellite therefore pass through more of the atmosphere, a situation under which they are more likely to pick up additional noise and other interferences.

You will therefore notice that on most satellite footprint maps, locations with low look angles (usually the 0, 5 and 10 degree elevations), relative to the particular satellite are clearly marked.

Relationship between size of the dish and frequency

The higher the frequency of the band you use, the smaller the dish you require. This relationship between dish size and frequency stems from a parameter known as the Gain of the dish or antenna.

The Gain of an antenna is directly proportional to the frequency of the received signal and the size (diameter) of the antenna from the classic reflector antenna equation:

$$G = \eta (\pi D / \lambda)^2 \quad \text{which can also be expressed as } G = \eta (\pi D f / c)^2$$

Where G is the gain of the antenna, η is the antenna efficiency, D the diameter of the antenna, λ the wavelength of the received signal, which is inversely proportional to the frequency of the signal f through their relationship to the speed of light c.

Therefore, for any given antenna Gain, the size of the antenna required to receive a given signal will reduce as the frequency of the signal increases. This partially explains why the higher Ku Band frequencies utilize smaller antennas compared to the lower C band frequencies.



VSAT Architecture

A typical VSAT network will have many VSAT stations communicating with one another or connecting to a public network such as the Internet or the telephone network as shown in Figure 9.

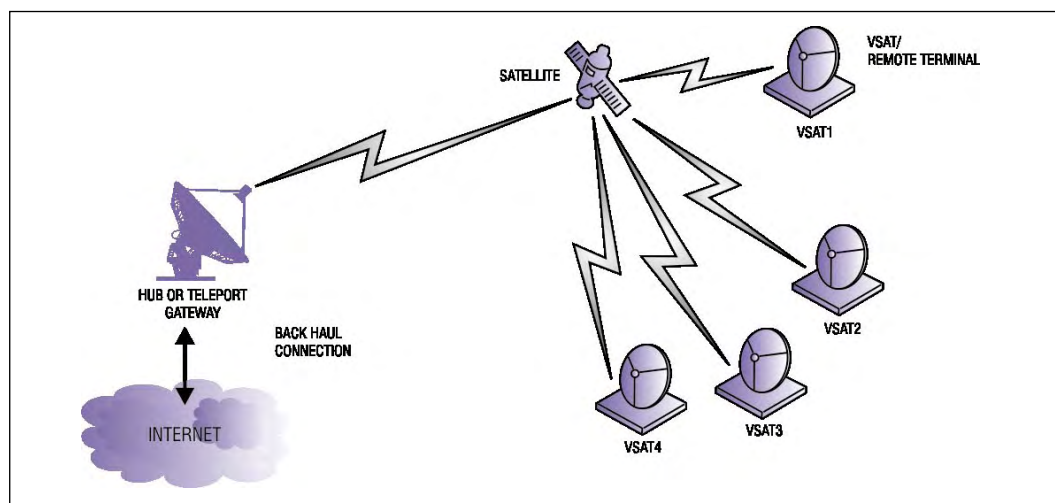


Figure 9 - VSAT Network

The VSAT network can be physically laid out or configured in various ways called network topologies. The VSAT stations in the network will communicate using either dedicated or shared bandwidth or channels using a variety of techniques called “access schemes.” This section briefly explores the common network topologies and access schemes in use.

Network topologies

There are five main network topologies:

Broadcast

This involves one terminal transmitting the message and several terminals receiving the message and is usually used in broadcasting where you can only receive but not transmit, for example in TV, radio and satellite video systems. Broadcast systems are also used for consumer Internet access; where low-cost receive only satellite dishes⁷ are combined with the use of



dialup telephone or mobile networks for the return path to the Internet. A broadcast network is shown in Figure 10, and will usually involve several receive systems and one transmitting system. Broadcast systems should not be confused with simplex systems. Simplex systems are two-way systems where transmission occurs in only one direction at a time.

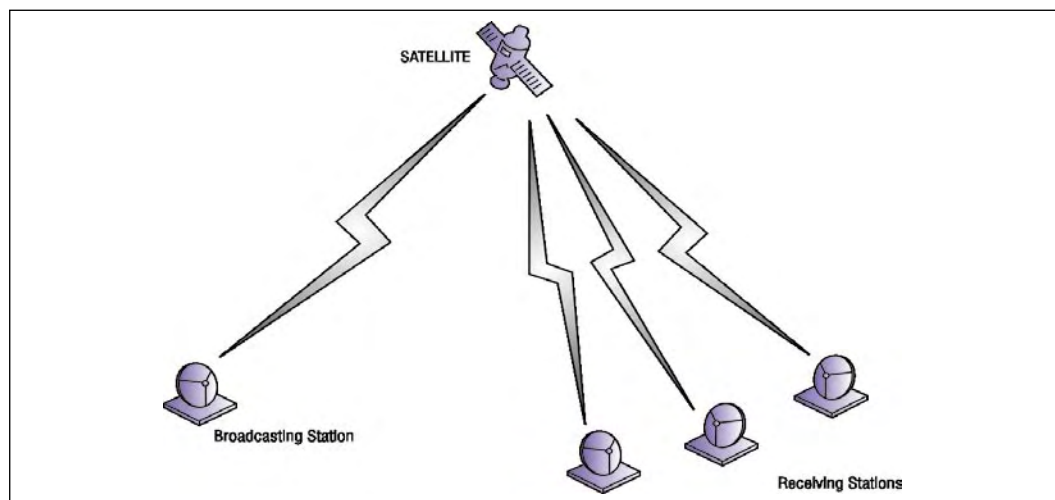


Figure 10- Broadcast connection

Point to Point

This is the simplest topology and involves only two terminals communicating directly with each other over a dedicated channel. Common applications include sending news reports from the field back to a central studio (Satellite News Gathering or SNG), providing telecommunication services to remote areas from a central switch such as extending the telephone connection to a remote town using VSATs and providing large amounts of bandwidth to Internet Service Providers. A point to point network is shown in Figure 11.

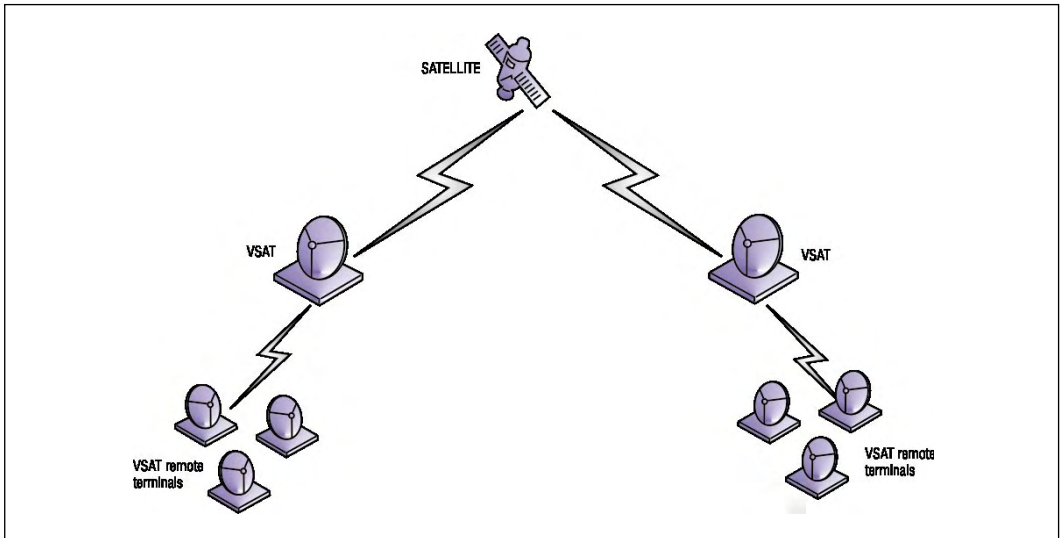


Figure 11- Point to Point network

Star

This is similar to a wheel's hub and spokes with several VSAT stations communicating through a central facility (the Hub) which regulates and controls communications. This is the more common network topology in use and is shown in Figure 12. The advantage of this topology is that the individual VSAT terminals can be kept relatively small (leading to lower start up costs) provided that a large dish (typically over 5 meters) is used at the Hub. The drawback of this network is that it is less suitable for “real-time” applications such as telephony between two stations *in the same network*, because this requires 2 satellite hops or jumps (double hop) - station 1 to Hub (first hop) and Hub to station 2 (second hop). The double hop leads to excessive “delays” or latency that affects real-time applications. Latency is the cause of annoyingly long delays most noticeable on long distance telephone calls.



Latency defined

Remember that Geostationary satellites are about 36,000 km above the earth. A signal sent up from one VSAT to the satellite and down to another satellite or the Hub will traverse about 72,000 km. If you recall, signals are electromagnetic waves and therefore travel at the speed of light (300 million meters per second), the time taken to travel to the satellite and back to earth, from the basic formula time equals distance divided by speed, is about 240 ms or about a 1/4 a second. That means that the round trip from transmitter to receiver and back is 1/2 a second. For a double hop, the round trip is almost 1 second.

This delay may not seem like much, but consider that the human ear will start noticing delays above 100 ms. Latency is the cause of the annoying delays when you are holding a long distance telephone conversation. If the delay is significant, the whole call experience may turn out to be very unpleasant. Latency is also the cause of "out of sync" voice and lip movement, which can be quite disconcerting, when you are following a videoconference or and when watching certain TV programs.

However, high latency can also significantly impact regular internet access reducing access speeds. For this reason, many VSAT providers now employ techniques such as TCP Acceleration or IP spoofing to reduce the impact of latency on regular internet access using VSAT. A fuller treatment of these techniques is beyond the scope of this Guide.

A good explanation can be found at http://www.bsatellite.com/Why_iDirect.html.

The delay of terrestrial systems such as fiber and DSL is between 15 ms and 60 ms making these ideal for real time applications such as telephony and videoconferencing.

Nevertheless, this is the current topology of choice employed by many VSAT Internet service providers. Typically, the Hub is connected directly to a high-speed telecommunications network or directly to the Internet and therefore issues of double hops affecting real-time communications do not arise, unless of course communication is between two stations in the same network. However, for Internet access only, double hops and their associated latency do not have any significant effect. This, of course, is likely to change as the Internet is increasingly used for VOIP applications, and even then the effects will be mostly felt when two or more stations in the same network are talking to one another.

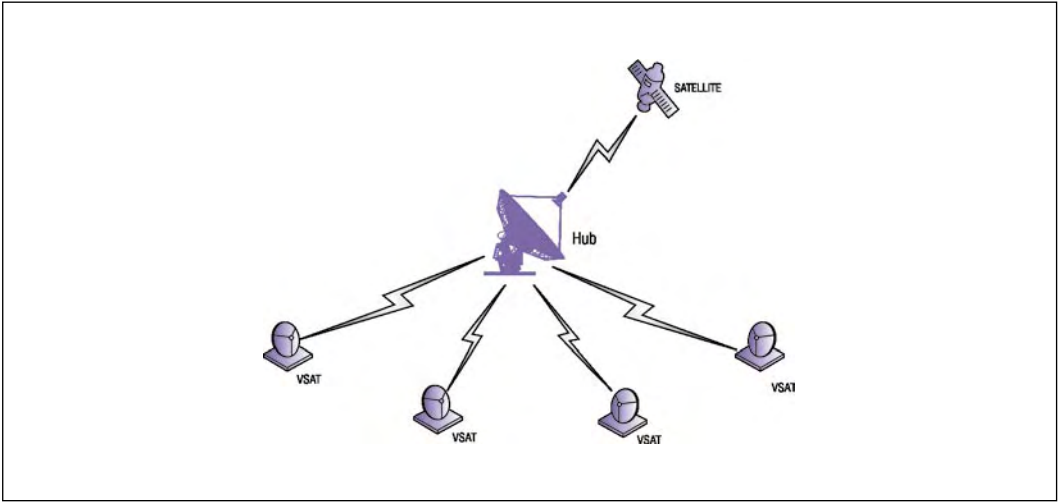


Figure 12- Star network

Mesh

In this network topology, shown in Figure 13, VSAT terminals have the ability to communicate directly with one another without going through a central Hub. As such, mesh networks are also referred to as “hub-less networks”. This topology requires relatively larger and more sophisticated VSAT terminals and indoor equipment which increases the start up costs. However, it is ideal for real time communications, such as telephony, among two or more locations in the same network.

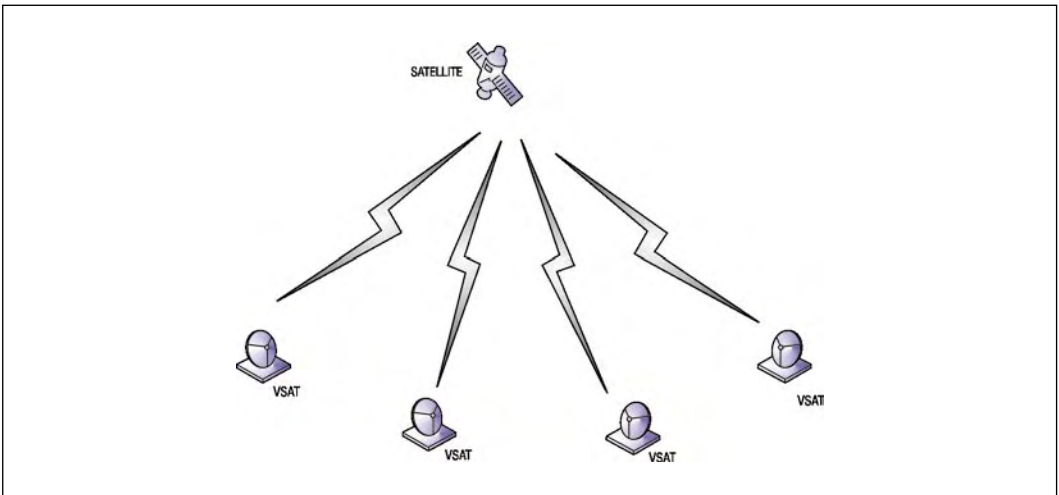


Figure 13- Mesh network



Hybrid networks

As the name implies, this is a blend or combination of star and mesh topologies, as shown in Figure 14. In a typical setup, most stations could communicate through a Hub, with a few stations having the ability to communicate directly with one another, without going through the Hub.

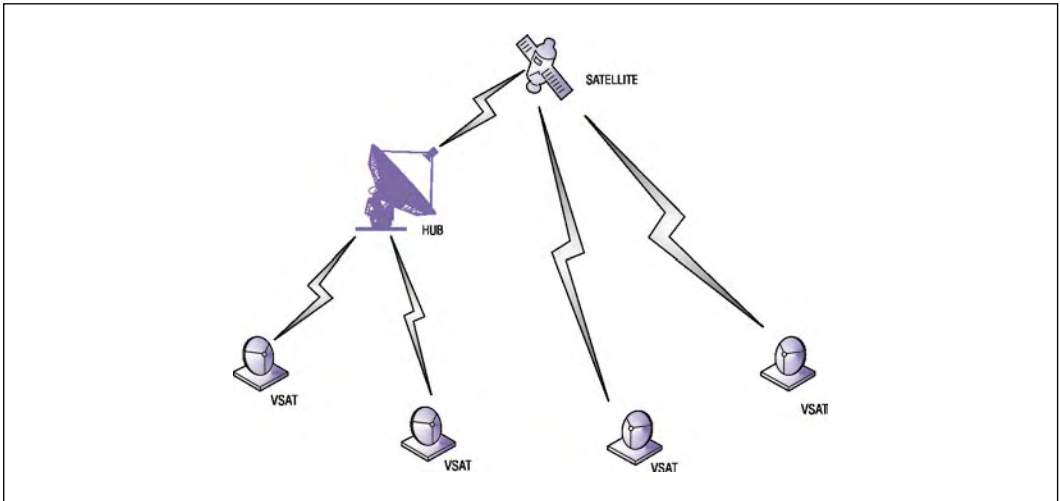


Figure 14- Hybrid network



A summary of the pros and cons of each topology is presented in Table 2.

	Pros	Cons
Broadcast	<ul style="list-style-type: none"> • Very cost effective if transmitting from one location to many locations simultaneously 	<ul style="list-style-type: none"> • Requires separate return channel e.g. telephone dial up connection for interaction
Point to Point	<ul style="list-style-type: none"> • Can transfer large amounts of information between two locations • Ideal for real-time communications as no double hops • May be cost effective to establish between two sites since no large Hub costs involved 	<ul style="list-style-type: none"> • Does not use a Hub so requires relatively large and expensive dishes at both sites • Bandwidth can not be easily shared with other sites and so not ideal for sporadic usage.
Star	<ul style="list-style-type: none"> • Requires relatively smaller low cost antennas at the remote locations • Bandwidth can easily be shared with other remote terminals and so ideal for infrequent “bursty” type traffic 	<ul style="list-style-type: none"> • Not ideal for real-time communications between two locations in the same VSAT network • Requires Hub which is expensive and so only cost effective if servicing many remote locations
Mesh	<ul style="list-style-type: none"> • Ideal for real-time communications among two or more stations in the same network since no double hops 	<ul style="list-style-type: none"> • Does not use a Hub so require relatively large and expensive dishes at any site
Hybrid	<ul style="list-style-type: none"> • Shares the pros of both star and mesh networks making it a flexible and adaptable network 	<ul style="list-style-type: none"> • Can be expensive to setup and run

Table 2- Pros and Cons of the different topologies



Access Technologies

With satellite bandwidth being a finite and expensive resource, various technologies have been advanced to make use of bandwidth as effective and efficient as possible. Access Schemes are the “rules” with which many VSATs in a network can share bandwidth when communicating with one another or with the Hub. There are five main access technologies used for VSATs:

Single Channel Per Carrier (SCPC)

As the name implies, every VSAT is allocated its own dedicated channel for communication. The channel is reserved and always “on” whether it is used or not. This “wastes” bandwidth when the channel is not being used and is only ideal for applications that require dedicated constant bandwidth. Many ISPs in developing countries connect to their upstream Internet provider using SCPC circuits as they are constantly in use and ISPs need guaranteed bandwidth to provide their customers with acceptable service levels.

Frequency Division Multiple Access (FDMA)

Under this access scheme, many VSAT terminals can communicate using a single channel. The VSAT terminal can only transmit and receive a fixed pre-determined frequency. As many VSATs can "share" and use the same channel, this scheme makes for more efficient bandwidth usage.

Demand Assigned Multiple Access (DAMA)

In this access scheme, each VSAT in the network is allocated a communication channel only when it is ready to communicate or “on demand.” This access scheme is usually used in conjunction with other access schemes such as SCPC or FDMA to improve the bandwidth utilization in a VSAT network that does not require each VSAT to have a dedicated channel all the time.

Time Division Multiple Access (TDMA)

In this access scheme, VSAT stations in the network share one channel, each VSAT using the channel at separate times from the others. The upside of this scheme is that the shared channel capacity need not be much higher than the average transmit capacity of any terminal since it



is shared, and therefore significant bandwidth savings can be obtained. The downside is that every terminal, regardless of capacity must be capable of transmitting up to the maximum capacity of the shared channel. Where there is a large capacity to be transmitted, large power amplifiers are required and this will increase terminal costs.

Hybrid Systems

Many VSATs systems will use different access schemes to receive and transmit information. For example, it is common to find VSAT systems using SCPC for transmission but TDMA or FDMA for reception.

Some common technical considerations

There are a whole host of technical considerations you will need to make when buying a VSAT. Most of them involve making trade offs among the technical characteristics that give you what you want and what you can afford. The common considerations you may be forced to make are:

- Whether to use inclined orbit satellites
- Whether to use C or Ku band
- Whether to use shared or dedicated bandwidth

Service Providers Weigh In

Africonnect says “ensure you understand the differences between the services that you are being offered (including C band vs. Ku band; contention levels; usage limits; CIR and burst capacity; availability of voice services”

Information Technology Service Limited (ITS) advises that you should specify the service you require e.g. internet access, VOIP, data transfer; Service Level Agreement; and the local regulator rules (license and authorization)?



Use of Inclined Orbit Satellite

The price of bandwidth on inclined orbit satellites is usually much lower since these satellites are nearing their end of life. The downside is that it requires a dish with tracking capabilities that can be very expensive. The high capital costs associated with the expensive antenna can be offset by lower operating costs but only if you are purchasing large amounts of bandwidth. You should therefore make sure that you carefully consider both your capital and operating costs over the period you intend to operate the VSAT. Of course, remember to ascertain the exact remaining life of the satellite, when making this consideration. If you decide to opt for inclined orbit capacity, caution is advised as the service can be down for a while in the event that you are running mission critical applications.

C Band vs. Ku Band

One of the big decisions you are likely to encounter when buying a VSAT is whether to use C band or Ku band. In order to enable you to arrive at an informed decision, we have briefly presented the advantages and disadvantages of each band. The 'Open and Closed Skies: Satellite Access in Africa'⁸ provides a visual map of C band and Ku band coverage over Africa.

Advantages of using C band

- C band is less affected by rain. If you happen to live in a high rain-fall area such as the tropics and your VSAT applications are “mission critical”, in other words, you want your system available all the time, you can opt for C band over Ku band. However, this does not exclude the use of Ku band systems in the tropics especially for home TV and Internet access since these are not mission critical applications and the consumers can live with a few hours of intermittent service.
- C band systems have been around longer than Ku band systems and thus rely on proven technology. However, Ku band systems seem to be overtaking C band systems as the preferred technology in the home consumer business in the last few years. Note that Ku band dishes are more likely to be smaller and therefore cheaper for any given application, because of Ku band's higher frequencies. You should also bear in mind that Ku band bandwidth prices are higher than C band prices and therefore any savings on capital costs could be offset by higher operating costs.



- C band satellite beams have large foot prints with the global beam covering almost a third of the earth's surface. If you are looking for single satellite hop operation (e.g. for real time applications such as telephony or videoconferencing) to connect locations far apart from one another, you may be forced to choose the wider coverage C band beams. However, the latest satellites launched have large Ku band beams covering entire continents. You should also note that two beams on the satellites can be connected through a method called "cross strapping" thus allowing two or more locations covered by two separate beams to be connected in a single hop.

Disadvantages of C band

- C band requires the use of larger dishes which can be quite cumbersome to install and are more expensive to acquire and transport.
- C band systems share the same frequency bands as allocated to terrestrial microwave systems. As such care must be taken when positioning C band antennas in areas where terrestrial microwave systems exist (for example TV or radio stations). For this reason, C band satellite transponder power is deliberately limited during the satellite's design and manufacture according to sharing criteria laid down by the ITU, leading to a requirement for larger dishes on the ground.

Advantages of Ku band

- Ku band systems require smaller dishes because of their higher satellite transponder power and higher frequencies, which translates into smaller, cheaper antennas on the ground and therefore lower start up and transport costs.
- The smaller Ku Band dishes can be easily installed on almost any surface- the ground, roofs or bolted to the side of buildings. This is an important consideration for areas with limited space.

Disadvantages of Ku band

- Ku band systems are more affected by rainfall because of their higher operating frequencies and as such are usually considered unsuitable for mission critical applications in



the tropics, unless specific measures are taken to provide for the added rain attenuation, for example by using larger dishes. This drawback has also been slightly offset by the higher power satellites being manufactured today. As noted above, Ku band systems are gaining popularity even in the tropics for home use where users can survive a few hours of intermittent service a month.

- Ku band satellite systems usually have smaller beams covering a small surface of the earth. Therefore if you intend to cover two locations a large distance apart, within a single hop or with a broadcast system, you may need to consider C band systems.
- Ku band bandwidth is more expensive than C band bandwidth. As noted above, the savings in capital cost you gain using Ku band's smaller antennas may be negated by the higher operating costs imposed by high bandwidth prices.

Advantages of Ka band

- Ka band dishes can be much smaller than Ku band dishes because of the even higher Ka band frequencies and higher satellite power. The smaller dishes translate to lower start up costs for equipment.

Disadvantages of Ka band

- The higher frequencies of Ka band are significantly more vulnerable to signal quality problems caused by rainfall and therefore Ka band VSATs are usually unsuitable for mission critical or high availability systems in the tropical and sub-tropical regions without the provision of measures to combat adverse weather conditions.
- Also, Ka-band systems will almost always require tracking antennas.
- Ka band bandwidth is more expensive than C band or Ku band bandwidth.
- Ka band is currently unavailable over Africa.



Shared vs. Dedicated Bandwidth

It is critical for you to decide whether you will accept shared or dedicated bandwidth. Shared bandwidth refers to bandwidth that is shared with other customers of your service provider. Dedicated bandwidth is “committed” solely to you. Shared bandwidth is obviously cheaper than dedicated bandwidth because you are also sharing the cost of the bandwidth among other users. Unfortunately, some service providers pass off shared bandwidth as dedicated bandwidth and charge you rates equivalent to those for dedicated bandwidth. You therefore have to be clear what you are buying.

Shared bandwidth is desirable when you will not be using all the bandwidth all the time. If your primary applications will be email and web surfing and you do not have many users e.g. a community telecenter, then shared bandwidth may well work for you. However, if you have a large volume of users accessing the system throughout the day or if you intend to run real time applications such as telephony or videoconferencing, then you will need dedicated bandwidth.

There are three key metrics you will need to consider when purchasing shared bandwidth:

The contention ratio

Contention is a term that comes from terrestrial internet systems such as Digital Subscriber Link (DSL) and refers to sharing. The contention ratio is the number of users sharing the bandwidth. Obviously the more users sharing the bandwidth, the less bandwidth you get if they are all online. For instance if you are sharing bandwidth with a capacity of 1 Mbps among 20 customers (contention ratio of 20:1), then your maximum connection speed when all the customers are using the bandwidth is 50 kbps, equivalent to a dial up modem connection. If, however, the contention ratio is 50:1 or 50 customers sharing the connection, then your maximum speed when all customers are using the system is 20 kbps. As you can imagine, how much of the 1 Mbps promised by the service provider you actually get depends on the contention ratio. Contention is also called “over booking” or “over selling” capacity.

Committed Information Rate (CIR)

Even with shared bandwidth capacity, your service provider may guarantee you certain minimum capacity at all times. This guaranteed capacity is the CIR. In our example above using a contention ratio of 20:1, this CIR would be 50 kbps, even though you are quoted a bandwidth capacity of 1 Mbps.



Bursting capacity

Bursting refers to the ability of a VSAT system to utilize capacity above and beyond its normal allocation. Bursting is only possible when you purchase shared bandwidth. If your service provider has implemented bursting, a portion or all of the shared bandwidth capacity will be pooled. For instance, several portions of 1 Mbps may be pooled together. When other customers are not using their capacity, you may be able to “burst” or use more than your allocated capacity. Note that bursting also only occurs when there is ‘free’ or available capacity in the pool. The amount of additional or burst capacity to which any VSAT station sharing the pool is entitled to is limited to a set maximum, usually less than the total pool capacity to ensure that there is always capacity available for other VSAT stations.

In summary, when purchasing shared capacity, you should ask your service provider to specify the contention ratio, your CIR and how much bursting capacity you can get.

There is one instance when you should consider shared capacity even when you have heavy users and real time applications. This is the situation in which you own the entire network. You would essentially be buying a chunk of dedicated bandwidth and then sharing its capacity among your network. The reasoning behind this is that if all VSATs are part of the same network, with the same profile of user, then you are likely to have instances when capacity would be unused. For instance, not all the VSATs in your network may be making voice calls or participating in videoconferencing all the time. This method is especially suited to global organizations with offices in different time zones.

Regulatory considerations

As we close this section on VSAT technologies and systems, it is appropriate to point out one factor that is likely to make or break your efforts to acquire and operate a VSAT, even before you contemplate purchase. This is the issue of licensing. In ALL countries, interactive VSAT terminals require special telecommunications licenses, and some times registration fees, prior to installation and operation. In many developing countries, the telecommunications environment is heavily regulated and only the incumbent telecommunications provider, which is usually a monopoly, is allowed to install and operate VSATs. In other countries, the telecommunications sector has been deregulated. In some countries, however, this may mean that only a few special operators are granted licenses to operate VSAT terminals, or the licensing process is so complicated rendering it almost impossible or the costs are very prohibitive as to lock out all but the richest multinationals or international organizations.



The good news is that most countries are deregulating their telecommunications sector even further and streamlining the licensing process. As a result, it is increasingly possible to obtain a license at a relatively low cost and without much difficulty. In any case, there are several innovative ways to go about acquiring VSAT licenses. One of the easiest ways is use your provider's license if they already have one. You should check to see if your service provider already has a license that you can use. This approach has been used by organizations such as Schoolnet Uganda and the Cameroonian university network, Réseau Interuniversitaire du Cameroun (RIC).

We should particularly point out the situation with Non Governmental Organizations (NGOs) or Community Service Organizations (CSOs). Some countries will waive or significantly reduce license fees, for these organizations because of their non profit and social development goals. For example, the Malawi Library and Information Consortium (MALICO) acquired their VSAT license from Malawi Communications and Regulatory Authority (MACRA) at a much reduced registration fee and no licensing charges for the first five years. Even in places where deregulation has not completely opened up the industry, a case can be made for use of a VSAT system to support a development project or social program. We would encourage you, if you fit this category of user, to explore this option in case you run into licensing problems.

Full and detailed information about VSAT regulation and licensing for most African countries can be found at the website of the Global VSAT Forum (www.gvf.org).



PART 2

GUIDE TO BUYING A VSAT SYSTEM





This section forms the heart of the Guide. It presents a sequence of steps and activities that you should follow in order to buy and operate a VSAT system that is right for your needs, within your budget and realizes a positive return on your investment. The overall buying process is summarized in Figure 15. You will notice that the actual acquisition phase is only part of the effort involved in buying a VSAT. This should stand out as an important lesson for you: buying a VSAT is a complex process that requires careful planning prior to and post acquisition.



The buying process involves four main steps, each with a number of activities that must be undertaken:

- Define your needs
- Develop a business plan and budget
- Acquire the VSAT
- Support and maintain the VSAT

It should be noted that this buying process, while tailored to VSATs, can be generally applied to the purchase of any complex ICT system.

The sections that follow will explore each of the steps in detail.



First things First

SUPPLIERS WEIGH IN⁹: DOS AND DON'TS FOR BUYING VSATS	
DO	DO NOT
Develop a well thought out business plan and work with your provider to obtain both technical and marketing information to ensure success of the VSAT implementation. The business plan should have clear objectives thus ensuring ease of scalability over time.	Do not over commit to either the satellite operator for bandwidth or the equipment provider for hardware at start-up. You can do this by minimizing the length of the contract and/or including provisions to terminate service with limited penalties.
Develop a list of the services you require i.e. internet access, data transfer, video conferencing, VoIP etc and if they need to be available 100% of the time.	Do not sign a Service Level Agreement (SLA) ¹⁰ that can not be provided i.e. does not spell out how the agreement will be monitored, how service levels will be tracked, how frequently they will be reported and how often performance will be reviewed.
Determine your bandwidth and hardware requirements and develop the budget accordingly.	Avoid the lure of low prices as this can end up actually costing more. Consider the whole business (technical and financial) proposition instead of focusing on a few seemingly low prices.
Make sure the appropriate infrastructure is in place to support the VSAT i.e. LAN, power requirements, security, technical skills etc	Do not install a VSAT system without proper power backup as damage may occur to the In Door Unit (IDU) in the event of power fluctuations.

Review all your connectivity options

It is important to remember that there may be other more suitable, cost effective and efficient connectivity options to consider aside from VSATs. This fact is often overlooked by organizations seeking to connect to the Internet, leading to what might be described as “technology tunnel vision”. Decision makers are apt to catch on to and demand the latest “hot” technology, as opposed to first thinking about their objectives, and then considering the range of possible solutions. The result is that these organizations try and adapt the solution to their business needs instead of letting their objectives drive the selection in the first place.



The choice of connectivity is determined by four main factors:

Feasibility

In some areas, a limited range or even single connectivity option is feasible, while in others a large number of connectivity options are feasible. VSATs may be the only possible connectivity option for remote rural villages with no terrestrial telecommunications network. This characteristic of VSAT systems gives rise to the notion that it is a “technology of last resort.” On the other hand, urban areas may have a good fiber or other terrestrial telecommunications network. In fact, fiber is a realistic option for countries in Africa connected to the SAT-3/WASC (South Atlantic Telecommunications Cable Number 3 and West African Submarine Cable) with landing points along the western coast of Africa from Morocco to South Africa and the northern coast to Egypt and soon for those which may be connected to the upcoming East African submarine cable system (EASSy)¹¹.

Why VSATs?

A review of our 4 case study institutions' reasons for buying VSATs is informative:

MALICO: VSAT was the preferred option due to the cost and lack of fiber optic cables available in Malawi.

Réseau Interuniversitaire du Cameroun: Cost and convenience were considered the main factors in selecting VSATs.

AVU: The results from the consultants hired indicated that VSAT was favored against options like fiber networks and was the only viable solution for the short to medium term.

SchoolNet Uganda: On review of ISDN, VSAT and microwave options, the cost and convenience offered by VSAT was favored over the rest and thus the preferred option for connectivity.

Another factor to consider under feasibility is license requirements. In some countries with heavily regulated telecommunications sectors, certain technologies such as VSATs or WIFI are restricted and or have high licensing costs rendering them unfeasible. If more than one option is available, then the next step is to evaluate the options against the other metrics discussed below.



Bandwidth Capacity

The maximum bandwidth capacity of a particular technology is another key factor in selecting one connectivity option over another. Having high capacity applications such as videoconferencing may preclude the use of low capacity options such as dial-up internet connections. It is important to consider both current and future capacity requirements, so that any selected option allows for scalability in the future. Otherwise, you may find yourself having to buy a new system when your bandwidth needs increase.

Reliability

Reliability includes such factors as latency, availability, mean times between failure (MTBF) and mean time to restore (MTR). For example, some technologies, including VSATs, have high latency making them unsuitable for real-time or VPN applications under certain conditions. See note in Part 1 about latency and its effects.

Cost

Cost is often the decisive factor in selecting from connectivity options that fulfill the other criteria outlined above. You should consider both one time or initial investment and ongoing or recurring costs throughout the useful life of the system selected. This is also known as the Total Cost of Ownership (TCO).

A comparison of common connectivity options, based on the factors discussed above is summarized in Table 3.

VSAT is a technology of last resort for reasons of cost and support, although it remains invaluable as a way of getting connectivity to places where it would otherwise be impossible¹².



Connection method	Capacity (maximum)	Feasibility	Start up costs	Average running costs/ per kbps (USD) ¹³	Reliability	Capacity Scalability
Dial up connection	56 kbps	Medium- anywhere with landline coverage	Low < \$50	\$ 12.90	Low to medium	Very low < 64 kbps
Leased wire line	ISDN – 128 kbps DSL- 1.5 Mbps	Low- depends on country's telecom infrastructure	Medium < \$2,000	\$ 2.87	Medium	Medium < 4 Mbps
Terrestrial Wireless	WIFI 802.11 a and g- 54 Mbps WIFI 802.11 b- 11 Mbps WIMAX- 75 Mbps	Low to medium- depends on country's telecom infrastructure although can be set up relatively cheaply	Low to Medium \$50 to \$2,000	\$ 6.77	Medium to High	High < 100 Mbps
Mobile/ Cellular	Basic GSM- 9.6 kbps GSM- HSCSD- 38.4 kbps GPRS- 171 kbps EDGE- 384 kbps UMTS- 2 Mbps	Medium - anywhere within cellular coverage	Low < \$50	\$ 12.90 ¹⁴	Low	Low < 2 Mbps
Fiber	In theory unlimited	Low - depends on country's telecom infrastructure	Medium < \$2,000	\$ 4.14	High to Very High	Very High > 1 Gbps
Satellite	<ul style="list-style-type: none"> VSAT- 100-155 Mbps (when loaded transponder downlink) Mobile satellite- 64 kbps (e.g. Immarsat, Worldspace) 	Very High - anywhere on earth	High to Very High > \$2,000	\$ 7.30	High to Very High	High < 155 Mbps

Table 3- Comparison of connectivity options



Preparing to start the VSAT acquisition process

Once the idea of buying a VSAT is mooted, you should consider forming a Committee or Working Group or Task Group of people who will be involved in the planning and acquisition of the VSAT. We are aware that this may not sound right to some of you whose experiences with committees are those of bureaucracy, permanency and a cover to avoid decision making. We agree that committees are often misused. For this reason, we shall predominantly use the term Working Group instead of Committee. However, VSATs are a complex acquisition combining equipment and long term service provision, which requires a mix of different skills and expertise to be brought to bear. To improve your chances of success, you need to ensure that the Working Group has a head or chairperson, who has decision making authority, effective leadership and management skills, and is fully accountable. This means either the head of the institution or a senior person with the authority to make decisions such as the head of the ICT or finance department, where this exists. You must also ensure that Working Group members have sufficient time to commit to the project.

If you are a small organization, you may not necessarily have to create a formal Working Group, but instead opt for a simpler approach where you could hold occasional one-off meetings together with regular email updates to those involved. However, even in this case, one person must be responsible for the overall project. This person will ensure that meetings are held, regular updates are provided to all involved in the process and that the project stays within budget and on schedule.

Intelsat cautions - "A major satellite bandwidth/ VSAT provision project may require months of planning, RFP preparation, bidder responses, bidder evaluation, negotiation and execution of contracts, procurement and delivery of equipment. A realistic timetable should be set as the larger the procurement the more time should be allocated for all these functions"

The Working Group to be created should draw representation from a wide cross section and be representative of all major stakeholders, who may include the major departments in your organization or even the community if you intend to provide community services. A large Working Group is unwieldy and you are advised to consider no more than 6 people. The committee should be composed of people skilled or knowledgeable in technology, finance and procurement. An all inclusive or representative committee is aimed at achieving two goals:

- i) To gain buy-in and shared understanding of the VSAT project across all sections of the institution, community or among all the stake holders. Remember that VSATs are an expensive undertaking for which you will have to pay for several years.



- ii) To help ensure that the requirements, expectations and views of all stake holders are captured. This results in purchasing a VSAT solution that adequately meets the needs of all stakeholders.

Lessons from RIC Procurement process

RIC invited expressions of interest (EOI) prior to issuing their RFP. Based on the EOI responses, they interviewed a group of potential service providers. This process eventually led to the selection of a service provider they had been in constant discussion with from the onset of the project and was easy to continue the existing relationship.

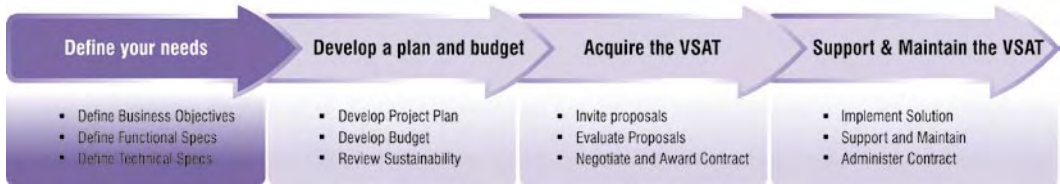
Challenges

As the network involved several universities, in some universities there was no one available to facilitate connection among the sites. In hindsight, ample time should have been provided for prior sensitization visits with the involvement of all the project stakeholders from the project planning phase to the end thus providing for ownership of the project across the network.

If you lack specialist staff in technology or finance, you should consider hiring a consultant(s) or asking for help from some of your external stakeholders such as the community or funding agency. If you do engage a consultant(s), remember that you are still accountable for the VSAT solution that you will eventually acquire and therefore this is not an excuse to delegate your responsibilities.



Step 1- Define Your Needs



Buyers of ICT systems often put the cart before the horse: they make acquisitions before deciding what they are going to use the system for, analyzing its benefits, considering the long term cost implications and any changes they may need to make. It is important to remember that ICT is a tool- it is not an end in itself. Therefore the right ICT should be chosen after it is clear what problem you are seeking a solution to or trying to address.

With this in mind, the first step in your VSAT buying process should be to reflect on and consider all your needs. This is also referred to as conducting a needs analysis.

The results of your needs analysis will be presented in three major ways, as:

- Business Requirements
- Functional Specifications
- Technical Specifications

Determine your business requirements

Business requirements are a statement of the problem you are trying to solve, the results you desire and the manner in which you wish to realize them. In detail, it requires that you define:

- What needs you are trying to address. The needs to address could include enabling basic communications using email and access to electronic resources or conducting meetings electronically. The former would require low amounts of capacity while the latter might require high capacity with real time communication capabilities.
- Who the beneficiaries or users will be and what their needs are. You will have to analyze the users' characteristics such as their location(s), age group and usage



patterns. For instance, a community telecenter may be adequately served with low bandwidth applications, such as email and simple web browsing, if used primarily for community access to information. These bandwidth requirements may dramatically change if the same community center will support distance education students or tele-medicine.

Business objectives from our case studies

SchoolNet Uganda: The VSAT pilot project is part of an on-going international initiative by World Links Program to pilot new concepts in technology and pedagogy to integrate Information Communication Technology (ICT) in education in developing countries.

RIC: To share and distribute resources among the 7 Cameroon universities, to reduce communication costs and to provide a medium for the exchange ideas among the universities in the network

The AVU: To provide affordable bandwidth by purchasing in bulk and extending the savings to its participating institutions for the ease and deliver of e-learning programs.

- What your short, medium and long term requirements are. While it may be difficult to anticipate the long term requirements, most organizations have a business or strategic plan spanning 3 to 5 years which can be scrutinized to arrive at these longer term requirements. Long term requirements can be used to predict future bandwidth needs, which may have an impact on the size of antenna, power of the BUC, characteristics of modem and access scheme to use. If short, medium and long term bandwidth requirements are not considered, it is possible to render a VSAT system bought today inadequate in a matter of months because of a large increase in bandwidth requirements.

- What your expected benefits or impact of the VSAT will be. This helps to evaluate various VSAT solutions against both objectives and benefits to ensure a tight fit between the selected VSAT solution and your specific and unique requirements. Benefits and impacts should, in so far as is possible, be quantifiable as this provides real figures to measure the returns due or success of the system. Examples of benefits could be:

- ☆ For an educational institution
 - 30% reduction in distance learning student failures or drop out due to increased and improved communications between the students and tutors facilitated by electronic means on and off campus in 3 years



- ☆ For a commercial entity
 - 50% reduction in time required to receive and processes orders and requests from remote branches
- ☆ For a telecommunications company
 - 20% increase in the number of subscribers in remote locations
- ☆ For a community telecenter
 - 20% increase in the number of Internet access and community telephone subscribers
- Whether you are purchasing a new system or you need to upgrade an existing system. If you already have a VSAT system and you need to increase the bandwidth of your connection, it is wise to first evaluate the feasibility of upgrading your existing VSAT instead of rushing into purchasing a new one.
- Whether fulfilling your business requirements requires or changing existing procedures or processes. It is important for you to plan for change management, obtain buy-in and engage users and staff before purchasing the VSAT. For example, with internet access, you may consider submitting reports and newsletters by email or putting your evaluations online, which may require changing your current business processes.

How to determine your business requirements

One approach often recommended by experts is to undertake what is known as a “Gap Analysis”. This involves determining what you have now and what you need in the future and then comparing the two to obtain your “gap”. This gap then forms the basis for defining your needs and requirements. Whichever approach you decide to follow, it will have to involve one or all of the following:

- Conducting debates, brain storming sessions and discussions within the Working Group and the broader stakeholder community.
- Interviewing all potential users by sending out questionnaires or using focus groups

You may elect to have the Working Group members undertake this needs analysis or hire a consultant to conduct the needs analysis. Consultants are often used if the project is very large and complicated, for example covering multiple sites.



Examples of business objectives or requirements

Business objectives for a university could be:

- To improve access to digital educational and research resources such as digital libraries, electronic journals and other content repositories.
- To enable easier communication between students and faculty or tutors on and off campus.
- To enable professors and students to interact, communicate and collaborate with their peers globally.
- To enable the global distribution and publishing of academic materials.
- To enable students to access educational and learning materials off campus and thereby increase the number of enrolled students or increase the flexibility of learning.
- To enable the joint development of electronic course materials with other universities.
- To enable the sharing of expert teaching resources (e.g. professors) with other universities.

Business objectives for a community telecenter could be:

- To promote the community and the community's products nationally and internationally.
- To enable the community access information on markets, prices, technologies and trade regulations.
- To enable easier communication and collaboration between members of the community and other communities.

Business objectives for a Non Governmental Organization (NGO) with several offices could be:

- To provide fast and effective communication among branch offices in remote locations.
- To reduce on telephone communications costs.
- To provide centralized and regularly updated information to all offices in the network in a cost effective, timely and efficient manner.



Define your functional specifications

Once you have your business requirements spelled out and the problem defined, they need to be captured in a form that technical personnel can interpret. This process is known as defining the functional specifications. These are half way between the technical specifications and simple business requirements.

Functional specifications are a statement of the purpose, specific functions and details of what the system should be able to do. It often includes the intended uses, applications, system capacities, key performance parameters, access issues, inter-operability issues and overall flexibility of the system.

Direct On PC checklist for functional specifications

1. What is your total network and application bandwidth demand?
2. Do you require shared or dedicated bandwidth?
3. What are your Uplink and Downlink requirements?
4. Do you require access to the Internet or Intranet?
5. How many computers and VSATs will be connected to the Internet/Intranet?
6. How many voice channels do you require?
7. What are the network growth projections?

Uses and Applications

You should determine what data types and applications you will require to fulfill your business requirements. Example applications include email, Internet browsing, VOIP and videoconferencing¹⁵.

Access

Access to the system is determined by:

- Availability- What times of the day do you most need it? What periods will the users most need the system? What is the maximum acceptable downtime?
- Reliability- What is the minimum acceptable time between failures or Mean Time Between Failures (MTBF)? What should the maximum recovery time be in case of failure?



- Security- Should the system have varying levels of access depending on user types? For instance, should some users have access all the time while others are restricted some time?
- Redundancy and disaster recovery- What would happen if the system was unavailable for any reason? (This also affects MTBF considerations).

Capacity

Capacity should consider such factors as:

- Number of sites and their locations to be serviced
- Number and types of users in each location
- *Bandwidth* required, how much *bandwidth* you require and whether it should be dedicated or shared
- Scalability of the solution and what the projected increase in the number of users, locations, applications and overall bandwidth will be in say 3 and 5 years.

Inter-operability with existing systems

You should consider whether your VSAT will need to interface or work with any existing ICTs.

How to define your functional specifications

This process is often undertaken by business and technology analysts who understand both technical and business systems. If you lack these business and technology analytical skills in house or can not find them from the community, you should consider hiring an external consultant to help you analyze your business requirements and draft your functional specifications. You can also ask your donor or funding agency to include the cost of hiring the consultant in the project budget.



Defining the Terms of Reference for external consultants

The AVU commissioned a group of external consultants to:

- Determine the feasibility of KU-band Vs C band and low cost technology alternatives
- Review satellite coverage over Africa
- Undertake bandwidth and hardware cost survey
- Undertake VSAT licensing survey in Africa
- Assist in developing technical specification for the RFP process
- Evaluate proposals
- Provide input to contract negotiations
- The ideal location for AVU to house its own hub and financial and technical considerations for this.

Setting your priorities

We should sound a word of caution at this point. You are likely to define all your imaginable functional requirements. You should take a moment after this exercise to go through all your functional requirements and consider what your priorities are. A useful exercise would involve ranking the priority or usefulness of each of the functional requirements you have listed. If later on, in developing the budget, you discover that the cost is too high, you would be in a good position to revise your requirements by dropping any low priority requirements to reduce the complexity or capacity and therefore the cost of the VSAT system.

The reverse situation is also likely: that you fail to consider all your requirements and therefore “under estimate” your requirements. This situation can be very difficult to correct later on in the buying process. It is advisable to over-estimate your requirements and trim them down to size as you go along. One exception where you have to be very careful is in the area of bandwidth. It is easy to increase your bandwidth but almost impossible to reduce it once you have signed the contract with your provider. Bandwidth being an expensive resource should be carefully treated to ensure that you have estimated the right amount of bandwidth for your immediate and long term needs.

Calculating Bandwidth requirements

The amount of Bandwidth required by an institution is a key factor to consider when purchasing a VSAT. Pay particular attention to the amount of bandwidth required for sending information



or for the uplink. The amount of uplink bandwidth required will partly determine:

- The size of your antenna (aside from frequency band and power of satellite you use)
- The power rating of the BUC
- The type of modulator required
- The access scheme employed.

However, estimating the amount of bandwidth is anything but simple. Considering that bandwidth costs in Africa are about 50 – 100 times those in the developed world means that for most institutions in Africa, the amount of bandwidth purchased is limited by available funds. And if you asked how much bandwidth an institution needs, you would invariably hear “as much as we can get”.

There are various ways of determining or estimating the amount of bandwidth required. Let's start off by reviewing a few factors that determine bandwidth requirements:

View from a service provider

Intelsat recommends three ways in which a customer can determine their bandwidth requirements:

- Contact a satellite operator to assist in the calculations of the required bandwidth
- Use in-house resources i.e. standard link budgets (the satellite operator can be contacted to provide the relevant satellite parameters)
- Contact an equipment vendor

The type of application

Some applications such as voice and videoconferencing require dedicated bandwidth of minimum capacity, while others like email or simple web browsing do not have hard minimum limits.

The number of users for a particular application

Aside from broadcast applications where all users receive the same information and hence use the same bandwidth, the number of users is proportional to the amount of bandwidth required. It is important to distinguish among three user parameters: the number of concurrent users (both on average and at peak times), the total number of users overall and the total number of *potential* users.



The number of computers

Because of limited resources in developing countries, there is often a large number of users sharing a limited number of computers (desktops, laptops, thin-clients). Therefore the number of computers may be a more useful parameter to consider rather than the number of users as this is the limiting factor.

Response time

For applications like web browsing without a minimum hard bandwidth limit, the determining factor is the time between users requesting information and receiving a response. Research has shown that there are maximum acceptable “wait” or response times before a user experiences frustration, loses patience or attention (see section on email and web browsing requirements below).

In most cases, a consideration of all four factors will be necessary in order to arrive at a meaningful estimate for the bandwidth required.

RIC: The bandwidth procured is distributed throughout the network based on application usage i.e. text 64 kbps, audio 256 kbps and video 512 kbps.



A summary of the capacity requirements of some popular applications supported by VSATs is presented in Table 4.

Application	In (kbps)	Out (kbps)
Email	No minimum	No minimum
Web surfing (per connected PC)	8	2
Audio conferencing (MS Messenger) ¹⁶	11	11
Audio conferencing (Webex)	56	56
Video web conferencing (MS messenger)	120	120
Video web conferencing (Webex) ¹⁷	56	56
Video web conferencing (E-Pop)	256	256
Group Video conferencing (E-Pop) ¹⁸	384	384
Application sharing (MS Messenger)	45	45
Application sharing (Webex)	56	56
Application sharing (Pop)	300	300
Web hosting		
VOIP	14	14
VPN		

Table 4- Bandwidth capacity requirements of common applications

As most VSATs will be purchased for the purposes of providing email and web browsing services, a more detailed examination of their bandwidth needs follows below.

Email

It is estimated¹⁹ that the typical size of email without attachments is 5 kB with the typical attachment size being 100 kB. The average corporate user in the USA (who in this case will be equated to an active network participant in Africa for lack of Africa specific data) sends and receives about 70 email messages per day of which about 20% have attachments. The total message size per day is thus about 1.68 Mega Bytes (MB) per user.

Email is asynchronous and in most cases read “offline” and does not require a constant connection. This means that the capacity of the connection required for email does not matter and will not adversely affect “user-ability” save for the fact that large emails may have delayed delivery.

Note however, that long delays in the transmission or receipt of e-mails do affect total



customer service perceptions! Long delays in the delivery of e-mails will also adversely affect web surfing activities and thus e-mails may have to be stored and downloaded in periods when the capacity is not required for other more "real time" applications.

Web browsing

Microsoft²⁰ estimates a page of text to be about 63 kB. The recommended response time for a page download on the Internet is between 1 to 10 seconds²¹ with an optimum download of less than 4 seconds. This requires a dedicated connection of at least 128 kbps downlink per PC to achieve 4 seconds or less downloads. With this connection, a 1.5 MB file (equivalent to a floppy diskette of information) would take about 1.6 minutes while a 4 MB file would take about 4.2 minutes to download.

The total bandwidth per application is the sum of the products of the single application bandwidth and the number of simultaneous users or devices at peak time using the application.



HOW OTHERS CALCULATE AMOUNT OF BANDWIDTH REQUIRED

THE BANDWIDTH TASK FORCE

The Bandwidth Task Force²² (Band-Its) formula for Higher Education bandwidth calculation is

$$\frac{10\text{Mb/day} \times 8\text{bits} \times 10 \text{ people} \times \text{number of networked computers}}{\text{Seconds in 10 hours}} = \text{number of Mbps}$$

This formula is based on the following assumptions:

- A computer was used as the standard unit of measure as internet access in Africa universities is dependant on the number of available computers.
- The average user spends about an hour per day on a computer thus an average of 10 users per day per computer.
- Accessing remote digital resources as opposed to journals available on the intranet with sizes ranging from 500 KB to 2 MB and each user downloading about 10 MB a day.

Based on the above formula and networked computers, below are sample bandwidth requirements

Networked computers	Bandwidth required
500	11 Mbps
1,000	22 Mbps
1,500	33 Mbps
2,000	44 Mbps
2,500	55 Mbps
3,000	66 Mbps

Table 5- Bandwidth requirements for accessing research information²³

One should note, however, that this formula only considers an hour per day per user which may be unrealistic for persons conducting research as the average time spent varies from 4 – 8 hours. Secondly, most organizations share bandwidth among computers connected to an Ethernet network thus avoiding the need for the factor “x 10 people” in the formula. Thirdly, commonly accessed resources would typically be stored on the institution’s intranet. Fourthly, it does not factor in bandwidth intensive applications like video conferencing and VoIP messaging. It is however interesting to note that most bandwidth usage charts indicate that after working hours there is no utilization of the link. If proper bandwidth management practices are instituted in the organizations, the majority of downloads can be conducted during off peak hours.

AVU

The AVU report to the Partnership for Higher Education in Africa recommends a total of 10 kbps (8 kbps receive and 2 kbps transmit) per connected PC. This is an asymmetric ratio of 20% that assumes that universities are “power users”. Typically, planning models for VSATs assume much lower asymmetric ratios than this (3%). Great care is thus required in determining whether the offered solution meets your requirements. Do not leave things to chance as this is a guaranteed path to poor network performance.



Hughes Network Systems and bandwidth calculations²⁴

Hughes Network Systems makes the following assumptions

- For 75 subscribers per 128 Kbps, 0.73 Kbps should be available per user.
- 10% of subscribers will be logged on, and
- 5% of logged-on users will be actively using bandwidth.

The Hughes formula is based on the assumption that users will only be utilizing low bandwidth applications i.e. no VoIP, video conferencing, file sharing or downloading or streaming video and music.

Please note that these examples of bandwidth calculations will provide you with “yard sticks” and not final accurate answers. You may use these to estimate your initial bandwidth and scale it up as you go along and after you have established your true usage through careful and regular monitoring.

The effect of bandwidth management

Effective bandwidth management is required to block allocation of bandwidth to applications that are not critical to the business. If you do not monitor and manage your bandwidth, your precious bandwidth resource could be eaten up by malicious applications such as spyware, spam relays, spam and viruses as well as by trivial use such as audio streaming of radio, file sharing, music sharing and other such low need but high bandwidth applications. You would therefore do very well to consider managing and controlling your network to avoid such applications running. Bandwidth management is discussed in more detail later on in this section.

Develop the technical specifications

You should now be armed with a clear idea of your business and functional requirements to be met. You are now in a position to explore the technical aspects and performance standards of the VSAT system you will acquire to meet your business and functional requirements. Technical specifications should be undertaken by your ICT experts. If you do not have any technical expertise in-house, then you should consider hiring an external consultant or look for a volunteer with the right technical skills and experience.



You can choose to fully or partially detail your technical requirements. You should be aware of the consequences of undertaking either a partial or full technical specification. These two approaches are compared in Table 6.

	Pros	Cons
Full specifications	<ul style="list-style-type: none"> • Tight control of solution outcomes • Easy to evaluate and compare proposals from prospective suppliers 	<ul style="list-style-type: none"> • Requires specialist engineering skills and knowledge beyond most institutions • Risk of integration failure lies with purchaser • Can restrict number of potential suppliers
Partial specifications with key performance criteria	<ul style="list-style-type: none"> • Risk of integration transferred to supplier • Benefit from innovation and creativity of service providers • Increases competition among providers • Does not require specialist engineering skills and knowledge 	<ul style="list-style-type: none"> • Can make it difficult to evaluate and compare proposals from prospective suppliers as they can propose different technical solutions

Table 6- comparison of full and partial specification of technical requirements

We recommend that you consider developing partial technical specifications or even only your functional specification detailed further to capture some technical requirements when soliciting for proposals from prospective service providers. This transfers the onus to align the technical standards and performance characteristics to your business requirements to the prospective service provider. In other words, you transfer the “technology risk” to your service provider. You will also benefit from a variety of creative and innovative technical approaches from different providers. Detailing your technical specifications in full narrows the opportunities you may have to consider creative alternatives.

Following the partial approach, you should proceed to describe your expected performance criteria for the most important components of the VSAT network, such as:

- Type and coverage of Space Segment
- Hub characteristics (antenna, location, connection to backbone)
- Remote terminals characteristics
- Access schemes
- Network topologies



Space Segment

Space segment is the portion of the network that is in space, that is, the satellite and its associated bandwidth, beams and frequency of operation.

Frequency Band

You should decide which frequency band you need to use. The section in Part 1 that compares the pros and cons of different frequency bands should be helpful. Alternatively, you can specify your preferred service availability level year around or in the worst month and leave it to the providers to decide what frequency band to use. The latter is the recommended approach to take.

Beam coverage

You should specify beam coverage especially if you are installing VSATs in more than one location. You should aim to have all the VSATs in your network use the same beam so that you can share central hub facilities. If you anticipate the use of a mesh network, then use of a single beam is necessary to avoid double hops and duplication of bandwidth resources due to the double hops. You should ask any potential providers to provide you with footprints or contour maps of the satellite they intend to use.

Dedicated vs. shared bandwidth

You should decide whether to use dedicated, shared or burstable bandwidth depending on your business requirements (applications to be used, number of users). Your choice of bandwidth type also has a bearing on what access scheme you choose, as some access schemes only support shared bandwidth approaches.

Hub/ Teleport

The Hub or teleport is the “heart” of any star VSAT network. It manages the entire network and controls several functions such as which VSATs can communicate and when they communicate and the amount of bandwidth assigned to each VSAT. The choice and robustness of the Hub are therefore important considerations for you to make.

Location of the Hub

The Hub should be located close to the high speed public and Internet backbone. This is important to reduce latency and to ensure cost effective connection to global resources and services.



Outsource vs. Purchase of Hub equipment

If you are purchasing a small number of VSATs, you should leave all Hub operations to your service provider. In this case, you are essentially outsourcing this to the provider. If you plan to purchase very many VSATs, typically over 100, then you may need to consider the option of outsourcing, renting or running your own VSAT Hub. A full treatment of rent vs. buy decisions is presented in step three under acquisition of VSAT.

Remote equipment

The remote equipment refers to your VSAT equipment. The remote equipment is important because it determines performance as well as being the single biggest initial cost you will incur. Among the considerations you should make are dish or antenna size and HPA size.

Dish size

You should specify the *maximum* dish size you are willing to accept. Remember that large dishes can be expensive, constituting a “barrier to entry”. However, larger antennas are necessary to improve overall link performance, to limit the size of the HPA, to transmit large amounts of information and to meet the interference criteria limits set by the ITU. Also larger antennas are required for operation at the satellite beam edges where the signal is weaker and for lowering bandwidth costs. You should therefore make provisions for service providers to use larger antennas if they can provide you with a satisfactory technical (e.g. for sites at beam edge or with low elevation angles) and economic justification.

HPA Size

The power rating of the HPA is a significant determinant of overall terminal cost. Therefore you want to provide some guidelines for maximum acceptable HPA size. However, as for the antenna, you should make provision for the service provider to use higher power HPAs provided there are justifiable technical and economic reasons.



Proprietary vs. Open Standards based equipment

There are really no universal or open standards for VSATs, save for Digital Video Broadcasting or Single Channel Per Carrier access scheme. Even then, the actual implementation of the DVB and SCPC schemes varies from one provider to another. There has been a push to standardize on DVB and DVB RCS but adoption, while significant, is not yet universal. A more important consideration should be inter-operability, or the ability of your remote equipment to work with different satellite and Hub providers systems. It is important to avoid proprietary equipment that is not supported by a large number of service providers.

Propriety equipment is not flexible!!

In the event that you want to switch providers, as was the case in SchoolNet Uganda the procurement process for new services was based on finding a provider whose services would operate on the existing propriety equipment. This caused long delays in the switching process and they eventually opted to abandon the equipment and purchase an entire new network. As such, they were stuck with their original equipment representing a significant investment literally lost.

Access Technologies

You may specify which access technologies you prefer after a careful analysis of your business and functional requirements. Various access schemes have different maximum information throughput rates they can handle which also have a bearing on scalability or future growth. This is especially important for the inbound route. Whether you specify your preferred access scheme or not, you should make provisions for prospective service providers to propose alternative schemes if they can justify them on technical, efficiency and economic grounds.

Topology

Applications are the major determining factor for topology. Real time applications such as telephony or videoconferencing among several locations in the same VSAT network may require a mesh topology. Simple internet access for web browsing and email is most economically served by a star network.

Access schemes and topologies are a major cost drive for VSATs as they influence the size and capacities of the remote equipment, the efficiency of bandwidth usage and the type of Hub infrastructure required. You should require any potential provider to detail technical and economical justification for their proposed access scheme and topology.



Other considerations

There are a few other requirements you have to think about in the early stages, which will have significant impact on the success or failure of your VSAT implementation. Some of the most important elements to consider include:

- Power source, including power backup
- How you will conduct acceptance testing and commissioning of the system
- Warranties and spare parts strategy
- Technical support you require and response times

Acceptance testing, warranties and technical support are covered in more detail in later sections. We only introduce them this early in the buying process to emphasize their importance. You should be aware that these elements must be covered by any potential service provider's proposal. A brief note on power supply sources and back up is presented next.

Power Supply

VSATs, like any other electrical device, require stable and reliable power to run. In the urban centers and towns, VSATs will be powered by the national electricity grid. In most developing countries, the power grid does not extend to the rural or remote areas. If you do plan to install a VSAT in these areas, you will have to consider alternate sources of power.

There are two main alternate sources of power:

- Fuel Generator- usually running off diesel or petrol
- Solar Power

Other feasible alternate power sources, which are not as developed as the generator or solar systems are wind power and bio-technology power.



Table 7 compares the two major alternate power sources.

	Pros	Cons
Fuel Generator	<ul style="list-style-type: none"> • Lower acquisition cost • Well known technology so more sources and service providers 	<ul style="list-style-type: none"> • Higher recurring costs, due to fuel • Requires regular maintenance and service • Noisy • Fuel fumes are a pollutant
Solar Power	<ul style="list-style-type: none"> • No pollution • Low running costs- requires batteries to be replaced once in a while • Very little service required 	<ul style="list-style-type: none"> • Works best in places with sunshine all year round • Much higher cost than fuel generator for same capacity

Table 7- Comparison of alternate power sources

Even where the grid exists in developing countries, it is often unreliable, with long power outages or brownouts. You would therefore do well to consider power conditioners and alternate power sources as backup power sources.

In the case of power backup, short or transient outages can be handled by UPS systems. These are essentially power storage batteries that supply power for short periods of time, usually up to 30 minutes, when the main source of power goes down. However, the more expensive units can run for up to 8 hours, depending on the “power load” they have to carry. Unreliable power also requires a voltage stabilizer- to avoid power spikes from damaging your equipment.

The type and cost of any alternate power source is driven primarily by its capacity, the amount of power it is expected to supply or the power load it is expected to drive. You should therefore start out by determining your power load. This is the total power that your electronic equipment will draw from a power source. The VSAT equipment that needs to be powered are the receiver and modulator (which often in turn power the LNB and BUC respectively). These typically consume less than 100 Watts and 300 Watts each respectively, which is a relatively low amount of power. If you are purchasing a UPS for your VSAT equipment, often a 0.5 KV UPS will provide you temporary backup of 5 to 30 minutes depending on the power storage capacity.

However, remember the VSAT is a tool- to provide you with a service through the use of other devices. Internet access requires computers while voice services require telephones, all of which need to be powered. Therefore, a calculation of your load should include all the other devices connected to your VSAT. A typical desktop computer’s power rating is about 500 Watts. For example, if you have 10 desktop computers in a cyber café powered by a VSAT,



your total power load will be 5,500 Watts. When purchasing an alternate power source though, you should provide an allowance of 50 – 100% of the current load for future expansion. In our cyber café example above, the power load you should be looking at should be a minimum of 8,250 Watts.



Step 2- Develop your Business Plan and Budget



You should not wait for a provider's proposal to realize that you cannot afford the VSAT system you need. Even more critically, VSATs, unlike many other technologies you are likely to purchase, cost more to run than to acquire. Funding can make or break a project and plays a major role in determining the VSAT technology, amount of bandwidth and types of applications you will buy. This step helps you determine whether you can afford to purchase the VSAT solution in the first instance and keep it in the long run. To do this, you need to develop a business plan that details, at the minimum:

1. How much the system will cost initially, and over the long term (expenses)?
2. Where the initial capital, as well as funds to cover long term running costs, will come from (income)?

It is also good practice to consider any risks you may face in implementing the VSAT and to devise mitigations.

Involve ALL stakeholders- MALICO

The Council for Scientific and Industrial Research (CSAIR) was sub contracted to implement the MALICO VSAT project. Meetings and phone consultations between the stakeholders were held with CSIR present at all the meetings as well as assisting in developing the MALICO VSAT business plan with all the stakeholders.

Determine costs and expenses

Finance and accounting personnel often complain that technology ends up costing a lot more than originally budgeted. This is because buyers seldom consider all the costs of owning a technology, often presenting the initial purchase cost and the more obvious running costs.



To prevent nasty cost surprises creeping up, we recommend that you use the Total Cost of Ownership (TCO) approach. This approach calls for a consideration of any conceivable costs of the VSAT system from “cradle to grave” or through the entire life time of the project. It involves considering the costs of acquisition, delivery, implementation, user training, operation, support, maintenance, repair, decommissioning, disposal and replacement, and covers all aspects relating to equipment, service, human resources and logistical costs.

It is also important to determine, classify and categorize the costs according to whether they are one time or recurring. This helps to determine how much you need to spend upfront and on an ongoing basis. Table 8 shows how costs may be classified.

One Time	Recurring/ on-going
<ul style="list-style-type: none"> • Design and engineering • Site survey • Purchase of equipment • Shipping • Installation and commissioning • Activation • Spares • Technical and user training 	<ul style="list-style-type: none"> • Space Segment (Bandwidth) • Hub/ Teleport services • Backhaul to Internet backbone • Power • Service and maintenance (including replacements after warranty runs out) • Monitoring and evaluation • User support • Project management

Table 8- Common cost classification system using TCO

In addition, you should review all the costs and determine which ones are fixed and which ones are variable and therefore likely to change as the number of users, locations or applications change. For a single location, all the one time costs except training will be fixed while all the recurring costs and training will vary depending on the number of users, frequency of usage or number of applications used.

How to obtain cost information

A common problem with costing and budgeting for technology is where to obtain data and information on costs. For VSAT systems, this appears to be particularly difficult because cost information is normally held in confidence by the service providers. There are four main ways of obtaining cost data for budgeting purposes:

1. *Issue a Request for Information (RFI) or Request for Quote (RFQ)*

The most accurate method to determine cost is to provide your business requirements and functional specifications to several providers, and ask them to outline how they



would fulfill your requirements and to provide budgetary cost information. The downside is that this is a time consuming process and service providers are unlikely to respond if they realize you have not made a concrete decision to purchase yet. However, as we shall detail later on, issuing an RFI could be made part of a strategic procurement process to shortlist potential suppliers. In this case, it becomes an integral part of the buying process and the time and effort spent is justifiable. Service providers are also more likely to respond if they realize that the RFI is the first stage towards qualification to provide a VSAT solution.

2. *Conduct price survey*

Instead of a formal RFI or RFQ, you could obtain cost information informally by calling up service providers, or formally by means of a written questionnaire. It is also common to contract a specialist consultant, with contacts in the VSAT industry, to undertake a price survey.

3. *Purchase market research publications*

A few consulting companies publish market research or market intelligence reports which sometimes contain pricing information. These reports can vary in price from a few hundred dollars to thousands of dollars.

4. *Review costs of existing VSAT projects*

The simplest way to obtain indicative cost data is to visit or call up one or more organizations with VSAT systems and ask them about their own costs. You should be aware that some providers require that customers sign non-disclosure agreements on price information and therefore may not be able to help you. In any case, information obtained from existing customers usually has to be used in strict confidence.

You should be prepared to use multiple approaches and consult more than one source in order to obtain the best cost estimates. These costs must of course be taken and used in context: by relating them to specific VSAT technology used (equipment types, capacities and service access schemes), amount of bandwidth and number of users and applications among other things.



An insight into service providers' bandwidth pricing

Ever wondered how service providers price their satellite bandwidth? You may need to, in a bid to devise strategies to help you lower the prices you obtain through quotations or proposals, without sacrificing the level and quality of service.

Bandwidth Pricing is more favorably priced the longer the term and the larger the volume i.e. a five year contract for 93 Mbps typically attracts rates 10-15% lower than a one year term for 5 Mbps²⁵

Every service provider has their own pricing scheme; however, in general, the following factors will influence the price you, the customer, will pay:

Technical characteristics of the satellite to be used

These include frequency band, coverage and EIRP. Ku band can be more expensive than C band depending on availability. Higher EIRP commands higher prices.

Duration of contract

The longer the contract you sign, the lower the price you will obtain. Contracts of five years or more will usually realize a 10-30% reduction in price compared to contracts of one or two years.

Warranty on space segment

If you require very high availability of your space segment, for example you want it restored in case of a satellite mal-function or outage; you may have to pay up to 40% more²⁶. See section on warranty for a full treatment of various warranty approaches for VSAT.

Competition environment in your country or region

As for any service, if you have many service providers and genuine competition, then prices for bandwidth are likely to come down.

Specifications of the VSAT

Larger dishes and more powerful electronics allow the satellite operator to be more efficient in delivering the required bandwidth, so prices tend to be lower for more expensive equipment.



Volumes purchased

If you are purchasing several Mbps of bandwidth, then you have larger negotiating leverage than somebody purchasing just a few kbps of bandwidth. You can and should use your negotiation power to lower the price.

Satellite operators price their bandwidth in terms of the *bandwidth* and power consumed on a transponder. A satellite operator determines whether the service requested is *bandwidth* limited or power limited. In the former case a calculation is done to convert the capacity requirement in Mbps into an equivalent *bandwidth* requirement in MHz. In the latter, an additional amount of *bandwidth* must be purchased to allow for the added power consumed. The *bandwidth* purchased is then referred to as the *power equivalent bandwidth*.

The case of inclined orbits and low cost bandwidth

As discussed in Part 1, satellites in inclined orbits can and do get used for communications, especially internet access. Satellite operators usually try to recover their initial investment and operating costs due to the satellite within the “useful” life of the satellite, i.e. within the first 10-15 years. If the operator decides to operate the satellite in inclined orbit, then this revenue is considered as “extra” and prices for bandwidth drop tremendously. The downside is that you, the customer, will have to install a moveable dish with a specialized tracking system. Tracking systems for this purpose can be very expensive, and increase in price as the dish size increases. For large dishes over 5 meters, the cost of a tracking system can be in the region of several thousand dollars! Therefore, while the recurring bandwidth costs for inclined orbit satellites can be very low, and therefore attractive, the huge upfront costs for a dish with a tracking system could wipe out any cost savings. In some cases, the TCO of using an inclined orbit satellite can be higher than using a regular satellite, especially if you are signing short to medium term contracts (1-3 years) and buying only small amounts of bandwidth. Inclined satellite bandwidth makes sense if you are purchasing very large amounts of bandwidth so that the cost savings on bandwidth can compensate for the high initial cost of the tracking dish within a relatively short time.

Therefore, before you commit to seemingly cheap inclined orbit satellite bandwidth, you should look at the overall TCO (equipment and services over the duration of your contract) and compare this to using fixed VSAT in a geostationary orbit.



Typical VSAT costs

Example typical costs are provided in tables 9, 10 and 11.

VSAT Equipment component	Typical cost estimates in US \$ ²⁷
2.4 m Antenna	\$2,500\$ - 3,550
3.8 m Antenna	\$ 10,000 - 12,000
Pedestal for 2.4 m Antenna	\$ 1,300
Pedestal for 3.8 m Antenna	\$ 2,000
5 W BUC	\$2,100 - \$ 3,210
10 W BUC	\$ 3,700 - \$6,500
20 W BUC	\$ 6,300 - \$7,600
40 W BUC	\$ 8,200 - \$10,500
C- Band LNB	\$ 400
IRD (DVB compliant)	\$ 2,000
Modem	\$4,000\$ - 7,000
Cables and connectors	\$700 - \$ 1,000
Rack Cabinet	\$1,200 - \$ 2000

Table 9- Typical cost estimates for VSAT equipment



Other one time cost components	Cost component elements	Cost in US \$ ²⁸
Design and Engineering	<ul style="list-style-type: none"> Costs of consultants to define business requirements or functional specifications and to design technical solution, consider alternatives and develop blueprints and network architecture documents Some service providers charge a fee for network design 	Approximately \$350-500 per day for 5 – 10 days
Site survey	<ul style="list-style-type: none"> Charged by service provider for staff costs of 1 – 2 days including transport (air and ground), accommodation and subsistence, and time and effort fees 	\$ 3000 - \$3500
Shipping	<ul style="list-style-type: none"> Packaging and crating Air or ocean freight Transport from port/ airport to site Costs of hiring crane or forklift for off loading 	Air freight \$4000 - \$9000 Ocean freight \$2000 - \$3000
Installation and Commissioning	<ul style="list-style-type: none"> Air tickets for 1 or 2 engineers if from overseas Ground transportation Accommodation and subsistence Staff time fees per day or per hour typically for 3 – 5 days Cost of constructing foundation (for penetrating mount) and other civil works Costs of hiring crane for hoisting for example if installation is on roof of high rise 	\$3500 - \$5000
Activation	<ul style="list-style-type: none"> Charged by the service provider for planning and coordinating carrier activation 	\$500 - \$1000



Spares	<ul style="list-style-type: none"> Recommended to carry spares onsite for critical parts that require redundancy: LNB, BUC, connectors, Modem, IRD, routers and switches 	\$5,000
Training	<ul style="list-style-type: none"> Encompasses hands-on and theory technical training provided to your staff during installation Sometimes need to send your staff to provider's premises for training (transport- air or ground, accommodation and subsistence, training materials, time and effort) 	<p>On site training during installation can be negotiated for at no charge.</p> <p>A typical VSAT course starts at \$2000</p>
Taxes and Duties	<ul style="list-style-type: none"> Government and local taxes, Value Added Tax (VAT) and import duties 	Vary from one country to another. Please check with your local tax authority
Licensing	<ul style="list-style-type: none"> Licensing cost imposed by the local authorities especially for interactive VSATs 	Varies widely from one country to another and can be quite hefty. Please see www.gvf.org for licensing costs of some African countries. Also consult your local licensing authority

Table 10- Typical cost elements for one time cost components

Budget for appropriate IT support

If you currently have a dial-up service and exchange just a few e-mails daily, when you put in always-on Internet access you will find within a few months that users are very unhappy with even a 5-minute outage.²⁹



Recurring cost component	Cost elements	Cost in US \$
Bandwidth	Internet service charges	\$2.4 - \$4.5 per kbps
Service and Maintenance	Cost of maintaining your VSAT	\$1000 – 2000 per month
Monitoring and evaluation	Cost of staff or consultants to undertake monitoring and evaluation	
User Support	Hire staff to support users.	
Project management	Cost of staff who manage project	

Table 11- Typical cost elements for recurring cost components

Strategies to lower costs

Some strategies to lower costs include forming a bandwidth buying consortium or sharing your bandwidth with neighboring institutions.

The consortium approach

As the age old saying goes, there is strength in numbers. You should consider inviting a number of like-minded institutions, typically ones that share similar visions and missions to yours, to form a bandwidth consortium. Instead of purchasing bandwidth as individual entities, you would pool your demands and purchase as a single entity. This has two major advantages, each of which help drive down costs:

- i) Increased bargaining power. As the volume of bandwidth or equipment you buy increases, you are more likely to demand and obtain volume discounts.
- ii) Leveraging economies of scale. Many institutions can share some central services such as teleport, backhaul channel and support. Although these services are partly dependent on volume, they are not as driven by volume as not to benefit from some economies of scale.

“United we stand, divided we fall”

The best approach to realizing a successful and practical consortium is to either form a separate, independent legal entity or appoint an independent experienced agent to act on behalf of the consortium. The consortium entity or agent will then undertake all purchases on behalf of



the consortium members, thereby realizing volume discounts on the pooled demand. The pre-requisite for this to work of course is that the institutions participating in the consortium must be willing to cede control and decision making on matters of selecting and managing the service provider to the consortium entity or agent.

The consortium approach is helping everyone.

MALICO: “Our service providers have dropped downlink monthly charges by about 10%: the consortium approach is helping everyone”

Sharing Bandwidth

If you will not be using your bandwidth all the time, you should consider sharing some or all of it with neighboring institutions. This involves setting up a wired or wireless connection to the neighboring institutions, and in effect acting as an Internet Service Provider. For example, you may share your bandwidth after normal working hours when all your staff have left the premises. This way, you share the costs of the bandwidth with the neighboring institutions. Be careful, however, to ensure that you do not compromise the effectiveness and reliability of your own system by sharing your bandwidth when it is required by your own users. You should make sure that you do not run afoul of your license requirements or other local telecommunications regulations or even your contract with the service provider by sharing your bandwidth, outside your own institution.



Extending the reach of your VSAT using wireless systems

To share your bandwidth with other institutions, or even with other offices in the same or separate buildings in your institution, you will have to extend the connection from your VSAT. The cheapest and most cost effective way to do this may be through the use of wireless access systems. The advantages of wireless systems are that you do not need to run any cables or dig trenches making installation easy and enabling very fast deployments. Wireless systems are also generally cheaper than cable systems such as fiber and have some decent range of operation. There are three types of wireless systems in common use today:

- **Fixed wireless.** Here you have two wireless antennas, one each at the sending (your institution) and receiving institutions acting much like a cable connected between the two. You may need to erect masts to hold the antennas as this system requires that you have a clear path or line-of-sight between the two institutions, as the connection is degraded if the path is blocked by trees, building, other infrastructure or hills. Fixed wireless systems can provide connection between two locations up to 30 km apart.
- **WIFI.** Wireless Fidelity or WIFI systems were designed primarily for local area networks (with ranges of 100 meters or a little more) but can be used to provide coverage over relatively large areas by using enough access points to create overlapping cells of coverage or what are called “hot spots”. WIFI can be used to provide connectivity from your VSAT across your entire institution say throughout the school or hospital grounds. With mobile devices such as laptop computers equipped with the right access card, you can create a truly mobile access environment where people can connect anywhere, anytime within the hot spots. The distinct advantage of WIFI is that you do not need line-of-sight operation.
- **WIMAX.** Worldwide Interoperability for Microwave Access or WIMAX is a newer access technology that combines the functionality of fixed wireless and WIFI. It is meant to provide WIFI like features at much longer distances. WIMAX is heralded as the solution to cost effectively offering connectivity coverage over large areas especially in the metropolitan areas in developing countries. Already trials are underway in Kenya and South Africa³⁰.

An illustrative example of the application of wireless systems to share bandwidth is with Schoolnet Uganda. Some of the schools are not equipped with VSATs but connect through fixed wireless links to the nearest school with a VSAT. This has enabled the schools to share bandwidth and costs.

For a full treatment of wireless systems, please see a paper by Intel at <http://www.intel.com/netcomms/technologies/wimax/304471.pdf>, and Wireless Toolbox developed by IDRC at http://www.idrc.ca/acacia/ev-10592-201-1-DO_TOPIC.html.



Sustainability

Bandwidth is an expensive resource and therefore it is critical to plan how you will cover the recurring costs. Moreover, most donors are not willing to fund recurring costs- at least not forever.

Challenges of the AVU VSAT network

- Recurring costs for bandwidth services as Learning Centers do not remit payments on time.
- The poor state of the Local Area Networks (LAN) that have not been fully optimized to take advantage of the new VSAT system.
- More users are connected to VSAT network with no consideration of the design and load balancing issues.

Sources of funding

It is important to determine where the funds to finance the VSAT purchase will come from. This determination must be made for both initial and recurring costs. The common sources of VSAT funding for the main audience under consideration here are donors, governments, community fundraising and user fees.

Donors

Donors are often more willing to fund one-time costs, than they are to cover recurring costs. Donors include public, development and private sector institutions.

Government

Some governments do provide funds for development or social institutions to tap into for ICT purchases. Special mention should be made of “universal access funds” levied on telecommunications providers by governments, which can be used to finance VSATs. Governments might also waive import duties or license fees for educational/social projects.

Community fund raising

If the VSAT will have direct community or social benefits, it is possible to raise funds from the community through fundraising activities.



User fees

Institutions such as schools or universities can levy a “technology development” fee on students for the purposes of purchasing the VSAT system.

Institutional budget

Some institutions have annual budgets funded from a variety of sources and a budgetary allocation could be made for acquisition of a VSAT system.

In some cases, the best approach will involve a combination of all of the above approaches.

There must be a firm commitment from the VSAT purchaser prior to investing capital in the VSAT equipment and space segment³¹.

Common strategies employed to realize financial sustainability include:

Levying fees

Probably the most practical way of raising funds to cover ongoing costs is to charge usage or access fees. Several schemes exist such as the internet café model where users are charged per hour of usage or subscription models where users pay a flat monthly rate. Whatever scheme is used, it is important to understand the dynamics of number of users, cost per user and bandwidth required in order to set acceptable and realistic fee levels. This approach is common to community telecenters and schools.

Share bandwidth with other institutions

Another way of recovering some costs is to redistribute your internet connection to other institutions for a fee. This in effect means operating as an Internet Service provider (ISP). Redistribution can be achieved by using wired (e.g. dial up) or wireless (e.g. WIFI) solutions (see note above on wireless systems). This approach is common to universities and other purchasers of large bandwidth quantities.



How institutions sustain their VSATs- the case of MALICO

A review of some of our case study institutions reveals that they consider sustainability a key issue. The importance of sustainability is aptly captured by MALICO: “VSATs are not cheap technology!” In the case of MALICO, the initial project funding and bandwidth costs for a short pilot phase were obtained from donors. MALICO hopes to cover on-going costs from a combination of user fees, donor funds and by acting as an ISP, providing access to other libraries such as the Rural Libraries of the National Library Service and SchoolNet Malawi through the use of wireless links.

Risks and Mitigations

It pays to consider the risks likely to afflict the project, especially those likely to impact financing, upfront. Some risks to consider include:

- Failure to obtain funds to pay for recurring service charges.
- Long periods of downtime in case of a failure of your equipment where your service provider is located overseas.
- In the case that you rely on user fees, the most devastating, and often overlooked, risk is that of failing to collect fees from users or from the institutions to which you distribute or share your Internet. This will scatter your sustainability plan and can lead to closure of your service. The following strategies can be used to minimize this risk:
 - Charge realistic market prices for your services. Over-charging will not endear you to your users or attract new users but under-charging will lead to shortages in revenues and termination of your VSAT service.
 - Be conservative in your estimation of number of potential paying users and also hence on the amount of bandwidth you purchase. Err on the lower side, as you can increase bandwidth as and when required provided of course you have sized your equipment and access schemes for scalability. This is a good reason to develop your business plan *before* purchasing your VSAT.
- Develop payment enforcement mechanisms and be ready to follow through on implementing them if users default on payment. An effective enforcement mechanism is to disallow access. It helps if users are aware of these enforcement mechanisms upfront.



- Include a float in the project budget that will cover two to three months of the initial recurring costs.

If your service provider is overseas or has no local presence, you should:

- Consider signing a separate support agreement with a local provider, or request your overseas provider (as part of the solicitation for proposals) to make local support available. Overseas providers can and usually do team up with local providers to offer this local level support.
- Consider purchasing and keeping spares of the most critical equipment on-site. This is discussed in more detail later in this section.

Support and Maintenance: Off shore vs. Local company

Schoolnet Uganda's original contract for support and maintenance was with an offshore company. This contract proved to be a major challenge as the support provided was mainly online, the turn around on this was sometimes slow due to the different time zones and it was very expensive as with the added cost and delays in flying technician's into Uganda to resolve problems with the network.

SchoolNet Uganda has changed it's Internet Service Provider and since signed a new support and maintenance contract with a local company that is able to provide timely support and non-propriety equipment used.

Develop an implementation plan

Finally, your business plan should have an implementation plan. This plan should lay out a schedule of activities and minimum and maximum acceptable durations for each activity. A detailed implementation plan helps you to estimate when you will have your solution in place and how much time and effort the Working Group members will need to put in. The plan acts as a guide to the overall project and will provide key input in soliciting solutions. Service providers must be made aware of the deadlines within which you are operating.



Step 3- Acquire the VSAT



CASE STUDY- MALICO

The Council for Scientific and Industrial Research (CSIR) was sub contracted by OSISA to implement the project. Meetings and phone consultations among the stakeholders were held between May 2004 and June 2004. CSIR was present at all these meetings and assisted in developing the MALICO VSAT business plan with all the stakeholders.

Site surveys to determine the needs requirements were conducted between December 2003 and January 2004 by CSIR. On completion of the needs assessment, a Request for Proposal (RFP) was prepared and advertised in international newspapers and magazines and also sent to a list of suppliers. Twenty companies responded and four were short listed after the evaluation.

The period for receiving bids closed in June 2004 and a bid evaluation meeting was held at the OSISA Headquarters in Johannesburg with a representative from MALICO and two consultants on the panel.

The criteria used in determining the winning bidder ranged from, how proprietary the equipment was, cost and speed of upgrades, flexibility in bandwidth assignment and sharing, recurrent costs i.e. equipment and bandwidth, option for 'mesh' topology, trade-in options for equipment, local support and Ku band versus C band etc,

The review of the bids was completed in a month and it is at this juncture that the UNIMA and Mzuzu librarians began to aggressively market the solution.

On completion of the evaluation and negotiations, a cost savings of 10% on the price quoted in the RFP was realized. The winning bidder was announced and the implementation phase begun.



Procurement approaches and strategies

Procurement is a buzz word often bandied about without fully understanding what it means. It is frequently associated with negative connotations such as delays in acquisition, bureaucracy, blocking your efforts and so on. However, this need not be the case. A well executed procurement process can save you time and money in your VSAT acquisition. For this reason, it is important to understand and follow formal procurement methods which have been tried and tested. Donors and other institutions or persons that insist on following seemingly tedious rules and regulations are only out to protect you and the institution to ensure transparency, economy and efficiency.

A good place to start is with your own organization's procurement rules, or if you are being funded by a donor, the donor's procurement rules. If your institution is a public entity, then you need to consult your government's public procurement regulations and procedures. The rules, procedures and regulations that govern procurement vary from institution to institution and from government to government. Therefore, we are unable to provide you with a precise set of rules or regulations. However, there are some basic principles and strategies of procurement that you would be applicable, regardless of the particular set of rules you may have to follow. These are presented later in this section.

Remember that you have a Working Group that you formed as soon as the idea to purchase a VSAT was conceived. This Working Group should and will be heavily involved in the procurement process. As advised earlier, the Working Group should have a procurement specialist, as one of its members. If you do not have a procurement specialists in-house, the option of hiring an external consultant to advise and guide on procurement should considered. Most donor or funding agencies are willing to make provision for this in the budget to acquire your VSAT.

Competitive and non competitive approach

The acquisition process involves either competitive or non competitive selection of your VSAT equipment and service provider(s). Under competitive selection, two and usually more service providers are asked to submit proposals or "bids". The selection is based on the best offer, arrived at by comparing all the proposals received using a pre-determined evaluation scheme. Under non-competitive selection, only a single service provider is invited to submit a proposal, and no other service providers are considered. Non-competitive selection is also referred to as single sourcing or direct contracting.



As you can imagine competition is healthy in order to obtain the best solution that matches your business requirements at the best price and in the most efficient way. Therefore, a competitive approach is strongly recommended except in very extreme situations that can and should be clearly justifiable on economic and efficiency grounds.

Non competitive acquisition or single sourcing should only be considered:

- In an emergency, for example if a VSAT is required to establish communication capabilities following a natural disaster and expediency is the over-riding factor.
- If there is only a single authorized or licensed supplier in your country or region.
- If you want to ensure compatibility and integration with existing equipment or systems.
- If you are extending an existing contract based on prior good performance and for continuity purposes.

This last factor is often the most cited reason for single sourcing. “But we have established a good relationship with them”, “they have provided us a superb service for the last 3 years” or “procurement will take forever while we still need to have services” are all common assertions. These are cover-ups for poor planning. In order to avoid having to extend a provider’s contract, without subjecting them to competition, you should avoid very short contracts say of a few months or one year and you should aim to start the procurement process at least 6 to 9 months before the expiry of your current contract. Subjecting your current provider to competition can lower prices and keep them on the edge, thereby ensuring that you obtain the same or even better quality service. In any case, if they are the best, they will still win the competition!

Purchasing end-to-end services vs. purchasing component services

As detailed in Part 1 of this Guide, in order to use a VSAT, you will need to acquire both VSAT equipment and network services. Services can be divided into four categories. You can purchase all the services together (end-to-end services) or individually (component services). The four categories are:

- Supply, installation and maintenance of VSAT equipment installed at your premises
- Satellite space segment or bandwidth
- Hub or teleport services
- Connection to public or Internet backbone.



If you purchase end-to-end services, you will engage and deal with a single provider. Acquisition of component services requires engaging several providers, but in most cases will involve dealing with two service providers: one to supply, install and maintain your equipment and the other to provide network services (bandwidth, hub services and connection to public network).

Types of VSAT Organizations

Organizations offering VSAT services can be broadly categorized as equipment manufacturers, satellite operators, service and equipment resellers and integrators.

Equipment manufacturers design and produce VSAT equipment. In most cases, they do not provide any actual network services apart from supplying you with equipment.

Satellite Operators such as Intelsat or New Skies are largely in the business of selling “raw” bandwidth to large customers or supplying resellers. They will seldom supply you with equipment or provide you with network design expertise or support and maintenance of the customer premise equipment or network.

Resellers will usually provide you with equipment or bandwidth or in some cases both equipment and bandwidth especially if they are reselling a large provider’s end-to-end service. They will usually sell you a “ready made” VSAT service and will not provide you with any customization or network design services.

Integrators will provide you with a full range of services from consultancy, network design, training, equipment, bandwidth, maintenance and support and ensure that all the pieces of your VSAT network are working together.

Understanding the different types of organizations you are likely to encounter should help you review the potential strengths and weakness of any provider who approaches you.

As you can imagine, it is easier to deal with a single provider, who will act as a “one-stop shop”. Fitting the pieces together, and therefore the risk of integration, is left to the provider. In the case of purchasing component services, you will deal with a minimum of two providers. This increases your administrative load and also exposes you to the risk of failure to optimally integrate the equipment and network services. A comparison of the two approaches is provided in Table 12.

In any case, we strongly recommend that you should not consider more than two service providers (one for equipment and the other for network services) except under special conditions, such as a complex high bandwidth, multi-application, multi-location (over 100) network.



Potential trouble with two or more providers

We should point out unless you have technically qualified and competent staff, you might find yourself between two suppliers, each of whom blame the other for service failure or non supply!

It should be quite obvious that for the majority of institutions, the end-to-end approach is the recommended way to go. It is also the model being adopted by most service providers. Even Satellite Operators, who have previously shied away from “competing” with their “resellers”, are providing end-to-end services direct to customers, albeit the larger ones. In the event that you are unable to find a single end-to-end provider or have a very complex network, then you should consider contracting two providers, one each for equipment and network services. In the latter case, you should demand that the suppliers work together to optimize the solution. Needless to say, whether you go with a single supplier or two suppliers, you should subject all suppliers to competitive selection.

	Pros	Cons
Component Services	<ul style="list-style-type: none"> You have full control of your network and can optimize it as you see fit- useful for large and complex networks 	<ul style="list-style-type: none"> Dealing with many providers increases administrative overheads Risk and cost of integration of services is borne by you Requires that you have highly skilled technical personnel or consultants for design and integration, who can be very expensive
End-to-end Services	<ul style="list-style-type: none"> You do not have to deal with integration- risks transferred to provider You have only one service provider to deal with, simplifying overall administration, monitoring and management of service provider You do not have to engage expensive and highly skilled technical staff or consultants 	<ul style="list-style-type: none"> Service provider is responsible for optimizing your network- you usually will have no or little say. May not make the most optimal configuration for your needs

Table 12- Purchasing component vs. end-to-end services



Single stage vs. two-stage competitive procurement

The World Bank³² has developed two major approaches to competitive procurement of complex information technologies such as VSAT systems that we consider to be exemplary. These are referred to as single stage and two-stage approaches. Even if you use different procurement rules, we advise that you familiarize yourself with these approaches as they present some important strategies and insights into procurement of complex information technologies.

In the single stage approach, prospective providers are presented with a detailed set of functional and technical specifications and are expected to provide a technical and financial proposal to fulfill your needs. This is the more common procurement approach.

In the two stage approach, prospective providers are presented with your business requirements and are expected to first provide one or more technical designs with detailed technical specifications (stage 1). The technical designs are then scrutinized to arrive at a single specification, for which prospective providers then provide a technical solution and financial costing (stage 2). Scrutiny of the designs may involve asking potential service providers to make formal presentations to the Working Group, visiting the service providers' premises to review demonstrations of the proposed design and visiting sites installed with VSATs of a similar design as that proposed by the prospective provider. A "best fit" design which may consist of several design components from different providers is usually selected after reviewing all the designs submitted. All the prospective service providers are then asked to provide financial proposals for realizing your chosen design.

The single stage approach should be employed in cases where you are confident of the functional and technical capabilities you require and you are knowledgeable about the range of VSAT solutions that can fulfill these capabilities. The two stage approach should be employed when you have limited capabilities to determine and detail your technical requirements or where the system under consideration is extremely complex, for example if you require a system to cover hundreds of locations or interfacing with terrestrial networks at several locations. The two stage process is a complicated affair and will usually require hiring technical experts to scrutinize each technical design.

Define your evaluation criteria

Before commencement of the procurement process, it is important for you to define both technical and financial evaluation criteria that will be used to compare proposals from prospective service providers. More information on defining evaluation criteria and on the evaluation process is provided later on in this part of the Guide.



Approval from management

With your requirements defined, cost estimates and sustainability plan detailed and a procurement strategy selected, it is time to seek full management approval before proceeding any further. Management approval should be sought from the head of the institution, board of directors or management committee depending on your particular institutional governance and management structures and processes. It is also common to obtain approval from the funding agency and donor at this stage. Approval should be sought on:

- The budget, implementation and overall business plan. This ensures that money is allocated in good time and put aside for the purchase of the VSAT before contacting potential suppliers.
- The procurement process to ensure that they are in line with institutional or donor policies, procedures and management.

Of course, it is hoped that the entire project Working Group is in agreement on the overall business plan and proposed procurement approach. If it is not, then the chairperson of the Working Group or the head of the institution must find a way of arriving at or negotiating consensus before proceeding or even presenting the plan for approval by the relevant authority.

Remember that procurement, especially using public funds, is open to public scrutiny. You therefore have to ensure that you are as transparent and objective as possible and that management is fully aware of all the issues and plans.

Preparing Bids and inviting Proposals

Invitation of proposals from prospective bidders is variously referred to as tendering or bidding. From start to finish, it involves:

- Preparing solicitation documents, also known as Bidding Documents or Request for Proposals (RFP).
- Inviting potential and prospective service providers, also known as “Bidders” or “Offerors”, to submit technical and financial proposals, also known as “Bids” or “Offers”.



- Ensuring that all Bidders are furnished with the right kind and amount of information in a transparent manner to enable them to prepare responsive Bids
- Receipt and opening of Bids

The tendering process should be carried out by a qualified procurement specialist. Most large institutions such as universities or large donor funded projects will have in-house procurement specialists. If you do not have your own in-house experts, then you should consider engaging a consultant, seek for volunteers from the community or ask your funding agency to provide procurement expertise.

Preparing the Bidding Documents

Bidding documents should be prepared by a procurement specialist, working with finance and information technology experts. Bidding documents usually contain the following information:

Instructions to Bidders

These are detailed guidelines that the prospective provider should follow and include communication protocols to be used with you and your staff, deadline for receiving proposals, any special formats for preparing Bidding Documents and evaluation criteria for comparing Bids. This section of the bidding document should also detail the evaluation criteria you will use to evaluate all Bids received. Evaluation and evaluation criteria are treated in detail later in this section.

Terms and Conditions

These are the commercial terms and conditions under which you will engage the service provider(s) eventually selected and should include details of the service provider's responsibilities as well as yours, details of the contractual arrangement you will enter into, governing laws and details of payments.

Requirements

These are the details of your business, functional and technical requirements as developed in Step 1. You should also include the expected project schedule.

Réseau Interuniversitaire du Cameroun (RIC)

The Request for Proposal (RFP) was prepared by the project team and ICT department of the University.



The Bidding Documents should be approved and cleared by management before issuing them to prospective service providers. In addition, and depending on your particular procurement regulations, the final Bidding Documents may need clearance by the funding agency prior to issuance.

Define format of Proposals

You should detail the format and general structure of the Proposals or Bids to ensure that all Bidders conform to a general standard and provide you with all the information you need. This also makes it easy for you to evaluate and compare the Bids. This should be done in accordance with your own specific procurement procedures. It is usual to request for the following specific information to be included in the Bid:

- The overall VSAT network and service design, including outbound, inbound channel system and VSAT stations.
- Satellite used with detailed coverage zones (transmit and receive).
- Detailed link budgets.
- Description of the hub/teleport, with location, staff, organization, interconnection to terrestrial networks (e.g. internet backbone, ISDN), and extra provided services.

For end-to-end service, you should, in addition to the above information, also request for:

- A confirmation of the space segment provider, that the space segment offered by the Bidder is available.
- A confirmation of the teleport provider, that the teleport service is available.
- A confirmation of the VSAT station hardware supplier, that the VSAT systems offered by the Bidder are available.

Inviting Bids

This process involves alerting Bidders to the availability of a commercial opportunity to provide services and equipment and providing access to the Bidding Documents.



Bidders may be alerted by several methods including:

- Posting an announcement on your website
- Posting an announcement on specialist websites for public sector procurement such as United Nations Development Business (www.devbusiness.com)
- Posting an announcement or advertisement in a newspaper or magazine of wide circulation. Most procurement systems call for advertising “locally” or within your country or internationally depending on the overall cost of the project.
- Sending emails to a list of known providers

Advertising of Bids

AVU: International Competitive Bidding (ICB) procedures were used with advertisements placed in regional newspaper i.e. the East African Newspaper, the AVU website and United Nations Development Business (UNDB).

RIC: Bids were placed in newspapers, the network website and announcements made on the radio.

The strategy here should be to ensure that the announcement is widely circulated in order to attract many Bidders and increase competition.

The documents can be issued to Bidders who express interest following the announcements, by email, registered mail, courier or hand-picked from your premises. In order to keep track of Bidders who are interested, you should send the documents only to those Bidders that contact you and express interest. As such, it may not be a good idea to provide a public download of the documents.

In some instances, for example if you want to invite only the most reputable organizations to bid because of the complexity of your planned VSAT network or applications, you may want to pre-select or shortlist a small number of providers. This can be done by issuing a set of criteria (see mandatory criteria under the section on evaluating bids) and asking only prospective service providers who meet those criteria to “express interest.” It is common to refer to this method as issuing an “Expression of Interest” or EOI. Only those service



providers who express interest and meet your set of criteria are then allowed to obtain the Bidding Documents and submit proposals. You should review your own institution's or your donor's procurement procedures for specific guidance on when and how to pre-select Bidders or issue an EOI.

Bidding Documents, especially those for large contracts, are often sold to prospective Bidders. This is done for two main reasons:

- To recoup the cost of preparing and printing the Bidding Documents
- To attract only serious bidders

You should ensure that the sale price is not prohibitive; typically no more than US \$100 or its equivalent in your local currency. If you opt to sell the Bidding Documents, then you can only consider Bids from those companies that prove that they purchased the Bidding Documents in the first place. You therefore should issue proper receipts and keep detailed records of the purchasers.

Length of bidding period

To a large extent, VSATs are not off-the-shelf items. It is important to grant Bidders enough time to prepare a reasonable proposal to meet your needs. Multi-site or high bandwidth systems may require extensive design and engineering to be undertaken by the Bidders. Bidders should be given at least 2 weeks to prepare Bids for single VSAT installations and a minimum of 3 weeks for multi-site or multi-service requirements.

Bidding period

The RIC Request for Proposal (RFP) was floated for four weeks. There was a bidder's conference held for any queries with presentations by the interested bidders. The installation begun about six months after the RFP was floated and the monitoring and evaluation of the project is an ongoing process

Experience has also shown that you are unlikely to obtain many responses to your announcement during the months of July, August and December because these are traditionally holiday months in many parts of the world, and most companies operate with a very limited complement of staff. If you must issue Bidding Documents during this period, you should be prepared to allow at least 4 weeks for responses. Strange but true!



Communicating with Bidders

You should ensure that all communications with Bidders are open and transparent. This can be achieved in a number of ways including:

- Laying down clear guidelines and procedures to follow to raise any questions or receive responses upfront. All requests for information and all responses should be in writing.
- Providing a clear and single point of contact, typically the procurement specialist or in some cases the finance person or head of the institution. As most questions are likely to be of a technical nature, the procurement specialist or other designated contact person will have to work with the technical specialists or outside consultants to provide required responses.
- Copying all questions and all responses to all Bidders. This ensures that all Bidders have the same information and avoids accusation of favoritism or unfairness.
- Conducting a “Bidders Conference”. This is a physical or virtual (e.g. online forum or telephone conference) meeting with all interested Bidders to give them a chance to seek clarification or obtain additional information. For complex systems such as VSATs, a Bidders Conference is usually unavoidable. You should ensure that you communicate the dates and details of the meeting in advance of the meeting to give Bidders enough time to make travel or other arrangements to participate in the conference and to compile questions they would like answered.

Receipt of Bids

You should have a deadline for submission of Bids. This deadline must be precise- give an exact day, date and time including time zone of reference (for example November 2 2005 at 12:00 PM GMT) to avoid ambiguities.

It is also usual to detail a Bid opening procedure in the Bidding Document. Most often, Bids received are opened in a public setting, at a specific time and place where Bidders are invited as well as other impartial witnesses. You should follow your institution's or donor's particular procurement guidelines in this regard, without deviation.

You should be careful during the Bid receipt and opening stages as they are often the greatest sources of queries and accusations of malpractice in the majority of cases where complaints



of inappropriateness are put forward. And have no doubt; with large contracts at stake, there will always be a few Bidders who will go to any length to win the Bid or discredit any other winning Bidders. You should therefore strive to be transparent, open and firm and document all your actions in strict accordance with your particular set of procurement procedures. It is also advised that minutes of meetings of the bid opening should be taken and upon completion circulated with sign offs from all the parties in attendance of either a private or public opening. Bids that arrive after the deadline should be rejected and should be returned to the Bidder unopened with a clear written explanation or treated in strict accordance with your institution's procurement requirements.

Evaluating Proposals

This step involves the comparison of Proposals or Bids to determine whether the solutions offered by the Bidders meet your business, functional, technical and financial requirements. There are a few points to note here:

- Evaluation is only meaningful if you use clear, unambiguous and measurable criteria
- You should determine, in advance, which criteria are mandatory and which ones are not. Mandatory criteria are scored on a pass/fail basis while non mandatory criteria are scored on a sliding scale, say using a range of 1 to 5, where 1 means the proposal does not meet the criterion and 5 means the proposal fully meets the criterion. A higher score translates into a better and more cost effective technical solution.
- All Bidders should be made aware of the evaluation criteria, including which ones are mandatory or not, upfront.

Mandatory vs. Desirable Criteria

Evaluation criteria should be divided into mandatory and non mandatory criteria. The former are non-negotiable and the latter represent criteria for which tradeoffs can be made. Any Bid not meeting even a *single* mandatory criterion should be dropped immediately and declared non-responsive to your needs. Examples of mandatory and non-mandatory criteria include:



Mandatory criteria

Experience of the Bidder

You should select Bidders that have prior experience supplying VSATs of similar technical characteristics to organizations similar to yours or in the same industry and whose projects were comparable to yours in size and scope. The more experienced and knowledgeable about your region and industry the Bidder is, the higher the chances of fulfilling your requirements on time and within budget. Prior experience can be demonstrated with customer references which you should endeavor to check out.

Solid financial standing of Bidder

Bidders must have an annual turnover the previous two years of at least two times the total anticipated contract amount including recurring expenses. You do not want your service provider to fold over and leave you hanging three months into your new contract! You should ask Bidders to provide annual audited accounts or financial statements which your financial staff should examine carefully.

Lead company in joint venture

You should require that in case of a joint venture, the bidding firm have a majority in the partnership and you should evaluate it against the other criteria above. You should be especially careful of service providers and resellers who are just “fronts” for foreign based companies. You should require that the individual firms forming the joint venture clearly spell out what their respective roles are. Be careful to determine who will provide you with monitoring, technical support and maintenance.

Space segment, teleport and equipment guarantees

For end-to-end service provision, you should ensure that the Bidder has secured access to space segment and teleport services and presents a letter to that effect. You do not want to sign a contract and discover that space segment is unavailable on the satellite proposed by the Bidder (and on which the technical evaluation was based) and that the Bidder will have to use a different satellite with different characteristics. This scenario derails the project schedule and can lead to provision of lower quality services. For purposes of ensuring the Bidder will provide warranty on equipment, you should ask for a letter from the equipment manufacturer stating that they will honor warranty on the equipment supplied by the Bidder. If the Bidder owns the satellite, teleport or is the equipment manufacturer, they should still provide a letter stating so.

Non-mandatory criteria

You should note that “non-mandatory” here does not imply that these criteria are not important. Only Bids that meet the mandatory criteria above should be evaluated against these



other criteria. These criteria should have scores against which the proposed technical solution will be evaluated. You should have a minimum total score to ensure that you obtain the best technical solutions that meet your requirements. For instance, if your total technical score is 30 points, only bidders who can meet at least 25 points after their technical evaluation should be considered for contract negotiations and award. These criteria could include:

- Minimum availability and overall performance of satellite link
- Technical characteristics of the Hub including redundancy schemes, size of antenna
- Quality of preliminary project plan including implementation schedule that will meet your target dates for receiving services
- Quality of proposed project management team (from Curriculum Vitae)
- Quality of proposed acceptance testing and commissioning plan

Technical vs. Financial Evaluation

A proposal can be accepted on the basis of the technical solution proposed, or the financial proposition or a combination of the two.

AVU Evaluation Process

The first step in the evaluation process was the technical evaluation whereby all the bids received were subjected to a mandatory technical requirements check list. All bids meeting the mandatory technical requirements underwent further technical evaluation. Only bids that met the minimum technical evaluation score for non mandatory criteria were considered for the financial evaluation.

Financial evaluation was based on the overall cost of services i.e. teleport, space segment, operational costs and the bidder with the highest combined score winning the bid.

It is advisable to conduct an evaluation of both the proposed technical solution and the financial proposal of the Bidder, and the final award made on the basis of a combination of both technical and financial evaluations. In a scoring system, each of the technical or the financial evaluations should contribute a proportion of the final score. For example, if the total possible score is 100 points, total technical evaluation contribution can be set at 30 points while financial evaluation contribution is set at 70 points. The relative score is dependent on

your particular circumstances and how important the cost is relative to the technical solution. In other circumstances, the technical evaluation is scored on a pass or fail basis and the bid awarded to the lowest cost proposal that passed the financial evaluation.

Technical evaluation criteria

These should stem from the technical specification and should be quantifiable and measurable or should be distinct and identifiable.

If any firm fails to meet the minimum technical score, you should immediately cancel the Bids and re-evaluate your business requirements, functional specifications and technical specifications. You may also want to undertake fresh bidding but this time extending the announcement to a larger audience for example, advertising in an international newspaper of wider circulation.

Evaluation committee

For transparency and efficiency purposes, evaluation should be carried out by a team or committee. This can comprise a subset of the project Working Group or other staff members can be co-opted for this task. It is usual to have between 3 and 5 evaluators for each of the technical and financial evaluations and to invite reputable external reviewers. Technical evaluations require some familiarity with VSAT systems and should be undertaken by your technical staff while financial evaluation should be carried out by your finance or accounting staff.

Where you are forced to use consultants because of lack of expertise in-house, you should ensure that they have a good understanding of your business requirements and intended outcomes in order to evaluate the Bids in context.

Negotiate and award contract

Negotiations are an art of their own, acquired through extensive experience and training. This section is not meant to make you an expert negotiator but rather to provide you with a few pointers that may help you obtain a better deal. Negotiations also involve clauses of the contract and culminate in signing the contract.

Because of the contractual implications, you should plan to involve your lawyer or provide for some legal consulting in your budget for the negotiation and contracting stages. You should

ensure that your lawyer is familiar with your intended business objectives and that he or she can advise you in context.

Before you consider sitting across from a table to negotiate your contract, please ensure that you are adequately prepared.

Preparing for negotiations

A quick note on preparing for negotiations is provided here because it is the key to determining whether you achieve any positive results. The “golden rule” is to know what you want and what the service provider wants. You should try to reach a mutual agreement that lets both you and the service provider achieve your objectives or what is commonly called a “win-win” situation. If anything, you should realize that you are entering into a partnership with the service provider for the next few years and do not want get off on a wrong footing. The larger the contract, the better prepared you should be for contract negotiation.

You should form a 2 or 3 person committee from your project Working Group to undertake negotiations. The members of the negotiating team should read and become familiar with your business requirements, the Bid Document and the Bid or proposal submitted by the prospective service provider.

It is usual to conduct negotiations face to face although they can also be done by email or telephone if the prospective service provider is overseas. For face to face negotiations, you should aim to have these at your premises or in a neutral location where the prospective service provider has no advantage of any sort over you including familiarity with the surroundings!

Negotiating prices

You should note that most competitive bidding procedures do not allow you to haggle over *unit* prices on the assumption that competition should give you the best possible market price in the first place. However, it is not always possible to obtain the lowest prices especially for donor funded programs which are synonymous with a lot of cash. You should also be wary of extremely low prices that appear to be much lower than regular market prices. This may be due to a compromise of quality, for example, a high contention ratio.



In any case, you should be aiming at getting more out of the Bidder for the quoted price. Where the Bidders quotes are way above your budget, you can reduce on the total contract price by varying quantities (of equipment or bandwidth) or other inputs such as human resources. For instance, you could opt to use a local installation company instead of flying in the Bidders engineers from overseas. You should be careful not to significantly alter the scope or even technical solution of the project during negotiations or else you stand to be accused, rightly, of being unfair to the other Bidders. This situation can be avoided by prior proper planning following the steps presented in the preceding sections.

Types and length of contracts

The actual contract used can be drafted by the Bidder or your institution or could be based on a Donor's standard contract template. If you do not have your own standard contract template or have access to standard template from a donor, you may have to use the Bidders own contract format. In fact, it is not advisable to try and draft your own contract as legal fees can be very high. It is far cheaper to have a Lawyer review the Bidder supplied contract.

Examples of Contract length

- MALICO has a 2 year contract with their service provider
- AVU has a 1 year contract with their service provider
- SchoolNet Uganda had a 1 year contract with its first provider and has signed another 1 year contract with the new provider

A major question usually arising during contracting is how long the contract should be. The answer is not very simple- it should not be too short or too long. A good contract length is 2 to 3 years with a provision for an extension usually of no more than 1 year.

Contracts more than 5 years should be avoided because:

- Technology advancement is rapid and a new and more efficient or cheaper technology may arise during your contract period and so you need some flexibility to be able to switch
- Prices of technology reduce over time either due to newer technologies, competition or maturation. You do not want to be saddled with a high cost contract when prices are reducing.



- There is a high turnover of companies in the technology industry because of cut throat competition and you want to guard against your provider going under and still holding you hostage to your contract (creditors may want to collect and continue running the company with reduced quality of service!)

If you do sign a long term contract there must be a clause that provides for the review of price according to current cost trends during the life of the contract.

On the other hand, you do not want a very short contract of say 1 year because:

- The process of finding another provider can be very lengthy and resource intensive as the steps above may have revealed. You therefore need a good lead time.
- Switching costs can be very high as switching may require changing the equipment. You do want to incur another huge capital cost so soon after your first contract.
- VSAT networks can take a while to “settle” of up to 6 months in which period they need constant monitoring and fine tuning to provide optimum performance.

What to include in your contract

Your lawyer should advise you on the standard clauses that a commercial contract should have, as well as any other clauses to cater for your particular set of circumstances. We shall simply point out a few issues that are important in regard to VSATs and that you should capture in your contract. In any case, you should review each and every one of them with your lawyer to ensure that they reflect your particular set of circumstances.

Start and end dates

Start dates, especially in regard to payment of the monthly recurring bandwidth costs for VSAT contracts can be quite tricky. You should therefore scrutinize and understand these. Start dates can be tied to:

- Date of signature of contract
- Date of start of service provision



Whichever way it is defined, you should make sure that you start paying for services- bandwidth- only *after* your equipment is installed, tested, commissioned and you have formally signed off. This is critical as there could be a significant time lag between signature of contract and provision of services, as equipment has to be ordered, shipped and clear customs and be installed and commissioned before services can begin. This time lag can be several months long for which you do not want to incur bandwidth charges simply because you have signed a contract!

End dates should be very clear. It is not enough to state “one year”- you should provide reference e.g. one year from start of services or from contract signature. You should reference the end date from start of services, rather than from date of contract signing because there could be a significant delay between the two as the service provider mobilizes and sets up the service.

Service Level Agreement (SLA)

The SLA is a collection of measurable performance metrics that ensures that you are getting the service you are paying for all or most of the time. The following metrics are common:

- **Availability-** you should ensure that the service provider commits to providing you with a service that you can use at least 99% of the time in the worst month. This is known as the availability. If you take a month to be on average 30 days or 720 hours, then 1% unavailability or downtime is 7.2 hours in a month or almost an entire working day. In a year, this translates to about 12 working days or 3 full days. As you can see, do not be fooled by the small percentages.
- **Latency-** A full treatment of latency is given in Part 1 of the Guide.
- **Mean Time to Restore (MTR)** - this is a measure of the average time it takes to bring your services back on line in case of a failure. If you define the availability, then there is no need to define MTR.

Because SLA involves measurements, you need to be prepared to measure the availability and latency of the service you are getting. For VSAT systems, the most common tools used are software based and include What's up Gold and the open source Multi Router Traffic Grapher or MRTG. You should require that your service provider monitor and measure the level of service you are receiving and provide you with regular (say monthly) reports which you should compare against your own. Some providers also avail you with access to their monitoring and measuring tools typically



through a standard web browser. You should also clearly state whose measurements will be used to determine availability and latency. You should not rely wholly on the service provider for obvious reasons.

Enforcing the SLA and Service Credits

You should not draw up and negotiate the SLA for the fun of it. You should be prepared to exact penalties on the service provider in case they do not provide the service to your expectation. There are two ways of penalizing the provider:

- Money back- for any outage outside the agreed unavailability, the provider should refund some of your monthly payment in cash. Most service providers will not agree to this proposition.
- Service credits- any outage outside the agreed unavailability, the provider should deduct an amount on the next month's service charge by providing you with a "credit". This is the usual approach undertaken. You should be careful to define how the service credits are calculated (usually pro-rata) and exactly when you start earning credits. This is usually captured in the Bidding Document and you should have Bidders agree to it as part of their submission.

Escape Clauses

You should plan for "escape" clauses that let you get out of or terminate a contract if the provider is not performing to your expectation or if the provider runs into financial difficulties. However, you want to ensure that you receive services up until the last minute. The following escape clauses are useful to negotiate and have included in your contract:

- Consistent or frequent violation of SLA. You can make provision that if your provider violates the agreed upon level of service more than a certain number of times, you are granted the right to terminate the contract without incurring liabilities.
- Mergers, Acquisitions or Liquidation. Because of high turnover of companies in the technology industry, you should ensure that you have a right to automatically terminate the contract without incurring any liabilities if and when your service provider merges with another company, is acquired by another company or goes into liquidation.



You should also beware of the provider's escape clauses. These are usually "hidden" in the Force Majeure section of the contract. You should have your lawyer scrutinize the contract for the provider's escape clauses, as well as your own escape clauses.

Acceptance testing

It is advisable to explicitly define how and when you will perform acceptance testing in your contract. As noted above, your services start date and start of payments should be linked to acceptance testing and not to the date when the contract is signed. We could not belabor this point more as it can be a cause of contention with your service provider. Details of how to carry out acceptance testing are provided later on in this section.

Contract Termination

You should be aware of one important fact- unlike most other commercial contracts, VSAT contracts usually have a termination clause that requires you to pay off the remainder of your bandwidth costs through the life of the contract if you decide to terminate the contract. You should therefore consider this fact carefully when signing long contracts. Nevertheless, you should try to negotiate for contract termination "with no cause" provided you give ample notice of 3 or 6 months without incurring costs for the remainder of the contract portion.

Review the Preliminary Project Plan

You should insist on receiving and reviewing a draft project plan from your potential service provider during negotiations, and before contract signing. The draft project plan should include the implementation plan, schedules and proposed or anticipated roles and responsibilities including the capabilities and qualifications of the service provider's staff. You should be aware of or negotiate how long it will take to begin receiving services, how the service provider will approach implementation and what your obligations are. All these should be agreed upon prior to contract signature.

It is also good practice to insist that Bidders provide preliminary project plans along with the Bids and to evaluate these plans as part of the technical evaluation process. This latter approach is one we would advise you to consider.



Signing the contract

Once you are happy with all the contract provisions and clauses, it is time to sign the contract. You should normally ensure that you have written clearances from your lawyer or legal department if you have one, your Donor and of course from your top management to sign the contract. You should also ensure that you follow any special procedures for contract signing imposed by your institution's or your Donor's procurement or financial regulations. At least two original copies of contracts should be signed, one each for you and the service provider.

As we conclude this section, we would like to reinforce the point that we have only provided you with general guidelines on procurement and contracting here. You should consult and follow your specific institutional, government or Donor policies and procedures on procurement and contracting. You should also ensure that you have adequate legal input and review, in line with your specific policies and procedures, throughout the procurement and contracting process.



Step 4- Implement, support and maintain your VSAT



Implementation

Once you have signed the contract, then it is time to move to the exciting phase of implementing your VSAT. The first step should be to review and finalize the project plan addressing schedule of activities, points of contact, communication protocols and the roles and responsibilities of the staff of all the parties- you and the selected service provider(s).

Implementation typically consists of:

- Site Survey
- Shipping and Delivery
- Installation
- Acceptance testing and Commissioning
- Training and Documentation

Site survey

VSATs have some stringent requirements in relation to where and how they may be sited. For this reason, it is important to undertake a detailed survey of the location prior to installation. This is undertaken by the service provider. There are three main considerations in siting a VSAT:

- Clear line of sight - The position where the VSAT will be installed must have a clear, unobstructed view of the sky in the direction of the satellite.
- Interference from ground Microwave systems- The frequencies used for C band is the same as that used for terrestrial or ground microwave systems such as those used for TV or telephone networks. The VSAT should therefore be sited away from any such systems that would cause interference.



- Distance between ODU and IDU- there is a maximum cable run length between the outdoor and in-door units of a VSAT of 100 meters. The location of the antenna relative to the location of the in-door equipment must be carefully worked out.

Shipping and delivery

The service or equipment provider will normally arrange for packaging and shipping of the equipment to your location. Based on your service contract and the expected start of services date, you should determine whether to ship your equipment by air freight or by sea. Air freight to any part of Africa takes about 4 to 7 working days. Ocean freight on the other hand, can take anywhere between 6 and 8 weeks. Obviously, air freight is two or three times the cost of ocean freight and the 6 to 8 week lead time does not provide for inland transportation which stretches the timeline as well as the budget of the project.

You should also ensure, through the right statements in the Bidding Documents and contracts, that packaging is right and will enable the equipment to withstand the rough handling and treatment during loading, shipping and unloading. You should also determine who is responsible for insuring the equipment during shipment and before delivery. Usually, you should take over custody and hence responsibility of the equipment after acceptance testing.

In almost all cases, service providers demand that you be responsible for customs clearance as it can be a tedious process. Because VSATs are telecommunication systems, they are usually subject to various import, licensing and customs restrictions in most countries. These restrictions usually mean longer and more complicated-than-usual customs clearance processes which could lead to long delays. Delays of several months are not unusual! You should therefore consider what impact any delays could have on the overall project. For instance, consider if there are specific deadlines to be met e.g. start of school year or if the initiation of other projects and activities is dependent on availability of good connectivity.

The following strategies can be employed to reduce customs clearance delays:

- Ensure you have obtained licenses or clarified the licensing situation before purchasing the VSAT equipment. Do not depend on “verbal authorizations” or licenses. Insist on written authorization or license from the relevant authority.
- Determine who is most likely to have the skills needed to get the speediest customs clearance. Is it your own organization, the VSAT supplier, the shipper or even an international company? In cases where you or the supplier does not have the knowledge



and skills to speed up clearance, you will usually have to identify and contract with a reputable local customs clearing agent. This should be done before shipment of equipment has commenced. These clearing agents usually have detailed knowledge of local customs requirements and can provide invaluable advice as well as expedite the process.

- Ask your service provider to furnish you with customs documentation (packing lists, bill of lading) before shipping the VSAT equipment. Lodge these documents with your customs authority preferably before shipping has commenced.
- Determine if you require pre-shipment inspection for VSAT equipment before purchasing the equipment and inform bidders during tendering process or your selected service provider of the need to undertake pre-shipment inspection. Find out and use your country's authorized or recognized entity for pre-shipment inspection.

Lessons Learnt from the African Virtual University

A realistic project plan was developed by the ICT, procurement and finance group. VSAT licenses were acquired in ample time, the project was in line with the AVU strategic objectives, adequate financing was secured and all World Bank procurement guidelines adhered to. The VSAT equipment was scheduled for delivery via air freight.

Plan for delays

Even with all this planning, the project began to stretch over budget and time. A decision was made for some of the equipment to be shipped via ocean freight to save on the project costs.

This decision caused a severe delay in the implementation timeline and increased the project costs. There was a delay in the ship departing from the port of origin in the US and a few delays in transit. In addition to the above delays, the equipment was lost en-route to the final destination for over a month creating further delays.

The other delays in the project were caused by delayed clearing of the goods from the port of entry, no VSAT license acquired prior to installation for some sites, delays in obtaining frequencies of operation from the service provider, equipment arriving with several components missing, lack of access to installation sites in some universities, delays due to political turmoil thus making them inaccessible for installation and the cost of flying installation engineers back and forth between East and West Africa.

The lesson learned: You should plan for delays and design contingencies in advance. Even in this case, you are still likely to come across un-imaginable challenges. The trick is to be adequately prepared, flexible, adaptable and able to react quickly.



Installation

Once the equipment has been delivered to the installation site, installation can commence. The first step is usually to construct a foundation for the VSAT to sit on unless you are using a non-penetrating mount (NPM) for a roof top installation. You should clearly spell out who is responsible for the civil works of the foundation in your contract with the provider. NPMs will usually require some heavy materials to weigh them down (referred to as ballast) and these should be located and stored close to the installation site prior to installation. Solid concrete blocks usually do quite well.

In some instances, installation civil works and laying of the foundation can commence before equipment is delivered. This ensures that equipment is installed immediately upon delivery. This approach is especially recommended if the actual installation will be conducted by an out of town or even foreign based contractor. You do not want to pay charges for an out of town contractor as they wait for the cement in the foundation to dry!

The equipment will then have to be unpacked, assembled (most dishes more than 1.8 m will require assembly on site), connected together, dish pointed, equipment powered and configured. These processes are the domain of the service or equipment provider or their designated agent and require skilled, trained and experienced personnel. Small dishes of up to 1.8 m can be installed by one person but any dish larger than that will require at least 2 people. 4.5 m and larger dishes can require several people (mainly manual labour to lift and fit the pieces together) and can take up to a week to assemble, mount and point. Unless you have highly skilled and experienced technical staff, you should insist that the equipment provider undertake installation and configuration of the equipment. There are cases where equipment has been delivered and lain around for months because no one was available to undertake installation or proper configuration.

A point to note- you may require a forklift or crane to offload and place the packaged VSAT components (usually in wooden crates) in the right installation location. You should therefore confer with your equipment provider and ensure provision for this has been made if required. Where the VSAT will be mounted on the roof of a multi-storied building, you definitely need a crane or to rig a special hoist of some kind.

Where the service or equipment provider is based overseas, the cost of installation can be prohibitive because of cost of flights and accommodation. You should insist in the Bidding Documents that any prospective provider should use local labour for site surveys, installation

and commissioning. Most countries in Africa will have local technicians qualified to undertake installation, thanks in part to the success of the satellite TV industry and partly to the deregulated telecommunication environment that has led to the proliferation of local VSAT resellers and service providers.

The duration of installation for any site depends on the size of the antenna and the experience of the installer and can range from a few hours to a week, excluding casting a foundation.

Acceptance testing and Commissioning

Before accepting, signing off on the installed VSAT and paying your service provider, you should make sure that it is working to your expectation. After all a VSAT system is a complex system that involves the tight integration of various components (equipment, space segment, hub services).

You should ideally specify a number of tests (acceptance testing) that will be carried out to ensure compliance with your functional and technical specifications. The entire process of acceptance testing and signing off on the VSAT system is called commissioning. Acceptance testing procedures should be carefully considered *prior* to purchasing your VSAT and you should demand that your prospective service provider agree to your acceptance tests. It is akin to suicide to consider acceptance testing only when you have signed a contract as you, at that point, are at the mercy and whims of the service provider.

However, if you are using the partial technical specifications approach, you may not be in a position to detail your acceptance tests. In this case, you should request prospective service providers to detail the acceptance tests and procedures they will use to commission the VSAT as part of their overall proposal. You should not accept promises of receiving these *after* contract signing! In fact, the quality of acceptance testing is a key criterion for evaluating prospective service providers' technical proposals.

You should require prospective providers to grant you an acceptance testing window after installation of your VSAT system in order for you to observe the system under normal operating conditions and ensure it is up to your expectations before you sign off and start paying for recurring services. This window can last anywhere from a few days to two weeks and should be used to "tune" the system.



Common acceptance testing procedures for VSATs involve:

- Powering the VSAT to ensure all equipment starts up.
- Testing for ability to receive and transmit to the satellite.
- Testing for routing and network connections.

Training and Documentation

Even where technical support and maintenance is the domain of the service provider, you should insist that at least one of your staff receive basic training and explanation on how the systems work during the installation phase. This is important for capacity building purposes but also builds a first line of support as well as knowledge and skills to defend your SLA.

If you have dedicated ICT staff, you may consider having one of them undertake a comprehensive training course on VSAT. See Appendix 5 for a list of training providers.

You should also insist that the service provider make available to your staff detailed documentation of the overall system and how the various parts fit together. You should also have manuals for all the equipment installed as well as a clear wiring or interconnection diagram for your installation.

Maintenance and Support

Installation and commissioning of the VSAT is not the end of the story. In a typical VSAT purchase, the post installation part of the contract costs i.e. the service provision cost is often much greater than the equipment acquisition and installation part. It is therefore folly to ignore the VSAT after it has been installed. You should still retain some interest in the day to day operation of the VSAT if you are to realize the full return on your expensive investment.

This section briefly highlights some of the post installation issues you will have to keep a close eye on as well as provides general information on ensuring your service provider performs to your expectation and satisfaction.

Bandwidth Management and Monitoring

As the International Network for the Availability of Scientific Publications (INSAP)³³ notes, while efforts and solutions to lowering Internet bandwidth costs are important and necessary,



an alternative approach to pursue in concert is to recognize that bandwidth is a “valuable institutional resource or asset that needs to be managed, conserved, and shared as effectively as possible.” Most VSAT buyers are seldom aware of how much bandwidth they are actually getting, how and whether it is used efficiently and effectively, whether it is enough in the first place or even where it is used.

Monitoring refers to the pro-active practice of measuring the amount of bandwidth received and used and understanding user and usage patterns.

Monitoring is essential to ensure that:

- i) You are getting the exact amount of bandwidth you are supposed to be paying for or what you thought you bought.
- ii) You can claim for any service credits due to any down periods.
- iii) Your bandwidth is not being “misused”, for example a few individuals using high bandwidth but non essential applications such as music sharing tools.
- iv) You can make informed decisions of when to and how much extra bandwidth you can buy.

Some examples of Bandwidth monitoring

AVU- Bandwidth monitoring is done by Multi Router Traffic Grapher (MRTG) graphs and these indicated that the service is used 80% of the time.

MALICO- Bandwidth management is a major challenge with the MRTG graphs showing inconsistent use of the bandwidth.

Management refers to the pro-active practice of controlling what the bandwidth is for and how it is used among other things. Management is often necessary to stop or prevent abuse and misuse of the bandwidth.

A full treatment of the rationale, issues, strategies and tools used for bandwidth monitoring, management and optimization are presented in an excellent report by the International Network for the Availability of Scientific Publications (INASP), which is freely available from their website at <http://www.inasp.info/pubs/bandwidth/index.html>.



Maintenance and Technical Support

Maintenance and technical support are vital to keep your VSAT equipment up and running. The biggest mistake many people make is to negotiate for technical support and maintenance after contract signature. That's like trying to close the barn door after the cow has bolted. You should endeavour to establish upfront, whether and to what extent your service provider, equipment manufacturer or supplier will be responsible for maintenance and technical support. The responsibilities of all parties (your institution, the service provider, equipment supplier) must be clearly spelled out and enshrined in any contracts you sign. This section is meant to introduce and enlighten you on some of the key concepts and issues around maintenance and technical support.

Examples of maintenance and technical support

AVU - The service provider does not have a local office and maintenance of all the fifteen VSAT systems is managed by the AVU ICT department.

MALICO - Technical support is provided through the Taide Network website and the contract has a SLA but no downtimes have been experienced to date.

Maintenance refers to actions taken on equipment and systems to rectify a fault or prevent one from occurring in the first instance. Maintenance usually involves repair, upgrades, running diagnostic and trouble shooting. Maintenance can be offered through one or more of the following ways:

- Trained technician or other technical person employed full time by you
- Contract with external technician or technical consultant
- Contract with external firm that offers technical support
- Contract with equipment or system manufacturer or supplier

Technical support refers to actions taken on behalf of users to help them resolve a problem or to enable them to maximise their use of a given piece of equipment or system. Technical support can be offered through one or more of the following ways:

- Physical site visits by qualified technical staff
- Telephone
- Email
- Website



SUPPLIERS WEIGH IN

Maintenance is very important to maintain value and continuity of operations. Some of the suppliers responses to our questionnaire had the following advice to offer³⁴.

- A competent local technician and a good after sales service arrangement are critical.
- Inexperienced operators or those who do not consider VSAT operations as part of their core mission should be avoided. Shop around for an integrator to procure, install and commission your VSAT, provide some hands on training and provide after sale service.
- Ensure that you have an ample stock of major spares on hand.
- Make sure the system is well grounded and a higher performance UPS is installed to protect the VSAT equipment.

Your aim in ensuring a good maintenance and technical support plan should be to minimize the amount of time your VSAT service is unavailable, or downtime. The following considerations may be very helpful:

- Hire or train a qualified technical person on your staff who can offer the first line of defence in your maintenance and support plan. It is preferred that this person be a full time staff. However, for low bandwidth users, you may consider training one of the existing staff members on the basics of maintenance, troubleshooting and support.
- Try to retain your equipment supplier to offer you maintenance and technical support on your equipment. Generally, you should contract a completely independent (from your equipment or service provider) company for technical support only as a last resort. This is mainly driven by the need to have somebody knowledgeable about the overall project provide you support, the need to reduce the number of contracts you have to administer and oversee and the requirements of warranty.
- You should insist that you have access to live (i.e. phone) technical support 24 hours a day, 7 days a week or 24x7 from your service providers, especially your space segment and teleport provider.
- Define clear and realistic response times. Response time refers to how long you have to wait before action is taken against any request for support or maintenance you file. Most service providers are able to offer you turn-around responses within 24-48 hours. You must note that you should be prepared to pay a little more, in most cases, if



you want quicker resolution of any problems. One approach is to categorize the nature of the problems into “critical problems” and “non critical problems” and demand for guaranteed resolution of critical problems within 24 hours at the outside. Critical problems are generally defined as those that lead to loss of service or downtime.

- Ask your service provider to spell out clear contacts and an escalation plan. Most service providers will make available a telephone number and/or email address for contact. This will usually end up on the desk of a low level technical person. You should be able to notify the top management of your service provider of any problems you are encountering, that are not resolved to your satisfaction or in a timely manner. Therefore, you should spell out, with your service provider, clear steps and timeframes to “escalate” an unresolved problem to higher management. Your provider should also be able to provide you with contact email and phone numbers for senior managers in case you need to escalate a problem.

All this said, you must be ready to back up your rights (assuming you have these enshrined in the contract) to a negotiated minimum level of maintenance and technical support with penalties, if denied. Such penalties should include provision of service interruption credits as well as the right for you to terminate the contract if your problems are not addressed or resolved within an agreed timeframe or to your satisfaction.

Warranty and Spares

One of the contentious technical issues when purchasing expensive and complex equipment and services such as those for VSAT system is warranty. Warranty is simply a guarantee that the VSAT will perform as expected backed up by a contractual and legally enforceable promise and commitment to remedy any problem through repair, replacement of parts or other means at no additional cost to you. You should therefore attempt to gain the best warranty provisions you can. Consider warranties for both equipment and service provision. What happens for instance if the Hub antenna of the service provider is knocked by lightning or the satellite's useful life comes to an end? Some things to consider:

Equipment

It is recommended that you demand for at least one (1) year full warranty on parts for all equipment. This means that any broken part within the warranty period will be repaired or replaced at no cost. You should find out if this warranty also includes labor, as you may require specialist help to dismantle or install a piece of VSAT equipment, which labor can be expensive. It is advisable to request and pay for “extended” warranty of up to three years. It costs a little extra but can make the whole difference if equipment ends up failing frequently.



Space segment

If you are purchasing your own space segment, then you must obtain warranties and guarantees on what happens to your service if the satellite is rendered non-operational for any reason. You should know that space segment warranties and guarantees come in a combination of two flavors- preemptible or non-preemptible and restorable or non-restorable. Preemptible space segment is one that can be taken away and used by the satellite operator for other purposes, such as in the event of an emergency. Non-preemptible bandwidth can not be taken over by the satellite operator. It is dedicated to you, the buyer, over the life of your contract with the operator. Restorable space segment refers to the highest form of space segment warranty. It means that in the case of a satellite failure, your service provider will immediately provide you with alternative space segment of equivalent or better quality and characteristics on another transponder or even another satellite. Non-restorable space segment is not guaranteed in the event of a satellite failure.

Hub

For the Hub service, it is usual to require the service provider to demonstrate full redundancy of all Hub components including electricity and climate control systems except for the antenna. This means that the service provider should indicate in their proposal whether they have on-site, standby backup replacement equipment and services for the major Hub components. Prospective service providers should be asked to detail what procedures they would take in case of an outage at the Hub and the maximum length of time outages are expected to last.

Ensure that you keep track of your warranty issues and that you invoke and utilize warranty as and when you detect a fault or problem.

CONCLUSION



The launch of the first communications satellite instantly transformed global telecommunications. It enabled countries and business to connect directly to one another. With the introduction of the VSAT, in the last 10 years, the transformation has become a revolution, changing the way business is conducted, and in many ways, the way we live our lives. Without VSAT technology, many of the early Internet access initiatives, responsible for sparking the ICT revolution, in Africa would not have taken off. It is somewhat difficult to imagine what the state of Internet connectivity in the under-developed world would look like if this technology had not been developed.

Today, the VSAT is the first choice of Internet connection for most of the world's poor. As we have detailed above, the ability to connect remote and rural communities, as well as urban areas with inadequate or unreliable telecommunications infrastructure, is unmatched by virtually any other technology in terms of feasibility, cost and ease of implementation. In the fight to bridge the digital divide, VSATs have been one of the most effective tools in the arsenal of technological solutions.

Despite their usefulness, very few people understand how they work and how to acquire them in the most cost effective manner. VSATs, therefore, are shrouded in myth and viewed as an extremely "complicated" technology best left to the technologists. Unfortunately, this attitude has meant that most organizations and institutions that acquire VSATs do not use them to the maximum, or acquire the wrong VSAT, undermining their business objectives and therefore their ability to improve their organizations in a positive way.

We believe that this Guide will debunk most, if not all of the existing myths. More importantly, we believe that this Guide will be a valuable tool and will simplify the complex decisions involved in buying VSATs, or indeed any other technology. While we have tried to make the Guide as comprehensive as possible, there may be certain information that is missing. It is therefore not a "magic bullet" in this regard. However, we hope that this Guide will provide you with a spring board to enable you to consider all the information you had hitherto not considered important in the acquisition process or at the very least, it will help you ask the right questions.

Lastly, a brief word on the future of VSATs may be appropriate. When we asked the service providers, as part of the case study process, what they thought of the future of VSATs given the increasing availability of alternative fiber infrastructure, they were all extremely enthusiastic that VSATs still had a significant role to play. Given the extremely dismal coverage of terrestrial telecommunications infrastructure in Africa, and the extremely high cost of developing this



infrastructure, VSATs clearly still have an important role to play. However, as we advised at the start of Part 2 of this Guide, you the buyer should continuously evaluate all the possible connectivity options available. Only then can you truly buy a solution that best meets your business requirements.



PART 3

APPENDICES





Appendix 1: Case studies

Methodology for case studies

Over thirty English and French questionnaires were sent out between May and August of 2005 to organizations that had recently procured VSAT systems and to VSAT suppliers. The questionnaire was also posted on the Global VSAT Forum secretariat and Intelsat provided access to VSAT suppliers in their network. A period of two weeks was given to complete and return the questionnaire and in some cases an extension was provided for, given the tight deadline. Upon receipt of the completed questionnaires, telephone interviews were conducted for further clarification with some institutions and suppliers.

Of the thirty plus questionnaires sent out and posted in different forums, four institutions and twelve suppliers responded. The responses from the completed questionnaires and from telephone interviews are presented throughout the Guide and provide valuable information from first time buyers as well as insights from suppliers.

Organizations featured in the case studies

Malawi Library and Information Consortium (MALICO)

<http://bunda.unima.mw/malico.htm>

Malawi Library and Information Consortium (MALICO) is a consortium of organizations established in May 2003 that combines its talents and resources to promote and deliver library and information services for Malawi and the global community. MALICO seeks to acquire and deliver electronic resources to its members and provide mechanisms for improved access to information.

At a General Assembly meeting of the Electronic Information for Libraries (eIFL) in St Petersburg Russia December 2002, an initiative to bring top quality Internet based journal articles to Southern African Universities from the International Network for the Availability of Scientific Publications (INASP), Programme for the Enhancement of Research Information (PERI) and eIFL resources was started. This great initiative was almost rendered worthless and the resources inaccessible due to the extremely slow internet speeds in majority of the participating institutions. To solve the connectivity challenge, MALICO held consultations with its members and approached eIFL.net, Open Society Institute and Open Society Initiative of Southern Africa (OSISA), Emergency Drought Recovery Project, and the University of



Malawi Dossani Trust Fund for funding and support. Four VSATs were purchased and are now located at Mzuzu University and University of Malawi at Bunda College, Chancellor College and Malawi College of Medicine.

SchoolNet Uganda

www.schoolnetuganda.sc.ug

SchoolNet Uganda is a national network of professional educators and schools whose vision is to transform the Uganda educational system from an industrial model (learning by assimilation) to a knowledge-based model to prepare the youth of Uganda to effectively enter a Global Economy based on Knowledge, Information and Technology.

The VSAT Pilot Project is part of an on-going international initiative by World Links Program to pilot new concepts in technology and pedagogy to integrate Information Communication Technology (ICT) in education in developing countries. Uganda was the first World Links country program and is now again the first of the twenty-seven World Links countries in Africa, Latin America, the Middle East and Asia to pilot the use of VSAT technology for school connectivity.

Réseau Interuniversitaire du Cameroun (RIC)

<http://uninet.cm> or <http://www.minesup.gov.cm>

Réseau Interuniversitaire du Cameroun (RIC) is a network of Universities in Cameroun that seeks to provide connection and modern telecommunications infrastructure to the universities in the network. RIC provides internet access, collaboration among the Universities in the RIC network, sharing and dissemination of scientific and technical information, e-Learning and University Information Systems.

The African Virtual University (AVU)

<http://www.avu.org>

The African Virtual University (AVU) is a pan-African educational network established in 1997 as a World Bank project to serve the countries of sub-Saharan Africa (SSA).

The AVU intends to be the leading continental and virtual education and training organization collaborating with, and supporting African higher education and training institutions in enhancing their capacities to utilize Open, Distance and Electronic Learning (ODEL) methodologies so as to effectively increase access to local and global demand-driven graduate and undergraduate programs in disciplines critical for Africa's socio-economic development.



Name of Organization	Contacts
<p>Malawi Library and Information Consortium (MALICO) Lilongwe, Malawi http://bunda.unima.mw/malico.htm</p>	<p>Margaret E Ngwira Secretary Tel: 265 9 955 856 mengwira@kcn.unima.mw</p> <p>Dr Busiso Chisala Technical Adviser Tel: 265 9 958 396 chisalab@chanco.unima.mw</p>
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<p>SimbaNET Com Limited Nairobi, Kenya http://www.simbanet.co.ke</p>	<p>Mr. Nimesh Shah General Manager Tel: +254-20-532349/556050 nimesh@simbanet.co.ke</p>



Appendix 2: VSAT Service providers in Africa

Operator	C band or Ku band	Service	Satellite Carrier	Satellite
AccelonAfrica			ASTRA	WORLDSAT-2
Afrisat	Ku	SPOTBytes	PanAmSat	PAS-10
Afsat	Ku	SPOTBytes	PanAmSat	PAS-10
AST	C			
Bentley Walker		F-TDMA/ DVB	PanAmSat	PAS-1R PAS-10 'Soon'
Bizarnet		F-TDMA/ DVB	PanAmSat	PAS-1R PAS-10
Comet Technology/ Simbanet		IPSys DVB/ SCPC	New Skies	NSS-7
EMC	C	MCPC/SCPC		
Emperion	Ku		Panamsat and Eutelsat,	PAS1R,PAS10 and W3A -
Geolink	C	DVB-RCS	Eutelsat	Atlantic Bird 3 (Stellat 5)
Gilat Alldean	C	DVB	Eutelsat	Atlantic Bird 3 (Stellat 5)
GS Telecom			New Skies, PanAmSAT and Intelsat	
IP Planet	C			
IPMC Ghana	See Q-Kon	SPOTBytes SCPC/ DVB	PanAmSat	PAS-1R
		ViNet		
IVSAfrica	Ku	DVB	PanAmSat	PAS-10
Menasat (GDBC/ African Lakes)	Ku	DVB	PanAmSat Nilesat	PAS-10 Nilesat 101
MWeb	Ku	DVB	PanAmSat	PAS-7
Pinet Informatics	Ku	TDMA/ DVB	PanAmSat	
	Ku	SCPC/ DVB	PanAmSat	
	C	SCPC/ DVB	PanAmSat	
Q-Kon		SPOTBytes	PanAmSat	PAS-10
		ViNet	PanAmSat	PAS-1R
Satcom Networks Africa Ltd			Intelsat	
Telenor			Intelsat, Eutelsat and Inmarsat	
Telkom South Africa	Ku			IS-904
Transcom	Ku	DVB/RCS	Panamsat	Pas-1R
		DVB/F-TDMA	Panamsat	Pas-10
Viasat	Ku		PanAmSat	PAS-1R
	C	SCPC/ DVB	Intelsat	IS-901



Source: The Case for Promoting Internet and Universal Access through Low-Cost Satellite Technologies (CATLA Report)

Note:

- Aramiska does not have coverage over Africa, using the Eutelsat Atlantic Bird 3 satellite. Menasat is a one-way service, with the return channel via dial-up or ISDN.
- PanAmSat has since been acquired by Intelsat August 2005



Appendix 3: International VSAT Service Providers offering services in Africa

Service Provider	Website
Alcatel Space	www.alcatel.com/space/
Arabsat	www.arabsat.com
Asiasat ³⁵	www.asiasat.com
Brad matt Telecom Ltd	www.bradmatt.co.uk/
Carrier to Carrier Telecom	www.carrier2carrier.com
Emerging Markets Communications Inc	www.emc-corp.net
Emperion	www.emperion.net/
Europe*Star	www.europestar.com
Eutelsat	www.eutelsat.com
GlobeCast France	www.globecast.com
Global Broadband Solution	www.gb-solution.com
Gilat	www.gilat.com/Home.asp
GT&T	www.globaltt.com
Hughes Network Systems	www.hns.com
Intelsat	www.intelsat.com
Inmarsat	www.inmarsat.com
Inmedia (Kingston)	www.inmedia.co.uk
IPPlanet	www.ipplanet.com/
Iris	www.irissat.com
KaliTel/Anatolia	www.kalitel.com
Link-Sat	www.link-sat.net
Loral Skynet	www.loralskynet.com
MM Telecom Corp	www.mmtelcom.com
MTI - Milano Teleport Italia Spa	www.net-teleport.com
New Era Systems	www.newerasystems.net
New Skies	www.newskies.com



Nile-Sat	www.nilesat.com
Panamsat	www.panamsat.com
Plenexis	www.plenexis.com
Q-KON	www.qkon.com
RASCOM	www.rascom.org
Redwing Satellite Solutions	www.redwingsat.com/
Satvision Plc	www.satvision.co.uk
SES ASTRA	www.ses-astra.com
SimbaNET	www.simbanet.co.ke
Stellar Gruppe	www.stellar-pcs.com
Taide	www.taide.net
Telenor Satellite Networks	www.telenorsat.com
TeraCom Mobile Links	www.mobilelinks.se
Thaicom Satellite Station	www.thaicom.net
Titan	www.titan.com
Tiscsat	www.tiscat.com
Verestar/Interpacket	www.verestar.com
ViaSat	www.viasat.com
Worldspace	www.worldspace.com



Appendix 4: Major Equipment Vendors and Service Providers

Company	Website
Accelon Pty Limited	www.accelonafrica.com
Advance Telecoms	www.advtel.co.za
AfriConnect Ltd	www.africonnect.com
AFSAT Communications	www.afsat.com
Alcatel	www.alcatel.com
ComTech EF Data	www.comtechefdata.com
Direct On PC Limited	www.directonpc.com
DVI	www.dvi-telecoms.co.za
EMS	www.emssatnet.com
Gilat	www.gilat.com
Hughes Network Systems	www.hns.com
PentaMedia Co.Ltd	www.pentamedia.com
QKon	www.qkon.com
STS	www.stssa.com
TELE Greenland International	www.telegreenland.com
Viasat	www.viasat.com



Appendix 5: Online Tutorials, Training Courses and Certification

AfriConnect

http://www.africonnect.com/vsat_tut.htm, <http://www.africonnect.com/techtutorials.htm>

African Advanced Level Telecommunications Institute (AFRALTI)

<http://www.afralti.org/>

African Internet Service Provider Associations (AfrISPA)

<http://www.afrispa.org/Default.htm>

Africa Network Operators' Group (AfNOG)

<http://www.afnog.org/>

African Network Information Centre (AfriNIC)

<http://www.afriNIC.net>

AITEC Africa

www.aitecafrica.com

COMSYS

<http://www.comsys.co.uk/vsatnets.htm>

Fratec Company

http://www.fratec.com/FAQ/NFO/NFO_WAN_011.HTML

Global VSAT Forum (GVF)

www.gvf.org

IEE Satellite Communications

<http://www.satsig.net/>

Intelsat

<http://www.intelsat.com/resources/satellitebasics.aspx>

International Telecommunications Union (ITU)

<http://www.itu.int/>

JIDAW Systems, Nigeria

<http://www.jidaw.com/>



Joint Information Systems Committee (JISC)
http://www.jisc.ac.uk/index.cfm?name=sat_home
MLESAT
<http://www.mlesat.com/>

NOVA STAR electronics
<http://novastars.com/vsat/>

Quantum Prime Communications
<http://www.qpcomm.com/vsat.html>

Q-KON Training Academy, South Africa
<http://www.qkon.com/>

Redwing , UK
<http://www.redwingsat.com/pdf/VSATInstall-Com.pdf>

SATCOMS
<http://www.satcoms.org.uk/education.asp>

Satcom Satellite School
<http://www.satcom.co.uk/School/index.asp>

Satellite Signals
<http://www.satsig.net/ivsatsat-africa.htm>

Sign on Africa
http://www.signonafrica.com/ict/vSat_tutorial.asp

Spread Spectrum Scene
<http://www.sss-mag.com/vsat.html#tut>

Tertiary Education Network (TENET)
www.tenet.ac.za/

University of Technology Sydney
http://services.eng.uts.edu.au/~kumbes/ra/Wireless_Networks/VSAT/Trevs%20Page/VSAT.htm

University of York, UK
<http://www.yorkvsats.com/>



Appendix 6: Books on Satellite and VSAT Technology

VSAT Networks by Gérard Maral

Satellite Communications Systems: Systems, Techniques and Technology by Gérard Maral, Michel Bousquet

Satellite Technology : An Introduction by Andrew F Inglis,

Satellite Communications by Dennis Roddy

Satellite Communication Systems (I E E Telecommunications Series) by Barry G. Evans

Satellite Communication Systems by M. Richharia

Business Strategies For Satellite Systems by D. K. Sachdev

VSATs: Very Small Aperture Terminals (I E E Telecommunications Series) - by John L. Everett

Satellite communications & VSATs: A practical reference book for managers & engineers by Ernest Simo



Appendix 7: Links to Satellite Link Budget Calculators

<http://www.satsig.net/linkbugt.htm>

<http://www.demarctech.com/techsupport/cals/link-budget-calcs.htm>

<http://www.tutorialsweb.com/satcom/satellite-link-budget-calculator.htm>

<http://www.satcoms.org.uk/budget.asp>

<http://www.wetzell.ifag.de/publ-cgi-bin/linkbudget.py>

<http://www.satellite-calculations.com/>



GLOSSARY



**Antenna**

Also known as a dish, the antenna is in the shape of a parabola, which has a special reflective property that enables it to reflect and converge electromagnetic waves to a single point, called the focal point.

Antenna Gain

The Gain is defined as the ability of the antenna to amplify the very weak incoming signal from the satellite.

ATICS

African Tertiary Institutions Connectivity Survey, www.atics.info

Asymmetrical connection

See symmetrical connection

Azimuth angle

The Azimuth is the angle of the path to the satellite in the earth's horizontal plane, measured clockwise from North. Therefore an object due East is said to have an azimuth of 90 degrees or one due South an azimuth of 180 degrees.

Backhaul Connection

This is the connection between the Hub and either the public network such as the Public Switched Telephone Network (PSTN), or the Internet.

Bandwidth

Bandwidth is the difference between the upper and lower frequencies of an analogue channel. Bandwidth is measured Hz. The capacity or data-rate that a channel can provide is measured in bps. There is a known but different relationship between bandwidth and data rate for all digital systems.

Unfortunately, bandwidth and capacity are used interchangeably in most literature dealing with ICT. In this document, bandwidth is almost always used for capacity, but not always so. The sections where the term is correctly used are specifically highlighted in italics to the reader.

Bit

One bit of data. A bit is either a "1" or a "0". Measure in b, kb, Mb or Gb. (Note, the "b" is **always** in lower case without exception!

bps

Bits per second. A measure of capacity of a transmission channel used for digital systems. See Hertz and bandwidth.

BUC

Block Up Converter- The BUC can be thought of the "transmitter", and its actions are effectively the direct opposite to the LNB. The BUC consists of the Up Converter and HPA.

Bursting

Bursting refers to the ability of a VSAT system to utilize bandwidth above and beyond its normal allocation. Bursting is only possible when several VSATs share a common pool of bandwidth. It only occurs when there is 'free' or available bandwidth in the pool

Byte

One Byte is equal to 8 bits. The "B" is **always** a capital letter. Bytes are measured in B, kB, MB, GB

Capacity

Capacity or Data Rate is a measure of the amount of information that a communications system can transfer from one place to another.



It is common to refer to the transfer medium as a channel. A simplistic but helpful analogy to use is a water pipe. The pipe is equivalent to the channel, the water it carries equivalent to information and the size or capacity of the pipe the Data rate or capacity. The larger the volume of water (information) the pipe (channel) can carry (transmit or receive), the larger is the capacity of the pipe. Capacity is measured in bps, kbps, Mbps, Gbps. Capacity or data-rate is always measured in the amount of data transmitted per second. See bandwidth for note on the terminology usage.

Note also, 1 Mbps is equal to an actual 1024 bps. This is because we are dealing with numbers to the power of 2 and not to numbers to the power of 10.

Carrier signal

A signal that is used to carry useable information to and from the satellite. The information is combined with the carrier signal through a process called modulation.

C Band

The range of communication frequencies from 3 to 7 MHz used for satellite communications.

CIR

Committed Information Rate

CIR is the dedicated or guaranteed bandwidth that your service provider will make available. This CIR bandwidth is not shared with anybody else.

CSIR

Council for Scientific and Industrial Research, South African Government research organization.

Decibel (dB)

The Bel is named after Alexander Graham Bell who first used it to define the relative differences in the loudness of sound. A decibel is one tenth of a Bel, as the larger unit is unusable for normal applications. Decibels (dB) are a logarithmic measure used to compare the differences in power of two signals. If one signal is assumed to be one Watt, then it gives a measure of relative gain or loss of power and is typically expressed as dBW. The advantage of using Decibels is that it enables one to manipulate input and output powers, their gain and loss with simple addition and subtraction arithmetic. 1 Bel = 10 dB

DSL

Digital Subscriber Line, a form of broadband or high speed terrestrial internet access service

DVB

DVB is an open, non proprietary standard developed for the transmission of digital video over satellite and terrestrial systems such as cable. It is especially efficient and effective at “transporting” digital data. Since Internet data is digital in nature, its also lends itself to effective transportation using DVB. The DVB-S standard describes how digital signals are transmitted over satellite links. Similar standards exist for cable (DVB-C) and terrestrial (DVB-T) radio systems.

The openness and non proprietary nature of the standard, and the fact that it could handle both video and data efficiently, made it attractive to equipment manufacturers and service providers leading to the development of cheap mass market receive devices. It has thus established itself as one of the major technical standards for internet offerings using VSATs.

Combined with a return channel over satellite,



a DVB-RCS (Return Channel via Satellite) open standard is now available for interactive VSAT networks.

EDGE

Enhanced Data rate for GSM Evolution

Effective Isotropic Radiated Power (EIRP)

EIRP is a measure of the satellite power or strength of the satellite signal that can be received at a given point on the earth, or transmitted towards a satellite from a dish. It is measured in decibel-Watt (dBW) when compared to a reference one-watt theoretical radiator. EIRP values are published by the satellite provider, usually in the form of contour maps. VSAT network designers must calculate the uplink EIRP value for a VSAT.

Elevation Angle

The angle of elevation is the angle of the straight line path to the satellite as measured above the horizon and can range from 0 degrees to 90 degrees.

Feed horn

The feed horn is a conically shaped device placed at the focal point of the dish. It is responsible for collecting the incoming receive signal from the satellite after it is reflected from the antenna and directing the outgoing transmit signal to the antenna for reflection into space.

Foot print

This is the area on earth covered by a satellite beam.

Frequency

The number of signal cycles per second given in Hertz

Frequency Band

The range of frequencies within which an

electromagnetic wave may be transmitted or received. Three main frequency bands are used for satellite communications: C band, Ku band and Ka band. These bands, designation letters and their associated frequencies are determined and allocated by the ITU.

Gbps

Giga bits per second. 1 Gbps equals one billion bps

Geostationary Orbit

A special form of geosynchronous orbit, aligned in the same plane as the earth's equator. See Satellite Orbit.

Geosynchronous Orbit

See Satellite Orbit

GPRS

General Packet Radio Service

Ground Segment

In a VSAT system, the dish and electronic equipment are said to form the "ground segment" of a satellite communications network.

The ITU defines all "ground stations" as "earth stations".

GSM

Global System for Mobile Communication, a standard for mobile phone communication mainly used in Europe, Africa and Asia.

Hertz

Hertz is a measure of the frequency of a radio wave. 1 Hertz equals 1 cycle per second. Analogue bandwidth is also measured in Hz, kHz, MHz.

(See bps and bandwidth).

Hub

This is a special earth station that acts as the



“heart” of a star VSAT network, through which all communications flow. Individual VSAT stations are connected to the hub like a wheel’s hub and spokes. The Hub controls which VSAT can communicate in the network and how much bandwidth each VSAT is entitled to.

HPA

High Power Amplifier- a device used to amplify the signal to be transmitted, enabling it to traverse the thousands of miles to the satellite. The capacity or rating of the HPA is given in Watts (W). It follows generally that the higher the HPA rating, the larger the signal (and therefore amount of information) a particular VSAT system will be able to transmit. HPA ratings for VSATs usually vary from 1 to 40 W. HPAs, BUCs and SSPAs are only found on interactive systems.

HSCSD

High Speed Circuit Switched Data

ICT

Information and Communications Technology

Indoor Unit (IDU)

The electronic equipment used for processing information is referred to as the “Indoor Unit” because it is installed and kept indoors.

Inter Facility Link

The IFL is one or more co-axial cables connecting the ODU (specifically the LNB and BUC) to the IDU equipment (the receiver and modem). Typically, there are separate cables for the transmit and receiver signals. Receive-only systems only have one cable in the IFL.

INASP

International Network for the Availability of Scientific Publications

Inbound

Inbound connections refer to information flow from the user to the Internet. For VSATs, the inbound connection is also referred to as the transmit link or signal.

IP

Internet Protocol

ISDN

Integrated Services Digital Network

ISP

Internet Service Provider

ITU

International Telecommunications Union, a United Nations agency that oversees telecommunications standards, policies and frequencies used by the international community for telecommunication services.

kB

kilo Byte

kbps

kilo bits per second. 1 kbps equals one thousand bps

LAN

Local Area Network

Latency

This is the delay between transmitting a signal and receiving it at the other end. An example of latency is the delay on a telephone line that one experiences when making long-distance telephone calls or the out of sync voice and video in a video conference (the participants lips move but the sound arrives a few seconds later), all of which can be quite unnerving. See satellite hop.

**Link Budget**

The link budget is a consideration of the signal's power gains and losses from the transmitter to the receiver (much like a monetary budget is about financial losses or expenses and gains or income). As the signal leaves the transmitter, traverses space, and arrives at the receiver, it experiences gains and losses in its power or signal strength.

When engineers calculate link budgets, they are making sure that the system is capable of and optimized to receive a signal of acceptable strength from the transmitter. This involves varying several parameters including the size of receive and transmit antenna, bandwidth of the signal and the power of the transmitter. In the case of VSATs, link budgets are used to arrive at the optimum combination of the dish size, transmit BUC and receive LNB rating for given link bandwidth.

LNB

Low Noise Block

A device used to amplify or boost the weak received signal without amplifying the noise signals (hence the "low noise" part of LNB) and to convert the high frequencies of the signal into lower frequencies, a process called down converting, for conveyance to the indoor equipment (demodulator) for processing.

MACRA

Malawi Communications and Regulatory Authority

MB

Mega Byte

Mbps

Mega bits per second. 1 Mbps equals one million bps

MTBF

Mean Time Between Failures

A measure of the reliability of a piece of equipment or system.

Modem

A **modulator** and **demodulator**. The modulator is the transmit device, whilst the demodulator is the receive device. See modulator, and receiver.

Modulator

A modulator is used only for transmission and therefore is found in only interactive systems. Modulators mix the useful information e.g. internet data, another signal, called a carrier signal, in a process called modulation.

MRTG

Multi Router Traffic Grapher, a web based application used to monitor and graphically display traffic and usage of an internet connection.

MS Messenger

Microsoft Messenger

OMT

The OMT is only found on interactive systems and is installed right behind the feed horn. It is responsible for separating transmitted and received signals and directing them appropriately to the BUC and LNB respectively.

OSISA

Open Society Initiative of Southern Africa

ODU

The antenna and receive/transmit assembly is collectively referred to as the "Outdoor Unit" or ODU because it is installed outdoors.



Outbound

Outbound connections refer to information flow from the Internet to the user. For a VSAT system, the outbound connection is also called the receive link or receive signal

PERI

Programme for the Enhancement of Research Information

PC

Personal Computer

Receiver

This is an electronic device that processes the received signal to obtain the useable data from the received signal by processing it through a complex array of electronic devices. Receivers are also variously referred to as “set top boxes” or “decoders”.

Remote Terminal

The remote terminal is the earth station or VSAT.

Satellite

In its loosest form, a satellite is any object or body that moves in circular-like orbit or path around a planet. The moon, for example, is a satellite of the earth. The term has however become synonymous with communications satellites, which are man-made objects that revolve around the earth and provide communications links among two or more points on earth. There are other types of man-made satellites such as those used to track weather conditions and for the global positioning system (GPS). The first man-made communications satellite, named Sputnik, was launched into space in 1957 by the Soviet Union.

Satellite Beam

This is a pattern of electromagnetic waves transmitted by the satellite. Just as a torch shining onto the floor in a dark room has

a defined beam or collection of rays of light, the transmission from a satellite also has a defined pattern. The beam can be wide or narrow covering a large or small area on earth.

Using a system of varying frequencies and alignment of antennas onboard the satellite, each satellite can have several beams within which all or most of the satellite's power is concentrated. There are four common types of satellite beams:

- Global beams: covering almost 1/3 of the earth's surface.
- Hemi beams: covering almost 1/6 of the earth's surface, shaped to cover specific regions and usually covering an entire continent.
- Zone beam: covering a large landmass, usually consisting of a few countries.
- Spot beam: covering a specific geographic area usually a specific service area. Spot beams are provided by "steerable antennas" on the satellite.

Satellite Hop

When a signal travels from one VSAT to another via a satellite, it is said to have made a single hop. For satellites in geostationary orbits, this “hop” takes about one quarter of a second. In a network with a Hub, any interactive communication will involve a double hop, i.e. information has to flow from one VSAT to the Hub and then out to the Internet (or to another VSAT) and back, which introduces high latency on the satellite link.

Satellite Link

The signal from the VSAT to the satellite or vice versa is said to form a “link”. The



"uplink" is the link from a VSAT (earth station) to a satellite. The "downlink" is from a satellite to a VSAT (earth station).

Note: The ITU refers to **all** stations on the earth as "earth stations" or "ground stations" and **all** satellites as "space stations"

Satellite Orbit

This is the path of the satellite around the earth. There are three main types of orbits differentiated by how far from the earth's surface the satellite is located which also determines how many times in a day the satellite can circle the earth.

- Low Earth Orbit (LEO): 500-2,000 km above the earth
- Medium Earth Orbit (MEO): 8,000-20,000 km above the earth
- Geostationary Orbit (GEO): 35,786 km above the earth.

At both low and medium orbits, the satellite circles the earth several times in a day. This means that if you remain at a fixed point on earth, the satellite would pass overhead several times in a day. For continuous communication from a single point on earth in this case, for example when making a telephone call, multiple satellites are required with one satellite handing over communication to another before disappearing over the horizon in one long "relay".

In a geosynchronous orbit, a satellite's speed of orbiting the earth is the same as the earth's rotation. In other words, the satellite takes about 24 hours to move around the earth. When the orbit is in the same plane as the equator, the satellite appears "stationary" relative to any fixed point on earth and is called geostationary. Geostationary orbits are

therefore a special form of geosynchronous orbits aligned in the equatorial plane.

Satellite Signal

A form of electromagnetic waves carrying information to or from the satellite.

Space Segment

This is the satellite portion of the network. Space segment is also used to refer to bandwidth of the satellite.

Symmetrical/ Asymmetrical connections

A symmetrical connection is one with the same amount of bandwidth for the outbound (receive) and inbound (transmit) connections. Conversely, an asymmetrical connection is one where the inbound and outbound connections have different bandwidths. For Internet access, the connections are almost always asymmetrical with the inbound usually set at $\frac{1}{4}$ or $\frac{1}{3}$ of the outbound. This is based on the premise that the information you request, for example if you click a link on a website, is small while the information that comes back, the linked webpage, is large. If you plan to host your own website at the VSAT location, you will then have to adjust the inbound upwards to cater for the fact that you will be "serving" the larger information for people whose incoming requests are "small".

Transponder

A transponder is a receive-amplify-transmit device onboard the satellite. Its purpose is to receive the signals transmitted from earth, amplify them, change (shift or translate) the frequency and transmit the amplified signal with the new frequency back to earth.

The frequency change is necessary to avoid interference between the received



and transmitted signals. Transponders are analogue devices defined by their bandwidth, typically 27, 54 MHz or 36, 72 MHz. Transponder capacity on a modern satellite is defined in terms of the number of "36 MHz equivalent transponders" to allow meaningful comparisons to be made between satellites. Smaller satellites have about 15 transponders on board whilst the larger ones can have more than 90 transponders.

UMTS

Universal Mobile Telephone Service

Up Converter

A device that forms part of the BUC. The Up Converter converts the low frequency signal from the indoor equipment carried along the co-axial cable to a higher frequency for transmission to the satellite.

UPS

Uninterruptible Power Supply

VOIP

Voice Over Internet Protocol

VPN

Virtual Private Network

VSAT

Very Small Aperture Terminal. It refers to a dish-like ensemble (or simply dish), usually less than 3.8 m in diameter, together with electronic equipment used to transmit and receive information (voice, video and data) via a communications satellite in space. The dish is also referred to as a satellite antenna, terminal or earth station.

WIFI

Wireless Fidelity

WIMAX

Worldwide Interoperability Microwave Access

END NOTES





¹ Accelon Pty Limited

² Intelsat

³ Russell Southwood

⁴ Science purists will note that centrifugal forces are in reality non-existent! This is true. The notion of centrifugal forces is one that an object traveling in a circle will experience an outward pull. In reality, an object will travel in a straight line unless there is a centripetal (with a p) force that draws it inwards and therefore causes it to curve. The notion of centrifugal forces is therefore only that- a notion to help explain the overall dynamics of objects moving in a circle. There in reality, the existence of a centrifugal force is the absence of “enough” centripetal force to cause the object to move to the center of the circle. See http://www.absoluteastronomy.com/encyclopedia/c/ce/centrifugal_force.htm, http://www.slcc.edu/schools/hum_sci/physics/tutor/2210/pointmass_circular/ and http://en.wikipedia.org/wiki/Centrifugal_force for details between centrifugal and centripetal forces.

⁵ http://www.panamsat.com/global_network/pas1r_c.asp

⁶ The satellite footprint for KA-band are much smaller and usually only cover a single metropolitan area. As a result KA band beams have not yet been deployed in developing countries as the markets here are much smaller.

⁷ The same ones used for digital television reception costing around \$100.

⁸ http://www.idrc.ca/acacia/ev-53486-201-1-DO_TOPIC.html

⁹ ViaSat, Inc, Intelsat, AfriConnect Ltd, Comtech EF Data, Information Technology Group (ITS)

¹⁰ See <http://guide.darwinmag.com/technology/outsourcing/sla/> for a comprehensive treatment of SLA

¹¹ For a full treatment of the current and planned fiber networks in Africa, please see http://www.acacia.org.za/africa_internet_map.htm and <http://eassy.org/index.htm>

¹² AfriConnect

¹³ From African Tertiary Institutions Connectivity Survey (ATICS) – a survey of 80 African tertiary institutions across 40 countries. (www.atics.info)

¹⁴ The cost for mobile connection is taken to be the same as that of dial up because current billing structures are the same. In fact, most mobile phone calls are more expensive than dial up in some countries. Please note that for gprs this may not be entirely true as you may be billed per packet, which can be very costly, or quite cheap, depending on country.

¹⁵ Note that VoIP and videoconferencing bandwidth requirements can vary considerably depending on the quality required, e.g GSM quality voice links, and low-refresh-rate video can be provided with as little as 4.8kbps per link, while higher quality voice may require 32Kbps or more and TV quality video 384Kbps.



¹⁶ <http://www.microsoft.com/technet/prodtechnol/winxppro/maintain/wmsgfaq.mspx>

¹⁷ www.webex.com

¹⁸ http://www.wiredred.com/epop_downloads_webconf_req.html

¹⁹ Kevin Craine, Email Archive Management- Watching the store, <http://www.dptmag.com/editorial2.asp?ID=104>, Debbie Moffat , THE COST OF EMAIL: <http://www.hpcwire.com/dsstar/03/0121/105321.html>

²⁰ Choosing the Right Connection: <http://www.microsoft.com/windows2000/en/server/iis/default.asp?url=/windows2000/en/server/iis/htm/core/iirtcon.htm>

²¹ Nielsen, Jakob Designing Web Usability: The Practice of Simplicity (2000:48)

²² <http://www.foundation-partnership.org/pubs/bandwidth/index.php?sub=appendix1>

²³ <http://www.foundation-partnership.org/pubs/bandwidth/index.php?chap=chap2&sub=c2c>

²⁴ Optimizing Internet Bandwidth in Developing Country Higher Education

²⁵ Intelsat

²⁶ <http://www.broadcastpapers.com/satellite/VistaCrisisRecipe-print.htm>

²⁷ Source: various VSAT tenders and requests for quotes 2004-2005

²⁸ Source: various VSAT tenders and requests for quotes 2004-2005

²⁹ Comtech EF Data

³⁰ <http://www.wimaxtrends.com/articles/archives/reports/f071505a.htm>

³¹ ViaSat,

³² See <http://worldbank.org/procure>

³³ <http://www.inasp.info/pubs/bandwidth/index.html>

³⁴ Viasat, Intelsat and AfriConnect

³⁵ No capacity over Africa