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Improving access to education via satellites in Africa: A primer (an overview of the opportunities afforded by satellite and other technologies in meeting educational and development needs)

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► To cite this version:

Mathy Vanbuel. Improving access to education via satellites in Africa: A primer (an overview of the opportunities afforded by satellite and other technologies in meeting educational and development needs). 2003. hal-00190216

HAL Id: hal-00190216

<https://telearn.hal.science/hal-00190216>

Submitted on 23 Nov 2007

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Improving Access to Education via Satellites in Africa: A Primer

IMFUNDO

(im-fun-doe) *n.*

The acquisition of
knowledge: the
process of becoming
educated. *[from the
Nguni languages of
southern Africa.]*



**An overview of the opportunities afforded by
satellite and other technologies in meeting
educational and development needs**



This Primer was commissioned by Imfundo:Partnership in IT and Education. It was written by Mathy Vanbuel of ATiT, Belgium (<http://www.atit.be>) and was first published online at <http://www.imfundo.org> in 2001. This edition is an up-dated version commissioned by Imfundo and written by Mathy Vanbuel and published online in October 2003.

Its objective is to provide an overview of the opportunities afforded by developments in satellite technology in meeting educational and development needs especially in Sub-Saharan Africa. This publication is protected by a creative commons license (Attribution-NonCommercial-ShareAlike 1.0). For the complete text and an explanation of what this means, visit <http://creativecommons.org/licenses/by-nc-sa/1.0/>

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Improving Access to Education via Satellites in Africa: A Primer



Executive Summary

1.0

The purpose of this Primer, "Improving Access to Education via Satellites in Africa" is to provide an overview of the opportunities afforded by developments in satellite technology in meeting educational and development needs especially in Sub-Saharan Africa. It has been commissioned by Imfundo as part of their mandate to use ICT in support of Educational Development and specifically as a contribution to Imfundo's Knowledge Bank. It was originally written in 2001 by Mathy Vanbuel of ATiT, Belgium and is published online at <http://www.imfundo.org>. This 2003 up-date of the Primer is designed to update the information contained therein as well as to introduce new elements including a more in-depth examination of multicasting and data distribution via satellite as well as alternative network applications like wireless technologies.

Information and Communication Technologies (ICT) can effectively support basic education in developing countries by creating environments more conducive to teacher training and education management. However, there are many challenges to making effective use of ICT in these countries, one of the most important being the lack of an adequate technological infrastructure. The current level and type of connectivity in Sub-Saharan Africa is insufficient to effectively support educational programmes.

Fortunately, developments in Satellite communication technology may alter parts of this picture in the short term. Rapid technological innovations drive the availability of low-cost one and two-way satellite services. These technologies build on the history and experience of using satellite technology to support a range of broadcast and communications services. In broad terms satellite communication technology is used in:

- Radio and television Broadcasting
- Telephony
- Data, Broadband and Multimedia services
- Mobile Communications

Satellite communications service providers are expanding their business range from broadcast-type services based on high-powered and large-scale installations towards various "direct-to-home" services. This evolution has been demonstrated by an increasing number of vendors offering cost-effective solutions for one and two way access to the Internet via satellite with small antennas. These services offer considerable advantages for end users, particularly for people in countries where other networks are not available:

- Reception is possible with small antennae (one already being used to receive TV could in many cases be sufficient).

- Connection is possible almost anywhere instantly within the footprint of the satellite, with no cabling work or delays depending on terrestrial infrastructure, thus solving the "last mile" problem.
- Consumer equipment is relatively low-cost.
- Internet connectivity can be combined with traditional broadcasting technologies such as digital TV and Radio, enabling content providers to select the most appropriate delivery means according to the type of content.
- In addition, multimedia push services via satellite, such as data broadcasting or information streaming, are extremely efficient. In these cases, there is no need for a return link via modem, eliminating the need and cost of an Internet connection.

Satellite supported networks for educational purposes are well-established and many examples of projects and on-going initiatives exist in both the developing and developed world. It is useful to investigate these examples to understand the various issues that arise in using satellite-based services to support educational initiatives. Aspects of good practice that are worth mentioning are:

- Network design is crucial and should be based on a broad understanding of all network options including emerging services like small scale VSAT networks.
- Network design should follow and support a sustainable and agreed pedagogical model. If the model is for a resources based learning model with ready access to digital materials then the network required will be very different from that for a virtual classroom model supporting synchronous audio and video based interaction.
- Vendors and service providers should be an integral part of the management and design team.



Improving Access to Education via Satellites in Africa: A Primer



Introduction

2.0



Increased availability of online educational resources and widespread interest and enthusiasm for Information and Communications Technologies (ICT) enhanced education are driving the search for ICT based approaches that can work in Africa. The use of ICT is dramatically changing the way in which formal and informal learning is taking place at every conceivable level of society and yet there are fundamental differences between North and South in the way in which educational change is approached and implemented.

For developing countries, the primary emphasis has to be on enhancing infrastructure, including telecommunications infrastructure, hardware, software and networks. Without access to minimal infrastructure, transformation in the education sector through eLearning is impossible. Regular and high-quality access to educational resources, centres of excellence, leading experts and lively peer groups is a pre-requisite for the development of eLearning programmes, regardless of where you live or study. Such access depends to a certain extent upon the available networks, their speed and reliability and how much it costs to run them. The African development agenda is turning towards ICT not only as a tool to support communications and information sharing generally, but to make quality education available to all citizens and bypass a history of neglect and poverty.

The Internet is emerging as a low-cost pathway that allows information to be more accessible, transferable and manageable; ready access to information is becoming a catalyst in transforming economic and social structures around the world. Even as African countries gradually move toward more open economies and societies, formidable challenges to sustainable development persist in the areas of environmental protection, disease prevention, literacy and private sector development. Africa needs access to powerful information and communication networks in order to obtain the resources and efficiency essential for sustainable development. According to Professor Francis Kofi Ampenyi Allotey¹ "[Africa] ...paid the price of not taking part in the Industrial Revolution of the late eighteenth century because we did not have the opportunity to see what was taking place in Europe. Now we see that information and communication technology has become an indispensable tool. This time, we should not miss out on this technological revolution." Unfortunately, the telecommunications infrastructure in most of continental Africa is extremely impoverished. Years of low investment and state exploitation have left many national telecom sectors in a state of disarray.

It is also important to point to a reluctance on the part of African telecom operators to spend vast

amounts of hard currency with service operators in other parts of the world through, for example, the rental of satellite time from European or North American suppliers. Naturally, African telecom providers would prefer to spend money for services with other African suppliers, hence the interest in African satellite developments like RASCOM described in Chapter 7.

The connectivity and bandwidth required for typical online educational applications is simply not available in much of Africa. According to Mike Jensen² "until 2001 few of the countries outside of South Africa had international Internet links larger than 64 Kbps" (this is roughly the same as the speed of telephone dial-up Internet connection available to almost all individual homes in Europe and North America). However, there are signs of progress: "today 23 countries have links carrying 1 Mbps or more, and 10 countries have outgoing links of 5 Mbps or more - Botswana, Egypt, Kenya, Mauritius, Morocco, Nigeria, Senegal, South Africa, Tunisia and Zimbabwe. Excluding South Africa, the total international outgoing Internet bandwidth installed in Africa is about 250 Mbps". Just to put this in context, Europe has more than 400 times this capacity.

World Average	19.26 (058)
South Africa	7.17 (082)
Kenya	1.58 (123)
Ghana	0.98 (135)
Tanzania	0.84 (142)
Egypt	0.80 (143)
The Gambia	0.33 (168)
Rwanda	0.26 (177)
Mozambique	0.13 (185)
Ethiopia	0.03 (196)

Source: ODCI (08/2003) and ITU (2003)

Number of Internet users per 100 inhabitants. (Between brackets global ranking 225 countries)

¹ Founder of the KNUST, Kumasi, Ghana.

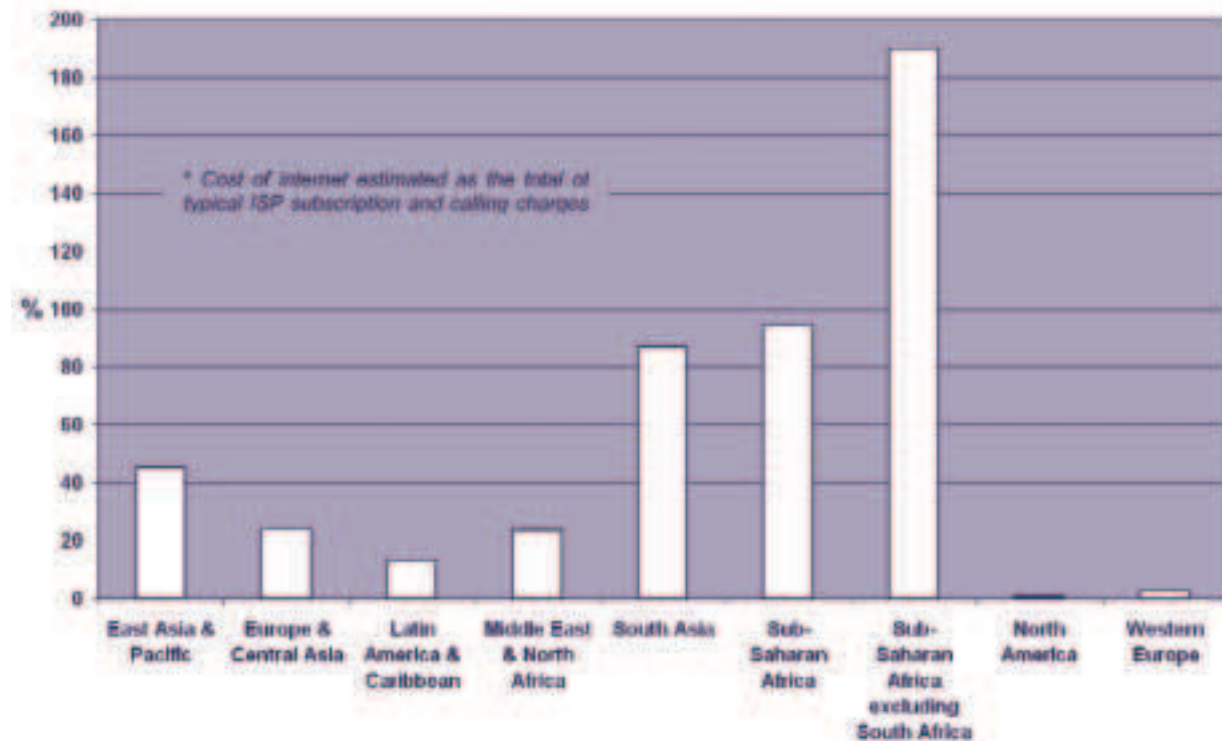
² Mike Jensen, article in Know Net, May 2001





The level of access is equally poor with approximately one Internet user for every 200 people compared to a world average of about one user for every 30 people and a North American and European average of about 1 in every 3 people.³ Costs are also relatively high. Thus, the average total cost of using a local dial-up Internet account for 20 hours a month in Africa is about \$68/month (usage fees and local call telephone

illustrates the cost of Internet access relative to GDP per capita for different regions in the world. The figures for Sub-Saharan Africa underline that Internet access at household level will remain beyond reach for most Africans. To increase penetration, Internet costs will need to be shared at community access points, offset by collecting revenue from its use or cross-subsidised⁴.



time included, but not telephone line rental). ISP subscription charges vary greatly - between 10US\$ and 100US\$ a month, largely reflecting the different levels of maturity of the markets, the varying tariff policies of the telecom operators, the different regulations on private wireless data services and on access to international telecommunications bandwidth. According to the Organisation for Economic Cooperation and Development, in 1997, 20 hours of Internet access in the U.S. cost 29US\$, including telephone charges. Although European costs were higher (74US\$ in Germany, 52US\$ in France, 65US\$ in Britain, and 53US\$ in Italy), costs have dropped since 1997 and all of these countries have per capita incomes that are at least 10 times greater than the African average. The table below

Cost of Internet as a percentage of GDP per Capita

Developments in information technologies have a major impact on the developing world. Costs of computing and communication have fallen rapidly, and provided the necessary skills can be developed, Information and Communication Technologies may help reduce the gap between the world's "have's" and "have-not's".

One key technology that holds great promise for the developing world is Satellite Communication. Important innovations are taking place throughout the satellite industry that are leading us more and more along the path towards low-cost two-way satellite services bypassing the need for expensive cabling. Such services can offer near

³ One example of subsidised Internet cost is the Education or E-rate, a reduced Internet tariff for educational use; the E-rate in Egypt has been set to zero, more African countries consider setting e-rates.



instantaneous high-quality access to digital information. However, much needs to be done and understood about these kinds of services before they can play a more significant role in the developing world. Issues of availability, reach, network design, cost, authorisation all have to be addressed and understood, both by potential service providers and potential users. In anticipation of wider roll-out by commercial operators now is the time to explore the possibilities and understand the issues. It is important that the potential and implications of satellite communication are understood in the developing world in order to influence the way in which services are made available but also to benefit early on from the exciting opportunities they can offer.

This primer has been commissioned by Imfundo as part of an overall strategy dedicated to finding the best ways of using information and

communication technology to improve access and quality of education in poor countries, with emphasis on sub-Saharan Africa. It has been revised in 2003 to update the existing content and to expand its scope to include multicasting, data broadcasting and alternative network applications such as wireless technologies.

The primer provides the non-specialist reader with an overview of the opportunities offered by recent developments in satellite technology for education. It includes an overview of the main players and current and expected services. Finally, it can serve as a general guide for those interested in setting up and using such systems in an educational context. The primer makes extensive use of examples to bring to life various types of educational applications of satellite technology to help the reader understand how the technologies can be put to use in Education.

Outline 2.1

To allow for updates and additions, the report structure separates static from more volatile information. It is divided into 4 main sections:

Chapter 3: Basics of Satellite Communications aims to introduce Satellite Technology from a non-specialist point of view. The basic principles will be introduced along with a list of generic functions that satellite technology can perform (broadcast, unicast, bi-directional, multicasting and more).

Chapter 4: Satellite Technology – Applications in Education and Training provides an overview of applications of satellite technology that are of particular interest to those concerned with education. It also provides a basic list of the cost considerations for service providers.

Chapter 5: Access and Connection Technologies describes various communications technologies from telephone access over wireless and satellite to power line access.

Chapter 6: Satellites in Education provides examples of applications from around the world.

Chapter 7: List of Current Vendors and the services they offer in Africa provides information about vendors active in the African continent.

In addition in order to assist the reader, the primer also contains a Glossary and a listing of Further Resources.





Background 2.2

This Satellite Primer was commissioned by Imfundo as part of their mandate to use ICT in support of Educational development in sub-Saharan Africa. It will be made available through Imfundo's Knowledge Bank. The Knowledge Bank is designed to share information on best use of ICTs in enhancing education across Africa. The Primer was first prepared by ATiT in Belgium (<http://www.atit.be>) from July to October 2001 and was completed through a combination of desk research and original text generation. It was then published online on the Imfundo web site at <http://www.imfundo.org>. This is an updated version of the same Primer, researched from April through August 2003 and published by Imfundo in September 2003.

Author

The primary author of this primer is Mathy Vanbuel, Managing Director of ATiT. Mathy has many years' experience in setting up and managing various types of projects using advanced technologies to support educational activities in the public and private sector. He provides consultancy and advice to a wide selection of organisations and institutions in an effort to de-mystify technological developments and opportunities for non-technical specialists in

the educational and training sector. Mathy worked with the support of Helena Bijmens, Anneleen Cosemans, Mathijs Bijmens and Sally Reynolds in ATiT and received input and contributions from a great many people and organisations. The chapter providing examples of educational activities supported by satellite technology would not have been possible without the input of the contact people who are listed in the relevant sections and we are also indebted to Bridges.Org in South Africa for their assistance in the section dealing with South Africa. Various vendors have also been extremely helpful in providing input and again, their contact details are included in the relevant sections. Specific mention should be made of two particular contributors, Mike Jensen from South Africa, and DTT Consulting (UK), who have made significant contributions to this primer; their support is much appreciated.

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Improving Access to Education via Satellites in Africa: A Primer

Basics of Satellite Communications

3.0

This chapter provides a basic introduction to satellite communication technology. First the principles and generic functions (broadcast, unicast, bi-directional, multicasting) of satellite technology will be presented. The chapter then traces a broad history of satellite technology and discusses the developments currently taking place, covering broadcast type functions and additional applications and services.

It will further introduce general trends within the overall ICT sector that have an impact on the evolution of satellite technology. Although some issues and topics may not seem directly related to the use of satellites in an educational context, it is important to understand the fundamentals of the

technology. This chapter is not the easiest part of the primer and the reader may consider skipping to the following chapter which discusses the practical applications and return to this chapter at a later stage. Both chapters are self contained and can be read independently of the rest of the report.

Introduction 3.1

A satellite is an object that orbits or revolves around another object. For example, the Moon is a satellite of Earth, and Earth is a satellite of the Sun. In this document, we will examine human-made satellites that orbit Earth. They are highly specialised wireless receiver/transmitters that are launched by a rocket and placed in orbit around the earth. There are hundreds of satellites currently in operation.

and television broadcasting and mobile and cordless telephones. Systems of this type rely on a network of ground-based transmitters and receivers. They are commonly referred to as "terrestrial" systems as opposed to satellite systems.

Satellite communication is one particular example of wireless communication systems. Similar and maybe more familiar examples of wireless systems are radio

Satellite communication systems differ from terrestrial systems in that the transmitter is not based on the ground but in the sky: the transmitter here consists of a ground based part called uplink, and the satellite based part that "reflects" the signals towards the receivers. This part is called the transponder.

Overview 3.2

3.2.1 Purpose

Satellites come in many shapes and sizes and have many uses. The first artificial satellite, called Sputnik, was launched by the Soviet Union in 1957 and was the size of a basketball. Its purpose was simply to transmit a Morse code signal repeatedly. In contrast, modern satellites can receive and transmit hundreds of signals at the same time, from simple digital data to complex television programmes. They are used for many purposes such as television broadcasting, amateur radio communications, Internet communications, weather forecasting and Global Positioning Systems (GPS).

one part of the world to another. The messages can be telephone calls, TV pictures or Internet connections. Certain communications satellites are, for example, used for broadcasting: they send radio and TV signals to homes. Nowadays, there are more than 100 such satellites orbiting Earth, transmitting thousands of different TV (and radio) programmes all over the world.

3.2.1.2 Other applications: remote-sensing satellites

Military, government, weather, environment, scientific, positioning

3.2.1.1 Communications satellites

Communication satellites act as relay stations in space. One could imagine them as very long, invisible poles that relay high frequency radio waves. They are used to bounce messages from

Remote-sensing satellites study the surface of the Earth. From a relatively low height (480 km) up, these satellites use powerful cameras to scan the planet. The satellite then transmits valuable data on the global environment to researchers, governments, and businesses including those working in map making, farming, fishing, mining,



and many other industries. Instruments on remote-sensing satellites gather data about features such as the Earth's plant cover, chemical composition, and surface water. Remote-sensing satellites are also used to study changes in the earth's surface caused by human activity. Examples of this kind of observation include investigations into presence of ozone and greenhouse gasses in the atmosphere, the desertification in West Africa and deforestation in South America.

Weather Satellites record weather patterns around the world. Almost all countries use the data coming from satellites like TIROS (Television Infrared Observational Satellite) ENVISAT to forecast weather, track storms, and carry out scientific research. TIROS is part of a system of weather satellites operated by the National Oceanic and Atmospheric Administration (NOAA). There are two TIROS satellites circling Earth over the poles. They work with another set of satellites in geosynchronous orbit called Geostationary Operational Environmental Satellites (GOES) such as the Meteosat satellites. Using this group of satellites, meteorologists study weather and climate patterns around the world.

Many satellites in orbit conduct scientific experiments and observations. SOHO (SOlar and Heliospheric Observation) for instance is an international project managed by Europe and the United States. Its very sophisticated instruments can measure activity inside the Sun, look at its atmosphere or corona, and study its surface. SOHO does not orbit Earth. In fact it orbits the Sun, about a million miles away from Earth. In that position neither the Moon nor the Earth can block its clear view of the Sun.

The military have developed the Global Positioning System (GPS), but now people are using these satellite services to determine their exact latitude, longitude, and altitude wherever they are in the world. GPS satellites can be used for navigation almost everywhere on Earth: in an airplane, boat, or car, on foot, in a remote wilderness, or in a big city. GPS uses radio signals from at least three satellites in sight to calculate the position of the receiver.

Military and government institutions make extensive use of satellites for a mixture of communication, remote sensing, imaging, positioning and other services, as well as for more secret applications such as spying or missile guiding. Extremely useful civilian technology spin-offs resulted from developments in this sector. GPS originated as a Military application. The domains of image processing and image recognition also benefited greatly from Military Research and Development.

3.2.2 System Elements

Although the purpose of this primer is not to train future satellite engineers, there are certain parts of a satellite system that are worth knowing about and which can help the reader understand how satellites behave and how they can be used for different purposes. From this point onwards we will focus almost exclusively on communication satellites, particularly those parts and elements that are relevant to satellite communications.

The two most important elements of the communications system are the satellite itself and the earth station.

3.2.2.1 The Earth Station

Earth station is the common name for every installation located on the earth's surface and intended for communication (transmission and/or reception) with one or more satellites. Earth stations include all devices and installations for satellite communications: handheld devices for mobile satellite telephony, briefcase satellite phones, satellite TV reception, as well as installations that are less familiar: VSAT stations and satellite broadcast TV stations. The term earth station refers to the collection of equipment that is needed to perform communications via satellite: the antenna (often a dish) and the associated equipment (receiver/decoder, transmitter).

Antennas vary in size to match the particular service for which they are designed. For example, a 70 cm antenna may be sufficient for direct reception of satellite TV programmes in the home, but would not be suitable for, for example, transmitting television programmes.



Images: Ericsson/Globalstar, SES-ASTRA (2)

Handheld Satellite Telephone, Antenna for Satellite TV reception, Satellite Transmitting Earth Station

The other part of the earth station is the application device which, in the case of reception, translates radio signals into information that can be displayed on a TV screen or processed by a computer. In the case of transmission, this device will transform information into a signal that is suitable for transmission via the antenna, using modulation, amplification and other processing techniques. In the case of VSAT type two-way systems, both send and receive functions can be carried out at the same time.

3.2.2.2 The Parts in the Sky

The two main parts in the sky common to all satellites are called the payload and the bus.

Payload: transponders, antennas

The payload represents all equipment a satellite needs to do its job. This can include antennas, cameras, radar, and electronics. The payload is different for every satellite. For example, the payload for a weather satellite includes cameras to take pictures of cloud formations, while the payload for a communications satellite includes large antennas to transmit TV or telephone signals to Earth.

The transponder is the key component for satellite communications: it is the part of the payload that takes the signals received from the transmitting earth station, filters and translates these signals and then redirects them to the transmitting antenna on board. Communication satellites carry a large number of transponders on board (normally from 6 to more than 24), enabling them to deliver multiple channels of communication at the same time. These channels are called carriers.

There are two main types of transponders. The "bent pipe repeater" does not actually process the signal at all. The second type of transponder, the "onboard processor", can introduce digital detection for the uplink signal and subsequent digital switching and modulation for the downlink. Onboard processing is a major step in the implementation of new technologies onto satellites. In the case of Iridium and many of the Internet access satellites, satellites act as mini switchboards in the sky.

Communication satellites carry, as part of their payload, antennas that receive the original signal from the transmitting earth station and re-transmit this signal to the receive stations on earth. The antennas that were used in the past to do this were omni-directional (transmitting signals in every direction) and not very effective. They were





replaced by more efficient high gain antennas (most often dish shaped) pointing quite precisely towards the areas they were servicing. To allow for flexibility in services or areas covered, later developments allowed the re-pointing of the so-called steerable antenna to cover a different area or to reshape or reformat the beam. Future developments will allow for a highly precise and efficient reshaping of the transmitted beam in order to cover very small areas (pencil beams). This will greatly facilitate the differentiation of services within large regions. The antennas on board the satellite are typically limited in size to around 2 - 3 m by the space that is available on the satellite structure.

Bus: physical platform, remote control

The bus is the part of the satellite that carries the payload and all its equipment into space. It is the physical platform that holds all the satellite's parts together and that provides electrical power, navigation, control and propulsion to the spacecraft. The bus also contains equipment that allows the satellite to communicate with Earth, a kind of "remote control".



Image: Eutelsat

Communications satellite

Orbits: GEO, MEO, LEO, elliptical, polar

The most common type of communications satellites, particularly the broadcast satellites like AfriStar, Intelsat, PanAmSat, Eutelsat and ASTRA are in geosynchronous orbit (from geo = Earth + synchronous = moving at the same rate). That means that the satellite always stays over one

spot on Earth. It does this by placing the satellite in a position 22,238 miles or 35,786 kilometres out in space perpendicularly above the equator. The imaginary ring around the earth where all geostationary satellites are stationed for their lifetime is called the Clarke belt. The consequence of this type of fixed location is that earth stations (receive as well as transmit stations on the earth surface) can almost be permanently fixed because they are constantly pointed to the same point in the sky where they "see" the satellite.

A medium earth orbit (MEO) satellite is one with an orbit from a few hundred miles to a few thousand miles above the earth's surface. Satellites of this type are in a higher orbit than low earth orbit (LEO) satellites, but lower than geostationary (GEO) satellites. The orbital periods (the time in between two successive passes over one particular place on earth) of MEO satellites range from about 2 to 12 hours. Some MEO satellites orbit in near perfect circles, therefore, they have constant altitude and travel at a constant speed. Others have a more elliptical shaped orbit, which results in different fly-over times according to the place on earth from where they can be seen. A fleet of several MEO satellites with properly coordinated orbits can provide global coverage. There are several advantages of the use of MEO satellites: because they are closer to the earth surface than geostationary satellites, they require less power to transmit. The earth stations (transmitters and receivers) by consequence can be much smaller and have a small rod-shaped antenna. It is possible to use mobile and even handheld terminals with such systems.

A low-earth-orbit (LEO) satellite system consists of a large number of satellites each in a circular orbit at a constant altitude between 200 and 500 miles (320 - 800 kilometres). Because they orbit so close to Earth, they must travel very fast so gravity does not pull them back into the atmosphere. Satellites in LEOs circle around the Earth at 17,000 miles per hour (27,359 kilometres per hour). The orbits take the satellites over the geographic poles. Each revolution takes from less



than 90 minutes up to a few hours. The fleet is arranged in such a way that from any point on the surface at any time at least one satellite is in line of sight. The system operates in a cellular network structure (almost like mobile phones). The main difference is that in a mobile telephone network the relay towers or aerials are fixed on the earth while with satellites these aerials (called transponders or wireless receiver/transmitters) are moving in space. LEO systems may form the space segment of future mobile phone systems (such as S-UMTS) that will allow true mobile, global, broadband multimedia connectivity. But although telecoms experts predicted a bright future for this technology in the beginning of this century, to date only a few systems have actually got off the ground.

Low Earth Orbiting Satellite System

Footprints: global, regional, spot beams

The area on Earth that the satellite can "see" (or reach with its antennas) is called the satellite "footprint". A satellite's footprint refers to the area over which the satellite operates: the intersection of a satellite antenna transmission pattern and the surface of the earth.

Global coverage requires that the pattern of satellite antenna transmission cover the largest possible portion of the Earth that can be viewed from the satellite. For geostationary satellites, the beam width for global coverage is about 17.4 degrees.



No satellite can cover the whole surface of the earth at one time: to achieve a global coverage, multiple transmission beams from at least 3 different satellites are combined.

Footprints

The map above shows examples of how different satellites cover different areas. The combined AfriStar satellite footprints on this map cover all of Africa. A person in Africa can use this satellite to communicate with anyone else in Africa. In combination with the regional beams from the Ameristar and AsiaStar satellites, communication can be established between many areas simultaneously.

Regional or zone coverage is the result of a partial illumination of the global coverage area. The area may have a simple shape such as a circle or ellipse or it may be irregularly shaped (contoured) to cover certain areas most effectively, for example the shape of a continent or sub-continent. Typical regional beams measure around 5 degrees in width.



Image: Worldspace Foundation





Regional coverage

Spot beam or pencil beam coverage is an area much smaller than global coverage. The beam width is reduced to around 2 degrees. Spot beams have the advantage of high antenna gain, but are disadvantaged because they can only cover a smaller area. This drawback can be overcome by a combination of multiple spot beams.

Spot beam coverage

Most geostationary telecommunication satellites cover large regions (continents or sub-continents). Some satellites cover different areas at the same time from where they are positioned. For example: the Eutelsat W4 satellite, a typical broadcast satellite, positioned at 36 Degrees East, provides a high-power coverage of Western Russia with a total of nineteen channels. In addition, the satellite provides a wide area African coverage carrying 6 channels covering most of central and southern Africa (image "Regional coverage") and a high-

power steerable very narrow coverage carrying another 6 channels directed towards Nigeria (image "Spot beam coverage").

Being on the edge of the satellite footprint means the curvature of the earth starts to disrupt transmission. It also means being further away from the satellite and therefore having to transmit or receive over larger distances through the atmosphere than would be required if transmitting/receiving from the centre of the footprint. Antenna size and power by consequence are invariably increased at the edge of the footprint. These values can be deducted from the footprint maps that are published by satellite service operators (see maps above). The numbers on the circles on the maps above indicate the signal strength received at that location expressed in dBW. From tables like the one below, users who wish to receive a transmission can read what size antenna they need. The size varies depending on the meteorological conditions of the location:



Image: Eutelsat

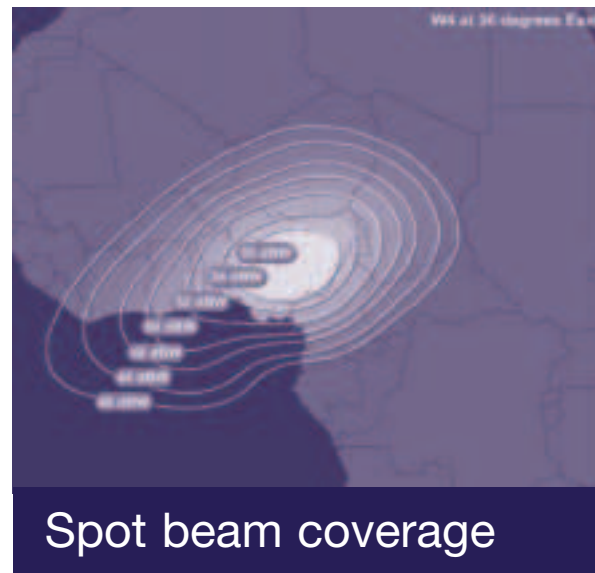


Image: Eutelsat



Signal Strength	Minimum Size	Maximum Size
36 dBW	240 cm	360 cm
37 dBW	180 cm	300 cm
38 dBW	150 cm	240 cm
39 dBW	135 cm	180 cm
40 dBW	120 cm	150 cm
41 dBW	120 cm	150 cm
42 dBW	110 cm	135 cm
43 dBW	99 cm	120 cm
44 dBW	90 cm	120 cm
45 dBW	90 cm	99 cm
46 dBW	80 cm	99 cm
47 dBW	75 cm	90 cm
48 dBW	60 cm	75 cm
49 dBW	60 cm	65 cm
50 dBW	60 cm	65 cm
51 dBW	55 cm	60 cm
52 dBW	50 cm	55 cm
53 dBW	50 cm	55 cm
54 dBW	45 cm	55 cm
55 dBW	40 cm	50 cm

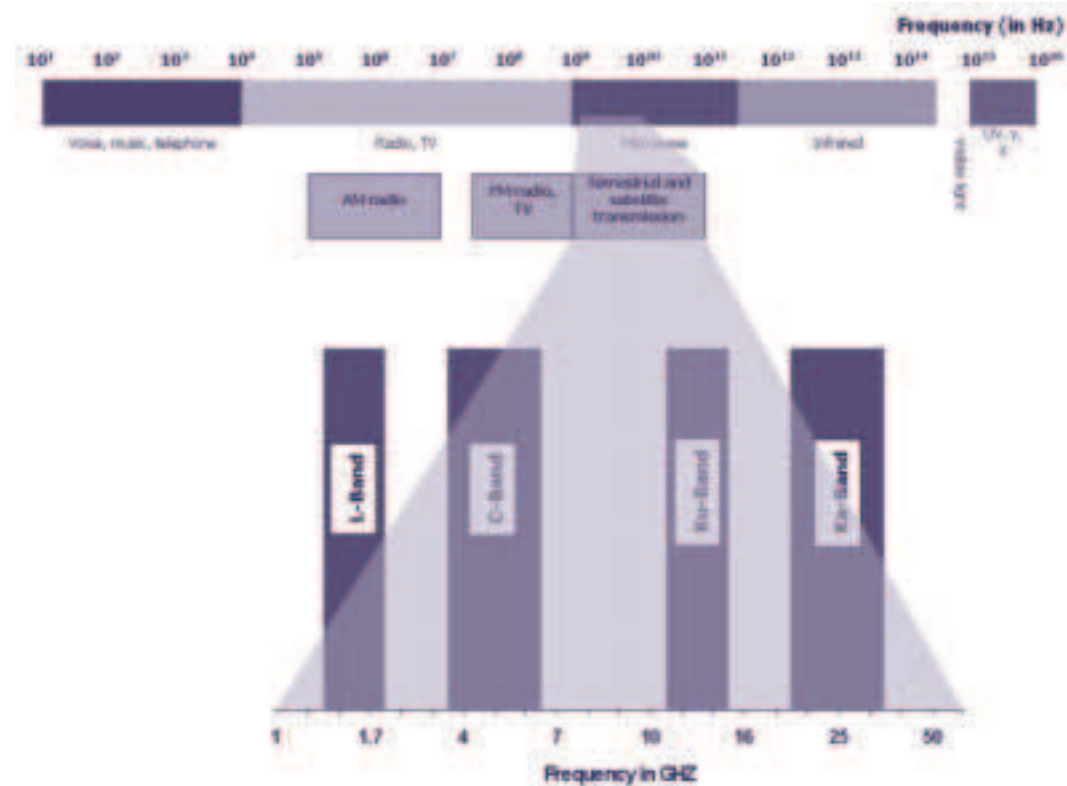
Antenna Size and Signal Strength

Frequency bands

Satellite communications like any other means of communication (radio, TV, telephone, etc.) use frequency bands that are part of the electromagnetic spectrum. The electromagnetic radiation spectrum starts with the longest waves (including those in the audible range) and extends through radio waves and the visible light, which is effectively a very small part

of the spectrum, all the way to the extremely short wavelengths such as radioactive radiation. Within this broad range of frequencies, the International Telecommunications Union (the United Nations institution that regulates worldwide use of airwaves) has allocated parts of the spectrum that are suitable for and dedicated to transmission via satellite. Some of these bands are exclusively dedicated to satellite transmission; others are shared with terrestrial transmission services.





Satellite Communications Spectrum Diagram

The satellite transmission bands that are of interest to us are the C, Ku and Ka Band. C Band is the oldest allocation and operates in the frequency range around 6 GHz for transmission (uplink) and between 3.7 and 4.2 GHz for reception (downlink).

Ku band is the most common transmission format in Europe for satellite TV and uses around 14 GHz for uplink and between 10.9 and 12.75 GHz for downlink.

Because both bands are becoming increasingly congested by an increasing amount of users, satellite service operators are more and more turning to the use of the Ka Band that uses around 30 GHz up- and between 18 and 20 GHz downlink frequency.

The selection of the band is not something that individual service providers decide, but is rather chosen by large satellite operators based on different factors:

- Availability: C Band is still the most widely available worldwide. Ku band is becoming more

available recently in regions which were less covered in the past (South-America, Asia, Africa);

- C Band is more prone to interference from other transmission services that share the same frequencies (adjacent satellites or terrestrial transmissions) than the higher bands;
- While the C Band technology is cheaper in itself, it requires larger dishes (1 to 3 metres) than Ku and Ka band (0.6 to 1.8 metres) and therefore imposes relatively higher (installation) costs on the end user;
- Ku and especially Ka Band make better use of satellite capacity;
- Higher frequency bands (Ku and especially Ka) suffer significantly more from signal deterioration caused by rainfall. To ensure availability in bad weather conditions, the signal has to be much stronger. Note that 0.1% of time unavailability means in fact that the service will be interrupted for almost 9 hours over a 1-year period. 1% unavailability represents 90 hours or almost 4 full days.



3.2.3 Satellite control and lifetime

In principle, geostationary satellites occupy a fixed position in space and consequently the ground-based antennas do not need to be constantly redirected to follow the satellite's movements. The fact that the orientation of ground-based antennas is fixed is a major advantage of the geostationary satellite orbit used by satellite broadcasters. In practice however, the satellite wanders slightly around its nominal orbital position under the gravitational influence of bodies such as the sun and the moon, as well as other influences such as sun radiation pressure and Earth asymmetry.

It is therefore necessary to take corrective actions in order to keep the satellite within acceptable margins from its ideal position. This is achieved by activating the so-called "thrusters" that are mounted on the body of the satellite as part of its propulsion system.

As long as the satellite has enough fuel left to operate its thrusters, it can be kept in the correct position. As soon as the satellite is out of fuel, it will drift out of control and into space, which brings an end to its operational life. The satellite service operator can decide to save on fuel (and by consequence extend the lifetime expectancy of a satellite) by allowing the satellite to drift a little bit. Although this may bring down the costs for the

communication via the satellite considerably, there is a consequence on the earth station side. These stations have to be equipped for tracking (following the drift) of the satellite. The earth stations that are used with LEO and GEO systems use omni directional antennas that make precise pointing of the antenna unnecessary. However, for this application, the ability to "see" the satellite (line of sight should not be obstructed by walls, roofs, excess foliage) is still required, which means that indoor use is excluded.

The communication functions of a satellite (antennas, processors) are powered by electricity provided through a combination of solar energy and batteries. These batteries automatically take over the power supply from the large wing-shaped solar cell panels at moments when the satellite finds itself in the shadow of the Earth.

LEOs and MEOs spin around the Earth at high speeds in order to resist the Earth's gravitational forces. They are designed to be cheaper and therefore are smaller and lighter than large GEOs. They take less fuel to correct their flight paths and in most cases have a shorter life expectancy than GEOs. LEO operators expect to renew their satellite fleet between 5 and 7 years. GEO operators estimate the lifetime of their satellites to be between 10 and 12 years.

Applications of Satellite Communications Technology 3.3

3.3.1 Introduction

Satellite communication systems differ from terrestrial systems in one obvious and important aspect - the transmitter is no longer located on the ground but rather in the sky. Because it's positioned in space, it is able to serve a very large geographical area. This has several advantages:

As few as three geostationary satellites can cover almost the whole of the earth's surface, with the exclusion of the sparsely populated Polar Regions. To achieve the same coverage by terrestrial means would require a very large and expensive network of ground-based transmitters.

Services can be established quickly, since coverage is available for everyone from the day transmissions start. There is no need for a phased introduction as is the case with ground-based transmissions where antennas need to be added to meet the expansion of the serviced area. With satellite communications, even users in very remote locations enjoy the same level of service as any other user in the coverage area.

Satellites can overcome national boundaries, providing possibilities for truly international services.

Although terrestrial systems may be better suited generally to provide communication services,



in many cases the need to be connected can only be met effectively and rapidly by the implementation of satellite services.

3.3.2 Radio and TV Broadcasting

The most familiar use of satellites is television broadcasting. TV Satellites deliver hundreds of television channels every day throughout the world. These satellites are even used to supply television signals to terrestrial transmitters or cable head end stations for further distribution to the home, or to exchange signals between television studios. The bandwidth required to transmit multiple programmes at the same time, can easily be provided using satellites. In addition, developments in broadcast technology (digitalisation, multiplexing and compression) allow different types of transmissions to be sent sharing the same satellite signal. To address the largest possible number of viewers, the cost to the viewers must be small, requiring small receive antennas and cheap receivers.



Satellite TV reception antennas

Satellite service operators such as Intelsat, Eutelsat, ASTRA, PanAmSat, NileSat, AsiaSat and AfriStar carry the signals for satellite broadcasters such as BSkyB, CanalPlus, Multichoice, DirecTV and WorldSpace. These in turn bundle programmes from different public and private broadcasters in order to make them accessible for their viewers in an open ("free-to-air") or closed (restricted) way. Some satellite broadcasters bundle special offers into so-called "bouquets of services" that are offered at additional cost.

The importance of satellite TV broadcasting is enormous: at the moment Eutelsat broadcasts over 900 TV channels and 560 radio stations to more than 84 million satellite and cable homes, the vast majority of them via the five HOT BIRD satellites at 13° East. ASTRA, another European direct-to-home Satellite System, transmits more than 1000 television and radio channels in analogue and digital format to an audience of more than 89 million homes throughout Europe. It does this via twelve satellites at the orbital positions of 19.2°, 24.2° and 28.2° East.

In order to make their offer more attractive to broadcasters, satellite service operators try to place their satellites aimed at the same regional market as far as possible in one single position. This is why we find the Eutelsat HotBird constellation at 13 Degrees East or the ASTRA position at 19 Degrees East, where in each case a number of satellites are clustered. In consequence, viewers need to point their antennas in one direction only in order to receive a large number of satellite programmes coming effectively from different satellites but looking as if they come from only one.



Image: Eutelsat

The Eutelsat HotBird position at 13 Degrees East

There are many different applications of satellite TV viewing, depending on the needs and objectives of the broadcaster or the viewers. Direct-to-Home or DTH - also called DBS or Direct Broadcast via Satellite - speaks for itself: the TV programmes are aimed at the consumer and

transmitted in such a way that residential customers can buy and install the equipment to receive the programmes at the lowest possible expense. This requires a network of local resellers that offer the hardware (satellite receive equipment), installers (technicians that assist the customer in setting up the receive equipment) and service suppliers (who provide and administer subscriptions).

Programme suppliers can opt for free-to-air programming, where every viewer with a standard satellite receiver can receive and view the programme without restrictions. However, some programmes contain information that is not for public viewing. To protect these programmes so that only those who are the targeted audience will be able to view the contents, some type of conditional access can be applied. What happens is that programmes are encrypted and must then be unscrambled with a specific device (usually integrated in the receiver and therefore often called an Integrated Receiver Decoder or IRD) to view the contents.

The Move from Analogue to Digital services

The number of analogue channels transmitted and the number of homes receiving analogue continues to decrease. However analogue takes up a significant portion of the range of frequencies available. In addition, even in space, transmission capacity is limited. Where an analogue signal will occupy a full transponder consuming a bandwidth of 36 or even 72 MHz, Digital Broadcasting makes it possible to compress signals, vastly increasing the number of channels available by combining multiple programmes onto one single transponder.

Most digital TV signals nowadays are compliant to the MPEG-2/DVB standard and can be received with standard consumer digital reception equipment that decodes the signal and separates the different types of content out of the data stream. With transmission bit rates between 34 and 38 Mbps, a digital signal can carry a combination of up to 12 television channels, along with numerous radio transmissions and data.

Consequently, it is digital television that is now driving the satellite TV market, aiming at large numbers of consumers equipped with small antennae of typically 50 to 80 cm in diameter in Western Europe and 1.2 to 1.5 m in diameter in other regions. Digital technology has spurred the development of interactivity and aided the convergence of the worlds of television, radio, personal computing and telephony.

It appeals to the end user by providing better video and audio quality, improved programme and service choice and greater control over content delivery.

Broadcasters and content providers are able to improve their service offers. New satellite facilities that are being offered or under development are Pay TV services, (Near) Video on Demand, IP-TV delivery and Personal TV using devices such as the Personal Video Recorder (PVR) or the Multimedia Home Platform (MHP5).

Pay TV is a service where the viewer is charged according to the programmes she/he views, selected from the TV programme on offer. Video on Demand and Near Video on Demand enables individual viewers to decide at any given moment (in the case of real Video on Demand) or at a later time to be scheduled (in the case of Near Video on Demand) to view the programme of his/her own choice. IP-TV is a Video on Demand application using compression technologies that allow highly efficient distribution of video and audio using common multimedia formats such as MPEG-1 and 2. Streaming technologies are based on the Internet Protocol, which allows delivery over all kinds of networks including the Internet.

The latest development in advanced television applications including delivery via satellite is the Personal Video Recorder (PVR). These devices are used both to digitally record and play back programmes: the programme provider sends the content the normal way (TV networks, cable, satellite). At the receive end the content is fed into the PVR. Compression such as MPEG-2 is used to decrease the bandwidth. The PVR unit is basically a computer that saves the incoming live

⁴ The Multimedia Home Platform is a software specification that will be implemented in Set-top Boxes, integrated digital TV receivers as well as multimedia PCs. The MHP will connect the broadcast medium with the Internet, television, computer and telecommunication and enables digital content providers to address all types of terminals ranging from low-end to high-end set top boxes, integrated digital TV sets and multimedia PCs.



TV signal from the cable or antenna onto its large internal hard drive. In this way, the viewer can play it back with a few seconds delay. The viewer is then watching off the computer hard drive, instead of straight from the antenna or cable connection. This allows the viewer to rewind, slow down, stop and pause at any point.

But even if the broadcasting world is rapidly going digital, analogue TV and radio are set to remain for several years yet. For some services, analogue is still the most attractive option due to the large installed audience base and the widespread availability of consumer equipment that is less expensive than digital equipment. Analogue is particularly popular for free-to-air broadcasting. Moreover, the capacity to transmit several audio sub-carriers on one analogue TV signal allows multilingual TV programmes. As for analogue radio broadcasting, up to 8 mono channels or 4 stereo pairs can be transmitted as sub-carriers of an analogue television signal. However, due to the heavy use of analogue sub-carriers and the decreasing number of transponders used for analogue TV, analogue sub-carriers are becoming less and less available. Service providers considering new audio services should therefore consider digital. When you take into account the cost of transmission and the numerous innovative applications that are becoming available, such as the PVR, encryption and the ability to carry data for multicasting, the appeal of digital broadcasting is hard to resist.

Business Radio and TV

Narrowcasting or business TV and Radio is a term used for satellite broadcasters who use transmission time to reach a very specific audience. Technically speaking, there is no difference with broadcast satellite TV applications described in the previous section. Digital television has made it possible to distribute information within organisations and companies that are geographically dispersed or to deliver distance education. Similarly, digital radio allows for the delivery of radio services to relatively small closed user groups.

MPEG-2/DVB technology is the dominant standard for digital television, but other computer-based media coding techniques (such as MPEG-1,

Real Video etc.) are also used to embed video and/or audio into data streams, often integrated with other multimedia or Internet services. Transmission via satellite requires there to be digital receivers available at relatively low prices on the consumer market. The advantage is that more advanced or popular audio coding techniques (for example MP3) can also be used and that the same stream can be used for other applications, such as data distribution, outside broadcast hours.

Contribution ("backhaul" and SNG)

Satellite transmission technologies can be used to bring the signal that needs to be broadcast to the place where it can be processed and prepared for re-distribution, for example to a broadcaster's main studio; to a number of cable head end stations; to an Internet Service Provider where it can be injected into the Internet; or to a network of local Points-of-Presence for distribution in local networks. These links respond to the need for point-to-point and point-to-multipoint transmission and are often called a "hop". The signal can be digital or analogue and can include video, audio, data or multimedia.

When used by news companies this type of contribution link is called Satellite News Gathering (SNG). News and information are sent from a mobile station – a truck equipped with an antenna or a suitcase uplink, through the satellite to a central point, which is in most cases the home studio, equipped with an earth station with a fixed antenna. The home studio can retransmit it live or record and re-edit it for later use.

3.3.3 Telephony

3.3.3.1 Thin route or trunk telephony

Telecom operators have been using satellite communications for many years to carry long distance telephone communications, especially intercontinental, to complement or to bypass submarine cables. To the end user this is transparent: the phone calls are routed automatically via the available capacity at any given moment. However, the 46,000 mile round trip, even at the speed of satellite signals, takes 250 milliseconds causing a delay that makes



telephone conversation rather unnatural, hence the preference for telephony over cable.

In regions where it is not so easy to install terrestrial telephone connections because of the low density of population or because of the nature of the terrain, satellite is still being used to connect the local switchboard to the telephone network. This technology is called thin route or trunk satellite telephone networking. Wireless (microwave, two-way radio, etc.) and optical links however are replacing satellite increasingly in this area. With the advent of true mobile telephony (cellular systems such as GSM), and new end user connection technologies such as Fixed Wireless Local Loop where there is no longer a need to wire up each subscriber, satellite thin route telephony is becoming less and less popular. In the future, satellite thin route telephony is expected to only hold a small share of trunk telephony in areas that are otherwise impossible to reach.

3.3.3.2 Mobile satellite telephony

Mobile telephony allows the user to make telephone calls and to transmit and receive data from wherever he/she is located. Digital cellular mobile telephony like GSM has become a worldwide standard for mobile communications, but its services lack coverage over areas that are sparsely populated or uninhabited (mountains, jungle, sea), because it is not economically viable or practical for the network operators to build antennas there. Satellite telephony seems to be able to provide a possible solution to the problem of providing voice and data communications services to these other locations.

Inmarsat

Inmarsat was the world's first global mobile satellite communications operator, founded in the late 1970s. It focuses on communications

services to maritime, land-mobile, aeronautical and other users. Inmarsat now supports links for phone, fax and data communications at up to 64 Kbps to more than 210,000 ship, vehicle, aircraft and portable terminals.

The range of Inmarsat systems includes mobile terminals from handhelds to consoles, with easy set-up mechanisms that allow users wherever they are to connect via a global fleet of geostationary Inmarsat satellites to the terrestrial communications network and to carry out telephone conversations, data transfers, and increasingly multimedia applications and Internet access. Inmarsat is aimed at professionals who need a reliable communications system wherever they are: ship owners and managers, journalists and broadcasters, health and disaster-relief workers, land transport fleet operators, airlines, airline passengers and air traffic controllers, government workers, national emergency and civil defence agencies, and peacekeeping forces. The cost is rather high while the capacity is still rather limited: voice/fax/data systems achieve a maximum data rate of 64 Kbps at a connection costs starting at almost 3 US\$ per minute. Dedicated mobile IP systems can achieve a maximum download speed of up to 144 Kbps.

LEO Based Telephony

Another mobile satellite communications system is the Globalstar satellite telephone network. Globalstar, which was established in 1991 and began commercial service in late 1999, offers service from virtually anywhere across over 100 countries, as well as from most territorial waters and several mid-ocean regions. Globalstar deploys handheld telephone sets that switch between the terrestrial wireless telephone network (GSM) and a LEO-based satellite network in places where no terrestrial GSM network is available.





Image: Globalstar Europe

Globalstar telephony coverage map (April 2003)

Signals from a Globalstar phone or modem are received by one of the 48 Low Earth Orbiting (LEO) satellites and relayed to ground-based gateways, which then pass the call on to the terrestrial telephone network.



Globalstar LEO Satellite Telephone Service

A similar low earth orbiting (LEO) satellite communications system is Iridium. Both Iridium and Globalstar are based on constellations of satellites that can communicate with small handheld telephone sets as well as between themselves, effectively acting as switchboards in the sky. The satellites orbit at approximately 500 miles (800 Km) above earth and provide worldwide mobile telephony and Internet access. Because of the short delay times (thanks to the low height and thus short distance between earth station and satellite) it is theoretically possible to introduce videoconferencing and interactive multimedia to both fixed (with outdoor antenna) and mobile transceivers at a later stage. It is easy to understand how LEO services would be suited for urban or rural areas that are not connected to a broadband terrestrial infrastructure or that cannot be covered economically using traditional terrestrial infrastructures.



Satellite Telephones

GEO Based Telephony

An alternative approach to satellite telephony uses a geostationary satellite instead of the LEO. This results in longer delays (approximately half a second). Switching on board of satellite tries to reduce this inconvenience as much as possible. The Thuraya mobile satellite system was launched in 1991, its satellite maintains a geo-synchronous orbit at 44° East. Thuraya operates effectively in both satellite and GSM environments. Its satellite network capacity is about 13,750 telephone channels. When within reach of a GSM network, Thuraya's mobile phone acts as an ordinary GSM handset. Outside this GSM coverage it seamlessly switches to become a satellite telephone. The system can be used for voice, data, fax, SMS and location determination (GPS-like). Thuraya handsets and subscription services are distributed through service providers (mobile telecom companies) located in 106 countries in Europe, Africa, Middle East, Asia and India. Through roaming agreements, customers can use their handsets in a number of other countries as well.

Image: Teit/Globalstar and Hughes/Thuraya



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Thuraya GSM/Satellite Telephone Service

Satellite based mobile telephony: conclusion

The deployment of these LEO based services has not been as successful as had been hoped by the providers. While initially it took a long time before the first service became available, the competitors, in this case cellular mobile telephony (GSM), had already won a market share that was lost for the new technology. The receivers were initially too expensive (about 2,000 US\$), the communications costs too high (from less than 1 US\$ to more than 5 US\$ per minute depending on the call destination and the payment programme, Thuraya being cheaper in general) and the service had a reputation of not being very reliable: the technology did not seem to be sufficiently mature and calls were frequently interrupted. The transmission speed was very low (maximally 9.8 Kbps which is comparable to GSM based transmissions).





3.3.4 Data, broadband and multimedia services

When we consider that TV and radio, telephone and fax nowadays are all being digitised and packaged in datagrams (small data packets) to be transported on any type of network, it is easy to understand that any digital content can be distributed in much the same way. This is obviously the case with data over satellite communications networks.

Normally, data does not suffer from the small delay caused by the long transmission path via satellite. Telecoms and global telecommunications carriers have been using satellite data links to complement existing wire-based data networks for many years. Large, multinational companies or international organisations in particular have exploited the ability to transfer data over satellite networks from when smaller and cheaper satellite terminals and more flexible satellite network services became available. Satellite services could support the different services they were interested in, such as data collection and broadcasting, image and

video transfer, voice, two-way computer transactions and database inquiries.

The development of common datagram and data transport standards, and the digitisation of voice, image, video and multimedia in general, have led to a shift to IP based satellite communication systems that integrate seamlessly into the Internet world. It is useful at this point to make a distinction between three different types of applications.

3.3.4.1 IP over satellite for ISPs

Telecoms and connectivity providers have started using satellite communications to bypass the increasingly clogged terrestrial and submarine networks to complement their backbone connectivity or to supplement them where they are not yet available. This approach takes advantage of the fact that satellite is not a real point-to-point connection like cable, but a connection that allows the delivery to multiple points at the same time. This allows for simultaneous updating of multiple caching, proxy or mirroring servers.

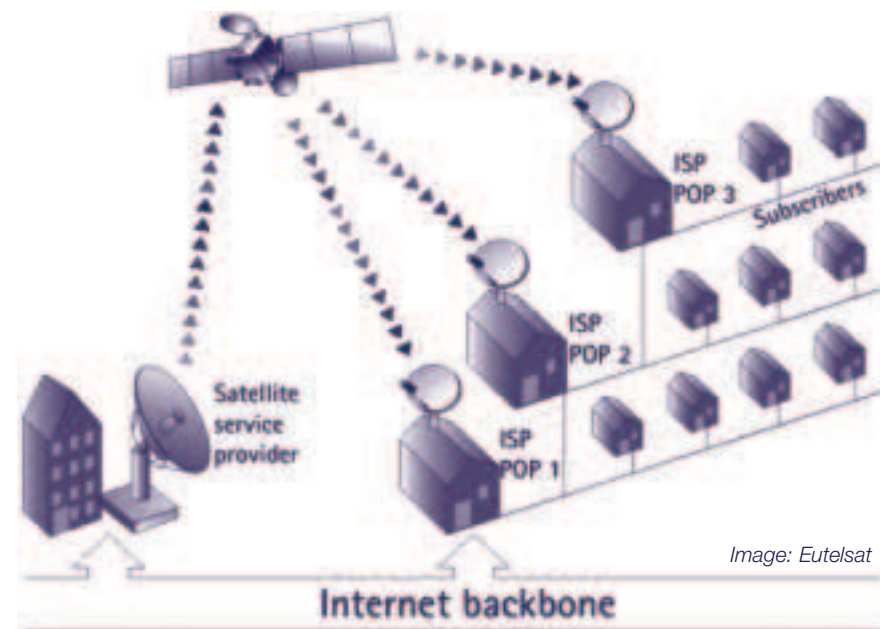


Image: Eutelsat

IP via satellite for ISPs



In much the same way, it is possible to push Internet content to and even over the edges of existing networks. When it is necessary to provide large amounts of content to places that are poorly connected to the Internet, it is now possible to push content to local PoPs (Point of Presence) edge servers. These can then in turn serve as ISPs to the local users or user communities.

Although cable may be the preferred way to connect areas with a concentrated demand for access (like cities or densely populated areas), satellite communications can still assist local ISPs especially when there is not yet a reliable wired connection to the Network Access Points or the Metropolitan Access Exchange points on the backbone. This is also practical when a large quantity of content needs to be transported between two particular points and high-capacity cable connections are not available.

3.3.4.2 Corporate or Institutional VSAT Networks

A particular application of data via satellite is VSAT networks. Organisations with many remote affiliates can create a private high-speed satellite intranet, which links the main office reliably with all local sites. Within and amongst institutions there is an ever-growing need to communicate and to enhance the existing networks, both human and physical. These networks, comparable to the corporate or institutional networks of large multinational companies or international institutions, today need high speed, reliable and cost effective communications. This is especially true when the locations are dispersed over remote regions and multiple countries, and barely connectable via a terrestrial network infrastructure. In this case, satellite communications are an effective way to provide private or secure data networks. VSAT can provide a complete network capable of connecting all sites and connecting to the Internet, wherever the facilities are located or wherever facilities will be located in the foreseeable future, including the homes of staff, members, students etc.

VSAT stands for Very Small Aperture Terminal and refers to combined send/receive terminals with a typical antenna diameter of 1 to 3.7m linking the central hub to all remote offices and facilities and keeping them all in constant immediate contact. VSAT networks offer solutions for large networks with low or medium traffic. They provide very efficient point-to-multipoint communication, are easy to install, and can be expanded at low extra cost. VSAT networks offer immediate accessibility and continuous high-quality transmissions. They are adapted for any kind of transmission, from data to voice, fax, and video.

The great advantage of VSAT is its flexibility. It permits any kind and size of network based around a central hub and remote locations. This makes them particularly useful for corporate networks or for example, communication between educational, government or health-care institutions. Through a VSAT network, a corporation can communicate freely and constantly with branch offices:

- Voice and fax transmissions;
- Local Area Network interconnection;
- Data broadcasting;
- Videoconferencing;
- In-house training.

Various network topologies, protocols and interfaces are available to implement VSAT communications applications. It is possible to lease satellite capacity on a carrier-per-carrier basis for any type of VSAT network. VSAT operators offer turnkey solutions including installation, licensing and maintenance.

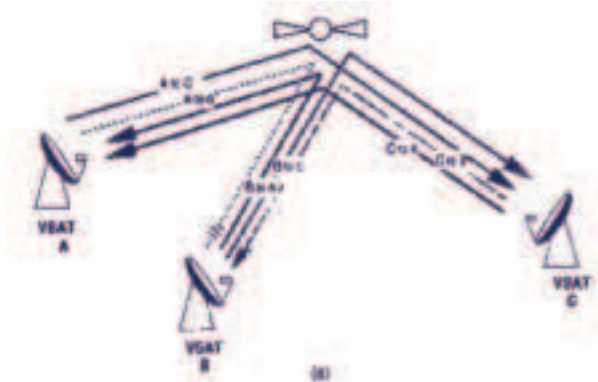
VSAT networks are generally “star” networks. This means there is a central location that acts as a hub through which remote locations can transmit and receive data to and from each other. They can be one- or two-directional.





VSAT Star-shaped Networks

A mesh configuration enables remote terminals to contact each other without passing through the hub and is particularly appropriate for large corporations where local facilities need to be in contact with other regions.



VSAT Mesh-shaped Networks

New VSAT technologies and services are being offered to support these demands. Employing one- or two-way satellite communication, IP-compatible solutions enable private network operators to provide their network members with enhanced speed and reliability for institution-wide communication. Networks featuring PC-based user terminals equipped with data cards linked to a receive/transmit satellite dish ensure fast Internet access and fast, simultaneous data broadcast to all user terminals via satellite. Intranets, Extranets, Internet access and email messaging are becoming just as important as the traditional video, voice and data requirements of videoconferencing, business TV and data file exchange. Different levels of VSAT services can deliver various options depending on the requirements of each network.

Capacity can be booked on a full-time basis with prior reservation for minimum utilisation of any 24-hour contiguous period per occasion or on an

ad-hoc basis according to a pre-arranged plan of identical transmissions during specific periods, or for occasional use.

PAMA or Permanently Assigned Multiple Access means having a permanently assigned frequency channel that provides dedicated bandwidth, through which the network can send data, voice or video. This may be required when larger amounts of data continuously need to be transmitted between each element of the network. This can be the case in mission critical real time processes such as: process monitoring, distributed processes, data collection but also in media streaming (like in TV and radio broadcasting).

DAMA or Demand Assignment Multiple Access provides intermittent communication or managed VSAT services on a pay-per-usage basis. With DAMA, satellite capacity is instantaneously assigned and adapted according to immediate traffic needs. It is available when needed, and users only pay for what they use. DAMA can



support changing or intermittent image-based or heavy data transfer needs and is best suited where multiple services are integrated into a single network, since it supports telephony, low and high speed data, video and multimedia applications. In order to be cost effective, DAMA requires the network to be designed quite precisely to meet the organisation's needs for data distribution and communications. Peak and minimal usage levels need to be particularly estimated. Demand Assigned Multiple Access is a highly efficient means of instantaneously assigning telephony and data channels in a transponder according to immediate traffic demands.

Advantages of VSAT networks include:

- Wide geographic coverage;
- Independence from terrestrial communication infrastructure;
- High availability;
- Communication costs independent of transmission distance;
- Flexible network configuration;
- Rapid network deployment;
- Centralised control and monitoring;
- Any service can be provided from telephony through to ATM, Frame Relay, and of course, high speed broadband Internet.

Disadvantages:

- VSAT services are generally expensive;
- VSAT services are not available for single site users, but only to multiple site networks;

- The ODU (outdoor unit, antenna) may be prone to vandalism or adverse weather conditions (lightning, storm...);
- Requires professional installation, management, monitoring and maintenance;
- In some countries VSATs are heavily regulated;
- As with all satellite solutions, there is a latency (delay) in the signal, making telephone and videoconferencing services more difficult.

3.3.4.3 End user services for home or small office

Broadband access for end users is usually considered a “wired” solution: fibre optic backbones, cable modems on coax, xDSL and ISDN on twisted copper. ADSL can only be provided up to a distance of between 4 and 6 km from the local telephone exchanges, depending on various factors. The cost to upgrade the existing copper network is very high. This means that many households, particularly those in rural and remote areas, will probably never be able to receive ADSL. Similarly, the cost of laying bi-directional cables for interactive TV and Internet means that cable distribution is also unlikely to be available to those living in small towns or in the countryside.

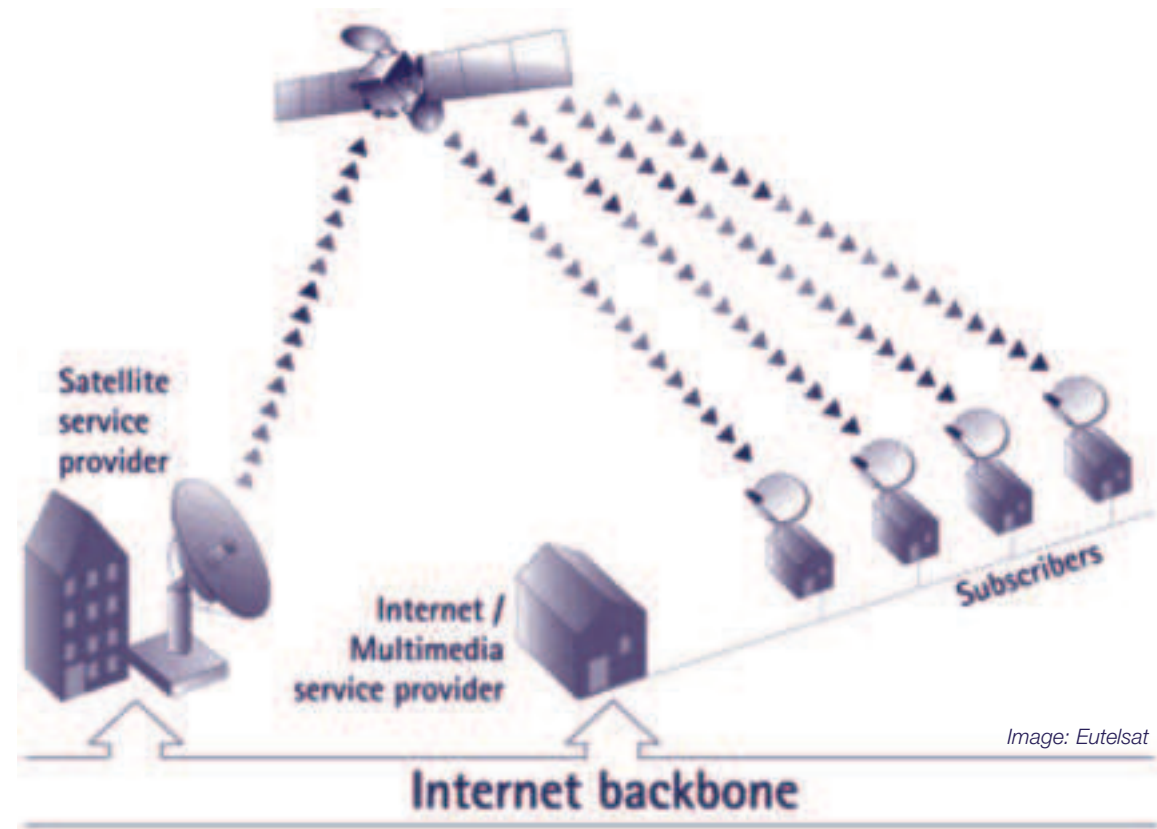
Satellite broadband connectivity has never been considered seriously as long as it did not allow for interactivity. However, nowadays satellites can provide interactivity via either the satellite return channel or by using a hybrid solution with narrow-band return path via a telephone line. With Internet via Satellite, every user with the correct equipment and living within the satellite footprint can now have a broadband connection.

⁵ Most Internet type traffic is asymmetric by nature: on average, the downlink (from ISP to end user) is 20 times greater than the uplink (from end user towards the Internet). It is worth noting however that this is not true for certain particular end users, web builders, content distributors etc. where the ratio is, of course, different



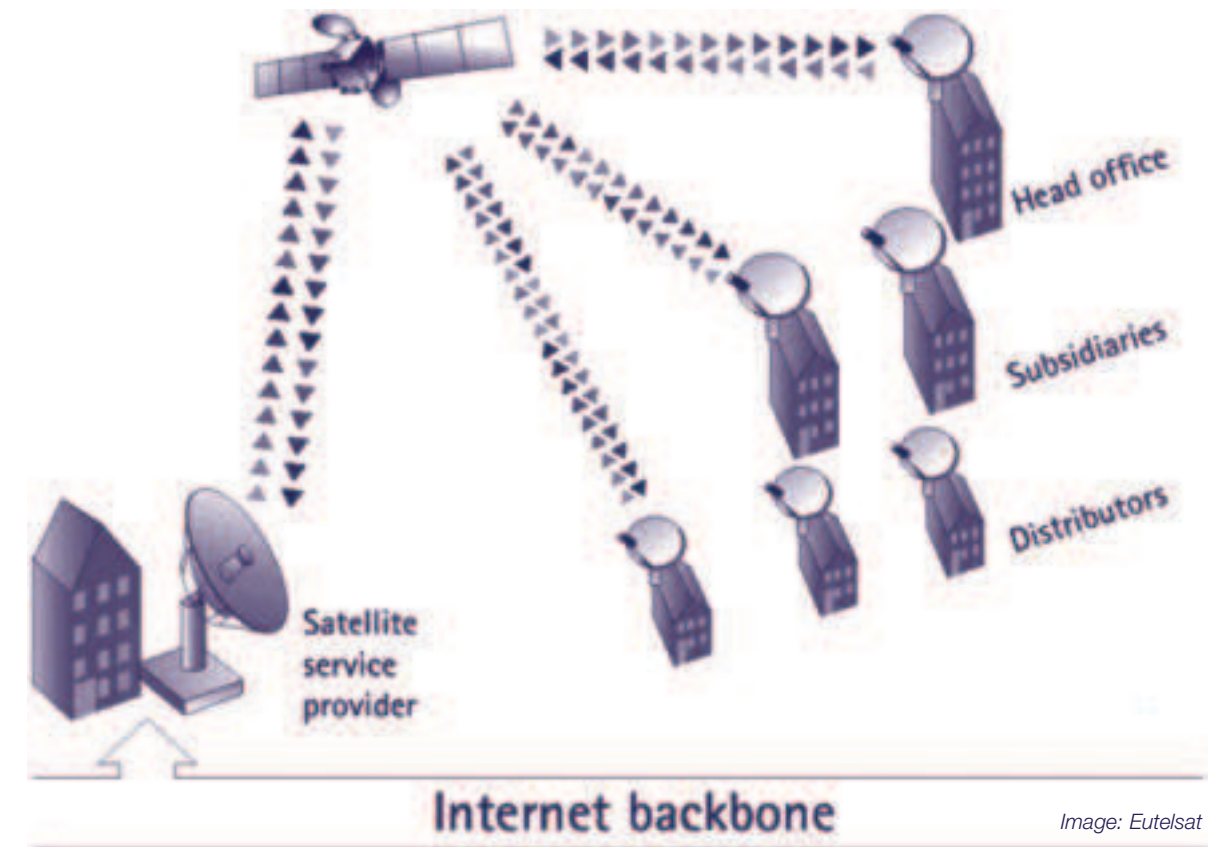


Satellite has the capability to reach everywhere, thus effectively removing local loop difficulties, especially in areas with poorly developed infrastructure. The subscriber requests (for example the click on a hyperlink in a web page) can still be routed through terrestrial telephone lines, but the downloaded data can now be routed via satellite directly to the earth station of the end user. The typical asymmetry of home and small business Internet use opens up the possibility of using a slow, small pipe in one direction and a fast, wide pipe in the other. The average user does not need in-bound high-bandwidth connectivity around the clock and need even less out-bound high-bandwidth⁶. So the hybrid of high-speed satellite for in-bound matched to a low-cost, low-speed request path may well be the most cost-effective solution. Using phone lines and a satellite downlink path means that you don't pay for more technology than you need.



One-way Satellite Internet Connection

Recent developments have made it possible to send all requests and return data through the satellite, which is ideal for areas with a weak telephone infrastructure.



Two-way Satellite Internet Connection

Current configurations can deliver data at a rate of up to 40 Mbps, but in practice, this means that the hub communicates with the end user terminals at speeds of up to 4 Mbps. The terminals have a return link to the hub depending on the set-up of the network via a telephone modem connection or via the satellite return system with speeds ranging from 16 Kbps to 512 Kbps. The hub is continually listening for data requests from the terminals so, to the user, the system appears to be “always-on”. It is understood that in order to use public Internet access through the satellite effectively, the hub needs to be well connected to the Internet backbone.

Not only does this system provide a broadband connection via the satellite downlink, but it also means that the inherent advantages of satellites in many applications can be exploited, especially the

ability to multicast or broadcast the same data to millions of users over a huge area. By applying intelligent caching techniques and news group feeds, traffic in the networks can be reduced and the relatively high bandwidth cost of the space link becomes insignificant especially when compared to the reach.

This allows not only for “pull” services, such as high speed web browsing, where a single user requests a specific item, but more importantly also for “push” or multicast services, where a file or stream is transmitted to many users at the same time, for example, real-time information or streamed video. This type of push service is much harder to accomplish with traditional wire based terrestrial Internet connection technologies because it consumes valuable bandwidth on all branches of the network.





With satellite transmission, the number of potential users that can receive and decode broadcast data can be restricted to one user, a group of users or all users. With a point-to-point data transfer, TCP/IP is used to send data addressed to one particular user. With point-to-multipoint file download or video stream, UDP or IP multicasting is used, and the satellite broadcasts data that can be decoded by a specific group of users.

Only authorised users can connect the base station through the Internet and operate in interactive mode (for example initiate an on-line Web session). Conditional access is implemented at the DVB transport level by conventional means, using “smart cards” or a similar technology. In addition, every user station has a unique station identification (hardware address) that is used at link level for individual addressing of stations. Service operators are able to set access authorisations on a user level so that transmissions may be restricted to a closed user group, for example, for security reasons, or to allow subscription-based services. The PC board can also be used for receiving video and audio broadcasting services already available and transmitted by digital broadcasters on the same satellite.

Satellite Internet connectivity offers possibilities that are becoming commonly accepted in many different end users communities, in regions that are excluded from access until such time as wired or wireless broadband become available. Because it is impossible to predict when such services will become available, it may be better to opt for satellite telecommunications technology as it is immediately available. While financially it may seem to make sense to wait for the best solution that will become available in the future, in the short to medium term this could mean a high cost of lost (educational) opportunity.

Educational institutions can communicate across countries, regions and cultures, share libraries and databases of research information, or offer distance-learning services that are based on the TCP/IP protocols. Medical institutions can develop

networks for telemedicine applications. Government entities can deliver citizen information services. Push services enable in all instances the multicasting of video and audio streams, database downloading and software update distribution. Access to Internet and multimedia becomes available to remote communities, effectively fighting exclusion.

To conclude, the advantages of two-way satellite Internet connectivity for end users include:

- Reception is possible with a small antenna (one already in use to receive TV can, in many cases, be sufficient but may require adaptation);
- Connection is possible almost anywhere instantly within the footprint of the satellite, with no cabling work or delays dependent on terrestrial infrastructure, thus effectively solving the typical “last mile” problem;
- Consumer equipment is relatively low-cost;
- Internet connectivity can be combined with traditional broadcast technologies such as digital TV and Radio, enabling content providers to select the most appropriate delivery means for particular content;
- In addition, multimedia push services via satellite, such as data broadcasting or information streaming, are extremely efficient. In these cases, there is no need for a return link via modem, so there is no additional cost for connectivity to the Internet.

Some of the main disadvantages:

- Satellite Internet is generally more expensive than terrestrial access solutions, at least in regions where they are available;
- The outdoor unit (antenna and cabling) are more prone to vandalism and weather conditions;
- Bandwidth availability is somewhat limited;
- Requires professional support;
- Not the ideal technology for videoconferencing.



3.3.4.4 Mobile data communications

We talk about fixed or mobile services depending on the specific application. Fixed services are aimed at earth stations that stay in the same place while operating. The antenna does not move during transmission and reception. Mobile services in contrast are aimed at users that need to receive or transmit while moving.

Euteltracs and some Inmarsat applications are examples of mobile satellite data communication services. Euteltracs equips cars, trucks, ships etc. with a small antenna, an on-board terminal with keyboard and LCD, plus software linking the on-board information system via the Euteltracs Network Management Centre based in France with the vehicle’s home base. This set-up enables low data rate services between the mobile

vehicle’s home base and the vehicle itself while on the move, this allows for:

- Vehicle or vessel localisation with an accuracy of 100 metres;
- Transmission of alarm and distress messages;
- Message exchange between the mobile terminal and base;
- Data collection and transmission from the vehicle or vessel;
- Access to external databases for example, for weather or traffic conditions.

This type of system is extremely rugged but allows only for very limited amounts of data to be transferred. It is therefore not an evident choice for multimedia applications.





Satellite Applications in Education

4.0



Education content: contribute, distribute and retrieve

3.3

4.1.1 An introduction to different types of content

So far, we have almost exclusively discussed connection technologies for communication and as a way to access information, regardless of the type of content or the type of communication. It is obvious however, that essentially there is no communication, no exchange of information without content or information. The type of content and the way the content can be transformed into transportable parts, can influence the choice of communications technology.

Communication technologies have no purpose without content. In the same way, content is of little value unless it can be shared and unless people have some form of access to it. Choosing the type of access or distribution technology to use depends on the nature of the content and of course the audience.

For the purpose of this chapter, we will distinguish two types of content: aural and visual.

Aural content

Aural information or audio is all content that appeals to our sense of hearing: the human voice, a conversation, a discussion, music, a speech, a lecture, and a play... Aural information can be recorded and transmitted. Aural content can even be recorded in written form (a transcription of a telephone message, an interview written down...) but then it changes its content format from aural to visual.

Visual content

Written material such as the handwritten note, a letter, a newspaper, a magazine, a book, a course, course notes, a written assessment etc. are all obvious examples of visual content. To absorb these, we use our eyes. Visual content is not just written but can be purely visual (the red light at a crossroads is information we all understand without reading). Often it can be packaged visually in a drawing (for example, a drawing on the

blackboard), a sketch, a map, a graph, an image, a photograph; even in moving images: a demonstration, a show, a film, a video, a computer animation... often accompanied with suitable audio information; for example, the soundtrack that goes with the film, a voice over on a videotape, sounds accompanying the animation.

The above information can exist in its original form (the sound of your voice "as you speak") or in a captured form (a tape recording of the same voice). The format of capture can be analogue (for example, the traditional audiocassette recorder is an analogue recording technology) or digital (for example, the audio CD). In both cases the content is no longer exactly the original, but a representation of the original: the information is packaged in order to be stored, transmitted, re-used, copied, multiplied, distributed....

A collection of content representations (for example, a library, a collection of cassettes or CDs, but also an archive of messages that were exchanged between a number of people) can also be considered a form of content. Some of these can be considered libraries or resources; some are almost like databases, storing content represented as structured data (a contacts database or an information management system for example). Others start to look like Knowledge Bases. Knowledge bases where users collect and organise content, information, and knowledge in such a way that they can consult and re-use the contents to their own advantage. These resources are sometimes static (the content does not change once the resource is created, for example, a library with all the works of Shakespeare). In other cases, the content is dynamic and the resource is changed interactively by all their users at all times, for example, the contents of a Newsgroup on the Internet. Websites are in essence archives of files, hierarchically and often dynamically linked to each other. The files can represent many kinds of content: sound, images, text and more.





Another form of content is a procedure or a programme: this can be in the form of software but it can also be less tangible, for example, in the form of a procedural description: instructions on how to perform certain repair actions on a machinery, or a cooking recipe. In order to be able to multiply or communicate these with others, they will have to be transferred to some material content format: in text, in an aural explanation, with drawings or pictures...

Another example of this content is a computer programme: this can be a software application such as a text processing or a spreadsheet application; it can also be a training programme, a simulation, a virtual reality application or a computer game requiring interaction between man and machine.

The most evolved form of content is a combination of all elements, where different types are combined in such a way that they make an effective and balanced mix. 'Blending' is the term that is being used nowadays to describe this. It is often used in education to describe the combination of a technology based delivery mode (for example, videotaped materials) with classroom teaching and learning but the definition can be used also for more elaborate mixed concepts: learning environments with classroom lessons, videoconferences with CD-ROMs etc.

Web sites can be considered the ultimate way to converge different types of content. A Web site is a collection of web files on a particular subject that includes a beginning file called a home page. These web files can consist of various types of media: text, audio, images (still, moving, animated, virtual...), and interactive elements: software applications and games, virtual reality applications, simulations etc.

It is important to note at this point that information and content as such are not the objective of learning: access to raw data or to information are not sufficient. An example. The following is data: "VS6012015JHB". These data do not make any sense until the user knows that it represents flight information: now we read the same data as "Virgin's 2015 flight to Johannesburg". Now if you know that this specific flight always arrives late, "VS6012015JHB" may reflect true knowledge based on data, information, and experience.

The objective of learning is the gathering of knowledge and acquisition of skills through experiences and by means of information collection and communication with teachers, tutors, and peers.

4.1.2 Digitalisation of content for communication purposes

Below, we see the photograph of a classroom: the original image as it was taken with a camera. The photograph is represented visually in the format that we all recognise and that we are able to interpret as information: a group of students studying in a computer classroom.

The information (students working in a PC classroom) has been translated into visual content (a photograph of that classroom).

(a photograph of that classroom).



The next image is a small part of exactly the same picture, but this time as it is recorded on the digital camera:



Now the content (an image that is recognisable and that represents some information) has been translated into data: more even, in data in its most crude or essential form: ones and zeros, one being represented as a black dot, zero as a white dot. This is called digital. This representation of the classroom does not make any sense to any viewer without the help of some system (in this case hardware and software) to translate these bits of black and white into a photograph of a classroom.

Why digitise?

Sending photographs, text, video, audio or any other form of content from one place to another or to many other places, can be expensive and difficult if you have to do so by mail or by any other traditional form of distribution. Using modern information and communication technologies that transform the content into bits and bytes, it is possible to economically and efficiently store, process, distribute, and transport content.

A book in digital form can easily contain in the order of 1 Mbyte or 1,000,000 bytes (to be precise we should say 1,048,576 bytes but for the ease of calculation, MB are rounded) or 8,000,000 bits (the little black and white dots as in the previous picture).

On a floppy disk, it is possible to store 1440 Kilobytes (which is as much as some documents or a book). On a CD-ROM, we can store as much as 640 Megabytes, which represents about 250,000 pages, or about 1000 books.

Alternatively, one minute audio is roughly equivalent to 10 Megabyte, and one minute of video can be as much as 15 to 100 Megabyte. All depending largely on the quality and size of the content: the number of images, text, the quality of the video, and the quality of the audio, etc...

While the size of the content in digital terms is expressed in bytes, the speed with which the content is transferred is calculated in bits per second. To convert from one to another, multiply the number of bytes by 8. For example to transfer a book of 1 Mbyte via a telephone line with a transfer speed (or bandwidth as it is also called), of 64 Kilobits per second (Kbps) it will take:

4.1.3 Accessing content: unicast, multicast, broadcast

Depending on the nature of the content and the interest of the user in a particular content, there

Maths Sum

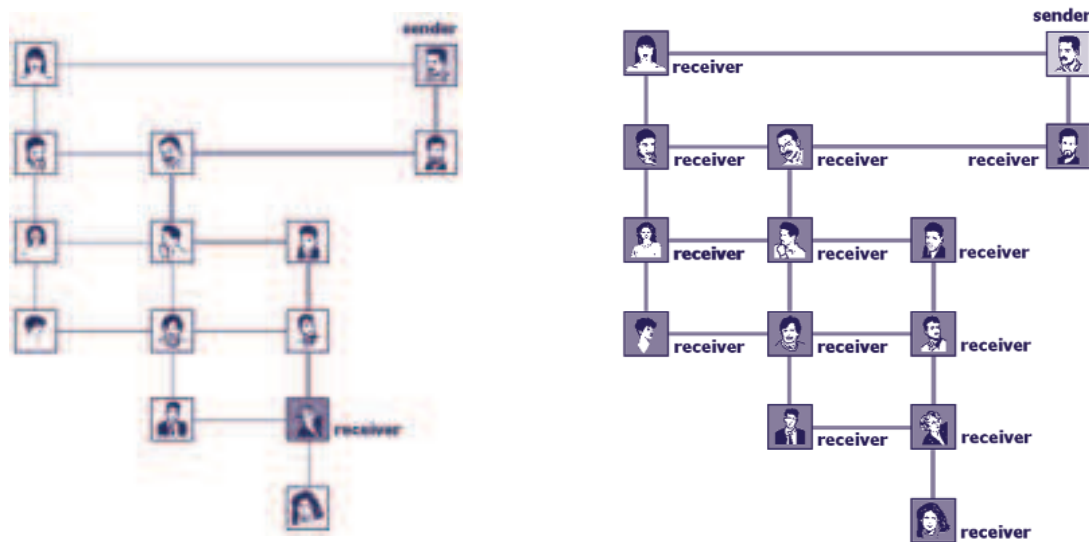
are different modes in which content is being delivered. Let's look at the various bits of information and communication that we receive or consume on an average day.

A hand-written, personal letter that arrives by ordinary mail (snail mail as it is being called nowadays) is unique: there is only one single copy, it delivers a personal message and travels from the sender to the receiver along a unique path. Newspapers on the other hand are less unique: maybe in your street there are a number of people that have subscribed to the same newspaper: they will receive the same newspaper at the same time, but each will have his/her own copy. In total there are maybe tens of thousands of news paper copies that left the printing press at the same time on their way to their subscribers. Another kind of information is the door to door publicity: when campaigners want to hit the biggest mark, they organise a door to door distribution campaign for their leaflets: there is no subscription needed, everyone with a letter box will receive the content.





These are three types of delivery modes: the first one, a personal communication mode is called unicast: the communication is strictly individual. It applies to personal letters, to making a phone call, to email, to sending an SMS, but also to certain information retrievals from a web site: for example, when one performs a specific search in Google, Google will return with a customised and individual response. Nowadays, unicast communication is still the most important communication mode. Consider the following generalisation: while newspapers take up 90% of the volume and weight of mail, they only account for 10% of the revenues of the Post, letters and other personal mail are net subsidisers of newspaper delivery. In Finland, revenues from SMS messaging has surpassed in 2002 the revenues that commercial TV stations make from advertisement. Email is still the killer application on the Internet, more than the web, and its share of the Internet traffic is still growing. Unicast is a way of communicating rather than of distributing information: normally sender and receiver know each other and acknowledge receipt of the message.



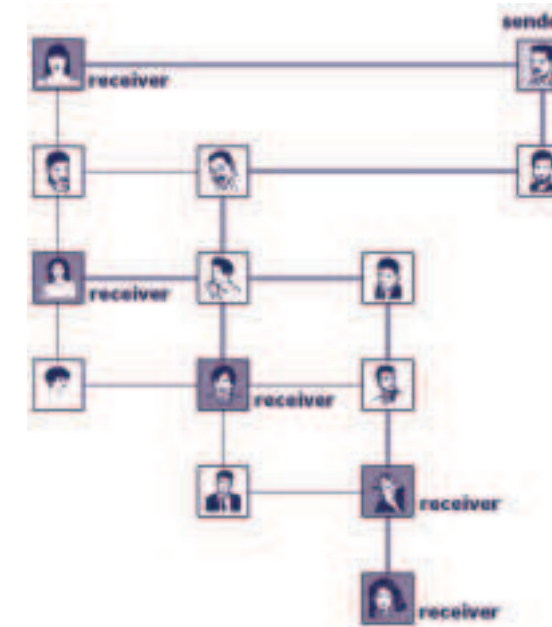
Unicast and broadcast communication models

Broadcast mode is when the message goes to all potential users that are within reach of the network or the signal. Broadcast here means that the signal is cast (sent out) in all directions at the same time. A radio or television broadcast for example, is a programme that is transmitted over the airwaves for public reception by anyone with a receiver tuned in. When used in relation to email it means distribution of a message to all members, rather than specific members, of a group such as a department or enterprise. Broadcast mode is a typical way of sharing information with as many as possible: normally a broadcaster is more interested in getting the message out to as many as possible, without knowing the individual receivers, rather than to communicate back and forth with each of them.

Multicast is communication between a single sender and a specific group of receivers, where the sender transmits a specific content set to a specific target group. A typical and traditional example of multicasting is the newspaper that is delivered by mail. The same content travels almost all over the area and past every door, but is only delivered to the subscribers. Pay TV, where people subscribe to certain programmes on TV, is another good example: the signals are transmitted all over the area, but only people that are allowed to decrypt the content will effectively see the content. In Internet terms, multicasting is used to send content to certain well defined IP-addresses, or to a specific range of addresses.



Broadcasting 4.2



Multicast communication model

Normally switched and wired networks are ideally suited for enabling **unicast** communication: for example, the wireline telephone network allows for a unique channel of communication between 2 parties. Because of the switching capacities of the network, it is possible to use the network highly efficiently: many parties can have simultaneous distinct exchanges while the overall capacity of the network is only restricted to its own switching capacity and the number of participants. Adding a new participant to an existing wired and switched network however requires establishing an additional physical connection between this new end user and the switching point.⁷

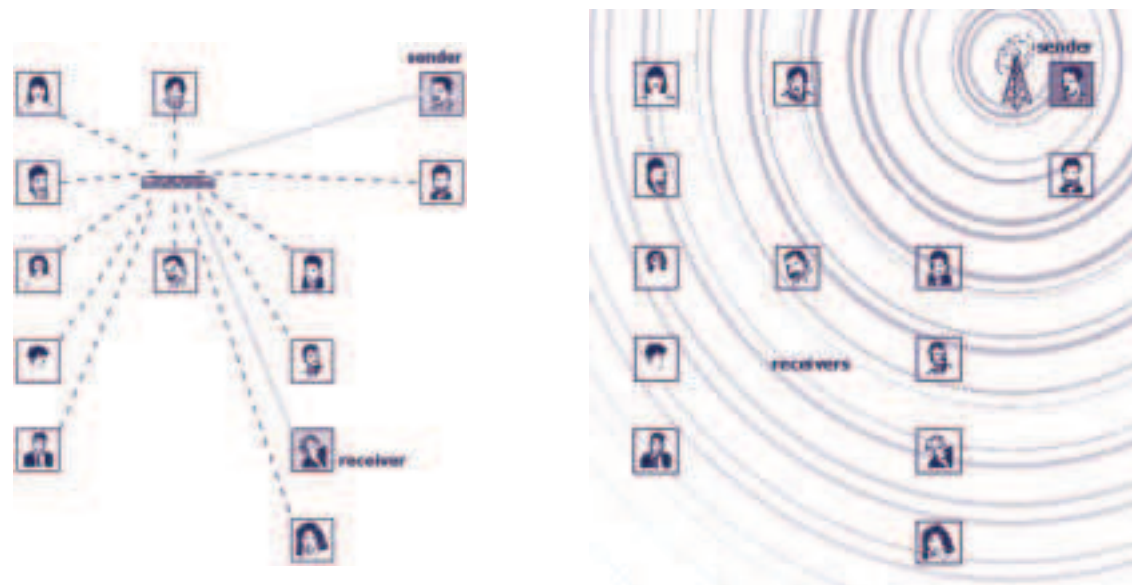
Wireless and radio networks are basically much better suited for broadcasting activities such as radio and TV. Intrinsically they are less suited to

enable a large number of discrete two way communications because of a number of limitations: the fact that the transmission medium is shared (the radio spectrum or available bandwidth in the ether), plus the fact that access to the transmission medium is almost completely under the control of the transmitting party (without the coordination that takes place in a switched network environment) makes it necessary to carefully regulate and agree on the use of the available radio spectrum. Transmission of a radio or TV programme to many is easier via this wireless and unswitched environment because the signals transmitted basically reach all the participants that are under the coverage of the transmission footprint. Adding new participants (typically called "receivers") to such a network requires only installation of end user equipment (or "receiver") at the new participants' premises.

⁶ Wired networks are not necessarily always switched networks. A Cable TV Distribution network for example is not switched and is typically a broadcast medium: it is used to distribute an identical bouquet of content from a central source to all cable-connected subscribers at the same time, very much indeed like terrestrial (Hertzian) television reaches all viewers that are within reach of a transmitting antenna.

⁷ To make the distinction between different communication networks even more complicated, you should note that Cable TV Distribution networks are increasingly converted into two-way interactive networks that also allow for typical unicast applications: in countries with a high penetration of Cable TV Distribution, it is becoming increasingly possible to use telephone and Internet access services via the Cable network.





Switched and wired versus wireless non-switched networks

The fact that a network is wireless does not necessarily mean that it does not allow for switched (or unicast) communications. The wireless telephone network (GSM or mobile phone network) is a good example of wireless switched. Another example is Internet via Satellite. Both are typical unicast applications. To establish a one to one connection they work on the basis of a request for time limited use of part of the available wireless spectrum. Concurrent uses of the available total bandwidth is possible as far as its capacity reaches. This issue is expressed in the contention rate, which indicates the maximum number of participants that can be sharing the service at one given moment. While it is the norm of the network provider to have some level of contention (for wireless and satellite networks, the contention rate varies between 1:20 and 1:508), it is best to obtain the lowest contention rate possible, in order to get the best service and to reduce the potential for a customer to experience congestion (communication interrupts) or reduced download speeds. The network service provider has to ensure that when the number of users of the network increases, also the number of available channels (the total amount of available bandwidth) increases at a similar pace. Otherwise the contention rate will drop and users may start

to complain of bad connection service. This is what happens in many African countries where the number of users of mobile phones increases much faster than the network capacity: the consequence is that many connection attempts fail because of a network overload. Similarly in Satellite based Internet access, users compete with each other for the available bandwidth: the satellite service provider has to keep up with the bandwidth demands of the user population and increase the total capacity accordingly.

4.1.4 Interaction

The concept of communication comprises a certain form of interaction. Interaction in terms of information and communication technologies has three dimensions: the first dimension is topology (the actors between which the interaction takes place), secondly there is a time dimension, and then lastly there is an aspect of symmetry.

Topology

Interaction can happen between a human being and a machine: for example, between someone sitting at a computer and the application on that computer. Computer based training programmes are of that type. Interaction of that type can range from simple actions (switching on and off the TV set can be considered the lowest level of interaction) to complicated and multi-layered

activities: for example, the kind of activities that take place on Web-based learning environments. Simulations and CD-ROM based learning applications fall also within this category.

Interaction also happens between human beings: discussions, dialogues, telephone calls, letters... all are examples of interactions. Some happen between two parties: a telephone conversation normally takes place between two people. A lecture in a classroom is an interaction between one (the teacher) and many (the students). An electronic news group or a bulletin board is an example of many to many people interacting with each other.

When selecting an information and communication technology to support one or the other interaction topology, there are a number of obvious choices that can be made: for a private communication between two people, telephone is an obvious choice when these two people cannot meet physically. When one person wants to address many people at the same time that are dispersed over a large geographic area, broadcasting via radio or TV may be an appropriate means. Whenever there is a large number of people involved groupware systems or news groups and billboards can be a solution.

Time

Another aspect of interaction is the element of synchronicity: in some cases it is necessary to communicate directly and without any delay between the exchanges: telephone conversations are the obvious example, videoconferencing too. Radio and TV broadcasts are synchronous too: if the receiving parties in the target audience are not watching, listening or recording while the programme is being transmitted, then their opportunity to receive is lost. Email is a typical asynchronous person to person communication system: the message is made available until the addressee has time to collect or read the message. In that sense, email compares again to the letter that is posted and sent via email or courier. Email may go as fast as the speed of light, email does not require the receiver to be present at the other side of the communication chain at the moment the message is sent. Therefore it is called asynchronous.

Teaching in front of a classroom is synchronous: it only happens when teacher and students are effectively present at the same time.

Symmetry/asymmetry

A third quality aspect of communication is the symmetry of the exchange or transfer of information. A normal conversation between two people can easily be understood to be symmetric: both parties have an equal say. In a classroom on the other hand, with one teacher lecturing to hundred students, it is obvious that the communication is not so equal: the information flow from professor to students will normally be many times bigger than vice versa. The same principle applies to technology enhanced communication. Depending on the symmetry of the communication flow, it will be necessary to opt for the appropriate communication service: when the parties are equal contributors, videoconferencing may be the preferred solution. Email normally also is symmetric in the sense that all subscribers have equal possibilities to contribute. Radio and TV are asymmetric: the content flowing from the transmitting party towards the receivers is much larger and of much higher quality than the communication that listeners or viewers will be able to return.

Communication and information exchanges by means of the World Wide Web display a similar character. Browsing the web is clearly an asymmetric activity: the browser sends very small amounts of data to the server when he/she clicks on a hyperlink to request a page view. The web server on the other hand returns a lot of data (the requested page view with all the page elements such as text, images, sounds, interactivity etc.) towards the end user. Browsing the web can effectively be called asymmetric communication. The webmaster and his/her web development team who are responsible for the content offered by the web server on the other hand are more contributing towards the web server than retrieving: their communication path may well be rather symmetric or even inversed asymmetric (more contribution than retrieval).

⁸ Note that also wired network service providers (Dial In or ADSL) deploy their services on the basis of a similar contention rate, comparable to the rates given here, otherwise their service offer would become too expensive.



4.1.5 Matching a pedagogical model with an educational information and communication technology selection

The learning and teaching methodology may mean that one or the other information and communication technology has to be selected. The table below gives an indication of how each of the most common used technologies specifically addresses the communication quality issues topology, synchronicity and symmetry.

	Person to machine	1 to 1	1 to many	Many to many	Same time	Different time	Symmetric	A-Symmetric
Audio tapes	Not supported	Not supported	Fully supported	Not inherently supported	Fully supported	Not supported	Not supported	Fully supported
Radio	Not supported	Not supported	Fully supported	Not inherently supported	Fully supported	Not supported	Not supported	Fully supported
Telephone	Not supported	Fully supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Not supported
Audio-conferencing	Not supported	Not supported	Fully supported	Fully supported	Fully supported	Not supported	Not supported	Not supported
Video tapes	Not inherently supported	Not supported	Fully supported	Not inherently supported	Not supported	Fully supported	Not supported	Fully supported
Television broadcasts	Not supported	Not supported	Fully supported	Not inherently supported	Fully supported	Not supported	Not supported	Fully supported
Videoconferencing	Not supported	Fully supported	Not inherently supported	Not inherently supported	Fully supported	Not supported	Fully supported	Not supported
Resource search on WWW	Not inherently supported	Not supported	Not supported	Not supported	Fully supported	Not supported	Not supported	Fully supported
Publishing on the WWW	Not inherently supported	Not supported	Fully supported	Not supported	Not supported	Not supported	Not supported	Fully supported
Using CD-ROMs, DVDs	Not inherently supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported
Email	Not supported	Fully supported	Fully supported	Fully supported	Fully supported	Not supported	Fully supported	Not supported
Computer conferencing	Not supported	Fully supported	Fully supported	Fully supported	Fully supported	Not supported	Not supported	Not supported
Mailing lists	Not supported	Not supported	Fully supported	Fully supported	Not supported	Not supported	Not supported	Not supported
Electronic Learning Platforms	Not inherently supported	Fully supported	Not inherently supported	Not inherently supported	Fully supported	Not supported	Not supported	Fully supported
Online simulations	Fully supported	Fully supported	Not supported	Not supported	Fully supported	Not supported	Fully supported	Not supported
Online laboratories	Fully supported	Fully supported	Not supported	Not supported	Fully supported	Not supported	Fully supported	Not supported
Computer Apps (Word, Excel, PowerPoint...)	Not inherently supported	Fully supported	Not supported	Not supported	Fully supported	Not supported	Not supported	Not supported
Computer Games	Fully supported	Fully supported	Not supported	Not supported	Fully supported	Not supported	Fully supported	Not supported
Educational software	Fully supported	Fully supported	Not supported	Not supported	Fully supported	Not supported	Fully supported	Not supported



In this chapter we have not referred to satellite communication technology at all. This will be done in the next part. However, it is important to understand the basics of (educational) content delivery before choosing a specific technological technology. In the next part we will attempt to clarify the potential relationship between the content, educational technology selection and satellite telecommunications.

Although it is not easy to categorise, it is useful to describe the various ways in which Satellite Communications can be configured and used in an educational context. In this section, we will provide some broad categories, describe the distinguishing features of each category and where appropriate the various sub-sections that occur within each category.

It is important to begin with a number of reservations to avoid misleading the reader. First,

the technological environment is changing fast and therefore certain distinctions that applied in the past are no longer relevant and emerging services often span two or more of the categories described. Secondly, even where technological change is not a factor, there is a lot of “carry-over” from one category to another and we have tried to point this out when it occurs. Thirdly, many terms like “Interactive Television”, “Videoconferencing” and “Multicasting” are being used differently, and there is little common understanding of terminology in this field. These distinctions are often region specific, for example, the term “Videoconferencing” is used differently in Europe than in the U.S. Different uses of the same terminology often occur depending upon sector or industry. For example, the broadcasting industry uses terminology differently from the computing industry.

Broadcasting 4.2

Most people are familiar with the use of broadcast Radio and TV to support education, as this has been a common means to provide educational service to potential learners for many years. Probably the first educational TV programme was Sunrise Semester, broadcast from Chicago in the U.S. in 1959. Continuing until the early Sixties, Sunrise Semester featured a single broadcaster, a teacher, standing in front of a class with a camera shooting over the heads of the students. The initiative ceased because it was not economically sustainable.

Traditional educational television is one-way, sent by the broadcaster to the end user at a fixed time and according to a set and pre-ordained schedule, as in the case of School TV and Open University programming carried by the BBC.

Categorised by its ability to address large potential groups of users, it is common for broadcasters to use satellite technology to transmit their signal, particularly in regions of the world where terrestrial broadcast services are unsuitable. The satellite technology used in such instances is usually a large-scale professional service involving large transmitting earth stations and significant

technical resources for production and play out of programmes. Reception equipment comprises a small dish with a satellite receiver. Many specialised broadcast channels offering, for example, sports, financial information and targeted programmes, are broadcast this way with the set-top box acting as a filter ensuring that all license and other fees are paid before the end user gains access to the channel(s).

Satellite supports good quality audio and moving video images thanks to its high bandwidth transmission capability. Production costs are relatively high and there is no possibility for interaction. Increasingly however, educational broadcasters are looking to embed this medium in a learning environment supported by other means. It is common nowadays to find associated web sites, help-desks and other support services for people accessing educational resources in this way. Well-known educational broadcast services in the world, like the China Central Radio and TV University, are transforming this type of service into a more interactive model (see next part on “Interactive Television”).





Numerous examples of this type of application exist including EMMA, BBC Education, Swedish Educational Broadcasting and InTeleCom in the US. Some are associated directly with public

service broadcasting organisations. Other operate more as educational programme producers that are selling programmes to broadcast television stations.

Interactive Television 4.3

The term “Interactive Television” is one of the most confusing terms. It can refer in fact to any form of interaction with a television or broadcast service. This ranges from tele-polling, choosing camera angles in sports events, using shopping channels to video-on-demand. Many Interactive Television services use satellite technology to support at least part of the communications chain. Typically an interactive television service will involve various types of media, each supporting different functions. Let us look at a number of different samples to explain the range of applications possible in an educational context.

Video-on-demand

This kind of Interactive Television service usually involves a broadcasting station setting up a service whereby viewers can choose to have programmes sent to them on demand from a video server. This can be on an “instantaneous” or “near-instantaneous” basis: depending on the service the programme is instantly available to the end user, or available later. The broadcast of the requested programme can be done via satellite. The ordering or request system is usually facilitated via a terrestrial telecommunications network or even via the Internet. These kinds of services are increasingly on offer from cable operators and there are some examples of Educational services using this service. The service offered by Les Amphis de France is a good example and is described in chapter 6. This type of service in an educational context demands considerable technological and organisational resources but is very useful when considered as a way in which educational institutions can manage access to large resources of video-based material.

It is essentially pre-recorded and little opportunity for any “live” interaction exists. Material can be maintained in a central service and then accessed when required by the institution or individual wishing to make use of the material.

One-way broadcast with asymmetric return

This model of Interactive television services is increasingly common. What happens is that viewers watching a broadcast programme interact with those in the studio or support network via telephone, Internet chat or email messages or via a videoconferencing link. In this is broadcast in the form of listener feedback or questions to the studio panel. The system is essentially “live” and can be configured in a number of ways. It supports synchronous communications although elements can be asynchronous, for example, using email for question and answer sessions after the “live” event. Broadcast via Satellite is often the way in which the signal from the studio is sent to the viewer, the return link is usually via terrestrial means. The quality of the signal from the studio to the viewers, is pretty much always of higher quality than the incoming one (from the viewer to the studio).

In the educational context such networks can be set up either as “closed” networks whereby those taking part are known to the educational provider or “open” where this is not the case and anyone with the means to receive the broadcast signal can interact with the studio and ancillary services. Interaction can take the form again of questions and discussion, polling and feedback, even group work in remote sites with feedback provided to the central studio via remote group leaders is possible.



This kind of broadcast using satellite one-way and various different sorts of return channels is commonly used by commercial training channels like the Computer Channel or by large corporations including Ford and Daimler Chrysler for training staff. It is also used by those providing specialised

medical educational services like Rockpointe Broadcasting in the US or Plymouth University in the UK. There are a number of examples of this application in the educational domain - in our list of sample projects; these include the African Virtual University and Consortio Nettuno.

Data Broadcasting and Multicasting 4.4

Data broadcasting and multicasting networks are often supported via satellite systems. These are essentially one way communication networks offering to the end user data such as video files, web site contents, analytical and statistical information, applications (software up-dates) or any other form of information that can be digitally stored. The end user stores the transmitted data on either a PC or on some sort of set-top box. These set top boxes are developing into Personal Video Recorder (PVR) or Multimedia Home Platform (MHP) systems, supporting standardised data broadcasting and multicasting. The systems increasingly use the Internet TCP/IP protocol in the management of the data transmitted. The way the network is configured may include satellite

download for one channel of the network - i.e. to the end user using the satellite capacity to handle the bandwidth requirements, which may be high if there is a lot of video in the material being downloaded. The way the network is configured can allow for specific addressing, i.e. multicasting to specific recipients so the service provider knows exactly who is receiving the data and when it is sent out, or it can simply be broadcast to a wide variety of recipients. This kind of network is used frequently by educational providers as it allows for secure and managed distribution of data resources and a couple of examples of this type of application have been included in the following chapter, including Espresso and La Caravane Multimedia.

Internet Access 4.5

Many Internet Service Providers use satellite services to support one or both channels of their service to connect their subscribers to the Internet backbone. This is particularly true of regions where the terrestrial telecommunications infrastructure is poor as in many parts of Africa. The type of infrastructure is normally based on relatively large size antennae and significant resources for hosting, providing gateways, proxy servers, security etc.

When considering how this use of satellite fits into an overall educational perspective, it is interesting to recall that the Internet really took off as an academic network and this genesis has important implications for how the expansion of Internet use takes place particularly in Africa. Very often, it is educational institutions and universities in

particular taking the first steps in providing an Internet service and Point-of-Presence (PoP) in regions where such services were not previously available. The very first ISP on the African continent was in fact the one that has been provided since 1992 by Universidade Eduardo Mondlane in Mozambique. As University Campuses extend their reach and educational providers of one kind or another seek to reach new learners the question of creating new PoPs arises. Satellite is often the only way such services can be extended and there are important implications here regarding licensing on a national basis and on how the provision of such PoPs can be made sustainable. Although we have not included any specific examples relating to this particular use of satellite in education, it is





important in our view that educational and development agencies follow what is taking place through the African Information Society Initiative and other such initiatives. It is equally important to follow market trends in this rather fragmented ISP environment to make sure that educational providers have access to good quality and

reasonably priced Internet connections either through a commercial service or by operating their own service. Satellite technology can be used to network ISPs should the need arise in regions of Africa for outreach to under served areas or to set up a content delivery network.

One and Two-way Connectivity 4.6

New satellite technology and more specifically Internet via Satellite can provide high speed IP connectivity via satellite with all the advantages of commercial digital television: wide uptake, high quality of service, scalability, data transmission capabilities.

Until very recently the vital return connection, the interactive connection or back-channel, happened via terrestrial lines, mainly through a dial-up modem connection via telephone line. This is a logical configuration given that most Internet applications are typically asymmetric - the traffic from client to server is usually much smaller than vice versa. This is usually in the order of 5 to 10% upload versus download, except for content creation and contribution. However, the return channel can also be supported via satellite as explained in the previous chapter.

The availability of these services via satellite for the end user is an important development that has terrific potential for the African continent. According to Mike Jensen, "Two-way satellite-based Internet services using very small aperture terminals (VSAT) to connect directly the US or Europe have also been quickly adopted where ever regulations allow. Namely in the Democratic Republic of Congo, Ghana, Mozambique, Nigeria, Tanzania, Uganda and Zambia which all have ISPs that are not dependent on the monopoly telecom operator for their international bandwidth". Information about the likely players in this field is contained in Chapter 7 of this report. Typically such services operating in the Ku-band or mixed Ku/Ka-band offer asynchronous network configurations of typically 56-128 Kbps outgoing (from the end terminal) and 200 Kbps - 8 Mbps

incoming. Service operators typically target so-called SoHo end users (Small Office/Home Office) but they are equally of value for educational users. They tend to operate with a relatively low-cost and small end user equipment relatively simple to install end user terminals hosted on either a separate box or as software installed on a PC. Dish sizes from the service providers currently active in the market range from 90 cm to 150 cm. Unlike the satellite services utilised by ISPs, these networks are aimed at the single end user or as a gateway to a small and local network (LAN). Licensing and network configuration are important issues to consider when considering these types of satellite-supported services in the educational context. How the network is configured depends upon the practical use that the organisation offering the service wishes to make of the service and so there are a number of sub-categories of potential educational use here, in broad terms we categorise them as follows:

Virtual Classroom scenario: in this case, the individual end user station is part of an educational network whereby other learners, teachers and resource people and materials are remote from the end user. The system is used for a variety of applications that are a surrogate for normal "classroom-type" activities. These can include quasi-synchronous communications (usually online chat), asynchronous communications using a closed bulletin board type system and a common store of resources usually housed on a remote server which are available to the user on demand or as part of a multicast set-up where digital materials are sent to the end user's storage device via satellite and accessed when necessary.



Resources based learning scenario: in this case the teacher and immediate learning peers are in the same location and use the satellite service to access resources when required, these resources can be accessed either with an open Internet type connection or to a closed intranet

hosted remotely at the location of the satellite up-link server. This is a similar network set-up as described in category 3, data broadcasting.

Examples of projects using this type of service in the following chapter are SchoolSat, LINCOS and the World Links project in Uganda.

VSAT Networks 4.7

VSAT communications can be used to set up virtual private satellite networks of one kind or another and are very often used in the commercial world to provide entire communications networks to outlying companies and institutions. Using relatively small size dishes (by comparison with broadcast type applications) such institutions use these kinds of services to support telephony, data communications and videoconferencing between a closed user set. VSAT networks are very common for example, in the banking world where commercial banks use them to provide a secure and comprehensive communications network. The exact configuration of such a network will depend upon the resources invested by the network operators, the bandwidth capacity required and often the location of the end users. They can be used in both synchronous and asynchronous configurations. Many organisations favour an entirely closed system for both security and management purposes, given that the overall

control of the system is completely in the hands of the owners and can be managed and controlled centrally. Such networks require high up-front investment and compliance with national and regional licensing authorities.

In the educational context, VSAT networks have significant advantages and allow the organisation flexibility in controlling the educational environment - within the technical constraints of the chosen network of course - to create learning scenarios with the precise media mix required. A good example of this kind of network is the Global Development Learning Network (GDLN) set up by the World Bank and described further in chapter 6. Interestingly, this network was built on the existing VSAT communications network used by the Bank for all its communications requirements. Now an independent network, it seeks to collaborate with other institutions with common aims interested in sharing the resources of the GDL Network.





Meeting Educational Needs by means of Satellite Networks **4.8**

Before discussing the application of satellite technology in education further, it is useful to take a look at how generic educational activities can or might be supported by satellite services and where such services are most suitable. The following table provides an overview of this topic.

Educational Activity	Satellite Services					
	Broadcast	Interactive Television	Data Broadcast	Internet Access	One & two way Interactivity	VSAT network
Accessing digital library resources				X	X	X
Receiving resource materials	X		X	X	X	X
Communicating with teachers or tutors		X		X	X	X
Communicating with peer learners		X		X	X	X
Sending assignments				X	X	X
Group-work		X		X	X	X
Doing exams				X	X	X

Overview of Satellite Supported Education Applications

Costs and Service Considerations **4.9**

This section will provide a basic list of the costing considerations that service providers need to consider. These include hardware at both the send and receive sites, software and server considerations, bandwidth costs, licensing, maintenance and service. It will also cover aspects such as training, operation and personnel support and maintenance. The section starts with three examples of cost models, related to three of the most familiar satellite applications for education and training. In the next part we will elaborate on

the different issues that surround the costing structure. Prices are calculated on the basis of averages and can only indicate a range of order. Most of the prices are susceptible to change especially in regions with a lot of competition. It has to be said that prices do not only differ from country to country (in some countries huge mark ups are applied with no apparent method of accounting), but also that fortunately prices tend to drop, slowly but steadily.



4.9.1 Cost models

4.9.1.1 Satellite TV Broadcast

The cost structure for satellite TV broadcasting is the simplest. We assume that the content is pre-recorded in an acceptable format and quality. The costs of production are not taken into consideration as they are not directly related to the transmission format: it can be assumed that they would be the same if the content were to be distributed on VHS tapes or via broadcast TV.

The costs can be divided into costs occurred at the originating side and costs at the receive side of the chain. Costs can be quantified easily because they are directly related to the duration of a programme. We present below the cost for a one hour programme, on a purely occasional basis. Tariffs will change according to the choice of satellite, the frequency of use, the number of transmissions, the time during the day of the transmission, the flexibility of the broadcast and several other parameters.

At the originating side:

	1 Hr analogue C-band	1 Hr analogue Ku band	1 Hr digital MPEG-2 C/Ku band (2 Mbps)
Play out	50.00	50.00	50.00
Uplink Transmission station	650.00	650.00	750.00
Transmission	1450.00	1200.00	200.00
Total	2150.00	1900.00	1000.00

All prices indicated in US\$/Hour

Satellite TV Broadcast Costs

Transmission in digital format is cheaper because it occupies only a small part of the bandwidth and therefore it can easily be combined with other content materials.

At the end user side: (cost per site)

	1 Hr analogue C-band	1 Hr analogue Ku band	1 Hr digital MPEG-2 C/Ku band (2 Mbps)
Satellite receive hardware (antenna)	1200.00	250.00	200.00
Satellite receive hardware (receiver)	300.00	300.00	400.00
Installation	500.00	500.00	500.00
Reception	0.00	0.00	0.00
Total	2000.00	1050.00	1100.00

All prices indicated in US\$





Satellite TV Receive Cost

The cost at the user side is per installation, not on an hourly basis. The depreciation time for this type of hardware, given the status of transmission standards, can be estimated to be at least 5 years. The number of receive site installations is unlimited in number, it is only limited geographically by the footprint of the chosen satellite and transponder. Because the cost at the originating side does not alter with the number of receive sites, it is easy to see that the cost per user per hour decreases by the quantity of clients.

One hour broadcast in digital video to one single receiver will cost US\$ 1100 per user per hour. 1,000 hours of broadcast (that is one hour per day over 3 years time) transmitted to 10,000 viewers will cost about US\$ 0.1 per hour per user.

Note: the above example is for non-supported content materials. If - as is mostly the case in educational TV programming - additional support (support materials, tutoring, helpdesk, etc.) needs to be put in place, the cost to do so will be affected by the numbers of applicants.

4.9.1.2 VSAT Community Network

As in the previous example we will provide an example of cost calculation without directly referring to the cost of the content creation, the pedagogical model, the standard or format of content exchange or the specific type of communications. A VSAT network, furthermore, can be tailored around specific requirements: architecture (star or mesh), bandwidth and power are just a few of the parameters that come into play. In the example below we describe the cost for a star network with broadband capacity (2 Mbps) available 24 hours a day all year long. This system allows for a mixture of videoconferencing with data and multimedia distribution and Internet connectivity. The specific costs for these applications are not included in the example below.

A VSAT network is a centrally organised and controlled networking system. Costs cannot be discriminated so easily between originating (central education provider) and individual clients costs. Because scale of deployment plays an important role, it is more appropriate to calculate the total cost of operation for the whole network.

	Total	Per VSAT per month
1 year / 30 VSAT stations	841,600.00	2,337.78
5 year / 30 VSAT stations	4,168,000.00	2,315.56
5 year / 300 VSAT stations	27,160,000.00	1,508.89
5 year / 3000 VSAT stations	209,660,000.00	1,164.78

Costs in US\$

VSAT Network Deployment Cost

The table above takes into account the following satellite communications related cost factors:

- VSAT Earth Station
- Equipment
- Installation
- Spare parts
- Maintenance
- HUB Station
- Lease cost or Ownership
- Applications platform
- Connection to Backbone
- Operation and Maintenance
- Satellite
- Bandwidth
- Licence
- One time fee (network)
- Annual fee (earth station)



In VSAT networks dimensioning starts to play an important role: the number of clients will indicate whether it is cheaper to share a central hub or to invest in an own hub, the available bandwidth and the connectivity to the backbone will also depend upon the dimensions of the network.

The above cost gives an indication for a full time high bandwidth secure private communications network. While the investment cost may be frighteningly high at first sight, it is important to look at the operational costs (total cost over usage period per terminal) and it becomes clear that VSAT is a solution for broadband communications that can effectively compete with terrestrial solutions, even in countries where good quality terrestrial connections are available.

4.9.1.3 Broadband Internet via Two Way Satellite

Small two way satellite Internet systems using Ku and Ka band are becoming more and more popular. They can be considered VSAT systems but they differ from the previous example in the sense that the network is set up by satellite providers who service a less homogenous community of users. The service usually offered is limited to some form of high bandwidth Internet access (in various bandwidth levels according to the customers requirements) sometimes extended with customised applications that are implemented to serve a particular part of the audience by multicasting, special intranet type of applications etc. In theory there is no need for the education provider to worry about the investment and running costs at the hub or server level of the system: it is enough to invest in client stations and connection fees. The service itself (connection of the hub server to the Internet backbone, satellite bandwidth sufficient to service all clients, maintenance and operation of the service) are not cost issues to the content provider. Specific centralised costs for the course or content provider are related to contribution costs (bringing or "porting" the content from the designer or producer to an access point within high bandwidth reach of the hub server, or preferably even on the hub server location itself), or the investment in specific server side applications or tools, if they are not supported by the service provider.

In this case, economies of scale affect neither the end user nor the education provider. They are taken absorbed in the commercial plan of the service provider. However, it may be worthwhile discussing the deployment plan for a network with the service providers involved, especially when it is very large and demanding, when certain levels of Quality of Service are required or when expansion is foreseen. It may turn out that migration from a public or semi-public service towards a VSAT community solution using the same technology is a more efficient solution.

Costs can be estimated easily:

	Unit price	Unit	Total
Hardware	2000.00		2000.00
Installation	500.00		500.00
License	120.00	per year	120.00
Communications costs	200.00	per month	2400.00
Total (per unit per month / depreciation over 5 years)			251.70

Costs in US\$





Two Way Satellite Internet Cost

Compared to the VSAT network, costs are very low. Compared to terrestrial broadband network costs are competitive, certainly when taking into account the availability of the connection virtually everywhere almost instantly.

The big difference with the VSAT network solution is the fact that the network capacity is shared with a virtually unknown number of concurrent users, which may affect the network performance. The speed of download depends upon the number of users logged on and consuming bandwidth simultaneously, i.e. the contention rate. The same is true for Cable connectivity and to a lesser extent for ADSL, where different connections need to share the same bandwidth.

Another disadvantage compared to VSAT, is the limitation of application implementation that content providers most likely will incur: this will hinder for example the use of synchronous bandwidth demanding applications like videoconferencing.

4.9.2 Service costs

With the term "service costs", we refer to all costs that add up to the total cost of the delivery of a service (be it an occasional offer or an ongoing service). We have distinguished so far a number of cost elements that are directly related to the delivery and thus end up on the final bill of the content provider and/or the end user.

Furthermore, in this part we will go briefly into the trends that are or will affect price evolution of these cost elements. This will involve some assumptions and crystal ball gazing, because as we know from the last 10 years, economic factors tend to change within periods of 6 months due to the rapid development of new technologies, the stormy nature of the Internet and the changing economics in which the largest players, especially the telecom companies find themselves.

4.9.2.1 Cost Elements

This section seeks to identify the different cost categories that come into play when talking about ICT based education and training. The highly important management issues that are related to

the change that ICT based education can bring into institutions are not examined here, because they can be considered external to the choice of the technology and delivery mechanism. It should be kept in mind that management plays a key role in the process and that even when certain technical choices impose themselves, it may be that managerial criteria change the options.

It is not our intention to cover on all issues of ICT based education and training in great detail. What we would like to do is indicate how the choice for a particular learning and teaching methodology and all its implications can influence the cost of network technology or capacity. We do not make a judgement on which methodology is best suited or most effective, this depends completely on the individual situation of each provider. Although some methodologies seem to be more appealing than others at first sight, their attractiveness should not mislead the user from the ultimate goal: enhancing education by means of technology support. Stepping into the pitfall of "technology support for technology sake" should be avoided at all cost.

Pedagogical Model

New information and telecommunication technologies such as the Internet, multimedia, videoconferencing, simulation etc. allow for innovative or extended experiences for teachers as well as learners. Content providers, institutions, teachers and trainers find new means of getting their contents out to new and larger audiences. Learners on the other hand, have the possibility to gain access to educational resources much less dependent on place and time.

The ways in which this happens, are varied: there are tele-courses via broadcast TV and Radio, videoconferences between multiple locations, courseware is distributed on CD-ROM or DVD instead of in printed format, courses are delivered via email or FTP, courses are distributed in such a form that a complete electronic or virtual learning environment is created, vast electronic libraries as well as research databases are being made available, virtual laboratories enable learners and researchers to expand their experiments. It should be noted that most often, a complete course or



content package consists of parts of each model, combining traditional modes such as face-to-face teaching, lectures, personal tutoring and print based materials, with technology supported modes that bring into the media mix elements that can be provided best in an innovative way.

To illustrate the vast choice of options that the content provider has, we would like to provide some examples that indicate how the mode can influence the choice of a particular technology: this list is not exhaustive and does not necessarily relate to the choice of satellite technology only. Our intention is to indicate how intricate the interplay is between all the different elements.

Telepresence classroom

The education mode that closest resembles the traditional classroom, as we know it, is the telepresence classroom in which the teacher teaches remotely to his/her learners by means of camera, microphone and supporting materials. The teacher can see, hear, and interact in real time with his/her students. Students can be miles away, even dispersed over a (limited) number of sites. Videoconferencing and to a lesser extend audio conferencing, is one of the most appealing applications of Information and Communications Technology in the domain of education and training, but not necessarily the most successfully implemented. Videoconferencing gives the impression that a quick and easy transition can be made from classroom teaching and training models towards ICT based education: setting up a camera and a microphone in the back of the classroom, adding the hardware to transmit the images and sound of the teacher plus the equipment to receive these images and sound at the remote sites, already seem to fulfil a number of requirements to reach remote learners. However, it is often forgotten that videoconferencing significantly adds to the traditional classroom requirements (seats, opening hours, accommodations, etc.) a number of technical requirements (AV equipment, telecommunications provisions, technical support, etc.). It requires from administrators, teachers and learners a certain level of adaptation: classroom organisation; style of teaching, lecturing and tutoring; format and style of

supporting lesson materials; interaction with the learners; all need to change to a certain extent to make videoconferencing a successful application.

ISDN is most probably the best network choice for the time being because it allows for a standardised global interconnection, it is rather widely available in the developed world, and it has a Quality of Service level that assures that performance is correctly predictable. Satellite technology and especially VSAT can support videoconferencing effectively especially in those areas and locations that do not have a reliable terrestrial telephone network. The newer type of VSAT systems not only allow for videoconferencing between the different VSAT stations of similar type, but also allow for seamless integration into an ISDN environment, thus allowing connectivity amongst systems in almost all parts of the world.

Depending on the quality requirements, one can choose for different levels of compression. Satellite latency contributes to the difficulties of using videoconferencing: not only is there a delay caused by the treatment of the originating audio and video signal (compression and encoding) plus the subsequent processing of the same signal at the receive side for display, but in addition to this delay comes the satellite latency due to its remoteness from Earth, another 0.25 seconds. In total, delays can add up quickly to several seconds when the encoding and compression take a long time. It is our experience that with a minimal amount of awareness training, most users will accept a total delay of maximum 1.2 sec. From 0.5 seconds delay a "walkie-talkie" effect starts to emerge. More than 1.2 sec makes normal interaction almost impossible.

In many cases it may not even be necessary to carry out interactive sessions live: it may be just as easy to distribute the audiovisual content in another way (via broadcast TV or radio) and, when time is not a critical factor, even on tapes, on CD, on DVD. It may be possible to set up an interactive system between learners and teachers and tutors separately from the content distribution mechanism: learners can view and consult the



content and ask their question, post their assessments via telephone, email, fax...

When the requirements of the AV media quality and the time constraints are not very high, the Internet may be chosen as the way to deliver the content. For videoconferencing, the public Internet is simply not mature until additional protocols such as RSVP and Mbone are implemented and the overall bandwidth availability has increased. Although videoconferencing applications are being used on the Internet nowadays, we clearly see an uptake of home and recreational use rather than mission critical business or education applications.

When putting in place a private or corporate network solution on which sufficient bandwidth is available to every client (be it over satellite or other links) it is worth considering the use of IP based videoconferencing protocols. This protocol adopts the transfer technology that is also used on the public Internet but when applied in a private controlled network, with much less restrictions and better controllability.

Virtual learning environments

With the advent of the Internet as the network of networks from the mid 90s onwards and its acceptance as the standard world-wide for communications between universities, research institutions, administrations, commercial organisations and individual end users, education providers started to recognise the possibilities of this new medium not only to reach new audiences but also to enhance existing education. This led to the creation of a new model of ICT based education and training: the electronic or virtual learning environment, integrated digital environments where the teaching and learning activity is organised and in large parts takes place. In other words, these applications are used for delivery of learning content and facilitation of the learning process. They can be used to electronically connect learners and the training departments whether at the same location or dispersed over a wider area. Many electronic learning platforms have grown out of communication and collaboration tools with an important additional set of features and

functionalities that make them more suitable for training purposes. Almost all platforms currently available are based on client/server architecture. In many cases, the client, located on the user side, is simply a web browser that is used to access HTML pages on the server. Although it is still possible to create and adopt learning environments that are completely stand alone (Computer Based Training and CD-Rom educational software) the vast majority of learning environments take advantage of enabling connections to teachers, tutors, peer learners, administrations, additional resources such as electronic libraries, simulations, the public Internet etc.

To understand what learning environments in general can do it is useful to consider the functionalities assigned to them.

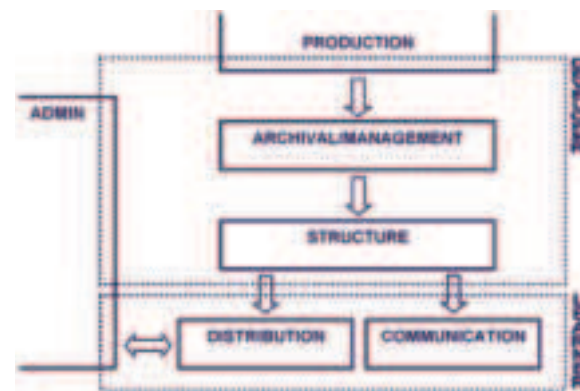


Image: EuroPACE

Layered model of the electronic learning platform

Each of the functions described in the diagram above fulfil a more or less complicated task that has an effect on the other aspects of the environment: production of the learning materials for instance can include the making of elaborate multimedia materials, the building of assessment tools for the learner, the provision of communication mechanisms, libraries etc.

There are many different learning environments commercially available on the market ranging from simple applications that concentrate on just one functionality, to complicated Swiss Army knife type of environments that can perform every possible function the user can think of.

A key aspect of the networked learning environment is its use of some way of connecting the different parties involved: creators, teachers, tutors, learners, and administrators. As a consequence, the success of the environment is highly dependent on the selection of the appropriate communications network. Most are making use again of the IP protocol for packaging and transport and allow the user to access the environment using a standard browser. All IP supported applications can therefore be made part of the environment: conferencing, email, chat, simulation, interactivity, multimedia, etc. The inclusion of some or more of these applications may have quite drastic implications on the requirements for distribution to the end user, especially when the end user is remote.

There are two possible ways of approaching this problem. The minimal way is to restrict the functions that one implements in the environment to the accepted minimal level of network capacity for the least served end user. However, especially in badly served regions, this may result in the elimination of a number of important desirable applications. The maximal way is to build the platform completely according to the pedagogical and technical requirements of the content provider and to impose the inherent network requirements to the end users. By providing a specific networking solution to support the environment, the content provider has the advantage of complete control over the total environment. This can be best achieved by the implementation of a VSAT type corporate or institution network that spans regions and countries and allows for centralised management and control. The new type of cheap VSAT solutions that are based on DVB allows not only for a certain degree of bandwidth control between hub server and client server but adds to that the multicasting functionality that allows for just-in-time distribution of all kinds of materials including streaming media, software updates, applications etc.

Content

Content can take many shapes as already indicated in the previous part: educational content comes in the form of direct communication (lecturing, tutoring, conversation, discussion) between many actors involved (authors, teachers, tutors, learners, researchers, peers) and supported in many different ways (multimedia, laboratories, exercises, assessments).

In this section we would like to demonstrate how content choice and treatment can influence the selection of telecommunications support.

Linear multimedia content

The production quality of the teaching and learning support materials is a decisive factor contributing to the overall cost of an ICT based education system. Some types of content require high quality production standards (for example, medical subjects mostly require high resolution and colour images, be it video, graphics or print materials), resulting in a relatively high production cost at the side where the materials originate from, and requiring equally high quality transmission systems. We do not intend to go into detail about the requirements for a certain level of production standard, but we would like to point out that the use of TV and TV like distribution as the medium means that viewers have a certain level of expectation regarding the overall quality: the reference frame of educational TV programmes and videos is not very different from what the viewer is used to seeing on the TV screen and therefore he/she will not so easily tolerate poor quality material.

To give an impression of what bandwidth means in the case of TV and video: a VHS tape of 240 minutes colour video with an English and a French language channel represents an uncompressed storage of 23.4 GB on a cassette costing less than 4 US\$, weighing less than 300 g, fitting into almost any pocket, playing on an estimated 980



Million VHS players installed worldwide⁹. MPEG-2 digital compression will allow you to store the same video in higher quality on 2 DVD disks, occupying about half the storage space expressed in Bytes. Materials cost about the same. DVD players however are only now becoming a standard multimedia device. Shipping to a large number of users will increase the total cost quickly to unacceptable levels: depending on the urgency and the distance of shipment, the cost per item will be from 1 to a few hundred US\$.

Broadcasting video content via a terrestrial or satellite TV channel will enable large quantities of users to receive the materials in high quality instantly and with very little cost per item, with satellite having the advantage of reaching audiences way beyond national borders¹⁰. These distribution technologies however require access to the originating broadcast site: the satellite uplink or the terrestrial transmission centres. The cost is relatively high but when spread over a vast number of potential receivers this cost becomes almost irrelevant. On average this type of play out costs is in the order of about 2000 US\$ per hour for analogue TV or less than half of that price for digital TV. Adding additional viewers to the receive target group does not affect the cost of the distribution as opposed to distribution by mail. The main distribution cost is entirely imposed on the content provider (who in turn of course can opt for schedules such as Pay TV or subscription fees to recover his/her costs). The cost to the end user is limited to investment in receive equipment and recording and display equipment (depending on the location the receiving antenna may cost from a few hundred to a few thousand US dollars, the receiver is again a few hundred US dollars).

The example above illustrates the costing principle for traditional video distribution, which should not be underestimated in terms of outreach, acceptability and impact.

IP over Everything, Everything over IP

In the mid nineties, the ability of the Internet Protocol (IP) to run across virtually any network transmission media and communicate between virtually any system platforms, led to IP's phenomenal success and to its ubiquitous presence on all communication means. The enormous growth of the Internet led to the convergence of the worlds of telecommunications (telephone), broadcast (TV) and multimedia (PC). The ability now exists to author and publish ones own content almost completely digitally (on the desktop) and to compress and package the content in such a way that it can be transported over the Internet. Such a system has a strong appeal to all types of content providers, commercial as well as institutional or educational.

A wide variety of new applications now make use of IP as the packaging protocol, to allow transport over any network, and many applications seem set to become available including telephony or voice over IP. However, this entire overload has made the Internet a victim of its own success.

Increasing the bandwidth - the data carrying capacity of the network - is not sufficient to accommodate the increasing demand. Internet traffic has not only grown dramatically, but it has also changed in character. New applications have new service requirements, and as a result, the Internet needs to change as well.

It all comes down to bandwidth. In an ideal world, all users, content providers as well as end users, would have unlimited bandwidth at their disposal, wherever they are. Unfortunately, that is not the case and it does not look like it will happen soon. The available capacity now is insufficient (hence the disappointing performance of many broadband delivery systems). Telecommunication and connectivity providers are struggling to keep up with the pace of the demand while being

⁹ The worldwide TV household penetration of VCRs is more than 50 percent. Remarks by Charles Van Horn, President of the International Recording Media Association (IRMA), at REPLiTech North America, 20 February, 2001, Los Angeles.
¹⁰ ITU estimates for 2001 indicate that there is a total of 54,574,913 households in Africa equipped with a Television receiver.



forced by the end user to decrease the price continuously. To give an idea, it is estimated that in Europe the bandwidth demand increases by almost 10% every month, while the price to the end user for Cable, ADSL or Leased Line Internet access has dropped more than 50% over the last 3 years.

Region	Mbps (2000)	Mbps (2001)	% (Growth)
Africa	649	1,231	90%
Asia	22,965	52,659	129%
Europe	232,316	487,400	110%
Latin America	2,785	16,132	479%
North America	112,222	274,158	144%

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Continental Interconnectivity Bandwidth Growth

This increase of demand is fuelled not only by the continuously increasing number of users but also by the bandwidth demand that applications are putting on all networks. This is true in all sectors of telecommunications: from mobile telephone to satellite communications. More and more users want to be able to do more while paying the same or preferably even less. Many of the new Internet applications are multimedia and require significant bandwidth. Others have strict timing requirements, or function on a one-to-many or many-to-many (multicast) basis. These require network services beyond the simple "best-effort" service that IP delivers. In effect, they require that the now "dumb" IP networks gain some "intelligence" or that the user chooses for an alternative networking solution.

It is most important to select the right type of communications mode that supports the application under consideration most efficiently AND cost effectively. Some simple examples:

There is no point in trying to do videoconferencing over cellular phone networks because of the low bandwidth (9.6 Kbps) and even given future versions of mobile wireless telephony it may not be the appropriate medium.

ISDN is much better suited for videoconferencing because it is a standard that is accepted and that allows for reliable connections with sufficient

transmission quality to allow for low quality images and sound to be transferred live.

For high quality images however, ISDN videoconferencing falls short. When the images need to be sent and received live (synchronously) a distribution medium with high guaranteed bandwidth may be required. This could be satellite when multiple sites in geographically dispersed regions are targeted, or this could be a point to point connection (via microwave link, terrestrial landline, or satellite) when only one receiver is targeted.

When on the other hand the images do not have to be displayed live, it is again possible to use a lower capacity and asynchronous network for the transfer.

Network Costs

Not only the amount of bandwidth (more bandwidth costs more) but also the chosen frequency band will have an effect on the overall cost: when the system requires the use of C-band satellite communications, it is understood that the cost for installation of earth terminals will be higher. The choice of satellite position (and its inherent coverage and power) will also influence the cost of the earth station (for example, size of antenna). Therefore it is necessary to carefully calculate the consequence of selecting the right satellite: paying higher costs for the lease of a more powerful or better located satellite, may pay back in savings made on the ground when installing smaller and cheaper earth stations.





Operational Costs

Choosing a pedagogical model, the technology to support it and a communications medium always brings a number of related costs that should not be underestimated. Computers in the classroom require for example, maintenance, upgrades, security provisions, initial training, additional peripherals etc. and are more expensive than TV receivers to install and operate. TV receivers have a much longer depreciation time than computers. A videoconferencing room is more than just the videoconferencing terminal: the room itself always requires adaptations that have an important cost consequence as well. It is not unusual to estimate the cost of a technology supported classroom installation and adaptation to be equal to the hardware technology costs.

Contribution

By contribution we mean the way by which the original content is brought to the place within reach of the end user: the transmission point. Course providers and content creators need a priority access to the repository where the materials are kept and from where they are distributed. In the case where the content is distributed via IP based transport, the producers need to have sufficient bandwidth to upload to the servers. In the case of a videoconferencing type application, the originating site may need adaptations in order to enhance the effectiveness of the teaching and tutoring. It is therefore necessary to take into account the specific requirements of the course contributors because they may affect the choice and architecture of the network.

Time

There are many time issues related to technology-supported applications for education. The application may require synchronous (instant) feedback (by telephone), or asynchronous feedback (by email), or no feedback at all. This influences the choice of network application. The use of a satellite service that relies on a geostationary satellite implies a certain latency in the communications path, caused by the distance between earth stations and the satellite. This delay

can be crucial in some applications (such as remote process control), cumbersome (in telephone conversations or videoconferencing) or unimportant (for example, in web browsing or in emailing).

More bandwidth over the Internet is becoming available at a rapidly growing rate. The Internet is still not always the medium of choice. As long as there are no procedures in place that allow for the occupation of a particular segment of the bandwidth for certain purposes, the medium is not the most suitable for the transfer of synchronous content in the shape of audio conferences, videoconferences or live broadcast programmes of sufficient quality. The protocols to allow for these applications are under development but it will take more time before sufficient bandwidth plus the required bandwidth allocation mechanisms are in place.

For mission critical content, that is content that needs to be supplied at a given moment with a guaranteed level of quality and success, the Internet is just not the best choice. The alternative is some kind of private network. Such a network can be provided via terrestrial telecommunication means such as leased line, ISDN, ADSL or other flavours of broadband distribution. Unfortunately, the roll out of terrestrial networks is highly dependent on costly infrastructure works that build incrementally on existing structures. The rather slow roll out of ADSL even in technologically advanced countries such as Finland and the UK is a clear demonstration of this problem. Satellite communications and especially the different versions of VSAT and broadband via satellite may overcome the long wait and may deliver the user an almost instantly available solution to connect according to his/her requirements.

Satellite network time requirements vary widely. Fortunately the technology adapts well to a range of different requirements: connections that are always-on; on at set time intervals; irregular and unpredictable; night time connections; and more. While connection time may be much cheaper at night, it may not suit the application. However, for data distribution that is not time-sensitive it may be a cost effective option.



Location

So far we have been demonstrating that satellite communication is ideal to overcome distances. ICT based education gives the user the impression that time and place are becoming irrelevant. However, careful consideration of the geographical requirements of a network application can avoid high costs or inefficiency. An example: the German Mediadesign Akademie (www.mediadesignakademie.de) in collaboration with a German employment office, uses satellite broadcast to deliver ongoing training courses to over 500 small offices and home offices all over Germany. The teacher/trainer lectures on camera for the largest part of the broadcast, and interacts during the lecture with his/her learners via email and chat. Because the images of the lecture have to be of sufficient quality, because some of the support materials have to be prepared carefully (slides, graphics etc.) and because the interaction returning from the remote students requires a certain amount of infrastructure and support, a minimal level of resources are required. These cannot be found in every location of the teaching staff, so a central "studio/classroom" based in Munich is being used, requiring the teachers to travel from all corners of the country to that location to deliver their teaching contribution.

The design of a distance education network can indeed involve the use of a central location from where the teaching contents are distributed. It may be that for reasons of investment only one classroom is sufficiently well equipped with all the tools and equipment to support the teacher/tutor in his/her work. This can be because the architecture of the network is such that the output of the central location is better than the output of the individual remote sites (for example, because of the use of an asymmetric network such as broadcast TV or radio). In that case, the operational cost of bringing teachers to the central location can be considerable and should be evaluated against the investment cost of installing additional remote contribution sites, or using completely symmetric networks where all sites are equal.

Similarly, when providing web based learning materials, it may be important to select the physical location of the content server in such a way that all end users are served with sufficient quality. It may be worthwhile considering the porting of the content to a new server location that is better suited to service the whole user community. This may be a location that is closer to the backbone of the Internet. Economic factors here are rather the availability of the server to all users on the network rather than to the content provider itself. For example, if the content provider has only limited bandwidth to the Internet, it may be better to use this bandwidth to transfer the content even over longer periods, towards a central server that has sufficient access bandwidth in order to serve many clients at the same time. Furthermore, it may be necessary to investigate the need for a Content Delivery Network, that pushes the content to distributed servers that are within an easier reach to the end user.

Whenever a networked application such as distance education or telemedicine is planned, a geographical plan should be part of the total project, because of the close relationship between costs of investment, network architecture, communications and operation.

Quality

Satellite communication can be tailored exactly to the needs of the users. Bandwidth and coverage are the most important factors of interest. Different levels of service can provide scalable levels of Quality of Service: fixed and privately allocated amounts of bandwidth or flexible bandwidth allocation whether always-on or available upon request. In addition, because there are no intermediate parties in the communications chain, monitoring, control and management can be done effectively and easily. Compare however the costs for VSAT networks with the cost estimate for a two way satellite Internet connection solution, and it becomes clear very quickly how quality of service (such as guaranteed bandwidth) affects the overall cost.





Quantity

For traditional communication technologies such as TV and radio broadcast, numbers are extremely important: the larger the audience, the more cost effective the broadcast can be considered. This argument is true in public broadcasting where the government pays the cost for all to receive free. It is also the case for commercial broadcasting: viewers pay for a subscription or to receive certain programmes, or advertisement pays for the broadcast so that audience can watch free of charge.

Quantity has a different significance for educators. It means economies of scale when they can produce once and reuse many times (for example, with good quality multimedia materials) or when they can distribute content (and teach) to many at the same time (for example, via broadcast TV or via the Internet). Communications technologies make it easier to reach more users. Technologies in themselves however do not always improve the quality of communication.

A simple example to illustrate this: videoconferencing interaction works very well between two sites when there are limited numbers of participants at each side. When the number of participants at each site increases, it becomes impossible to interact effectively with each of them, very much like in a 500-seater University lecture hall where little or no interaction happens between the lecturer and the student at the back row. When more than two sites need to be connected via videoconferencing, costs increase while interactive effectiveness decreases.

In a similar way one should not underestimate the cost of support and tutoring required with Web based learning environments. These can be set up relatively easily and then made accessible to many. Support, tutoring, assessment and follow up however increase with the numbers of users. While the basic principle is sound (improving access to learning materials and education) the practical elaboration may require scalability consideration.

Availability

When the satellite system is properly designed at all sides (uplink dimension and redundancy; downlink specification; transponder availability), satellite is able to guarantee an almost unparalleled availability. An important factor is the balance between required availability (expressed in % per year) and installation margins. Availability of 99.5% and more is easily achieved. The weakest link in the chain here is the end user earth station that may suffer from adverse meteorological conditions (storms), accidents, lack of maintenance or interference. The availability of satellite communication parallels easily the availability of terrestrial Internet connectivity.

Energy

Power and access to telecommunications are considered readily available commodities in regions like Europe and North America. This is not so in large parts of Africa and other continents. While satellite can bring access to telecommunications surpassing territorial and geographical barriers, energy will still be needed on the ground to receive, process and apply the contents.

Battery powered and even hand-cranked radios are still a valuable and very popular means for distributing contents of all kinds, including educational content.

Satellite and terrestrial TV are equally accepted and important, but they require power for receiver and TV monitor. Satellite broadband and Internet are no different: their power consumption has become low but is still important enough to cause problems at some locations (for small VSAT type installations including multimedia PC an average 500W is needed). Combinations of solar energy and battery power need to be provided in some cases.

Security

Because satellite communications avoid borders and physical infrastructures such as nodes and exchanges, it is a highly secure system. The only



part of the transmission chain that is exposed and is in some way vulnerable is the outdoor antenna. The rest of the communication provision is not dependent on any intermediating elements that can delay, curtail or hinder the communications. The management and control system that is inherent to satellite communications, also allows the network provider to contain or restrict the communications, to set up a completely “walled garden” or private network infrastructure that keeps the user community safe and secure. All levels of security and privacy can be managed easily and centrally, allowing for content filtering, conditional access, even pay-per-use and accounting.

Hardware Installation and Maintenance

The use of advanced technologies has a certain element of risk in it because of the lack of experienced support people in the field. In many cases where satellite communications are used for the first time, more initial support is required. Networks based on terrestrial communications on the other hand are build more incrementally and allow both service provider and end user support services to become fully acquainted with all service and support issues.

The selection of a particular communications service (broadcast TV vs. VSAT vs. Internet via satellite for example) brings a different support requirement.

Support for the course and content provider in the case of Broadcast TV is almost always extensively organised as an inherent part of the professional TV broadcast and satellite transmission services. The support service at the end user side is also commonly dealt with in the commercial sector by professional satellite installers and resellers. Worldwide-distributed brands of consumer equipment using common standards make interchangeability and support easy even for the end user themselves. Because there are no security issues around the use of receive only satellite installations, installers and technicians do not require high levels of training, and consequently there is no shortage of this expertise. Service to the end user is cheap.

VSAT at the other end of the scale requires a lot more specialised support that is network specific. Service engineers and installers are not as widely available as for satellite TV and in some cases they will not even be based in your country but cover a wider region. Although the technology is very reliable and tested, support and maintenance will be needed and may be more expensive than in the previous example.

Internet via Satellite again, is relatively new to either group of support staff. It will probably require the set up of a new and quite extensive support structure (including remote assistance, help desk etc.). Because this system is aimed at end users, support structures close to the end users (local and regional sales and support services) are required. Customers have learnt to expect and appreciate a certain level of support from ICT providers, and they will not compromise for a new service such as Internet via satellite.

Both last examples require more than ordinary installation skills, because transmission implies security and safety risks on the ground as well as for the transmission path itself. Finding trained staff is more difficult than for the first example.

Depending on the scale and the typical requirements of each application, it may be that the course provider sets up his/her own support network, possibly linked to remote departments, facilities or affiliates. This may represent a considerable cost factor.

Support

An efficient service relies on quality support mechanisms. End users need to be able to call for help with different aspects of the educational service. The first level of help is directly related to the content or the methodology of the provision and is ideally organised by the course provider and involves the person responsible for that particular course. This is the default support level for the end user. Calls at this level can be dispatched to the appropriate destination: to the course content specialists, to the tutor or teacher, to the administration or elsewhere. In the case of technology support calls, the call needs to be





transferred to the appropriate technical help service: this can be either a local or network specific support service, or the technical support service that is related to the satellite service provider. For example, let us take the case of a student participating in a web based course delivered via 2-way satellite Internet where the terminal is located at a remote campus of a University. If the student encounters a problem with his/her connection to the web site with course materials, he/she first calls the course providers' support service. This service checks if the problems are related to the content, if not the service will pass on the call to a technical support service that is located as close as possible to the end user and that will diagnose first of all the technical problem. If the problem is related to the satellite network, the local support service will pass on the call to the satellite service provider.

Training

Depending on the selection of the technology and the pedagogical model, the parties involved may require a certain amount of training. It should be clear that very little training is required for the specific satellite part of the chain.

Regardless of the transmission path (terrestrial or satellite), most applications of technology-supported education require some training or at least some raising of awareness. Teaching and learning by means of a web based learning environment, requires some basic skills that are not related to the telecommunications technology but rather to the methodology. It is much the same for producing quality video for distribution on tape or via terrestrial and satellite transmission. Videoconferencing requires some training in order to be effective, and in which there may be some specific reference to the network technology used: every network technology under consideration here will affect the performance in some way, whether it is ISDN, Internet or satellite.

Using satellite communication technology may necessitate specific training for those working at the side of the originating earth station or the hub server where it may be necessary to make the satellite service provider's staff aware of specific

educational issues. At the end user side there may be a requirement for training in specific hardware related topics such as the set up of the earth station (antenna pointing or software updates). Training can be provided to either the end user him/herself (for example pointing of a satellite receive dish), or to local or regional support people when the technology requires a higher level of competency or specialised tools that cannot be made available to all end users.

Sustainability

When considering the total cost of a technology application, all too often only the initial investment cost is taken into account. However, when setting up an ongoing service solution, operational costs including support, network communications costs, replacement, scalability, and upgrade costs are all important factors. Satellite communications services are perceived as being expensive. Satellite communications however in general score very well with regard to operational costs: VSAT networks for example have a lifetime of more than 5 years before the network requires extensive upgrades or changes. This is because the network is independent of intermediate nodes and switches and technologies can easily be implemented network wide.

For IP services over satellite, where the competition comes from terrestrial broadband networks such as fibre, a shorter lifetime expectancy is reasonable: with the evolution of fibre technology and the increasing installation of new backbone links to as well as within large areas (for example the construction of the Africa One loop), satellite connectivity for backbone connectivity to the ISP, will become less interesting within a few years. ISPs therefore take only medium to short term leases (up to 2 years) for this type of satellite service.

Internet connectivity for the end user (using small one way or two way VSATs) may also have a medium term life expectancy (3 to 5 years) at least in the areas where, because of the economic and demographic situation, deployment of terrestrial solutions is viable. In remote areas where access technologies will not become available within the



short to medium term, satellite Internet may be a solution for at least 10 years. The problem with this type of technology however is that many operators and service suppliers are relatively unfamiliar with supplying services to the end user, and the sustainability of this has to be proven. The good news for the end user is that costs keep coming down, both for hardware and for communications costs.

Revenue

We rarely think in terms of revenue when referring to education solutions. It is probably more appropriate to speak about potential cost savings. This can be achieved by combining the usage of technology solutions.

On the one hand, it is good practice to use the same network and technologies that are already in use (by the course provider itself or by a related institution or course provider). By joining a group or institution that is already using some service, a large part of the initial set-up costs (including piloting and trial costs) can be saved by sharing experiences and enlarging the existing network. Some of the services described in chapter 5 are certainly open to this type of proposition.

On the other hand it is increasingly common for educational providers to make their technology solution available to others: for example by opening Internet access facilities to other community or even commercial services. A school or a remote campus can for example share the infrastructure with a medical service, or make the access available to businesses and individuals outside campus hours. Although this approach requires careful planning and maybe some additional investment (security, accountancy), it may be worthwhile.

4.9.2.2 Pricing Trends.

Costs in the ICT world have come down dramatically over the last 10 years. Personal computers are costing less than 15 years ago and can come down much further. Competition in the telecommunications sector has brought the price

of a telephone call down. The cost of Internet access has gone down significantly in the decade that it has become widely available to the public.

While this trend towards lower costs will probably continue, end users are recognising more and more that there is no such thing as a "free lunch". The decline of DotComs has clearly demonstrated that electronic services need to adopt sustainable business models. Although free Internet access was very appealing to users, many providers have gone out of business. For professional or mission critical applications a price has to be paid for a certain level of quality and service.

The same applies to satellite communications. While objectively speaking the costs have come down, a threshold seems to have been reached. Prices in the satellite communications industry have reached a level that can be compared to terrestrial services such as ADSL or leased lines. Service suppliers in any of these technologies will watch each other's price settings in order to stay competitive. When new technologies or players enter the market, they will again set their prices according to the service levels and quality guarantees they are able to deliver.

4.9.3 Regulatory issues

Satellite communications make use of a part of the radio spectrum, which is a valuable resource, shared by many different types of applications and users. In order to avoid conflicts, abuse and interference between users, but also to watch over public safety and health issues, some form of regulation is required. This regulation is handled by national or regional institutions that apply international recommendations, agreed in organisations such as the International Telecommunications Union. Some freedom does exist however within ITU recommendations for each regulatory body to adopt the procedures according to local requirements. For the sake of simplicity we will in this section address VSATs in the generic meaning of the word: "Very Small Aperture Terminal", any fixed satellite terminal that is used to provide interactive or receive-only communications.





Licensing problems

While satellite communications offer immediate cost-effective solutions, some countries' policies, rather than facilitating satellite communications, hinder or prevent their deployment. In many African countries where such solutions are most needed, regulation procedures are outdated, expensive or cumbersome.

In some countries, the national public telephone operator is the only entity that may install and service, or even own, operate and maintain VSATs. In other countries a local commercial presence is required by administrations as a precondition for licensing.

Licensing fees also remain too high in many countries. Furthermore, some regulatory bodies apply additional taxes, annual operator fees, high customs tariffs restricting importation of VSAT equipment, tariffs be paid to the PTT - even if the PTT does not participate in the service chain. The accumulation of too many fees tends to be prohibitive for many VSAT applications.

Furthermore, many countries still apply unnecessary burdensome license application processes resulting in unnecessary delays issuing regulatory licenses. Sometimes, existing earth station regulations are geared to the broadcast industry and do not contemplate current uses such as data, Internet, and private voice networks. Some countries enforce zoning restrictions that prevent the installation of rooftop VSATs.

Some administrations require type approvals for antennas, even though the antenna type is already being used for the particular satellite system being requested.

While there are more than 500,000 VSATs operating in most of the world's countries, many of them are precluded from international applications. This is an unfortunate waste of resources, because VSATs are ideally suited not only to provide domestic connectivity, but also to offer trans-border communications for wide-area networks. On the national level, VSAT rules are often neither transparent nor accessible to the

general public. Further, these rules are often difficult to interpret. On the regional level, service providers are required to seek out a multiplicity of application forms - as well as contact details for the officials responsible for processing them - among the jurisdictions where they provide services.

In general, it has become apparent that the more regulations, fees, and other requirements that are imposed on providers of VSAT systems and services, the fewer communications options will be provided in the individual country.

Licensing perspectives

Individual nations are increasingly interested in formulating policies within the context of policies being considered or used by other nations located within or proximate to their own region. Many African nations, for example, have no policy to accommodate VSAT system and service provision. So they are evaluating regional policy solutions that could be used to advance the entire region, as well as each individual nation. These may be adopted by the African Telecommunications Union (ATU www.atu-uat.org), Southern Africa Transport and Communications Commission (SATCC) of the Southern African Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA), Economic Cooperation Organisation of West African States (ECO-WAS) or other African organisations.

The Global VSAT Forum, which acts as a representative body for the VSAT industries, has developed regulatory recommendations and guidelines as a tool for regulators and policy makers, who are interested in modifying regulation to facilitate the use of VSAT-based services. Regulators around the world are already taking these factors into account and are implementing new policies that facilitate the use of VSAT systems and services. In order to advance furthermore the uptake of satellite communications, the GVF encourages the elimination of licensing and monopolies to wipe out sub-standard services offered at above-market prices.



4.9.4 Conclusion

It should be clear from this chapter that a network solution for education, be it via a satellite communications network or via any other distribution means, has many different cost elements. Very often, decision-makers find themselves blinded by the cost of distribution. It is essential, however, that the contribution of these costs should not be overestimated. The first and foremost cost is always the cost of creation, collection and adaptation of the content and the cost of tuition and support. It is commonly observed that the cost of production of the

content is at least 5 times the cost of distributing the content. The latter cost is only marginally affected by the medium itself.

The value of the distribution medium should be evaluated correctly by looking at the direct costs (and every education provider will agree that these are costs that are to be avoided as much as possible) as well as looking at the opportunities the technology brings to the education system. The possibility to widen the audience, to reuse materials, to better use staff resources and to improve the teaching and learning experience are factors that cannot easily be expressed in financial terms.



Access and connection technologies

5.0

This chapter focuses on the information and communication technologies (satellite based and others) that allow for end users to communicate and exchange information. We intend to discuss only those technologies that connect end users to the public access networks (the so-called 'Last Mile' or the connection technology that connects to the home) and amongst themselves (local area networks - LANs and wireless local area networks - WLANs). The technologies that make up the public networks themselves (the backbone infrastructure) and the ISP to ISP infrastructure is not covered.

We will not discuss receive only network technologies such as radio and TV broadcasting. This is not because they are not of particular value within the range of information and communication technologies for education and training, on the contrary, as discussed in the previous chapter, they are still invaluable especially in those countries that do not have a sufficiently extensive public access network. We do believe however that applications based on information and communication and especially on Internet, can already play a vital role in the development of the global society. Hence our emphasis upon these technologies in this chapter.

It is most important to make a distinction between access technologies that allow for communication with the public network and the technologies that are used to communicate within a closed (private) group or environment. To make a simple comparison: the public network is like the public traffic and transportation system: this consists of

public roads (from minor dirt tracks to multiple lane motorways), plus public transport (buses, trains) and boats and planes. To travel in the wider world one selects the appropriate means of transportation: travelling to your neighbour is possibly done by walking, travelling to another country possibly by plane. In a similar way it is possible to connect to the public network by various means, depending on each end users' typical situation, his/her requirements and the possibilities offered by services to and from his/her location.

In our roads analogy, the private network is limited to the local premises. Depending on the size and complexity of the estate, there is a choice of different technologies to connect the different parties within the estate and to connect if necessary to a gateway to the outside world (the public network). Compare this gateway to your own driveway between the garage and the public road: without an appropriate driveway it would not be possible to get from the private to the public space.

Access to Public Networks

5.1

5.1.1 PSTN, the Public Switched Telephone Network

This is the most common access technology also known as dial-up access: it requires a telephone connection, a modem, some kind of terminal or appliance that allows for interaction or communication with the hosting network (for example, a computer) and an account or agreement with the network owner or access provider that allows for dial-up access (for example, in the case of Internet access: the Internet Service Provider or ISP). The user establishes a connection by calling via its modem and the modem located at the network to access the services offered by the network. The public Internet is the most common example of such an

application, but there are other applications such as billboards, or Compuserve and AOL initially.

This technology is the most commonly available. It should be noted however that although analogue telephone networks of this type are well deployed in most parts of the world, there is a wide tele-density gap (numbers of lines per inhabitant) between different regions: while the world's average tele-density stands at 15.0 fixed lines per 100 inhabitants, Africa is lagging behind with an average for the whole continent of 2.61 fixed lines per 100 inhabitants¹¹. And even within Africa there is significant disparity between rural and urban areas. 71% of the population lives in rural areas. Yet, more than 83% of fixed telephone lines in these countries are in urban areas.



World Average	14.80 (105)
South Africa	11.69 (114)
Rwanda	7.68 (131)
Egypt	5.32 (150)
The Gambia	2.13 (176)
Ghana	1.17 (185)
Kenya	0.98 (189)
Mozambique	0.51 (200)
Tanzania	0.35 (210)
Ethiopia	0.35 (211)

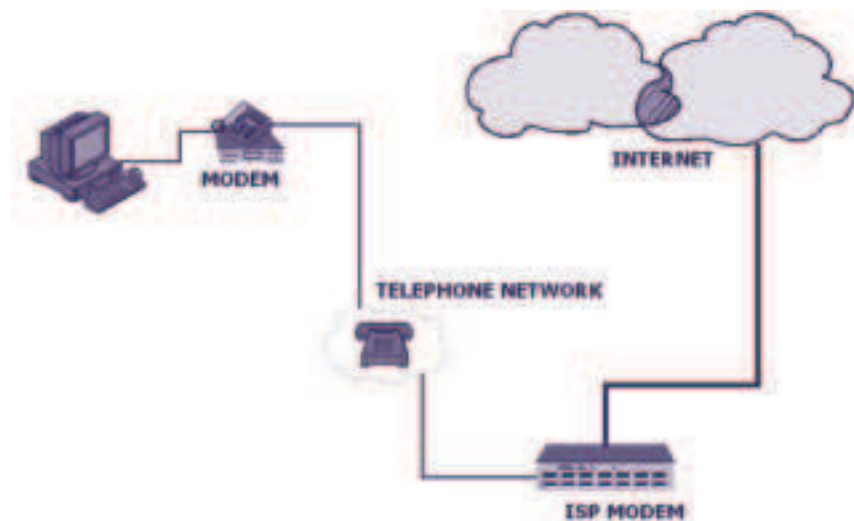
Number of fixed lines per 100 inhabitants. (Between brackets global ranking 225 countries).

The quality of analogue telephone connections is somewhat limited: because they were conceived in the first place to carry voice transmissions, they are not so fit for data communications as well. Consequently the speed of transmission of data over such connection is low (maximum 56 Kbps¹²). Such slow speed is less suited for media rich applications (for example audio and video distribution, flash animations, multimedia web pages). This type of connection is adequate mainly for email with limited size attachments.

Source: ODCI (08/2003) and ITU (2003)

Poor quality telephone networks also regularly result in loss of connection or degradation of speed. The cost for the user is relatively high because connections costs are almost always charged by the minute. And because the connection makes use of an existing telephone connection, voice calls over the same line are not possible during the connection.

The advantage of using the telephone network is the fact that when the connection is established between your computer and the ISP, the bandwidth is uncontended, because of the switched nature of the network, that connection channel cannot be shared amongst multiple users, you, and only you, are the sole user.



5.1.2 ISDN, Integrated Services Digital Network

Integrated Services Digital Network (ISDN) is fundamentally a development of the analogue PSTN telephone network. ISDN allows for better services but requires an upgrade of the network for example, by installing ISDN switching equipment at crucial points in the network. The end user needs to install ISDN enabled terminating equipment: that means an ISDN telephone set, a different type of fax machine, ISDN modems etc. In return the user gets more and better services: his/her telephone line

¹¹ Compare this to America 35.3 lines per 100 inhabitants, Asia 10.8, Europe 40.6, Oceania 40.0.
¹² An electronic version of the Bible and the Khoran on the web is about 2.34 MB. Downloading such a file over this type of dial-up connection would take at best 5 minutes 42 seconds.
¹³ The download of an electronic version of the Bible and the Khoran from the web (size of 2.34 MB) would take at best (connecting over both ISDN channels at a maximum of 128 Kbps): 2 minutes and 30 seconds.



capacity is doubled (2 channels over 1 single line make it possible to carry out 2 phone calls or 1 phone call and another connection at the same time and with better quality.) ISDN allows also for higher connection speeds: 64 Kbps per channel, 128 Kbps per line maximum¹³. The main advantage is the increased speed of the connection and the short connection set-up time (about 2 seconds) for the connection. This allows for a more satisfactory connection experience compared with the set-up time of an analogue PSTN connection that can sometimes last about a minute. The stability of the connection quality and the fact that multiple ISDN lines can be combined (bundled) to result in even higher capacity, allows for applications such as videoconferencing. Still, the connection is not an always-on connection: connection costs are normally charged by the minute¹⁴. And although ISDN is regularly being called broadband, in our opinion its speed and connection comfort cannot be compared with a real always-on broadband connection.

The major disadvantage of ISDN is its availability: although it has been taken up well especially in Western European countries, ISDN has generally not been available on the African continent. Recently a number of countries have started to offer ISDN services in mainly urban business areas. Amongst these countries are Botswana, Cote d'Ivoire, Egypt, Kenya, Ghana, Mauritius, Morocco, the Seychelles, Sudan, Togo, Tunisia, South Africa and Uganda. About half the number of installed ISDN lines is in use in South Africa (at the end of 2002, this was estimated to be 30,000). ISDN is mainly installed for videoconferencing purposes and less for ISDN based Internet access (also due to a lack of ISDN capable ISPs).

5.1.3 Mobile and wireless telephony

Mobile telephony has over 500 million users worldwide and is available in almost 200 countries, of which more than 60% use the GSM standard¹⁵. Global System for Mobile communication or GSM is a digital mobile telephone system that operates at either the 900, 1800 or 1900 MHz frequency band. Since many

GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries. Telecom operators

South Africa	16.51 (045)
World Average	8.99 (065)
Kenya	1.71 (111)
Mozambique	1.64 (112)
Rwanda	1.04 (125)
Ghana	0.73 (137)
Egypt	0.51 (146)
The Gambia	0.37 (155)
Tanzania	0.08 (178)
Ethiopia	0.03 (190)

Source: ODCI (08/2003) and ITU (2003)

in developing countries see many advantages in a rapid expansion of the mobile telephone network.

Number of mobile phones per 100 inhabitants. (Between brackets global ranking 225 countries)

Wired telephone networks require extensive and expensive work on the infrastructure to cover large areas, especially in sparsely populated (rural) areas and in areas where the terrain is inhospitable. Wired networks are also vulnerable (the copper lines in the ground or on telephone poles have been known to attract thieves). Wireless antennas on the other hand can be relatively quickly, easily and safely installed, and they instantly cover a wide area. Depending on the specific set-up of the network (frequency, power) and the local environmental situation (relief, foliage), one mobile phone antenna can cover up to a 25 Kms diameter area. To connect isolated or remote GSM antenna sites to the telephone network, VSAT technology (see picture below) or other wireless technologies (radio links, optical relay) are being used.

¹⁴ There are exceptions to the call duration charges: in some countries (USA, Singapore and others), call connection charges are billed, duration charges are not for certain calls.

¹⁵ GSM uses a technology called time division multiple access (TDMA) and is the most widely used of the three digital wireless telephone technologies. Alongside the digital technologies, a few analogue mobile networks still exist, but these are disappearing slowly.





Inauguration of a GSM antenna site on Mount Mary hilltop Somanya (Ghana)

Mobile telephony operates very much in the same way as wired telephony in the sense that it establishes switched connections. Again the transmission speed is rather low (GSM typically not higher than 9.8 Kbps)¹⁶. Because it was conceived for voice communication it is not an ideal way to connect to the Internet or to carry multimedia services, although it can be done.

Because of the exponential uptake of mobile phones, nowadays many mobile phone operators especially in developing countries, seem to have problems coping with the growth of their customer base and the resulting increasing demand upon the network capacity.



In its present state mobile telephony is not ideally suited for Internet access. Wireless mobile telecommunication is however evolving rapidly towards new mobile telephony and mobile data technologies that allow for voice and data communications of higher quality, such as Internet access and multimedia¹⁷. These include technologies under development such as High-Speed Circuit-Switched Data (HSCSD), General Packet Radio System (GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Telecommunications Service (UMTS). While it is too early to take these into account for practical applications, it should be noted that in some African countries (South Africa, Nigeria, Ghana, Egypt, Morocco and others) pilots and trials of some shape or form are being held with one or the other technology, but mainly with GPRS. These innovative technologies, if ever implemented, will enable data transfers comparable to ISDN (around 128 Kbps) in the case of HSCSD, EDGE and GPRS, and up to ADSL-like capacity (from 384 Kbps to 2 Mbps) (see further in this chapter). The new technologies also allow for always-on connection, again as is becoming the norm for broadband Internet access.

¹⁶ The web download of electronic versions of the Bible and the Khoran would take at best 32 minutes and 30 seconds via GSM.
¹⁷ iMODE, WAP, SMS, MMS and other current innovative adaptations or additions to the existing mobile phone network give a foretaste of things to come. iMODE is a Japanese GSM technology that allows for games, downloads, limited information services etc. WAP or the Wireless Access Protocol allows the mobile phone itself to be used as a device for access to web content. Short Message Services allow for short texts to be sent between two mobile phones. Media Messaging Services is the latest addition to the GSM technology of this generation: it allows for transmitting pictures between two mobile phones.



5.1.4 Satellite telecommunications

The solutions that satellite can offer, range from telephony in places where there is no other telephone network availability using portable handsets, to high quality private data networks that can carry voice, video, data, Internet etc. (For extensive details about the various solutions that satellite telecommunications can provide, see chapter 3). Depending on the network technology and the application, satellite provides connection speeds from a few hundred bits per second¹⁸ (for example with L-Band data transmission systems) to 80 Megabits per second¹⁹ and more for example for TV broadcasts. Satellite technology offers a great deal of flexibility (it can be applied almost anywhere with minimal costs related to infrastructure and with minimal delay in deployment) but it is not very efficient in its use of the available radio spectrum. Therefore almost all satellite telecommunications are heavily regulated²⁰ and although this is not necessarily a uniquely negative fact, it is often seen as a barrier. Satellite-based services are also considered expensive. Costing a satellite application is complicated because of a large number of parameters: the cost of hardware and the communication costs vary widely depending on the solution required.

Satellite telecommunications are most effective for broadcast or multicast type applications: the larger the target audience, the cheaper the application per use, without putting an unacceptable load on the network, unlike with switched terrestrial networks. TV and radio broadcasts as well as also other types of content delivery (for example pushing software applications, files, web pages, news content etc.) from a central server to a large number of client locations, especially when these are very dispersed and difficult to access, are the most efficient uses of the technology.

The use of satellite for two-way communications (small two-way satellite systems for Internet access, VSAT systems) can provide a rapid solution for

access again in places with insufficient terrestrial network capacity such as in most rural parts of Africa. Because of its cost, this type of solution is most viable for larger end users (for example schools or even whole communities or for aggregated access solutions: shared between multiple user groups). In this way it is being applied by end user organisations (in the case of small two-way satellite Internet access solutions) as well as by telecommunication providers to provide end users as well as the public with connectivity.

All African countries have a number of satellite service providers (private as well as public, including the national telecom operator) that can offer a range of solutions depending on the local regulatory situation, from satellite telephony to Internet access, most often as subsidiaries of larger international consortia.

5.1.5 Leased lines

The traditional alternative to the public switched telephone network, is the so-called leased line, which is simply a telephone line that has been leased for private use, sometimes also called a dedicated line. Typically, leased lines are rented from the local (public or private) telephone company to connect sites with a certain quality of service: that means availability (for example the line stays connected 24 hours a day allowing for always-on connectivity), and guaranteed speed of transmission (leased lines are normally available in circuit segments of 64 Kbps and can be upgraded to 2 Mbps and more). The alternative is to buy and maintain one's own private line or, increasingly, to use the public switched lines with secure protocols such as Virtual Private Networks over Internet.

Leased lines are a commonly available technology that can be deployed virtually on every existing wired telephone line. Their cost however is prohibitive for other than critical businesses like banks, medical institutions, security services and government agencies.

¹⁸ At this speed it would take us 36 hours to download the digital Bible and Khoran file.
¹⁹ At this speed it would take less than a second to download the whole Bible and Khoran.
²⁰ Regulations especially in the radio communications services are necessary to make sure that users of the bandwidth provided can do so safely and securely and that there is no unwanted interference from un-authorized users. However, it can be argued that many regulations are only in place to keep competitive or complementary service providers out of the market and to protect the incumbent operators, by imposing overly complicated and expensive procedures. Controlled and impartial regulation can contribute to a healthy telecommunications climate that is of an advantage to the whole country and society in general.





5.1.6 Digital Subscriber Loop – DSL

Digital Subscriber Line is a technology for transmitting digital information at a high bandwidth on existing phone lines that remain available for ordinary telephone voice conversations. DSL is mainly aimed at provision of Internet access services for home and business users. Unlike the regular dial-up phone service, DSL provides continuously-available (always-on) connection. DSL comes in many flavours: ADSL, SDSL, VDSL etc. Asymmetric Digital Subscriber Line or ADSL is asymmetric in that it uses most of the channel to transmit from the service provider towards the user and only a small part to receive information from the user. SDSL, VDSL and the other DSL types provide even better quality services.

Telecom operators can adapt their existing copper wire based telephone network infrastructure but this at a considerable cost: to deploy DSL services the whole network needs to be equipped with new hardware at the local and the central exchanges. Even then, DSL only serves as a last mile solution: to connect from the local exchange to the end user. Because of the specific technology used, DSL is limited in distance and it stretches up to a few miles only (2 to 7 miles maximum), depending on the type of DSL as well as on the quality of the existing copper wire infrastructure. The transmission speed ranges typically from 256 Kbps to 4 Mbps. With ADSL, the upload speed (traffic from the end user towards the Internet) is usually slower than the download. Typically we see speeds of 256 to 512 Kbps for uploads. For downloading providers offer from 512 Kbps to 6 Mbps. The typical switched telephone network infrastructure that lies at the heart of the DSL technology allows for very high contention rates, hence the quality of the connection is seen to be very high. DSL has been the most successful broadband technology in regions with a good telephone network (in Europe for example DSL accounts for 69% of all broadband connections.)

As it requires a wired telephone infrastructure of a certain quality level, and as we have seen from the

fixed line penetration level in Africa, it should not come as a surprise that DSL is not widely deployed in Africa. Telecom operators in various countries are investigating or piloting deployment mainly in urban areas where there is a business opportunity because of the numbers of potential customers. For example, Telkom South Africa has deployed DSL in some cities on a limited scale. Its cost however is still quite high (US\$500 per month) and the bandwidth offered quite low (512/256 Kbps)²¹. Other countries with an emerging DSL service offer are Egypt, Kenya, Madagascar, Mauritius, Tunisia and Uganda.

5.1.7 2-Way Cable

Interactive cable or two way cable makes use of the existing infrastructure of the TV distribution cable. That network in itself is not interactive, it is originally only intended for distribution (broadcasting) of TV and radio programmes, and therefore to become interactive and fit to provide other services such as telephone and Internet it must be converted into a two way network. This needs to be done again at a whole network level: at the central nodes, at various points throughout the network (local exchanges, repeaters, etc.) as well as at the end user premises by adding cable modems. These modems allow for the connection of telephone sets and fax machines, but also for the connection of one or more PCs to the Internet, and to bring interactive services to the TV (games, TV shopping etc.)

As with ADSL, the investment in the network adaptation is considerable, and although the cable used for cable TV distribution has inherently a greater potential than the copper wire used in telephony²², it was originally, by its typical network architecture (broadcast rather than switched), less suited for Internet and voice connectivity. Because all users within a certain connection cell on the cable share the available bandwidth (contention) they are in practice offered bandwidths around 1.5 Mbps although, in reality of course, the cable is capable of much wider bandwidth.

²¹ This means that downloading the Bible and the Khoran would take about 38 seconds. Uploading (sending) the same files from the end user to the Internet (for example as an attachment to an email) would take twice as long.

²² The coaxial cable on which cable TV services are offered, have a bandwidth of several hundreds of Mbps with less distance limitations as the copper wire used in telephony. The telephone wires also are limited to a much lower capacity (at best 10 Mbps).



The number of cable TV networks in Africa is very limited, and most of them are local or community based and used mainly for redistribution of broadcast materials (as CATV or Community Access TV). To our knowledge, none of these are yet providing two way services.

5.1.8 Microwave, Radio, Wireless

Microwave and radio based systems are deployed to provide access networks in two basic network architectures. The first is a point-to-point arrangement where one station connected to the core network provides connection to another single station. The second arrangement, point to multipoint, includes a base station connected to the core network that serves a number of remote subscribers within a coverage area.

5.1.8.1 Wireless point-to-point connections

In regions where the wired telecommunications infrastructure is not optimal, radio could form a valuable alternative for telecommunications. Besides of the way radio is used for broadcasting (as in public, regional or community radio and TV programmes), radio has also been used as a 2-way communication device when the division of the available radio spectrum allowed access to service operators other than broadcasters, resulting in various new radio applications such as amateur short wave radio transmissions, as well as walkie-talkies and two way radio applications for Internet access.

Telecom operators use microwave links based on radio transmission technology. The microwave uses a frequency higher than 1 gigahertz (billions of cycles per second), corresponding to very short wavelengths (comparable with satellite transmissions).

Microwave signals travel in straight lines and are affected very little by the atmosphere but they work

only within line of sight: two connecting antennas need to “see” each other and some attenuation occurs when microwave radio frequencies pass through trees and non-concrete buildings. Radio-frequency energy at longer wavelengths (such as the one used for radio and TV broadcasting) is much less affected by walls etc, allowing for example for radio reception within buildings.

Microwave is used by telecom operators for wireless transmission of signals having large bandwidth, for example to connect regional exchanges in cities that are otherwise hard to connect. In this way trunk telephone traffic is enabled between larger towns.

Optical cable (fibre) still allows for much higher capacity of traffic but is often more expensive to install²³, its deployment is difficult because installing it involves building permits along the whole trajectory, coping with adverse geographical conditions, etc. In insecure regions, cable installations are also considered vulnerable.

Microwave and radio solutions are rarely used for end user connection solutions except for larger customers (for example banks, hospitals, universities and corporate clients) and in that case they complement satellite VSAT-type solutions by providing short and middle distance coverage. The decisive factor is the availability of a radio or microwave provider, as well as the total cost of the deployment of the land based radio relay stations that are required. Radio based solutions such as microwave certainly have great potential in Africa and other developing regions because they are highly effective in flexibly extending an under-developed telecommunications network: Ghana Telecom for example hopes to support the growth of its telecommunications network including the provision of new services such as Internet connectivity almost entirely on the set-up of a nation wide microwave-based backbone network.





5.1.8.2 Wireless point-to-multipoint connections

There are a wide number of access solutions that fit within this description depending on the specific requirements of the end user as well as on the availability of specific technology providers in the area. We are loath to go into too much detail about all the possibilities but we will try to indicate those that are, in our opinion, of most importance for African countries.

Some solutions can almost be called hobby solutions in the sense that they can be constructed by non-professionals and are made up of off-the-shelf parts and tools. They may need however some careful research and testing. Lower frequency bands have the characteristic of permitting radio transmission without direct line-of-sight. This makes them particularly useful for communication to sites that are distributed in small villages and towns. Higher bands (10 GHz and higher, although this varies somewhat) on the other hand offer the advantage of larger bandwidth and thus more capacity. These bands require a clear line-of-sight radio path and need to account for rainfall attenuation

The 2.4 GHz band

This band is used extensively for indoor or outdoor Wireless LANs and also for outdoor Fixed Access links. For telecommunication purposes it is exempt of licensing in most countries. The band is shared between users on a mutual interference basis, but various spread spectrum modulation schemes have been defined to permit co-existence, including Bluetooth and wireless Ethernet (also called mistakenly WiFi) or IEEE802.11b. Similarly part of the 5 GHz band (IEEE802.11g) is used without licensing for Local Area networking.

These are short range nomadic systems where users can move within the range of the transmission without losing connectivity. Others can deliver high speed IP data (including voice service) over ranges of 5km or more in urban areas by using special antenna and amplification designs. Provision of service guarantees by operators in this band is difficult due to interference from many competitive systems, the security issues (it is not difficult to hack into this type of network) and the narrow spectrum available. This limits the potential uptake for business critical services. The main advantages are that they are unlicensed, cheap and easy to set up. The issue remains that at the central location some access to the public network with sufficient capacity needs to be provided. This can be a satellite gateway (as in the Ghanaian example below).



Wireless Ethernet Campus Network, Winneba Ghana

²³ For example, in Germany the average cost for laying cables is around 15 US\$ per meter. In Ireland, the average meter of cable installation costs 10 times as much due to the less favourable geographical conditions.



Competitive technologies: present and future 5.2

In recent years there has been an almost euphoric attitude about the potential for growth within the satellite communications industry. The recent failures of companies to become profitable from the new Internet services via satellite, however, have given rise to a belief that developments in the multimedia broadband area will stall. ISPs and connectivity providers are taking only medium term leases on satellites (maximum 2 years) because they expect fibre capacity to become sufficiently available thanks to the greater offer as well as transmission technologies that will enable more transmission over the same physical cable. There already seems to be an over-capacity of dark fibre (fibre that is not yet used for transmission) on some of the major traffic routes. It is only until such time as fibre effectively connects all global regions will satellite trunk telecommunications have a window of opportunity. From that moment, it looks like satellite capacity will shift massively towards an ever increasing TV and Radio broadcasting market.

Two-way Internet access, although being deployed by an increasing number of companies (BT OpenWorld, TiscaliSat, Aramiska, Starband, Web-Sat) is not expected, at least in Europe and North America, to become a real threat to cable or ADSL broadband access. It may always remain a niche product although this could still represent an average of 10% of access in developed countries, and a lot more in developing countries.

The innovative high speed broadband LEO satellite based initiatives such as Teledesic and SkyBridge that looked very promising especially as a way to provide services to sparsely populated areas that are under served, seem to have been put on the back-burner since pioneers like Iridium, ICO and Globalstar failed to make a business case.

Terrestrial wireless telephone solutions such as GSM or cellular telephone, are being taken up in African

countries at a fast pace. This is a positive evolution in the development of telecommunications. It remains to be seen however, how far the mobile network will be spread over the territory in order to reach all areas on the continent. The same will be true for the emerging and future versions of mobile telephony: GPRS, EDGE, UMTS, etc.

Fixed Wireless Local Loop, another broadband connectivity technology, uses terrestrial radio transmission networks to connect remote locations. Although it may well have some use in sparsely populated areas in developed countries, FWLL has come up against cost and licensing problems. FWLL has to rely on a vast (and thus expensive) terrestrial network of existing connections to be successfully deployed.

5.2.1 Fibre vs. Satellite

Roughly speaking there are about 6200 transponders available on commercial communications satellites in operation. In the unlikely case that they would all be used for data transmission, we could estimate that there is a total capacity of about 450 Gbps available via satellite. Compare this to a single undersea cable system which carries more than this amount of data, thanks to revolutionary advances in fibre optic technology. This means that the capacity of a single undersea cable system already exceeds the combined throughput of all the world's commercial communications satellites. However no worldwide voice or data network is complete without satellites and almost half of the world's countries remain dependent on satellites for international connectivity. Satellites and fibre play complementary roles in international networks. Fibre offers network builders practically unlimited bandwidth, but limited geographic reach, while satellites can provide limited bandwidth, but essentially limitless reach.





And although fibre optic capacity has grown exponentially, satellite operators have continued to prosper (apart from the debacles of some Low Earth Orbit systems like Iridium).

The largest satellite system operators, including PanAmSat, and New Skies, have relied on broadcast applications to build solid businesses. These operators have also provided, to a lesser but increasing extent, point-to-point services such as voice telephony and IP backbone connectivity. IP backbone connectivity, which mainly links ISPs in developing countries to the Internet, is currently the fastest-growing service segment for satellite operators. IP traffic on the New Skies system, for example, rose from 7% of revenues in 1999 to nearly 25% in 2000.

A key question facing satellite operators is how long this positive market trend will continue. The build out of terrestrial and undersea cables is proceeding at a fast pace. As terrestrial networks continue to grow, opportunities for satellite operators to provide point-to-point services will decrease. Market analysts therefore discourage IP over satellite, and therefore ISP investment, on anything longer than 2 year terms.

Operator Name	C- and Ku-Band Transponders
Intelsat	2,105
SES-Global	1,094
PanAmSat	883
Eutelsat	498
New Skies	257
JSAT	184
Telesat Canada	165

Transponders owned by the major satellite operators

5.2.2 Exploitation of new space in the ether

Room for expansion in the cramped C-Band and Ku-Band is increasingly limited due to the many services that are relying on these proven technologies. Satellite service providers are therefore researching the use of new frequency bands, starting with the Ka-Band (between 20 and 30 GHz). Although at first sight this frequency band lends itself better to the new multimedia services that are being put in place, the deployment of Ka-Band applications is suffering from delays, due to many technical problems. Although it was common some years ago to predict satellite multimedia services to be delivered at a fraction of the cost for the existing Ku- and C-Band services, this price setting has been revised in the light of the R&D costs incurred so far and the cost for deployment of a reliable service.



5.2.3 Software-Defined Radio (SDR)

Software-defined radio refers to wireless communication in which the transmitter modulation is generated or defined by a computer, and the receiver uses a computer to recover the communication signal. To select the desired modulation type, dedicated software controls the transmitter and receiver.

The most significant advantage of software-defined radio is its versatility. Wireless systems employ protocols that vary from one service to another. Even in the same type of service, for example mobile telephony, the protocol often differs from country to country. A single SDR set with an all-inclusive software repertoire can be used in any mode, anywhere in the world. Changing the service type, the mode, and/or the modulation protocol involves simply activating the required computer programme. The ultimate objective of software-defined radio is to provide a single radio transceiver capable of playing the roles of wireless telephone, cell phone, wireless fax, wireless email system, pager, wireless videoconferencing unit, wireless Web browser, Global Positioning System (GPS) unit etc. from any location on the surface of the earth. Up to now, SDR has been more science fiction than reality. Its development can be expected only in 10 to 15 years.

5.2.4 Power Line Access Networks

Digital power-line networking services come in two forms. The first of these uses power lines of the electricity grid, the public or private electricity main power provider, to provide Internet access services to the individual subscribers' home or office from a power-line Internet service provider (ISP). The second involves the provision of networking between computers and other devices within a subscribers home or building through existing electrical home wiring and electrical outlets.

5.2.4.1 1.1. Internet access through power lines

Together with water, electricity is normally one of the first commodities brought into homes, schools and buildings of all kinds even in rural areas. Electricity and broadband Internet service can travel on the same physical network, sharing a single line because their frequencies don't interfere with one other. Devices installed on the electrical grid inject the data from the Internet's backbone (fibre-optic lines) or access points into an electrical power line after it has left a power station. This type of power line communications technology has the potential to run at a very high transmission rate, competitive with broadband technologies such as Cable or ADSL, with speeds well over 2 Mbps. Because electricity is more prevalent in homes than telephone lines or cable, it could become a new communications infrastructure particularly in rural areas, where access has lagged behind.

The idea and concept of using power lines for communications has been around for several years, but technical difficulties have plagued attempts to make it work. Attempts at offering Internet services through the electrical outlet have been frustrated by technical problems such as electromagnetic incompatibility created by transmitters and high-frequency transmission on the power line, as well as line noise caused by various devices connected to the power grid, all possible causes of data communication disruptions. Communication on the unshielded power lines causes them to emit radio-frequency signals that can interfere with radio transmissions and, can also, some observers believe, pose health risks. Power line networking is also vulnerable to interference from devices connected to the power infrastructure, such as microwaves, computers and even hairdryers. Moreover, the





transmission of data over a network that anybody has access to can also pose a data security problem. Tapping the signal could allow people to eavesdrop on communications.

Nowadays, pilot projects are demonstrating that transmission speeds at least as fast as cable Internet or digital-subscriber-line service are becoming a viable option, at least in areas with good quality grid networks. Power line ISPs are becoming available in some countries (USA, Sweden, Netherlands and Germany) with tests revealing these systems to be fast, reliable and secure. The systems use frequencies between 1MHz and 30MHz to send data from the home to the local power substation. From there the data is moved onto a communications cable that the power company will have to install. A typical substation in Europe services between 150 and 200 homes, an attractive potential customer base for power companies. In the US where substations are covering very small user communities (6 to 10 users) a different technology is being used. The tests to date have been small, insofar as they have investigated financial and technical viability. It has become clear that besides regulatory, security and health issues, the main obstacle is the physical network itself. While the power network is probably the widest available of all physical networks, it may also be the most difficult to adapt to carry communications signals, significant investments are needed to both install connectivity to the Internet backbone, and to filter, amplify and route the signals along their path.

Wide-scale use of electrical lines to transmit Internet and other telecommunications data is still several years away. This is because further and broader testing is necessary as well as negotiation regarding potential regulatory issues. However the concept of power-line communications is potentially of great interest and if the current difficulties are overcome, can be expected to have significant impact within five to 10 years. In highly developed countries power line communications will likely be a niche activity, provided that the telecommunications industry keeps investing in DSL. However, it is reasonable to expect that power line communications will be significant in regions where the telecommunications infrastructure is limited, like Africa, Latin America and China.

It should still be kept in mind that in these regions, the power grid infrastructure needs to be of sufficient quality and that an important investment is required to make this power grid suitable for data communication: data injection, data routing and switching equipment will have to be installed over the whole network. It is unclear as to how far countries with little or no margin for investment in infrastructure will find it appropriate to invest in an additional wired communications infrastructure. It should be said however, that when necessary investment in power grid infrastructure has to be done, it would be wise to implement communication possibilities at the same time, as is happening now with the installation of fibre alongside high voltage power transport lines.



5.2.4.2 1.2. Home power line based networking

Comparable to the power line access networking as just described, it is also possible on a much smaller scale to use the electricity network inside a building for communications purposes. Homes and buildings often have multiple power outlets in every room, power outlets that are all connected together through the electrical wiring already installed in the building. Home power line based technology allows the power outlets to serve as both a power source and a network port: it uses the existing electric utility wiring to network computers and printers, within a building. The presence of the data signal on electrical lines has no effect on the electrical service in homes. Because it requires no new wiring, and the network adds no cost to the electric bill, power-line networking is the cheapest method of connecting computers in different rooms. Engineers have been dreaming for decades about the use of home wiring for communications, but it is only since 2002 and the adoption of the HomePlug standard by the power line networking industry, that we are seeing power line products becoming available at affordable prices (\$100 US and less).

The system has a number of advantages over other systems for house or in building network

installations. It is very easy to install by the end users because it does not require new wiring. The network adapters are plug and play. A printer, a server, a router or any other device that doesn't need to be directly connected to a computer, doesn't have to be physically near any of the computers in the network.

There are some disadvantages as well: the connection speed is currently rather slow: present speeds are no higher than 500 Kbps, which is significantly slower than wireless ethernet networks (basic 802.11b wireless speeds are theoretically 10 Mbps, 802.11g even 54Mbps, in real environments however the throughput is significantly less.) This is, however, remarkably slower than wired ethernet via UTP (Unshielded twisted pair). Furthermore, the performance of the power line home network can be affected by usage of other electrical devices, or by older wiring. For the time being it works only with Windows-based computers. What is also important is the fact that security measures are necessary to shield the information from neighbours and other homes sharing the same power line, because its signals could be broadcast between different buildings or homes (a concern for apartment dwellers, or even for homes on a shared power grid).





In a previous chapter we referred to various applications of satellite technology in education and described various broad categories in which such use could be considered. To recap, these categories are as follows:

Category	Type Short	Short description
1	Broadcast	Common use of satellite technology where complete educational programmes are broadcast to large numbers of potential learners, commonly used by large-scale public service broadcasters like the BBC and ABC.
2	Interactive Television	Often a mixed media service where satellite is used for one-way delivery of educational material and other interactive systems used for the return link from the learner, also includes services like Video-on-Demand
3	Data Broadcast	Essentially one-way communication networks offering to the end user data such as video files, web site contents, analytical and statistical information, applications (software up-dates) or any other form of information that can be digitally stored.
4	Internet Access	Where Internet Service Providers use satellite services to support one or both channels of their service to connect their subscribers to the Internet backbone.
5	One & two way Satellite Internet Access	This is where satellite technology is used by providers to offer one or two-way high speed IP connectivity via satellite to individual end users
6	VSAT network	Virtual private satellite networks of one kind or another often used in the commercial world to provide entire communications networks to outlying companies and institutions

Satellites in Education

6.0



In this chapter examples from different parts of the world illustrate the use of satellite-supported services in educational contexts. Contact information is provided for further information on each example or initiative where it is available. We have also indicated when this information was last up-dated, however as with all such information the material included in this chapter is subject to change and so we recommend that if you are interested in a particular example, you contact the project directly.

In this chapter and our description of each example, we will use this system of categorisation.

African Virtual University

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Type of Application

This is an example combining one way broadcasting (i.e. Interactive Television or Category 2 in our categorisation) with a synchronous and asynchronous return channel via either telephone or online chat.

Coverage

The AVU service footprint (via New Skies Satellites) does not cover all of Africa equally well: see the areas indicated in the following diagram.

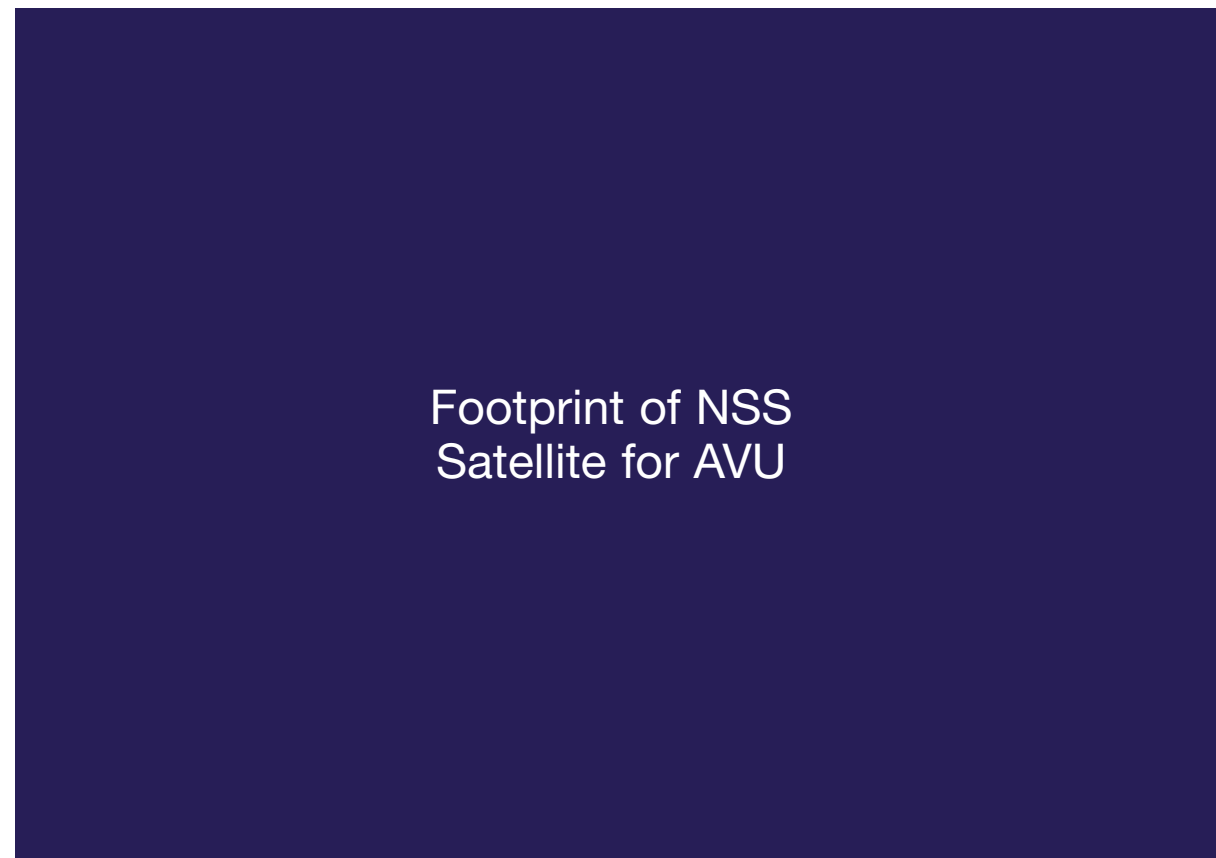


Image: African Virtual University/NSS

Footprint of NSS Satellite for AVU

Short Description

The AVU has a core commitment to enable greater access to higher education for African students using modern information and communication technologies (ICT). The strategy involves a more focused and African-based operation committed to overcoming the constraints that limit access to quality tertiary distance learning opportunities in Africa.

The AVU began its pilot operations in 1997. By 2003, 31 AVU learning centres have been established in 17 sub-Saharan countries in Africa. During this pilot phase AVU delivered some 3000 hours of instructional programmes, registered over 23,000 students in semester-long courses, provided 1,000 personal computers to learning centres, and provided a range of other services to its members. In addition to courses, AVU offers a digital library with 2,000 full-text journals and a catalogue of subject-related Web links, as well as a web-site, which functions as a portal and currently receives over one million hits on average per month, with over 45,000 active email accounts and other Web-based services.



The AVU infrastructure currently consists of a broadcast network with the up-link at Netsat express hub New York, USA and multiple receive-only sites (AVU learning centres) spread across Sub-Saharan Africa. This network utilises digital video and audio broadcast over the New Skies Satellite (NSS) 7 in C-Band.

A flexible, mixed mode delivery approach has been adopted, in recognition of the learner environment in which AVU operates. This approach uses a careful combination of synchronous video broadcasting, online materials, pre-packaged learning materials on CD-ROMs and DVD as well as synchronous chat sessions.



AVU classroom in Cape Coast, Ghana

Interaction between the learner and the lecturer is primarily by email, and online chats during synchronous lecture sessions. Students also have access to online chat sessions and discussion forums with their teaching assistant throughout their programmes. All tuition will emanate from the learning centres. Students are expected to register at the learning centre before attending specifically scheduled synchronous sessions.

AVU Learning Centres (LCs) are supervised by trained facilitators. These are individuals who are familiar with the subject matter being taught and are mature enough to assist students during synchronous and asynchronous sessions. The facilitators are always in close consultation with the lecturer and teaching assistant teams.



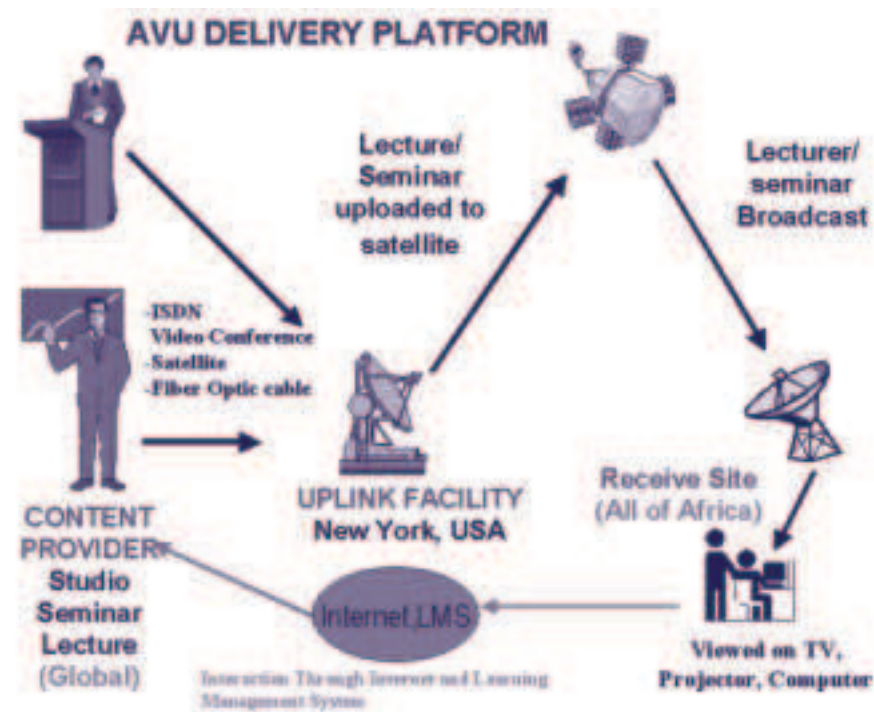


Image: African Virtual University

While the two first phases of the development of the AVU are successfully accomplished, the third phase of the AVU consists of developing a full two-way audio and video communication network. The AVU will achieve this through the deployment of VSAT systems with integrated video conferencing, video streaming, Video-on-Demand and VOIP (voice over IP) technologies.

Last up-date: accurate according to web site July 2003

Africa Learning Channel

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Type of Application

This is an example of one way audio broadcast and data broadcast (multimedia files to PC), i.e. an example of both Category 1 (broadcast) and Category 3 (data broadcast).

Coverage

The target public of the Africa Learning Channel (ALC) is situated in Africa, the Indian Ocean region and the Middle East. (See footprint map in previous chapter.)

Short Description

The Africa Learning Channel is an initiative from the WorldSpace Foundation which aims to provide access to information for disadvantaged people in the developing regions of the world using technology that broadcasts digital audio and multimedia signals directly from satellites to radios. The foundation tries to achieve this mission by supporting the acquisition and distribution to the lowest income people of suitable radio receivers, and other activities aimed at the distribution of education and information programmes. WorldSpace Foundation has 5% of the channel capacity on the three WorldSpace Corporation satellites for non-commercial social development and distance learning programming.

ALC is an English Language Education and Development Radio service broadcast via AfriStar that was launched in December 1999. It is a collective audio channel that combines educational and social development programming from African NGOs and producers for broadcast to rural and isolated communities in Africa, thereby giving NGOs access to new digital technology, and a mechanism to reach a broader constituency throughout Africa and the Middle East.

The spirit underlying the Africa Learning Channel (ALC) is that it serves as a forum for Africans to communicate with Africans about common issues and problems.

The Africa Learning Channel is WorldSpace Foundation's flagship project and aims to empower African communities to address their

communication needs. This learning channel concept was developed after the Foundation conducted extensive research and gathered input from various groups in Africa about the information needs of an African audience. WorldSpace Foundation produces programmes for the Africa Learning Channel by collecting content from African groups on a variety of topics and then post-producing the material for transmission on the satellite. In exchange, the foundation places receivers with partner groups at low cost, and ensures the dissemination of the groups' programming to a much wider audience than traditionally possible. The Foundation promotes a policy of "one receiver reaching many ears" by encouraging partners to organise co-ordinated listening groups in communities where receivers have been placed. Listening groups enable discussion of the programme content and the education of many. Currently, the ALC has an estimated audience of 1.2 million people based on reports from partners in 21 African countries.

The ALC is first and foremost a radio channel that addresses issues in such areas as basic education, health, literacy, conflict resolution, disaster relief, women and family development issues, environment cultural heritage preservation and vocational training.

To receive the satellite signal from the ALC special radio receivers are required. The receivers run on batteries or an external power source, and can be adapted to run on solar energy. They have data ports, which when connected to a computer via multimedia adaptor cards, enable users to download web-based text and images, thus expanding the receivers' capabilities beyond audio to digital multimedia transmissions.

The ALC also has a multimedia service, which is called ALC-data, transmitting both text and images (still and dynamic) via the satellite to the computer hard drive without phone lines, at the rate of 64 Kbps for a maximum download of 600 MB per day. The ALC Multi-Media Service is a cost-effective service for the partners working in regions with little or no access to the Internet to



transmit web-based multimedia documents via satellite to the computers of target audiences. Since April 2000, many African physicians, community health workers, farmers, meteorologists, community development workers, disaster relief workers, and community broadcasters have been receiving a variety of social development information through this service. On April 29, 2002, World Space Foundation launched the service in Asia and the Pacific, enabling their local and international partners to transmit similar information to audiences throughout the region.

Last up-date: Accurate according to the web site July 2003

The AVD project, Austria

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Type of Application

This is an example of video broadcasting via satellite using the SkyMultimedia system (Category 3). SkyMultimedia is an interactive satellite-based system which enables the transmission of IP-based content between server and client (for example desktops). It uses the satellite for down-stream (from the central office to the clients) and any medium (dial-up modem, ISDN, satellite, leased line, GSM) for up-stream (from the clients to the central office). Because of the use of DVB/MPEG2-standard, the signal can be received from any current DVB-home-receiver (integrated receiver/decoder). The information is only available for authorised receivers.

Coverage

The satellite that is used is called Eurobird. The AVD project involves 89 schools, which are connected via satellite and provided with broadband access to the Internet.

Description

The AVD project ran during the school year 2002-2003 in Austrian schools and was co-ordinated by Education Highway in cooperation with the Federal Ministry of Education, Science and Culture and Telekom Austria.

The aim of the project was the creation of a satellite-based broadcasting system for media-on-demand solutions and interactive telelearning in schools. Upper secondary professional schools (economical and technical) and grammar schools and main general secondary schools from all over Austria could apply to participate. All participating schools received equipment, which was used for the following activities:

Download of videos via satellite (on demand): Videos with supporting teaching material (working sheets, educational hints, subject analysis, content...) could be downloaded overnight via satellite and could be used the next day in school. The videos are searchable for picture sequences, single words or time codes without rewinding or forwarding. The teacher can choose and demonstrate the video or single clips of it in school. Each clip has a key frame (single pictures in chronological order of the content) and



a short description of the prepared theme to give a quick review of the videos. Through simple navigation tools (for example a text transcript of the spoken word or key frames) it's possible to access and playback at any stage in the video. Additional material to each video was also provided, examples include short descriptions of the video content, theoretical backgrounds, learning aims, didactical hints/tips and resources on the web. Pupils also had access to all the video material provided. They could use the additional material, key frames, speaker text and the video clips for own projects.

Streaming of Interactive Telelearning: In special equipped broadcasting studios (locations in Linz) live lectures have been held and streamed via satellite to the schools. A special software tool was used, DistLearn, which allows for interactivity during the lecture. DistLearn integrates 3 components: audio and video display, a messaging tool (chat), a web browser and VNC (for slides, html-sites or word documents or any other screen the teacher would like to display). All courses have been recorded and archived so that all project schools have the opportunity to see the course "offline" anytime and anywhere.

Last update: July 2003

Channel Africa

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Type of Application

Radio broadcast (Category 1: Broadcast).

Coverage

Channel Africa is available on the World Radio Network via WorldSpace AfriStar & AsiaStar, Intelsat 707, PanAmSat 7 and PanAmSat 10, ASTRA 2B, Galaxy 5, Telstar 5

Short Description

Channel Africa aims to be a multi-lingual source of reliable information about Africa - with news, music and sport, free of subliminal agendas or foreign interpretations. It broadcasts news via shortwave, satellite and internet radio (real audio).

World Radio Network relays a weekday programme from Channel Africa called 'Dateline' that is available at various times throughout the day on their satellite services. There's also a weekend feature programme called 'Network Africa' that covers the past week's news events across the African continent.





The content of these two programmes consists of news, current affairs, economics, trade, industry and technology, political and social issues, education and training, environment and wildlife, tourism and sports. Live broadcasts of major African sporting events are also relayed by many of Africa's broadcasters. Special interest programmes include occasional round-table discussions with prominent African personalities and surveys of developments in the world of arts and entertainment.

Although mandated and largely funded by South Africa's Department of Communications, Channel Africa remains editorially independent. Unfettered by constraints of state propaganda or dictates of sectarian affiliations, and free to explore appropriate avenues for self-funding, Channel Africa is one of very few options available to organisations and companies needing to reach people all across the African continent.

Last update: August 2003

Consorzio Nettuno, Italy

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Type of Application

This is essentially an Interactive Television type of application (Category 2).

Coverage

The Eutelsat HotBird 2 footprint provides full coverage of Europe and covers North Africa and Asia, including the entire Middle East.

Short Description

NETTUNO uses two satellite television channels and Internet to broadcast its courses and to carry out didactic activities. Reception is available as far as Moscow and Dubai. Participating universities in Italy are: the Politecnico of Bari, and the Universities of Ancona, l'Aquila, Bologna, Camerino, Cassino, Ferrara, Firenze, Genova, Lecce, Messina, Milano, Milano "La Bicocca", Modena, Napoli II Università, Padova, Palermo, Parma, Perugia, Pisa, Roma "La Sapienza", Salerno, San Marino, Siena, Teramo, Torino, Trento, Trieste, IUAV Venezia, Viterbo "La Tuscia". Other participants include the Open University in the UK and National Centres for Distance Learning of Tirana, made up of the eight Universities of the Republic of Albania. Foreigners can earn a degree via NETTUNO on condition that they are subscribed to one of these universities.

The NETTUNO network was set up in 1992 by the Ministry for University, Scientific and Technological Research, and delivers first level University degree courses at a distance to a network of participating institutions which include 34 Italian State Universities, the Open University in the UK, technological companies and bodies like TELECOM Italia, RAI, IRI and the Confindustria.



The teaching model used is a mixed one that combines the advantages offered by the traditional teaching system and by guided learning with those offered by a distance-teaching model that makes use of new technologies. The model of distance teaching proposed by NETTUNO considers the distance arrangement that includes activities out of which the student studies alone and activities that use new technologies and activities that make the student interact with other people, either in person or at a distance. Professors that carry out studies in the different disciplines are the same ones that teach both traditional face-to-face courses and home study courses.

Satellite television and the Internet are fundamental among the technologies used by NETTUNO. All Distance University Degrees are broadcast on two satellite channels RAI NETTUNO SAT1 and RAI NETTUNO SAT2. 280 courses are produced by the NETTUNO network which provides a total of 14,000 hours of university video lessons. Besides the Video lessons, there are didactic books, workbooks, multimedia software and products, and didactic Internet web sites linked to the video lesson that are used for the distance learning courses. Students can interact amongst themselves and with the professors through chat, forum, email and videoconferences.

Students enrolled in NETTUNO distance university courses may access didactic and institutional support activities through the following structures:

The National Centre based in Rome which manages the didactic co-ordination between supplying universities, co-ordinates the video lessons and multimedia didactic materials production, takes care of the arrangement of databases and telematics connections between

different sites, plans and checks transmission on the two satellite channels, realises and checks the Didactic Portal on the Internet, and carries out research programmes.

The Supplying Universities take care of the students' enrolments, their curriculum and issue university degrees.

The Technological Poles are the didactic structures inside the Universities and they supply students with the following services: practice exercises, lab activities, tutor assistance, video lessons and course didactic materials archive (software, exercises and written materials), exams, Internet access and videoconference tools.

The Auditing Centres and Enterprises Technological Poles are the structures outside the associated Universities in enterprises, private or public bodies and structures and carry out, in close cooperation with the Supplying University Technological Poles, student didactic assistance functions.

The "work at home" station consists of a video recorder, a television with a satellite dish and a decoder, a computer, a printer, a modem/fax, telephone and an Internet connection. Students can follow, from their homes or from wherever they want, university courses on television and carry out practice exercises, they can even interact with other students, tutors and teachers in real time by telephone and Internet or by fax and email.

The University Technological Centres set up in the associated Universities consist of multimedia didactic classrooms and laboratories equipped for video recording. Video lessons are recorded in these classrooms for transmission.

Last up-date: Accurate according to the web site July 2003





CRO.CU.S

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Type of Application

This service used the IPerSAT communication platform, which is based on the Digital Video Broadcasting (DVB) standard deployed world-wide for digital television. It allows the user to receive television programmes and Internet high speed services with the same small antenna (Category 3). Communication between users and the Service Centre was performed in an asymmetric way: the users received the multimedia data via satellite at high rate and transmitted via modem their data at the rate allowed by their terrestrial Internet connection (PSTN or ISDN).

Coverage

Sessions were transmitted via the Eutelsat 13° E Hot Bird fleet, which reaches every country of West and East Europe plus those countries who belong to the Mediterranean Sea basin so including all those areas greatly affected by the immigration phenomena.

Short Description

The Crocus (CROss-CULTural Satellite services for immigrant communities in Europe) project, supported by the European Space Agency, ran from November 2000 till June 2002. Its purpose was to disseminate multimedia and interactive didactic units for first and second language learning and intercultural education via satellite to schools, cultural centres, libraries, training agencies and associations of immigrants.

This use of this technology guaranteed the necessary flexibility to follow complex curricula in an optimum fashion, ensuring continuity in teaching, training and social care for immigrant or refugee families children, both at Italian and European level.

The CRO.CU.S system included:

- A pupil section for distance teaching to pupils from ethnic minority groups. The satellite-distributed lessons were integrated with text books, CD-Roms, videotapes, and web-distributed learning units. The system offered distance tutoring and distance learning during lessons which were broadcast live.
- A tele-kiosk section that offered multilingual services to school administrations and families from ethnic minorities. The service facilitated communication between school and families regarding administrative procedures and immigration legislation.
- A teacher section for in-service training of teachers and other school staff in the field of intercultural teaching, multilingualism and the integration of foreign pupils in the school community.



The main components of the CRO.CU.S communication system, implemented by Telespazio to run the CRO.CU.S services, were:

- the Telespazio Service Centre: which housed the system equipment and the distance learning platform called NetStre@m.
- the Up-link station: located at FUCINO (AV) Space Centre.
- the Space Segment: to roll out the CRO.CU.S pilots, a 512 kbps Ku band on the Eutelsat 13° East Hot Bird fleet was used.
- a teacher station: this remote station allowed the COSPE Centre in Florence to manage the live services and to schedule the contents distribution.
- a satellite network: including the CRO.CU.S Pilot Schools and the Project Partners.

The users, who were students, teachers or families could enjoy the CRO.CU.S information and learning services in real time or when convenient.

The CRO.CU.S services were configured and delivered in an “interactive” or “push” modality according their typology or the need to interact. Learning programmes were received via satellite on a weekly basis and the CRO.CU.S portal could be accessed anytime by the Internet terrestrial connection.

The experimental phase of the CRO.CU.S project, completed in June 2002, involved over 400 pupils from ethnic minorities, 30 schools and cultural centres in various regions of Italy from the South to the North and 3 Albanian schools. The schools included primary, middle and high schools, the centres included libraries, documentation centres, immigrant associations.

With the start of the new school year 2002-2003, a new phase began, with the promotion of the system so that it could function independently from a financial point of view. During the school year 2002-2003, the services were offered but only via terrestrial internet connections and not via satellite anymore. This was because the number of subscribed schools was not yet high enough to make it an economically viable option. In the future, when more schools are subscribed to the CRO.CU.S services, satellite technology will be reconsidered.

Last update: June 2003

Cyber Seminars, Japan

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Type of Application

Broadcasting using the DVB standard in the C-Band (Category 1).





Coverage

PAS-8, PAS-9 and PAS-10 from Panamsat were used. They each have the following coverage:

- PAS-8: Asia, Oceania
- PAS-9: North & South America
- PAS-10: Asia, Europe, Africa

Short Description

The National Institute of Multimedia Education (NIME), Japanese Ministry of Education, which has been involved in various projects with overseas institutions, has embarked on an experimental collaborative project with the Waseda University, NHK International and Rikei Co. Ltd. In January 2002, NIME and Waseda University telecast four lectures developed by the university's Centre for International Education (CIE) for use by overseas institutions.

The lecturers are representatives of large Japanese companies and focus on the operations of Japanese companies and internationalisation of the Japanese corporate sector. The lectures were in English and designed for students, faculty and others interested in Japan and its corporations in an era of globalisation. The presentations were essentially designed and delivered for the classroom and then adapted for telecast purposes.

One programme series composed of four lectures was telecast three times a day (one lecture per day) from 28 January to 31 January 2002.

The Series title was "The International Roles of Japanese Business" and it consisted of the following lectures:

- The Remaking of Japan (Dr. Robert Feldman, Managing Director, Morgan Stanley Dean Witter)
- The Globalization of Japan's Electronics Industry (I) (Mr. Kenji Tamiya, Senior Adviser, Sony Co.)
- The Globalization of Japan's Electronics Industry (II) (Mr. Norio Gomi, Senior Adviser, Matsushita Electric Industrial Co.)
- The Japanese Financial Market in the Global Age (Dr. Leslie F. Hoy, Manager, Orix Co.)

Each lecture ran for approximately 70 minutes and was broadcast via the satellites used for NHK World TV, namely the PAS-8, PAS-9 and PAS-10 from Panamsat.

The cyber seminars are not being repeated anymore since the summer of 2003 because of a local management difficulty.

Last update: July 2003



DigiNet, Nigeria

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Type of Application

This is an example of two-way Internet connectivity supported by satellite (Category 5).

Coverage

The satellite that is currently in use is PAS1R, previously PAS10 was used. The first phase of the project reaches 35 secondary schools in Nigeria.

Short Description

The DigiNet Project is an initiative from SchoolNet Nigeria that aims to ensure that Nigerian schools are given the opportunity to allow their students to cross the 'Digital Divide', and use Information and Communications Technology (ICT) to enhance their learning experience. The project aims to reach all schools in Nigeria, and equipping them with computer and communications technology. More importantly, the schools receive educational content, and teachers are put onto a teacher development programme to ensure that they can effectively use the technology in the classroom.

The first phase of the project was approved and is being funded by the Education Tax Fund. This phase started late 2002 and was completed in July 2003. Thirty-five sites spread over 6 states, and the Federal Capital Territory have been equipped with VSAT connectivity via the DircqSat solution of DircqLearn (www.dircqlearn.org). It involves a 1.8 meter dish and a DircqPC earth station at each school. This gives the schools 24 hour access to the web. The project at each school is sustained by running a tele-centre/Internet café from their lab outside of school hours to offset the cost of bandwidth. Bandwidth costs are covered only for the first six months of the project. Thereafter schools have to be self-sustaining. The overall solution includes open source Internet cafe billing and management software (DircqCafe), in order to help manage the system.

The computer labs are run on a Linux platform, with thin client terminals that use Linux Terminal Server Project at the core. The clients run KDE on the desktop and have all the graphical user interface functionality that is normal today. The selected distribution on the server is Mandrake Linux. This has been adapted into an offering called DircqOpenLab, which also includes an educational portal. The terminals have no disk drives and therefore no locally installed software. This approach has significant TCO (Total Cost of Ownership) benefits, since the hardware specification is reduced over fat client and the software is free.

Last update: July 2003





Digital Broadcast Initiative (DBI), Nepal

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Type of Application

DBI is a combination of audio broadcast and download of large files of data, video imaging, text and graphics via the WorldSpace Satellite System (Category 1 and 3).

Coverage

The satellite used is the WorldSpace Corporation's AsiaStar L-Band satellite.

The initial focus of the Digital Broadcast Initiative is in the Asia Pacific region. The pilot phase entails establishing a minimum of 800-1000 sites in 4-5 countries. Nepal is the first place where the initiative is being piloted. Future plans include expansion of the project to Afghanistan, India, Laos, Malaysia and Indonesia.



Short Description

Equal Access, a non-for-profit organisation based in San Francisco, California, has established an information and education network - The Equal Access Asia Development Channel- on the WorldSpace Digital Satellite System.



The Equal Access Asia Development Channel began operations in April 2003, and launched the first phase of the region-wide "Digital Broadcast Initiative" in Nepal. This 18-month pilot project has been launched in conjunction with the United Nations Development Programme. Other project partners include UNICEF, the UNDP, CARE Nepal, the Early Childhood Development Division of the World Bank, the Ford Foundation and the US Agency for International Development (USAID).

The broadcasts, which began in April 2003, reach more than 10,000 Nepalese directly through satellite receivers in 390 rural communities in 14 districts and about nine million people via rebroadcasts by Radio Nepal and local FM stations. The project is expanding to 51 districts in collaboration with the UN Population Fund and UNDP Nepal.

The current content areas in Nepal focus on HIV/AIDS awareness and women's empowerment, expanded content topics will include a range of subjects including human rights, early childhood development, micro finance and sustainable livelihoods. All programmes are broadcast in the Nepali language.

The districts involved in the pilot are chosen because they suffer from a lack of infrastructure, low literacy rates and high population mobility. These areas are, thus, susceptible to the spread of HIV and to escalating HIV transmission to other Nepalese regions.

From a technical point of view there are 2 types of community sites involved:

- Receiver-only sites, equipped with a WorldSpace radio receiver that will pass on information to local people via audio programming and listening groups.
- Hub-sites, equipped with computers and peripherals. Solaria Corporation is providing solar systems integration to power receivers and computers in remote areas that lack electricity. The hub-sites are able to provide access to a selection of multimedia materials downloaded direct from satellite at rates up to 128kbps.

These materials include electronic educational material such as school texts and health journals as well as instructional and informative videos. Video programming could take the form of concerts or 'edutainment programming' not available otherwise with relevant messages interwoven through transmission in a variety of creative forms, such as breaks in the programme for comments and questions raised by the commentator.

Equal Access has a 3-team project implementation methodology:

- The content production team consists of a coalition of NGOs, government, community leaders and people living with HIV/AIDS. This team produces culturally appropriate and entertaining content in a variety of formats including soap operas, facts of the day, interviews and music/song in local languages.
- The outreach team is comprised of community-based organisations chosen for their depth of experience and already established presence in the communities being served. These organisations orient participants to the programme, establish listening groups and conduct regular discussions following the broadcasts. Participants provide feedback on what's working and what isn't and this information is fed back to the content group. In this way the participants have a direct voice in critical issues concerning their own development.
- The assessment team is made up of a team from the University of California, San Francisco, Centre for AIDS Prevention Studies (CAPS) and an assessment organisation in each project country. In Nepal, the local assessment partner is the Valley Research Group (VaRG). The two assessment partners are collaborating to conduct a comprehensive assessment of the effectiveness of the Digital Broadcast Initiative in Nepal, specifically assessing the impact of the project on knowledge, attitudes and behaviour in the identified content areas (HIV/AIDS Awareness and Women's Empowerment).





Although the project in Nepal is an 18-month pilot project, it is expected to be taken up afterwards largely by the community participants and the organisations themselves. Equal Access is helping to build project sustainability and local ownership, both by their ground-up collaborative project methodology, and by the scalable and cost effective nature of their satellite technology applications.

Last update: July 2003

GDLN - World Bank

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Type of Application

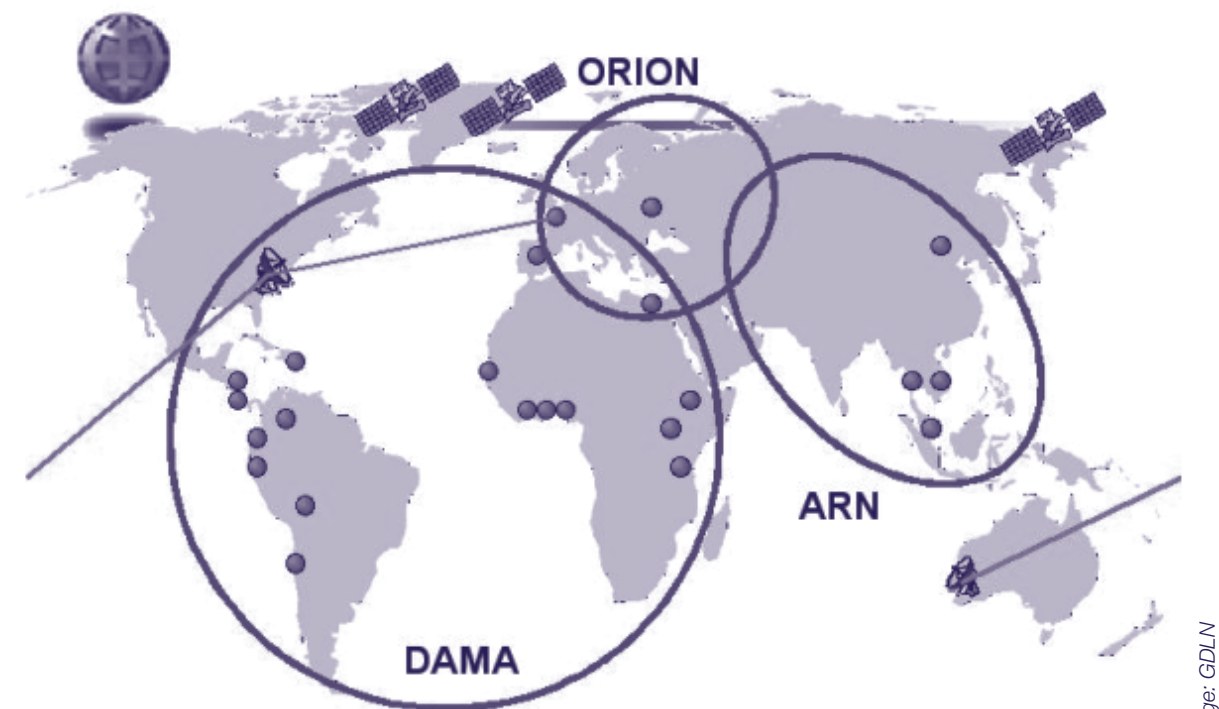
GDLN is an example of a VSAT network being used in an educational context (Category 6).

Coverage

The GDLN network uses a mix of satellites covering Africa, the Americas, Eastern Europe and Asia. (See footprint map below.)

Short Description

The Global Development Learning Network established by the World Bank is a partnership of public, private, and non-governmental organisations providing a fully interactive, multi-channel network with a mandate to serve the developing world. GDLN partner organisations work together to take advantage of the most modern of technology, for building local capacity, sharing learning and knowledge, and building a global community dedicated to reducing poverty. The mission of GDLN is "to harness modern technology – including interactive video, the Internet, and satellite communications – in a cost-effective way, so that people who know are brought together with those who need to know, to learn with and from each other about the full range of development issues". Network connectivity is achieved through a very small aperture terminal (VSAT) satellite transmission system for voice, video and data. A total of three satellites provide coverage to Africa and the Americas, Eastern Europe and Asia. GDLN uses Intelsat over the Atlantic to cover Africa and Latin America, using a technology called DAMA (Demand Assigned Multiple Access). Over Europe and parts of Central Asia they use Orion and over South Asia and East Asia they use an IOR satellite from an uplink in Perth. GDLN connects with Perth by fibre from Washington. In this way, the whole system is one satellite hop. The whole network is currently being converted to IP.



Linking the World Through Learning

The Satellite Coverage for GDLN

The GDLN network involves a growing consortium of facilities with high quality interactive video conferencing and Internet capacity that is currently linking more than 50 countries in Africa, Asia, Latin America, and North America. GDLN grew out of the successful pilot programme "World Bank Learning Network", which has been under development since 1997 and relied on the Bank's high-capacity communications system. The following centres in Africa are members of the network:

- Centre d'Education à Distance, Bénin
- Centre d'Education à Distance, Côte d'Ivoire
- Ethiopian Civil Service College, Ethiopia
- Institute of Management and Public Administration (GIMPA) in Accra, Ghana
- British Council Knowledge and Learning Centre (KLC), in Accra, Ghana
- Ecole Nationale d'Administration et de la Magistrature (ENAM) in Dakar, Sénégal
- Tanzania Global Development Learning Centre (TGDLN), Tanzania
- Uganda Management Institute (UMI), Kampala, Uganda
- Centre de Formation et d'Echanges à Distance (CFED), Mauritania
- Informatic Centre of Eduardo Mondlane University, Mozambique
- University of Namibia (UNAM), Namibia





GDLN classroom and antenna in Accra, Ghana

Course topics include: Political Economy of the Environment for Journalists, Economic Growth and Poverty Reduction, Procurement, Urban and City Management, Analytical and Policy Issues in Macroeconomic Management, Controlling Corruption: an Integrated Strategy, Capital Flows Volatility and Financial Crises, Health Sector Reform and Sustainable Financing, Gender Health and Poverty, Social Safety Nets and Rural Development.

For a full schedule of courses broadcast on GDLN and further information about taking part visit the GDLN web site.

Last update: accurate according to web site July 2003

La Caravane de l'Internet, Senegal

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Type of Application

Radio broadcast via the AfriStar satellite from WorldSpace, (Category 1).

Coverage

The caravan travelled through Senegal from August 2000 until January 2001 after it came from Mali. After the Senegal experience it went on to other African countries. According to the organisers in Senegal, the project is no longer active.



Short Description

The "Caravane de l'Internet" was an initiative from OSIRIS, Observatoire sur les Systèmes d'Information, les Réseaux et les Inforoutes au Sénégal. The aim of the project was to use the mobile station that has been configured by WorldSpace, as a means of bringing ICT to the wider public and to connect isolated geographical regions to the Internet to familiarise people with ICT. For five months, this lorry equipped with the necessary equipment to connect to the Internet, with multimedia hard- and software and with a whole range of other features such as telephone, toured through the regions of Senegal.



Image: WorldSpace Foundation

Caravane de l'Internet

The caravan stopped on 22 locations where it stayed for about 3 to 5 days. At every location the caravan was transformed into an Internet platform, which provided information, educational opportunities and allowed people to experiment with multimedia. In this way people from rural communities could get in touch with the rest of the world and also find out about the previous sites visited by the caravan (including geographical, cultural, tourist and economic information).

A temporary web site was created especially for the project showing the travelling pattern of the caravan and offering a forum where people could exchange information with their relatives who had migrated.

The caravan was made up of the following components: a WorldSpace lorry, a minibus for the transport of the staff of the caravan (technical and administrative staff), a van for the transport of support items (tent, chairs, accessories), and the cars of partners who were presenting specific projects.

The specific services offered by the Caravan were the following:

- Internet connection: the connection was established via normal telephone lines. Once the Caravan arrived at a certain location, it arranged a connection to the Internet with Sonatel from an existing telephone line available somewhere in the town.
- Radio reception via the WorldSpace receiver.
- Medical tele-diagnostics: data broadcasting for medical purposes.
- Sound studio: this was available to people who were making music and who wanted to present their music to possible producers in the cities.
- Archives (audio and video): they were made of the stories, proverbs and legends of the region.

Last Up-date: July 2003





Les Amphis de france 5

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Type of Application

This is an example of educational programmes video broadcast via the satellites Telecom 2C from France, HotBird 5 (analogue) and HotBird 5 (digital – TPS) from Eutelsat Telecom, the ASTRA 1 H (canal satellite) from ASTRA (Category 2).

Coverage

An estimated 14 to 20 million people watch france 5 every week, mainly in France but also in the rest of Europe and North Africa.

Short Description

Les Amphis de france 5, a French educational TV programme and website has been operating as a service since February 1996. It allows schools, training centres and individuals to access audiovisual products and documents via a dedicated website or via television. The aim of Les Amphis de france 5 is to distribute knowledge and to provide pedagogical support, mainly to students and teachers in higher education. The programmes are also of interest to the general public, covering themes such as work, economy, sciences, art, history, literature and media.

Visitors to the website will find a catalogue of 500 titles and the broadcast schedule. At the same time the website allows access to the accompanying documents such as texts, exercises and corrections.

The TV channel france 5 is part of the France Television Group, alongside France 2 and France 3. The programme 'Les Amphis de france 5' is broadcast according to the following schedule:

- Monday mornings from 5.40 AM: programmes that have been suggested by the public. For this purpose, viewers can choose from the 500 titles in the catalogue. The most requested programmes are then broadcast. This could be called a near "video-on-demand" service.
- From Tuesday to Friday, every morning at 5.40 AM: video lectures by academics from all over France. Each day covers a different subject area (science, humanities, mathematics, languages).
- On Saturdays and Sundays, every morning at 6 AM: a selection of discussions and conferences.



Les Amphis de france 5 are also broadcast online via streaming as part of "Canal U", the web TV service of French higher education establishments. Canal U consists of 10 different channels offering about 1500 hours of educational videos. The channel 'Les Amphis de france 5' offers 130 programmes, enriched with synchronised illustrations and accompanying documents.

The programmes of Les Amphis de france 5 are available on 3 types of communication network:

- Terrestrial network: This consists of more than 1000 broadcasters on the UHF band and exploited by Telediffusion de France. This network covers more than 87% of the French population.
- Cable network
- Satellite network: The programmes of france 5 are also distributed by satellite for an international audience. This consists of the following satellites:
 - Telecom 2C from France Telecom
 - HotBird 5 (analogue) and HotBird 5 (digital – TPS) from Eutelsat
 - ASTRA 1 H (Canalsatellite) from ASTRA

Last update: July 2003

LINCOS, Costa Rica

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Type of Application

This is an example of one and two way connectivity (Category 5).

Coverage

SATMEX 5 from Hughes Space and Communications Company (now Boeing Satellite Systems Inc.), which covers the whole American continent.

Short Description

LINCOS (Little Intelligent Communities) is an initiative of the Fundación Costa Rica para el Desarrollo Sostenible, created by the former president of Costa Rica Jose María Figueres-Olsen, which involves the installation of modern Community Centres with information and technology platforms and an educational and sustainable development approach for the use of the technology. The initiative, along with the Massachusetts Institute of Technology and the Instituto Tecnológico de Costa Rica, developed





a technological platform where a series of technologies converge, such as: a computer science laboratory, a telemedicine unit, a videoconference centre, an information centre with electronic trade possibilities, a community electronic mail service and newspaper. There are 14 such Community Centres.

A variation of LINCOS operating in Bohechio, Dominican Republic involves a Village Area Network (VAN) also developed by the eDevelopment group of MIT in the US that provides information and communication services to an entire rural community supporting a range of roaming and fixed services. Schools, rural clinics, government offices, police stations, agricultural co-operatives, and local residences will be empowered with access to information and a new way to communicate with one other and the world at large.



Image: LINCOS

Celebration at the LINCOS Community Centre in San Marcos de Tarrazu

The VAN is centred around a LINCOS multipurpose community tele-centre and extends the LINCOS facilities with mobile handheld and fixed wireless services in strategic local centres such as schools and hospitals. Bohechio is located in the centre of Dominican Republic. The total population is approximately 7000 and the principal economic activity is agriculture. Only 5 telephone lines exist in the community.

The LINCOS telecentre has a 256 kbps VSAT satellite link connection to the Internet. A point-to-point link has been made between the LINCOS centre and the radio mast that houses an omni-directional antenna. An omni-directional antenna was placed on the top of the City Hall where a radio mast already exists. The antenna enjoys line of site to every part of the community. Fixed and mobile wireless stations, equipped with network interface cards supporting wireless Local Area Networking, allow members of the community to access network resources. The VAN coverage is roughly 11 square kilometres.

The actual LINCOS concept is related not only to Information Technology but also to a network of different community members who all use LINCOS technologies to create development opportunities for these communities. A health monitor, an environmental guardian, an information broker, a computer mediator are just some of the actual process facilitators available. In this initiative, LINCOS has the participation of private companies and 15 universities from Costa Rica, the USA and Germany.



The project innovates every day with new applications such as the new water disinfections system since many of the actual Lincos communities lack access to safe water. Karaoke and other entertainment applications are part of the wide range of applications available.

The LINCOS second generation concept builds on the original LINCOS concept and aims to stimulate new community and individual needs and attitudes in such a way that persons within the community become agents for change, thus contributing to a genuine process of personal and community development.

Last up-date: accurate according to web site July 2003

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Type of application

Uplink via radio link to the nearby tele-centre where the request is further handled via dial-up internet connection. Download via satellite (Category 3).

Coverage

The satellite service that is used is provided by the technology and research organisation, CSIR in South Africa.

Short description

Manguzi Wireless Internet is a project that provides Internet access, email and learning resources to 2 schools in a very remote area of South Africa's KwaZulu Natal province where no telecommunications infrastructure exists utilising a unique combination of radio and satellite broadcasting technologies. Partners in this project, apart from the Manguzi community organised in the MDIC, are WBS (Wireless Business Systems), Siyanda (satellite broadcaster), CSIR (Council for Scientific and Industrial Research), Kwazulu Natal Education Department and SchoolNet SA (NGO).

The Information and Communications Unit of the CSIR (icomtek) first established a tele-centre in the centre of the town called Manguzi. This tele-centre has been equipped with a phone shop consisting of a PABX with four incoming lines; five computers; printer; scanner and photo copier. Internet access is established via a dial-up link.

However, the community's desire was to have Internet available to the largest possible audience, including the students of the nearby rural schools Maputa Senior Primary School (400 children) and the Shayina Secondary School (1002 children) connected to the Internet. Traditional solutions such as telephone line, ISDN or leased line weren't appropriate for various reasons, amongst which the total absence of any telecommunications infrastructure. The additional requirement was that a solution had to be cheap.





The implemented solution consisted of a combination of radio communication and satellite broadcast technology. Each school was provided with a computer. Attached to this computer is a radio with its antenna, as well as a satellite receiver card and DSB dish. The Tele-centre has a small local area network and serves as the hub of the network because it already has Internet access. A computer was connected to the Tele-centre network to act as router. This machine has an Ethernet card installed and a radio connected. When a user at one of the schools wants to access the Internet, the request is relayed to the Tele-centre via the radio link where a Unix file-server dials on demand to execute the request. The requested information is then downloaded directly to the user's PC using satellite broadcasting technology. The solution is feasible due to the asymmetric nature of the data requirements of Internet applications. In addition to providing the schools with the infrastructure, the teachers were also trained in how to use a computer, utilise the Internet as an educational tool and to contact colleagues using email.

An important aim of the project was that the underlying technology should be completely transparent to the users. Teachers or learners should not have to worry about radios, satellite dishes or antennas in order to use the facilities. The users access the Internet and their email using Internet Explorer and Outlook by simply clicking on the relevant icon, as would any user attached to a local area network (LAN). A couple of young people in the community have been trained to support and maintain the infrastructure. The users use the facilities to access education-related information on the Internet as well as to contact other educators via email. Educational software on CD was also made available to the teachers at the schools participating in the project.

This project was limited to one PC at each of two schools. The schools are also quite close to the Internet access point. Developments are underway to increase the number of PCs supported at the remote site, the distances that can be covered and performance. Rollout will be in a cellular fashion with "base stations" - which will serve as the Internet access point - each with their own "outstations".

Last update: accurate according to web site July 2003

Multichoice Africa Foundation

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Type of Application

Multichoice Africa Foundation combines both Interactive Television and Data Broadcasting (Categories 2 and 3).

Coverage

Currently available in 8 Provinces of South Africa (Eastern Cape, Free State, Gauteng, Kwazulu-Natal, Mpumalanga, Northern Cape, Limpopo Province and North West Province). The Western Cape province will be included from 2003 onwards.



Short Description

In 2001, a number of MultiChoice social investment projects including the SHOMA Education Foundation were consolidated into the MultiChoice Africa Foundation, where they continue to employ MultiChoice Africa's expertise. The Foundation aims to expand opportunities by providing far-reaching access to technology, restoring the necessary human dimension to the technological progress of the country.

The Foundation provides educators in rural and disadvantaged communities with cutting-edge, locally developed electronic content, which assist teachers in developing well-rounded learners. The content is versatile in terms of delivery platform and can be streamed online, via satellite delivery in some cases or via a local area network (LAN). The teacher training programme operates from the premise of streaming e-content to centres countrywide owned, operated and maintained by provincial departments of education. Programme curriculum include multi-media teacher resources on Outcomes Based Education for the first 9 years of schooling and also 60 modules of e-content in the critical subjects of Maths and Science for the senior secondary level. The programme utilises extensive convergence of television, video and IP-based technologies and content is prepared in conjunction with the National and provincial Education Departments, as well as NGO's and Universities.

Provincial departments of education normally schedule training annually from February to October. The training applies a specific, three-tiered process of learning that continuously reinforces specific themes. The training facilities are made up of a dedicated space in either education department buildings, institutions or schools. In order to derive maximum benefit from the equipment made available in centres, a rotational timetable is used to expand the number of daily users.

In the broadcast component, a video of the specific learning theme is provided. The broadcast ends with a thought-provoking question that prompts the group into discussion. With this question, the aim is to actively engage the

recipients and negate passivity amongst them. Curriculum developers of the provincial education Department mediate the group discussions, whilst lead teachers facilitate in other centres.

The IP content requires a platform comprising of a server and workstations. Content is downloaded, either online via satellite or is accessed via CD on a LAN. The computer material provides digitised video and audio clips, which have been compressed, using MPEG technology. This convergence of computer and television technology confers greater flexibility to the learning process. Teachers work here individually on the computer and these sessions last approximately 45 minutes.

Thirdly there is a lesson development component. It is here that teachers have the opportunity to practice the theory learned in the broadcast and computer rooms. In this room teachers collaboratively develop their own lesson plans for the following week. The technology works as follows: educational material, designed to support the school syllabus, is prepared by recognised service providers and funded and project managed by the MultiChoice Africa Foundation. The Foundation and government agree on the preferred means of delivery.

Learner content

Over and above the educator content programme which the MCAF develops, a sister company also provides learner based electronic content. This content is available on line or CD format and comprises:

- grade R-12 curriculum based programmes
- examination paper databank
- on line mentoring facility and
- electronic library

This content is purchased on a commercial basis unlike the educator content which is free of charge. This is heavily discounted for use in public schools.

Last update: July 2003





Myeka School project

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Type of Application

Myeka provides Internet access over satellite (Category 5) and multicasting of data via satellite from InfoSat (Category 3).

Coverage

The satellite used is PAS-7 and covers large parts of Asia, Africa, Middle East, and Europe. However, in this project only the Myeka School in South Africa is involved. The South African region is covered with a Ku-Band capacity spot beam.

Short Description

Myeka High School is in the Valley of Thousand Hills in remote KwaZulu-Natal and is one of more than 16400 schools in South Africa without electricity or standard technologies. It has 850 students.

MYEKA Site



Images: Myeka

Through the convergence of solar, cellular and satellite technologies in 1998, Myeka created a computer laboratory equipped with PC technology. The classroom comprises five PCs linked to 20 monitors. Solar panels were erected by Solar Engineering Services, they were connected to the Dell PCs in a specific configuration saving 44% of the power that would be required if they were connected individually. The solar panels take care of the power. To enable Internet connectivity they use cellular technology for the outgoing signal and InfoSat provided them with the satellite technology for the incoming signal. In conjunction with the Learning Channel Campus, a Johannesburg company dedicated to empowering people through educational technology and a premier educational resource for South African high



schools, InfoSat allows for the data-casting of educational resources to the school's computer centre, using satellite technology to bypass the need for traditional land based communications infrastructure - sorely lacking in the rural Inanda Valley district. Included in the sponsored package is an installed satellite dish with receiver card, a satellite-ready server with the complete Learning Channel Website, as well as InfoSat-enabled email and a 24-hour connectivity segment. Dial-up requests are handled by a GSM modem, with information returned at high speed via the satellite link. The information is sourced via the Learning Channel web site. The site contains interactive lessons, virtual laboratories, downloadable textbooks, online assessments and so much more. Besides acting as a knowledge tool and revision aid, the site's chat forum also allows students to participate in group discussions and communicate with fellow learners countrywide.

Last update: July 2003

Plate-forme de ressources éducatives sonores (PRES, ex-Canal EF)

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Type of Application

Data broadcast (multimedia files to computer) via the AfriStar satellite from WorldSpace (Category 3).

Coverage

The target public of PRES is situated in Africa and in the Indian Ocean region.



Image: Worldspace Foundation

Footprint of AfriStar





Short Description

After a pilot phase of a few months, the project Canal EF turned into a real service in September 2000. After an experimental period of two years, an evaluation of the service took place. There appeared to be several problems:

- The radio partners didn't deliver much content.
- The target group was too large.
- The objectives of the project weren't clear: confusion between an educational radio and a radio to arouse awareness
- There were too few listeners.

As a result, a drastic reorientation of the project was necessary. Not focussing on the requirements of radio broadcast, the Agency plans to concentrate itself in the future on the broadcast of digital services via "data casting". In the upcoming months, a platform of educational audio resources (PRES – Plateforme de Ressources Educatives Sonores) will be put in place. These resources will be produced by and in the countries that are targeted and will be financed by the Agency. It will be broadcast via the radio partners, the Internet and a data channel of the Afristar satellite, that will permit reception and storage of the data (audio materials, texts, services) on PC's (connected with Hitachi receivers).

PRES will contain resources for long distance learning of adults, teachers and trainers. The platform's content will be defined in relation to the priorities in education and training that the French-speaking community has identified (knowledge of the French language, supplementary training of teachers, struggle against illiteracy, etc. As they are produced by the targeted countries, the resources will be adapted to the expectations and the needs of the public who can use them in different ways.

The new project's mission is to reinforce national competencies by using innovative technologies that respond to social needs. The first call for content will be launched in the beginning of 2004.

Last update: August 2003

Sat&Cllic

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Type of Application

The satellite communications infrastructure included a transmission platform and a hub located near Paris, which up-lined the educational bouquet of digital TV and internet IP data multiplexed in DVB/MPEG2 standard. The signal was transmitted in broadcast mode by one high power TPS transponder of the HOT BIRD 3 satellite of EUTELSAT to the SAT&CLIC terminals. The TV signal was decoded by set-up-box equipment. A satellite board installed in a standard PC decoded IP data. The PC could be used as gateway to be linked to any type of local network, (Categories 1,3 and 5).



Coverage

Coverage of the HOT BIRD 3.

Short Description

At the beginning of 1999, the Satel-IT programme was launched by the French Education, Research and Technology Ministry. In this framework the SAT&CLIC project, running from December 1999 until June 2001, submitted by LAGARDERE Group and TPS (Television Par Satellite), had been selected to demonstrate how the space systems could help in providing interactive multimedia services for educational applications: internet access, co-operative work, internet conferencing and interactive digital TV.

The SAT&CLIC project involved more than 200 educational establishments in France, including primary and secondary schools, universities, teachers training centres (IUFM) and resources centres (CNDP). The network was not expanded after June 2001 due to a lack of support from the new government.

During the project's lifetime, the LAGARDERE Group, through its media (Hachette Multimédia, educational publishers, ...) and technology partner companies from EADS Group (ASTRIUM, EADS Telecom ...), had developed a global SAT&CLIC offer which included a wide spectrum of educational services and multimedia products. Internet and broadband communications technologies were used for delivery of these services and products.

Satellite technology had been chosen because it offers the following advantages: an immediate availability on a large area especially for rural areas, the same service delivered for every users in this area, a low-cost terminal when using current DVB standard for digital TV technology. Moreover, satellite was found efficient in this educational context because it allowed multicasting data while operating in an asymmetric interactive transmission mode, which is well adapted to Internet applications such as browsing the web.

The SAT&CLIC bouquet of services included a set of IP broadcast and multicast services. They supported delivery of educational on-line applications and multimedia contents, developed by Hachette

Multimedia, LAGARDERE group publishers (Hachette, Didier, ...) and several associated partners. In addition, Digital TV s selected for educational purposes were provided by TPS.

SAT&CLIC provided a set of IP services, including:

- **Hi-Net** service providing internet access with satellite down link. Optimisation of satellite link performance was based on the use of proxies and caches.
- **Hi-Want** service enabled users to request for remote loading of internet web servers into local caches.
- **Hi-Cast** service supported secured data multicasting for distribution of any type of data to networked communities; applications were developed to support co-operative work between groups of teachers (intranet), and data base replication.
- **Hi-Channel** service for data streaming through dedicated satellite channel; applications were developed for broadcasting videoconference, live or recorded.

Others IP services deal with FTP server mirroring, distribution of news feed (newsgroups), multicast of Mbone programmes.

To take benefit from satellite transmission, and more generally from broadband telecommunication infrastructures, Hachette Multimedia provided dedicated educational applications, in collaboration with media companies of LAGARDERE Group, and many other public or private associated partners.

DIDACTUA was one of these on-line applications. DIDACTUA was a new multimedia service that gave access to:

- Educational services and contents associated to news events
- Educational libraries

Contents, structured by "modules", were linked to radio news, videos, TV resources, articles from newspapers, web sites and other specific resources produced by publishers.

Last update: June 2003





SchoolSat, Ireland

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Type of Application

SchoolSat is an example of 2-way internet via satellite and is based on the Digital Video Broadcasting (DVB) standard, which is deployed Europe-wide (and is becoming accepted as a worldwide standard) for digital television (Category 5).

Coverage

The SchoolSat service is based on Web-Sat (<http://www.web-sat.com>) equipment and operates over Eutelsat W3. It is being trialed in Ireland with a small number of representative schools in a remote region in the North-west part of the country. There are 9 secondary or Vocational schools taking part in Donegal County as well as the Donegal Education Centre.

Short Description

SchoolSat is an initiative which began in 2001 and which aims to improve Irish schools' access to the Internet by using an innovative two-way 'Internet via satellite' network. It is a direct response to the relatively poor level of connectivity to the Internet experienced by primary and secondary schools, despite the Irish government's stated intention to provide every Irish classroom with a broadband connection to the Internet. The expected outcome of the project was the establishment of a business and deployment plan for a fully operational and sustainable service for the Irish compulsory school sector based on a strategic mix of unicast and multicast services. In order to come to this business and deployment plan, a pre-operational satellite based service has been set-up and evaluated with 10 sites.

SchoolSat ran from December 2001 to February 2003 and was partially funded by the European Space Agency through the ARTES 3 Programme. The partnership consisted of prime contractor ATIT (Audiovisual Technologies, Informatics and Telecommunications, Belgium), NCTE (National Centre for Technology in Education, Ireland) and Web-Sat (Ireland). From February 2003 till June 2003 the project was extended thanks to further funding from the Department for Education and Science in Ireland. At the time of writing, discussions have just been concluded to extend this service for a further academic year, 2003-2004.

The satellite system that is used by all the sites involved allows the user to receive Internet services with a relatively small antenna (less than 1 metre diameter) and a PC equipped with a satellite modem anywhere within the footprint of the Eutelsat W3 satellite. This PC can be used as a gateway to connect multiple PCs to the Internet.

The system is supplied and serviced by Web-Sat in Dublin, a wholly Irish-owned company. It gives schools a fast connection to the Internet with up to 4Mb download to the school and 64 Kbits return.

The teachers and pupils in the schools taking part are using this improved access to research the World Wide Web for various school subjects and for carrying out projects on lots of different topics.



For many of the schools, this is the first time that they have been able to really use the Internet for educational purposes and it is really making a difference as to how the Internet is perceived in secondary schools. Digital content from a variety of sources, including data and video, is brought together into a managed content repository, www.schoolsat.net, where it is themed and channelled. A final report is publicly available about the operation and outcome of SchoolSat from: http://www.atit.be/dwnld/schoolsat_final_report2.pdf

Last Update: July 2003

St. Helens e-Learning Bus

Contact details

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Type of Application

Two-way Internet via satellite through VSAT technology from Hughes Network Systems (Category 5).

Coverage

The satellite used is the EUTELSAT W1. The bus can be used by all inhabitants of the town of St. Helens (near Liverpool, UK) and the surrounding villages.

Short Description

As one of 7 IT Learning Centres in Granada Television's 'IT's Never Too Late campaign', the St. Helens e-learning bus was launched on 10 November 2002, as the result of a unique partnership between St. Helens Rugby League Football Club, St. Helens College and Granada Television. The funding was provided by the UK Online initiative and the New Opportunities Fund.

The 'IT's Never Too Late campaign' is specifically aimed at: the young unemployed; long-term unemployed; ethnic minorities; people lacking in basic skills; lone parents; the disabled; giving them a chance to get back into learning when they may be reluctant to attend more formal venues. The campaign is founded on local partnerships and is using sport as the lure.

The purpose of the bus is to tackle the digital divide. St Helens is an industrial town and has large areas of people with low self-esteem who think that going to college is something of which they would not be capable. The bus will go out into their community and give them the confidence to sit at a computer, use email, surf the Internet, and use basic packages like Microsoft Office and learn how to stay in touch with friends and family.

Many of the courses are delivered through learndirect and can be accessed on-line. There are also other learning and promotional activities associated with the college and its principal sponsors. Dedicated courses that are delivered include IT, Skills for Life, and Business and Management. Some of the courses are chargeable (but not expensive) and some are free. On board the bus there is continuous support from 2 facilitator/tutors.

There are 12 workstations on the bus which are linked to the Internet. Computer games and other hi-



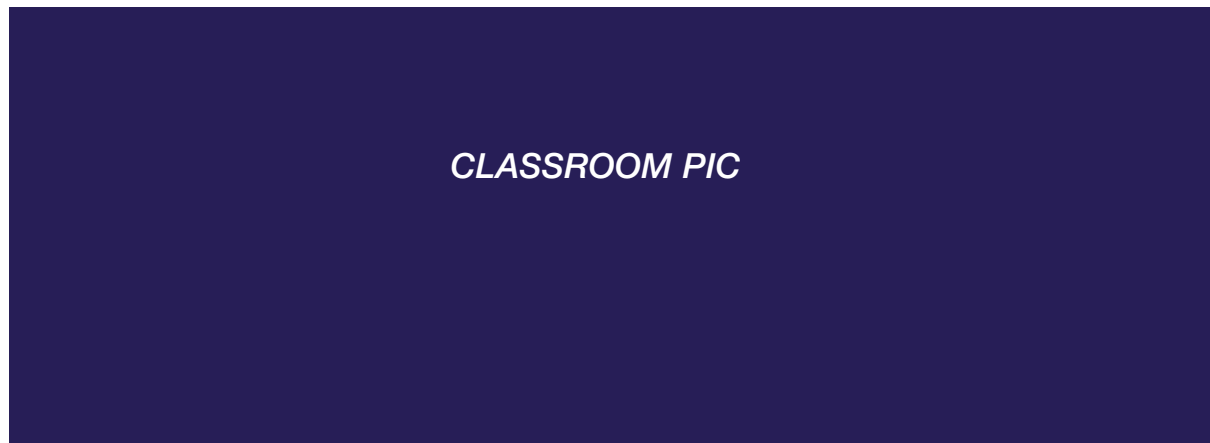


tech equipment are also available. The transmission bandwidth is relatively limited (about the same as an ISDN line), the download is approximately the same as a terrestrial broadband connection. The service is provided by Hughes Network systems. The bus travels around St Helens (12 miles from Liverpool) stopping at set location at set times. The Internet connection is established by a satellite dish that is permanently fixed to the roof. It automatically unfolds, seeks the satellite and locks onto it. The system tracks its location via GPS and has a built in compass to help it find the signal. The operator performs the operation from inside the bus using the MS2000 ISA server.

Current status

The initiative is becoming more and more popular and will continue as long as there is demand.

Last update: July 2003



Telesecundaria, Mexico

Contact details

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<http://edusat.ilce.edu.mx/>

Type of Application

Telesecundaria broadcast educational programmes or Educational Television via satellite (Category 1).

Coverage

The satellite used is the Satélite Solidaridad II, a government-owned satellite managed by the Ministry of Communications and Transportation.

Satélite Solidaridad II covers all of Mexico, the South of the United States, Central America and part of South America.



Short Description

Telesecundaria was launched in 1968 as a means of extending lower secondary school learning with television support to remote and small communities at a lower cost to that of conventional secondary schools. It is the oldest project of its kind in Latin America.

In recent years, Telesecundaria has been renovated and extended to primary school and technical teaching as well, through the System of Educational Television Via Satellite (EDUSAT). Three institutions collaborate to produce the televised programmes: the Telesecundaria Unit (Unidad de Telesecundaria, UT), the Educational Television Unit (Unidad de Television Educativa, UTE), and the Latin American Institute for Educational Communications (Instituto Latinoamericano de la Comunicacion Educativa, ILCE). Staff of the Telesecundaria Unit includes teachers, communications experts and specialists in the production of educational materials. The Educational Television Unit produces the televised components of Telesecundaria. The Latin American Institute for Educational Communications is responsible for a broad range of distance education programming, and publishes a bimonthly magazine that lists programming for all six channels of educational and cultural television that form Red EDUSAT (EDUcation via SATellite). Five channels are used for other educational and cultural purposes, with one channel being used to provide training for Telesecundaria teachers.

The Telesecundaria programmes are broadcast on Canal 11 according to the following scheme: From Monday to Friday courses from 8.00 AM until 14.00 PM, the programme is relayed between 14.00 PM and 20.00 PM. The programming scheme can be viewed on the EDUSAT website, accompanied by a short description of each course.

Some 33,500 reception centres, with decoders and television sets, have been set up throughout Mexico. Each Telesecundaria school has at least three television sets, a decoder to decompress EDUSAT's digital signal, and a 1.9 minimum meter external satellite dish. Larger schools are likely to have more TVs, and schools with more than five TVs require a second decoder. On average, the Telesecundaria schools have three teachers—one for each grade—and 22 students per grade. Students attend school 200 days a year, 30 hours a week. Each course takes approximately 15 minutes, afterwards students study the relevant material in a specially-designed textbook, followed by teacher-led discussions to help students fully understand the content of the course.

Last Update: Accurate according to web site July 2003

TELETUKS

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URL: <http://www.up.ac.za/telematic/teletuks/intro.htm>

Type of Application

TELETUKS is essentially an Interactive Television service (Category 2).



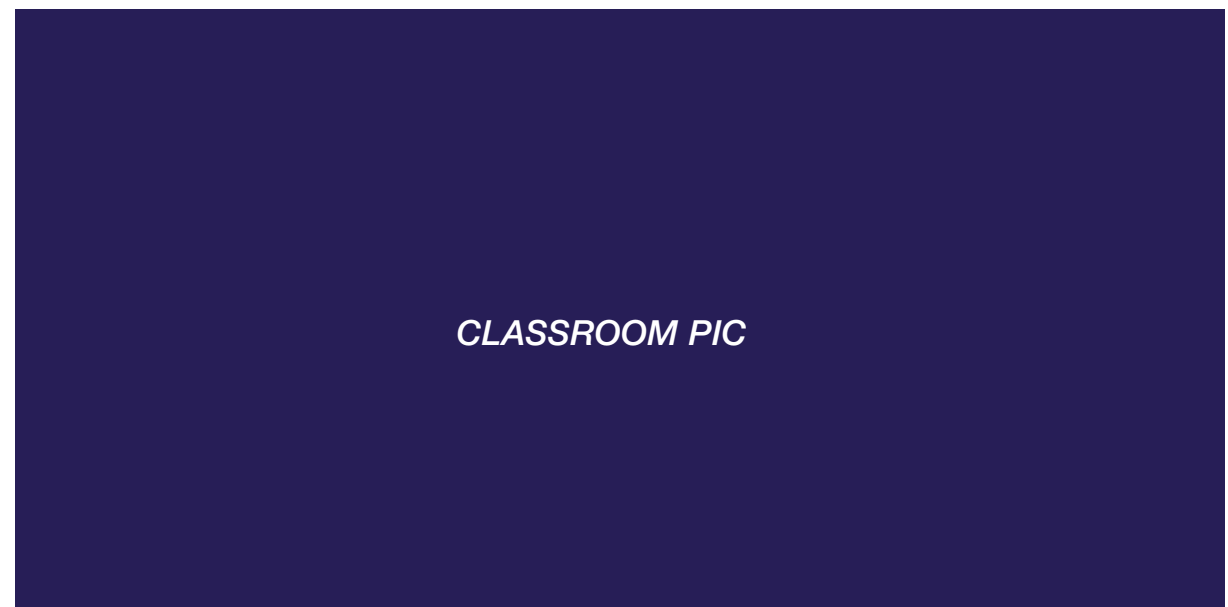


Coverage

PAS 7 (Ku-Band) from PanAmSat. The University signal is multiplexed with 58 other commercial channels and grouped in one of three bouquets of channels. The scrambling of the signal is done with the IRDETO algorithm technology. At present, the signal is only spot beamed to Southern Africa.

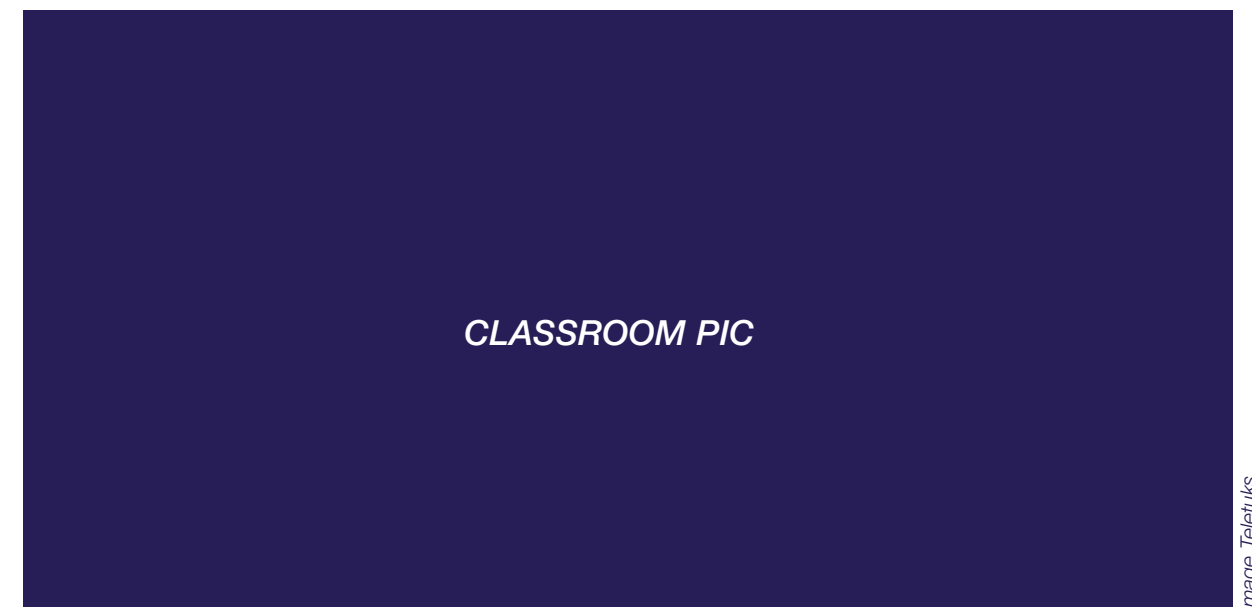
Short Description

The University of Pretoria has a history of investing in sophisticated educational technological applications. The Department of Telematic Learning and Education Innovation has used satellite transmissions, electronic networks, the Internet, and its virtual campus, to supplement traditional under and postgraduate teaching for the past 7 years. Such education innovations not only support flexible, life-long learning, but also make it possible to provide high quality education to learners, many in remote areas, who cannot be accommodated in traditional face-to-face teaching scenarios. The niche markets which the interactive transmissions serve are students enrolled for courses in the fields of education, nursing, African languages and some modules in other faculties



Teletuks classroom with TV

TELETUKS is a community-based project and broadcasts are currently beamed via digital satellite to 72 schools in the four inland provinces, namely Gauteng, Northern, North West, and Mpumalanga. These schools are primarily located in rural areas although some townships schools have also been equipped using sponsorship money. The transmissions can be viewed at any of the more than 72 viewing venues across the country or by anyone who has access to DSTV at home. Synchronous or asynchronous interactivity is possible as students can give feedback by phone, fax or email. The formal university programmes also includes print based materials.



TELETUKS Classroom

As a community service, TELETUKS also televises school lessons to senior secondary learners in an endeavour to help address some of the educational needs of the country and to help prepare potential students for the demands of tertiary study.

It is a free service aiming to supplement what educators do at schools by giving extra tuition in the "killer subjects" like Mathematics, Physical Science, Biology, English, Geography and Accounting. Career Guidance and Primary Health Care slots are integrated as well, dealing with issues like AIDS awareness and even ways of becoming involved in playing professional rugby! The intention of the programme is not to replace educators at schools, but to assist learners preparing for their final school-leaving exam in the more difficult aspects of the particular subject. The lessons are generic and aim to review, rather than introduce new content. Logistics, however, prevent printed support material being offered. The programme is currently aimed at senior learners aged 16 – 18 (Grade 11 & 12) who can watch 50-minute lessons in two subjects, four afternoons a week of the academic year. The lesson schedule is prepared a term in advance and sent to schools where the designated facilitator is expected to notify learners and make further arrangements regarding accessibility and operation of equipment. Apart from the weekly lessons, a winter and spring School are also scheduled during July and October school holidays. A total of 30 hours per subject is screened annually.

The providers of Teletuks argue that as a mass medium, television is more accessible to the average learner than computer technology. Within rural areas, learners are also more likely to make a personal investment in satellite technology - which could be shared by the community - rather than buy a PC that has a dedicated application.

Last up-date: July 2003





Vendors and Services in Africa.

7.0

This chapter will indicate the main satellite operators active on the African continent, it will describe how ISPs are using satellite for generic connectivity and will then indicate what current and emerging services exist for one and two-way connectivity in various African countries.

Satellite Operators 7.1

RASCOM

One of the on-going and important satellite initiatives in Africa is the proposed RASCOM satellite system. RASCOM (Regional African Satellite Communications Organisation), established in 1993, is an intergovernmental co-operative that provides satellite capacity to more than 40 member countries in Africa for the operation of their national and international public telecommunications services, including radio and television broadcasting services. The Organisation, which has its headquarters in Abidjan, Cote d'Ivoire, was established in 1992 during a meeting of African ministers of telecommunications following an intensive feasibility study that was facilitated by the Organisation of African Unity (OAU-OUA). RASCOM started initial operations by pooling and optimising satellite capacity leased at specially discounted prices mainly from Intelsat. The ultimate aim is to have a dedicated Africa-owned regional satellite system that can keep hard currency currently passed to satellite operators in other parts of the world within Africa while providing universal telecommunications access to Africans.

The principal objectives are:

- The provision of telecommunications services on a large scale in the rural areas of Africa by using appropriate technologies at lowest possible cost.
- The development of inter-urban links within the interior of each African country.
- The provision of direct major telecommunications links between all African countries (presently large volumes of traffic between African countries have to be routed via European countries at high cost)

Current position

The first of three satellites, the RASCOM Star, is planned to be in orbit by 2006. In total the project is expected to cost US\$630 million, of which US\$450 million is being provided by outside investors and US\$180 million by RASCOM.

The initiative supported by 44 countries including Nigeria and South Africa remains controversial. South Africa in particular is thought to be less than enthusiastic, as it appears to believe the services being offered by RASCOM are not competitive. Telekom SA argues that it can get better prices itself from Intelsat. South Africa currently accounts for more than 50% of telecommunications in Africa. It has been offered a 20% stake in RASCOMStar-QAF, a company owned by 26 private and state-controlled, mostly African, telecommunications companies for US\$ million. The Libyan Telecommunications Company, DPTC, has the largest stake of 30% in RASCOMStar-QAF, while the French company Alcatel Space has 12%. In March 2001, RASCOMStar-QAF officials gave South Africa 3 months to come up with the money and provide its technical specification requirements before Alcatel began building the satellite which was due to begin in May 2001. It appears construction will begin whether or not South Africa invests. In June 2003 RASCOM has achieved the financial closing triggering the effective start of the construction of the first RASCOM dedicated satellite. RASCOMStar-QAF will implement the first African dedicated satellite telecommunications system by 2006.

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





VITA-Connect

Volunteers in Technical Assistance (VITA) is an international NGO with over 40 years experience responding to the information needs of the poor. When, more than fifteen years ago, VITA became the first private voluntary organisation to apply low-cost, microelectronics and space technology to the dissemination of technical information for development and humanitarian purposes, it was taking a stand against the information-marginalisation of the rural poor. Based on that pioneering work, VITA became the only non-profit ever granted a satellite communications license by the FCC and it continues to be a leader in turning rhetoric into reality at the far edges of the digital divide. It was founded in 1959 by a group of engineers and scientists who believed that access to information and technologies is essential to improving the quality of life in developing countries.

Currently VITA is implementing long-term programmes in Benin, Mali, Moldova, Guinea, Morocco, and Ukraine. Other countries in which VITA has worked include Afghanistan, Belize, the Central African Republic, Chad, China, Djibouti, Honduras, Kenya, Indonesia, Liberia, Madagascar, Thailand, Sudan, Burkina Faso, Mali, the Philippines, Sierra Leone, and Zambia. Funding for these projects has come from both the public and private sectors.

VITA has developed and field-tested a satellite-based system, called Vita-Connect, capable of delivering communications and information services to remote communities having no access to line-based or wireless telephone service. The system uses store-and-forward email messages relayed to the Internet via non-stationary, low-earth orbiting satellites.

VITA's current 2-satellite system has the capacity to serve approximately 2500 remote rural ground stations that will be installed in schools, clinics, community centres, post-offices and local development organisations. Using satellites already in orbit, the system is ready for immediate deployment.

For further information, contact VITA's president, George Scharffenberger or VITA's director of informatics, Gary Garriott through vita@vita.org.

VITA's telephone number is: +1 703 276 1800

<http://www.vita.org>

AfriStar

WorldSpace Foundation (WSF) is a not-for-profit corporation established by WorldSpace, Inc., an international digital satellite radio company with services to Africa, Asia and Latin America (2001). WorldSpace Foundation and VITA have a memorandum of understanding under which they are developing joint projects with VITA-Connect providing interactivity (return channel) for WorldSpace Foundation's multimedia offerings. Initial collaboration is slated for Niger and Zimbabwe.

WorldSpace runs the Africa Learning Channel (ALC), which was launched in December 1999. A collective audio channel combines educational and social development programming from African NGOs and producers for broadcast to rural and isolated communities in Africa. It is broadcast via the AfriStar satellite, which has three beams that cover the entire continent of Africa and the Middle East. Each beam has a coverage area of approximately 14 million square kilometres.

The WSF Multimedia Service enables partner groups to transmit web-based text and images to targeted audiences in regions with limited or no Internet access. It became operational in March 2000. This service provides international, regional, and local NGOs working in the developing world with a means of sharing large amounts of information with their partners, field workers, and constituencies in a timely and cost-effective manner. When connected to a PC by a special adaptor, the WorldSpace receiver operates like a modem through which web-based multimedia data is transmitted from the satellite to the



PC. Images, text, audio clips and video streams are downloaded from the satellite to hard drives at the rate of 64 Kbps for a maximum download of 600 MB per day.

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

PanAmSat

PanAmSat is a 23 satellite GEO system that provides broadcast and telecommunications services to customers worldwide. Their main services include the distribution of cable and broadcast television channels, private communications networks for businesses and International Internet access. Additional services include ship-to-shore communications, videoconferencing, paging, satellite newsgathering and special event and sports broadcasting. PanAmSat's customers include broadcasters like the BBC, Disney, China Central Television, news organisations like Reuters, Internet Service providers in more than 30 countries and telecommunications providers in the USA, Latin America, Europe, Asia and Africa. Hughes Electronics are major shareholders of PanAmSat.

<http://www.panamsat.com>

Intelsat

Intelsat has currently a fleet of 24 satellites, which will be expanded soon to 32. It provides Internet access to 150 ISP's as well as television broadcast (including SNG, special events, studio-to-studio, direct-to-home). Intelsat also offers high quality digital voice, data, and multimedia communications for corporate networks.

Intelsat operate several satellites that have footprints covering parts of Africa. Intelsat 704 (IS-704 at 66 degrees) is representative of satellite operation in Africa and is used by several South African virtual teaching institutions including the University of Stellenbosch and the African Virtual University. In 1998, Intelsat donated a year of capacity to jump-start the AVU. The footprint covers most of the Southern African region, as well as most of the African region north of the equator.

In April 1998, Intelsat established New Skies Satellites (see below) as a wholly owned subsidiary.

<http://www.intelsat.com>

ARABSAT

ARABSAT is active in providing all types of satellite-based communications services to the Arab world, with special focus on non-commercial services like Telemedicine and distance learning. They are providing Internet services to IT centres in the poor and rural areas, hospitals and open universities but they are now, in particular, working with some local Governments to provide Internet to their schools and connect them to the main centre via Satellite. Egypt is already using ARABSAT for education, they are working with Jordan (Ministry of Education) and Saudi Arabia (The National Project for providing Internet to Schools). ARABSAT has started to provide high-speed, cost-effective Internet access and end-to-end communication services to ISPs, Telcos and broadcasters.

ARABSAT is offering three Internet services:

- The most robust, reliable, and dedicated tier Internet access available via two-way earth station; appropriate service for large Internet Service Providers, Telcos, and broadcasters.
- Cost-effective, reliable Internet delivery for emerging Internet Service Providers. Tier 2/3 access using remote earth station; appropriate service for small/medium ISPs, businesses, and governments.
- Low-cost, instant access to high-speed Internet via low-cost remote earth station; appropriate service for individual end users, small businesses, and schools.

ARABSAT also offers a VSAT service for voice, fax and data.

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





Inmarsat

Inmarsat supports links for phone, fax and data communications at up to 64 Kbps to more than 210,000 ship, vehicle, aircraft and portable terminals.

Inmarsat Ltd is a subsidiary of the Inmarsat Ventures plc holding company. It operates a constellation of geostationary satellites designed to extend phone, fax and data communications all over the world. The constellation comprises five third-generation satellites backed up by four earlier spacecraft. Today's Inmarsat system is used by independent service providers to offer a range of voice and multimedia communications. Users include ship owners and managers, journalists and broadcasters, health and disaster-relief workers, land transport fleet operators, airlines, airline passengers and air traffic controllers, government workers, national emergency and civil defence agencies, and peacekeeping forces.

The Inmarsat business strategy is to pursue a range of new opportunities at the convergence of information technology, telecoms and mobility while continuing to serve traditional maritime, aeronautical, land-mobile and remote-area markets.

Inmarsat's primary satellite constellation consists of four Inmarsat-3 satellites in geostationary orbit. Between them, the main ("global") beams of the satellites provide overlapping coverage of the whole surface of the Earth apart from the poles. The Inmarsat-3 satellites are backed up by a fifth Inmarsat-3 and four previous-generation Inmarsat-2s, also in geostationary orbit.

Inmarsat is now building its new Inmarsat I-4 satellite system, which from 2005 will enhance the existing Inmarsat Regional Broadband Global Area Network (RBGAN), operating now at a maximum data transfer speed of up to 144 kbps. From then on mobile data communications for Internet access, mobile multimedia and many other advanced applications at speeds up to 432 Kbps will be offered.

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

Eutelsat

Eutelsat's satellite infrastructure supports TV and radio broadcasts, the delivery of Internet backbone, push and cache services in Europe, and capacity for corporate networks, satellite newsgathering, telephony, mobile voice, data and positioning services. From its core market of Europe and the Mediterranean Basin, Eutelsat has expanded its market presence into the Middle East, Africa, southwest Asia, North and South America. Eutelsat's in-orbit resource include 20 satellites positioned in geostationary orbit between 5 degrees West to 76 degrees East and providing coverage from the Americas to the Indian-subcontinent. Eutelsat also commercialises capacity on three satellites operated by other companies (Loral Skynet, Telecom Italia and Russian Satellite Communications Company). It has invested in three additional satellites that will be launched in the coming 12 months.

<http://www.eutelsat.com>

SES-Global

Société Européenne des Satellites S.A. (SES) is the operator of ASTRA, Europe's leading direct-to-home Satellite System. Via thirteen satellites at the orbital positions of 5.2°, 19.2°, 23.5°, 24.2° and 28.2° East, ASTRA transmits in analogue and digital format more than 1000 television and radio channels as well as multimedia and Internet services to an audience of more than 89 million homes throughout Europe.

SES is a pioneer of satellite broadband services through SES Multimedia, a wholly owned subsidiary. SES Multimedia operates the ASTRA-NET platform, enabling service and content providers to transmit data directly, via satellite, to personal computers in businesses and homes across Europe.

The ASTRA fleet consists of thirteen satellites which are located at the orbital position of 5.2°, 19.2°, 23.5°, 24.2° and 28.2° East. ASTRA currently covers only Europe including Eastern Europe. In order to



provide global connectivity to their customers and users, SES are expanding ASTRA's geographic reach. More powerful satellites, such as ASTRA 1KR, to be launched in the second half of 2005, will increase ASTRA's coverage area in the European core market.

SES is also a major shareholder in:

- AsiaSat, the leading satellite system in the Asian/Pacific region (34.10% since January 1999). The combined footprints of ASTRA and AsiaSat provide access to 74% of the world's population in Europe, Asia and Australia.
- Nordic Satellite AB (NSAB), operator of the Scandinavian SIRIUS satellite system (50% since October 2000)
- Star One (formerly Embratel Satellite Division), owner and operator of Brasilsat, the largest satellite fleet over Latin America (19.99%, also since October 2000).

Through its strategic investments in AsiaSat, NSAB and Star One, SES will be able to interconnect the European ASTRA and SIRIUS satellites with the Asian/Pacific AsiaSats and the American AMERICOM satellites to offer satellite broadband services spanning four continents.

<http://www.ses-astra.com/>

<http://www.ses-global.com/>

Hughes Electronics

Hughes Electronics Corporation is a world-leading provider of digital television entertainment, broadband services, satellite-based private business networks, and global video and data broadcasting. Hughes owns 81% of PanAmSat. One of its main units is Hughes Network Systems, a supplier of satellite-based private business networks. It is also a producer of set-top receivers for DIRECTV and provides the DirecPC satellite-based Internet access service. Hughes Network Systems provides a wide array of cost-effective global broadband, satellite, and wireless communications products for home and business. Through its innovative ground and satellite-based communications networks, HNS tries to set the standard for the next generation of high-speed communications including video, data, voice, multimedia and internet services.

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

New Skies

New Skies Satellites N.V. (New Skies) is a wholly independent satellite operator with five satellites in key orbital locations around the globe. New Skies operates NSS-6, NSS-7, and NSS-806 in the Atlantic Ocean region, NSS 703 in the Indian Ocean and NSS-5 in the Pacific Ocean region. These satellites provide complete global coverage at C-band, and high-powered Ku-band spot beams over most of the world's principal population centres. New Skies Satellites N.V.'s (New Skies) global fleet of C- and Ku-Band satellites are suited for Internet, multimedia and corporate data transmission, and point-to-multipoint distribution of video to cable head ends around the world.

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

Intersputnik

Intersputnik is an intergovernmental organisation, formed in 1971 to provide satellite telecommunications for the Soviet Union and other socialist countries around the world. Recently, Intersputnik has adopted a more open, commercial policy and many more countries have joined.

In mid 1997, Intersputnik formed a joint venture, Lockheed Martin Intersputnik, with Lockheed Martin which launched its first satellite in 1999.





Intersputnik's space segment is based on six satellites deployed in the geostationary arc extending from 14° W to 142.5° E. The satellite fleet consists of Express and Gorizont series spacecraft as well as the new generation LMI-1 and Express A satellites.

Over 70 trunk earth stations, four monitoring stations and a ground control centre operate in the Intersputnik system.

Intersputnik provides satellite capacity for establishing international, domestic and regional communications services including PSTN, VSAT networks, television/radio broadcasting and high speed Internet access.

Currently Intersputnik is planning a major expansion using up to 100 small geostationary satellites.

www.intersputnik.com

Europe*Star

Europe*Star is a joint venture between Alcatel Spacecom (51%) and Loral Space and Communications (49%).

Europe*Star leases wholesale transponder capacity for Internet and other broadband data applications, and for television and radio services. As a satellite owner-operator in the purest sense, Europe*Star's services are exclusively based around the provision and management of transponder capacity on our growing fleet of geo-synchronous satellites.

Satellites already in-service or planned include:

- Europe*Star 1 came into service in January 2001 at Europe*Star's 45° East orbital slot, the first satellite in a US\$450M programme that includes two satellites and ground segment. The satellite provides high-power coverage within and between Europe, Southern Africa, the Middle East, the Indian subcontinent and South East Asia
- Europe*Star B was brought into service towards the end of 2000 at the 47.5° East orbital slot. It provides cost-competitive point-to-point connectivity within Europe, with its primary market being Internet backbone access for Central and Eastern Europe.
- Applications include DTH TV and programme contribution, Internet backbone, and interactive services using small two-way VSATs.

www.europestar.com

ISPs and Satellite Links 7.2

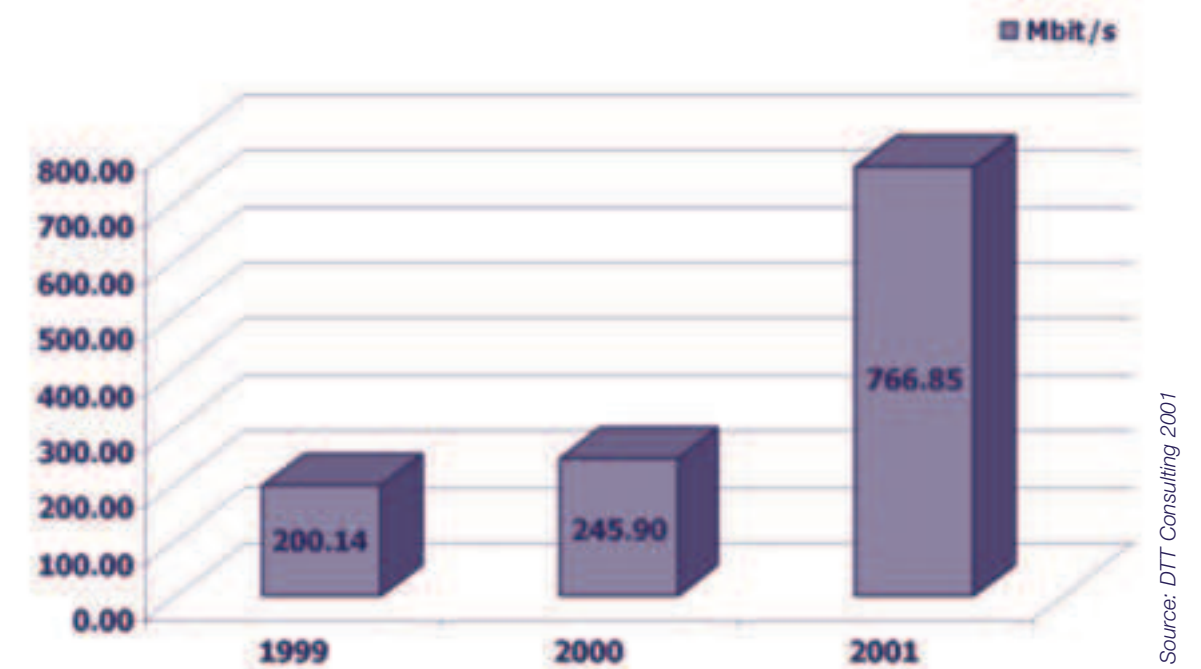
The level of access to the Internet is on the increase. There are now about 13 African countries with more than 100,000 Internet subscribers, 24 countries with more than 10,000 and 14 countries with less than 10,000 subscribers - Liberia, Somalia, Comoros, Central African Rep., Chad, Guinea-Bissau, Lesotho, Burundi, Congo (Democratic Republic of the), Eritrea, Mauritania, Sierra Leone, Sao Tome and Principe, and Seychelles²⁴. Most African capitals now have more than one ISP and in early 2001 there were about 575 public ISPs across the

region (excluding South Africa, where the market has consolidated into 3 major players with 90% of the market and 75 small players with the remainder). Fourteen countries had 5 or more ISPs, while seven countries had 10 or more active ISPs: Egypt, Kenya, Morocco, Nigeria, South Africa, Tanzania and Togo, and 20 countries had only one ISP. Although Ethiopia and Mauritius are the only countries where a monopoly ISP is still national policy (i.e. where private companies are barred from reselling Internet services), there are other countries in which this practice still

²⁴ ITU World Telecommunications Indicators 2003



continues, predominantly in the Sahel sub-region where markets are small. Increasingly, Internet Service Providers are using satellite services for Internet connectivity and Africa has been a big area of growth since the beginning of this century. However the impending launch of new fibre capacity serving Southern Africa (including Africa One) may dampen growth.



Growth in Satellite Traffic for ISPs in Africa

In general the demand for satellite capacity for satellite links to backbone has been for C-Band. Even drier areas suffer from rain-fade because of downpours, making Ku and Ka less effective. A number of satellite operators such as Europe*Star and Eutelsat offer Ku-band steerable spot beam capacity that can be used to serve Southern Africa. Telecoms regulation is usually rudimentary in sub-Saharan Africa and is a key issue. It is also quite common for ISPs to operate unlicensed or un-authorised satellite links to backbone.

7.2.1 Country reports

A small number of countries have been selected for further investigation. These countries are not chosen for any particular reason apart from the fact that our reports demonstrate how much variation exists with regard to satellite and use of IT generally within the African continent.

Annex 1 contains a comparison of various relevant indicators (population, economy, education and ICT) for the selected countries and the UK.





Egypt

	Egypt
Population	65,643,000
Rural population (% of total population)	57
Urban population (% of total)	43
Households	14,033,000
GNI per capita, PPP (current international US\$)	3,710
Gross domestic product (GDP) (in Million US\$)	86,120
Public spending on education, total (% of GDP)	N/A
Primary education, pupils	7,856,340
Pupil-teacher ratio, primary	22
Secondary education, pupils	8,323,597
Personal computers installed in education	48,816
Annual telecommunication investment (in Million US\$)	608
Daily newspapers (per 1,000 people)	31
Radios (per 1,000 people)	N/A
Television sets (per 1,000 people)	217
Television equipped households	12,407,000
Cable television subscribers	0
Television receivers	15,400,000
Personal computers (per 1,000 people)	15
Main telephone lines per 100 inhabitants	11
Total telephone subscribers per 100 inhabitants	18
Residential monthly telephone subscription (US\$)	1
Residential telephone connection charge (US\$)	126
Telephone mainlines, waiting list	583,254
Telephone mainlines, waiting time (years)	2
Business telephone monthly subscription (US\$)	1.57
Business telephone connection charge (US\$)	252
Mobile phones (per 1,000 people)	43
Cellular connection charge (US\$)	126
Cellular monthly subscription (US\$)	16
Cellular - cost of 3 minute local call (peak) (US\$)	0.01
ISDN subscribers	9,766
Internet users (estimated)	1,500,000
Internet hosts	3,061
Internet service provider access charges (US\$ per 30 off-peak hours)	9
Internet telephone access charges (US\$ per 30 off-peak hours)	0.14

Egypt has been seen for many years as the communications centre of the Middle East, a position underlined through the leading role it has played in the Nilesat25 project. Telecom Egypt, one of the few African countries to offer an ISDN service. (www.telecomegypt.com.eg), still enjoys a monopolistic position in the telecoms arena however Egypt also has an independent regulator and there are several increasingly active commercial contenders. Egypt intends to liberalise all telecoms by 2005, removing Telecom Egypt's monopolies over PSTN and (partial) monopoly over international connectivity in that year. Egypt accounts for 25% of the population of the Arab world.

Egypt began issuing licences for VSAT networks in the mid-1990s. However, the country has a limited installed base of VSAT earth stations. Various sources suggest that the installed base is around 100 units nationwide, excluding any two-way Internet access terminals. In 2002 it was reported by DTT Consulting that only two companies hold VSAT licences in Egypt: They are Alkhan (also known as Alkan) and ESC. The latter

²⁵ The Egyptian-based satellite operator, Nilesat, provides a regional DBS platform that covers not just the Arab world but also Turkey and Iran. It operates two Ku-band satellites, Nilesat 101 and Nilesat 102, both at 7° West.



is an acronym for the Egyptian Space Communications Company (www.esc.com.eg). There is understood to be another VSAT network provided by RITSEC26. This was, in its initial form, set up to connect 6 information centres in rural governates in Upper Egypt to the Internet. According to Martin Jarrod of the Global VSAT Forum, Egypt is considering reform of its VSAT policies and regulations.

Egypt has a lively and well established Internet sector and one factor that is almost certainly not now inhibiting Internet growth are Internet access charges; there are a number of ISPs offering free net services, making their revenues from revenue sharing arrangements with Telecom Egypt. There are approximately 40 ISPs²⁷ in Egypt, with most increasingly dependent on fibre over satellite through Sea-Me-We 2 and 3 and the regional Alitar-Brytar (Aletar-Brytar) link (connecting Egypt, Syria and Lebanon). There has been marked change in this regard over the past 2 years. In 2001, most ISPs still depended heavily on satellite connectivity to the backbone. However it looks as if the use of satellite links to connect Egyptian ISPs to backbone is now nearly if not completely obsolete and research carried out by DTT consulting in 2002 failed to identify a single one using a satellite link although admittedly, the trace route source base was the UK rather than the USA. Anecdotal evidence from a number of ISP web sites suggest that some are still using satellites, maybe for backup or US-Egypt paths.

According to African Internet expert Mike Jensen, in 2002 Egypt overtook South Africa as the African country with the most international bandwidth (550 MBit/s vs 380 MBit/s), following the launch of government backed international connectivity provider, Nile-Online.

There has been a small but well established market for hybrid Internet access services in Egypt, starting some years ago with ZakSat. It is clear that a number of ISPs have used these services to provide a low bandwidth connection to Internet. Zaknet has since evolved into Shownet. Subsequent services to have been offered include those from Menasat which is available from Nilesat 101. Menasat is a joint venture between Nilesat (50%) and the ISP MenaNet

Communications (45%) and its aim was to provide "Broadband and Internet services" to the Middle East and North Africa. The service uses a Nilesat space segment. MenaNet is now owned by the African Lakes Corporation but retains its own separate identity. It is reported to be Egypt's second largest ISP. In early 2001 it was reported to have had 7,300 dial-up subscribers and 9,000 users of its Freenet service, then limited to email. Kuwait-based Falconstream is available in Egypt and has had three agents there. It offers both hybrid and two-way satellite-based access.

DirecPC is distributed in Egypt by Dubai-based Bond Communications. United Communications is an Egyptian company which, until early 1999, was ZakNet's partner in Egypt, selling ZakNet's technology to ISPs and larger organisations in the country. However, it decided to go its own way in 1999 and launch two services: PC SkySat, a hybrid access service, and I-SkySat. The latter is a satellite simplex link aimed at ISPs, corporate companies, universities and other large organisations. United is now offering a two-way Internet access service under the brand name PC-SkySat. This is described as a bundled package, offering corporate customers a one-stop-shopping resource for satellite space segment and a dedicated Internet backbone connection. Direct links between a customer's point of presence and a major Internet backbone network can be made at speeds ranging from 64 Kbps bursting to 256 Mbps.

PC-SkySat Hybrid is, as its name implies, the new brand name for the company's hybrid access service.

HNS now has a presence in the Egyptian market for its DirecWay two-way Internet access service. It is using the HNS Eutelsat W1 platform at 10° East. The hub for the service is located in Griesheim in Germany. HNS's partner in Egypt is EgyptSat (www.egyptsat.com - this web site is largely in Arabic). Costs for the HNS equipment in 2002 were US\$2,450 plus US\$195 delivery for the earth station and monthly subscription fees starting at US\$195 for 128 KBit/s (both ways) rising to US\$400 a month for the full service.

Last Update: July 2003

²⁶ Regional Information Technology and Software Engineering Centre, an Arab regional R&D and Development Organisation

²⁷ Reference DTT consulting May 2002





Ethiopia

	Ethiopia
Population	67,347,000
Rural population (% of total population)	84
Urban population (% of total)	16
Households	12,874,000
GNI per capita, PPP (current international US\$)	720
Gross domestic product (GDP) (in Million US\$)	N/A
Public spending on education, total (% of GDP)	5
Primary education, pupils	6,650,841
Pupil-teacher ratio, primary	55
Secondary education, pupils	1,495,445
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	35
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	189
Television sets (per 1,000 people)	6
Television equipped households	250,000
Cable television subscribers	N/A
Television receivers	370,000
Personal computers (per 1,000 people)	1
Main telephone lines per 100 inhabitants	1
Total telephone subscribers per 100 inhabitants	1
Residential monthly telephone subscription (US\$)	1
Residential telephone connection charge (US\$)	36
Telephone mainlines, waiting list	155,208
Telephone mainlines, waiting time (years)	8
Business telephone monthly subscription (US\$)	2.01
Business telephone connection charge (US\$)	36
Mobile phones (per 1,000 people)	0
Cellular connection charge (US\$)	99
Cellular monthly subscription (US\$)	6
Cellular - cost of 3 minute local call (peak) (US\$)	0.02
ISDN subscribers	0
Internet users (estimated)	50,000
Internet hosts	43
Internet service provider access charges (US\$ per 30 off-peak hours)	94
Internet telephone access charges (US\$ per 30 off-peak hours)	0.24

Ethiopia is one of the only African countries where a monopoly ISP, Ethio Internet run by the State Ethiopian Telecommunications Corporation, still exists. However there is some evidence that the government at time of writing is considering opening up the market. Ethio Internet (www.telecom.net.et) had 2590 dial-up or dedicated line accounts as at the end of April 2000 and was then using 512 Kbps of satellite capacity, probably on a Global One/Spring link. However as is the case throughout Africa, many Internet accounts are shared and so it is rather difficult to estimate the exact number of Internet subscribers in Ethiopia.

Last Update: July 2003



Gambia

	Gambia
Population	1,372,000
Rural population (% of total population)	68
Urban population (% of total)	32
Households	175,000
GNI per capita, PPP (current international US\$)	1,680
Gross domestic product (GDP) (in Million US\$)	434
Public spending on education, total (% of GDP)	3
Primary education, pupils	156,839
Pupil-teacher ratio, primary	37
Secondary education, pupils	56,179
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	7
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	N/A
Television sets (per 1,000 people)	3
Television equipped households	19,000
Cable television subscribers	N/A
Television receivers	20,000
Personal computers (per 1,000 people)	13
Main telephone lines per 100 inhabitants	3
Total telephone subscribers per 100 inhabitants	10
Residential monthly telephone subscription (US\$)	2
Residential telephone connection charge (US\$)	51
Telephone mainlines, waiting list	10,884
Telephone mainlines, waiting time (years)	6
Business telephone monthly subscription (US\$)	2.23
Business telephone connection charge (US\$)	51
Mobile phones (per 1,000 people)	41
Cellular connection charge (US\$)	19
Cellular monthly subscription (US\$)	16
Cellular - cost of 3 minute local call (peak) (US\$)	0.05
ISDN subscribers	N/A
Internet users (estimated)	18,000
Internet hosts	568
Internet service provider access charges (US\$ per 30 off-peak hours)	18
Internet telephone access charges (US\$ per 30 off-peak hours)	2.70

The local PTT, Gamtel (www.gamtel.gm) acts as the country's regulator and sole supplier of basic telecommunications. However it is not a complete monopolist as it competes with QaNET, Gamtel supplies the international link for QaNET (run by Quantum). Both Gamtel and QaNet operate via GAMTEL's Satellite station in Abuko, using Teleglobe as their service provider with a connection point in Canada. They have access to 2.084 Mbps from the backbone with .768 Mbps return capacity, although note this is a best guess with regard to the return path from Gambia to Canada, as few sources ever state this return path.



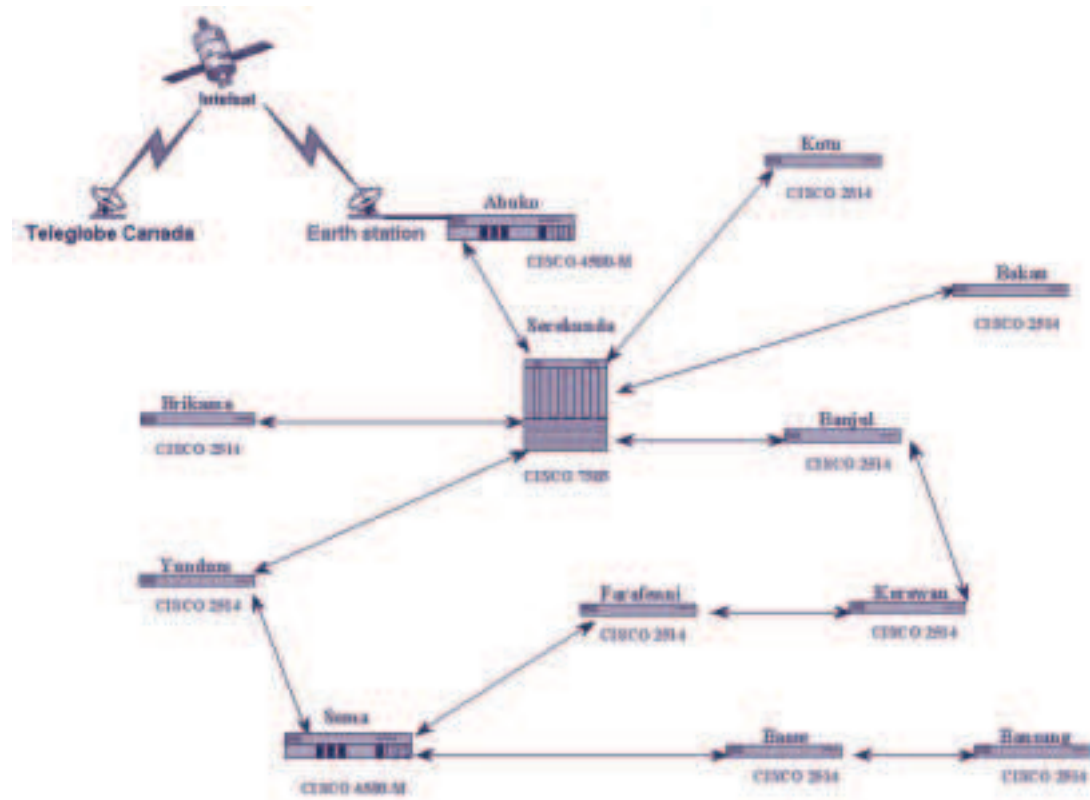


Image: Gamtel

The GAMTEL Internet Backbone Structure

Full high speed Internet came to The Gambia late in 1998 when the World Bank/UNDP supported Gateway project was opened for the private sector and for individuals. Access nodes are available in the major towns around The Gambia which provide standard PoP3 and TCP/IP.

A recent survey on Internet access in Gambia revealed that youth, who constitute about 50% of the population, are lagging behind in the use of the Internet. The survey found that the majority of Internet users were aged between 36-45 and approximately lived mainly in the greater Banjul area (excluding Brikama) with the remaining 8% located elsewhere. The survey further revealed that only 20% of 5000 Internet users access the Internet in their homes with the rest accessing it in their offices or in cyber cafés operated by both GAMTEL and Quantum.

Last Update: June 2001

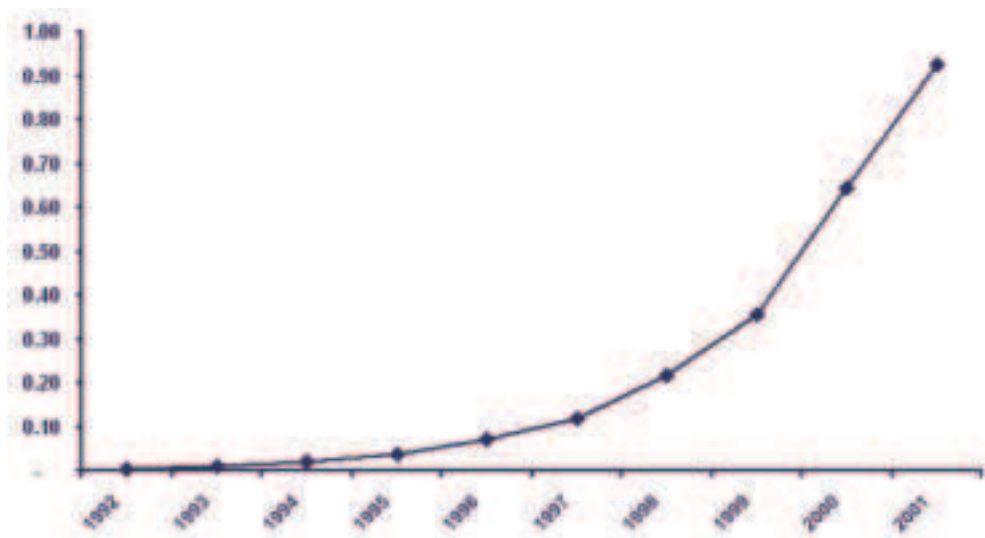


Ghana

	Ghana
Population	21,674,000
Rural population (% of total population)	63
Urban population (% of total)	37
Households	4,463,000
GNI per capita, PPP (current international US\$)	2,000
Gross domestic product (GDP) (in Million US\$)	4,380
Public spending on education, total (% of GDP)	N/A
Primary education, pupils	2,477,990
Pupil-teacher ratio, primary	33
Secondary education, pupils	1,031,402
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	38
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	N/A
Television sets (per 1,000 people)	118
Television equipped households	920,000
Cable television subscribers	6,000
Television receivers	1,100,000
Personal computers (per 1,000 people)	3
Main telephone lines per 100 inhabitants	1
Total telephone subscribers per 100 inhabitants	2
Residential monthly telephone subscription (US\$)	-
Residential telephone connection charge (US\$)	56
Telephone mainlines, waiting list	154,782
Telephone mainlines, waiting time (years)	N/A
Business telephone monthly subscription (US\$)	0.35
Business telephone connection charge (US\$)	56
Mobile phones (per 1,000 people)	9
Cellular connection charge (US\$)	37
Cellular monthly subscription (US\$)	7
Cellular - cost of 3 minute local call (peak) (US\$)	0.03
ISDN subscribers	156
Internet users (estimated)	40,520
Internet hosts	313
Internet service provider access charges (US\$ per 30 off-peak hours)	36
Internet telephone access charges (US\$ per 30 off-peak hours)	0.38

The overall telecommunications situation in Ghana has significantly improved since 1994, but according to ITU indicators, Ghana seems to be performing below the average for Sub Saharan African countries (excluding South Africa) for indicators such as main lines per 100 inhabitants, although that this does not reveal a complete picture of the service provision and quality. The number of mobile phone subscribers for example is growing faster than elsewhere in the region, although that uptake was hindered by serious conflicts related to interconnection costs between the different network operators.



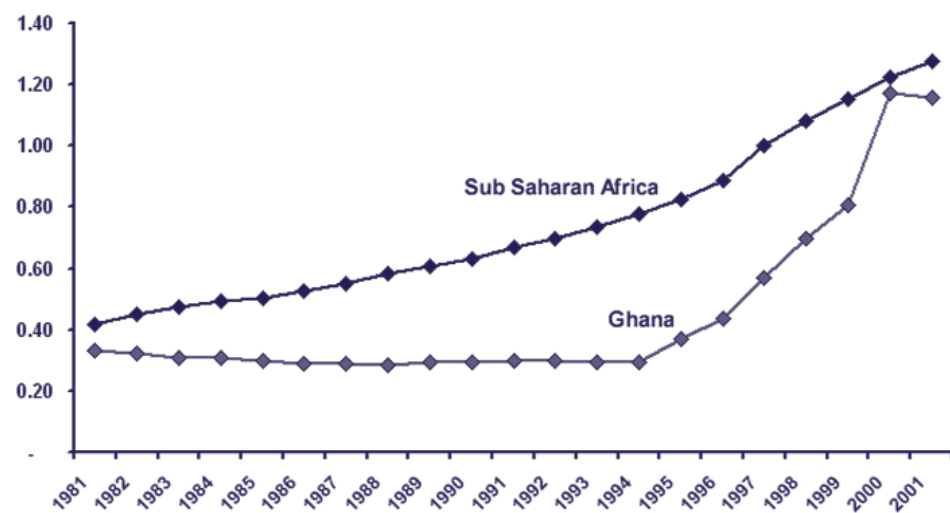


Source: ITU 2003

Number of Mobile Phones per 100 Inhabitants

Since the changes of management within Ghana Telecom in the late Nineties, ambitious plans were drafted, initially leading to an important increase in services and subscribers, showing faster growth than anywhere else in the region. The management of Ghana Telecom however did not meet the objectives set by the Government and was replaced by a new management team.

New performance agreements between the Government of Ghana and Ghana Telecom are expected to show effective growth results from 2003 onwards. These agreements require the telecom operator to expand the network with 400,000 subscriber lines before end of 2005, "in order to extend telephone services to every town with a Senior Secondary School or Teacher Training College, for Internet and other applications."



Source: ITU 2003

Number of Telephone Lines per 100 Inhabitants

Since the deregulation offered competitors the possibility to start providing telecommunication services, Voltacom, a subsidiary of the state-owned electricity company, Volta River Authority, is challenging the 2 existing providers (Ghana Telecom and Westel). Voltacom has a license for data transmission, and owns a fibre network that runs alongside its power lines to all district capitals. This network would provide opportunities to connect especially areas with poor services to date.



There has been a lot of activity in relation to VoIP (Voice over Internet Protocol) and the Independent regulatory agency in Ghana, the National Communications Authority, has forced the closure of ISPs for providing VoIP services. This was largely because of the threat such services posed to the dominant fixed line carriers in the country, namely Ghana Telecom and Westel.

The Government of Ghana has been considering the installation of a Communications Infrastructure Company, that would concentrate all available infrastructures for telecommunication services (the core telephone network, the existing backbone and trunk networks, the wireless infrastructure, but also the Voltacom fibre network) under one single management with the objective to avoid unfair and unhealthy competition, dilution of limited resources, and redundant offerings in certain areas. The present owners of the infrastructure networks are divided about this plan. It is unclear what will happen with the CIC and until this becomes clear, providers seem to be in a state of limbo.

In 2003 the Internet Service Provider InternetGhana has started to advertise DSL connectivity on its website, for rates ranging from 75USD to 250USD depending on the type and quality of service. The DSL seems to be available in some larger towns (Accra North, Central and Cantonment, Adum and Takoradi) and is announced to become available soon in Cape Coast, Ho, Koforidua, Kumasi (UST) and Sunyani. This same provider is also experimenting with wireless access technologies using GPRS.

Recent estimates of the number of Internet users in Ghana indicate that there are about 40,000 subscribers. However the number of Internet users must be far higher due to the extensive use of wireless links and university networks, as well as the exploding use of Internet cafes. International Internet connectivity in Ghana is rather limited (around 6 Mbps), the capacity comes mainly via a 2 Mbps VSAT link and connectivity to the SAT3 West African fibre optic cable with a capacity of 2 times 2.5 Gbps. Although that there are a large number of ISPs (in

2001 there were 29 companies licensed as ISPs) but many of them have never begun to operate.

The following are some of the main active operators.

- NCS (<http://www.ghana.com.gh>) was the first Internet service provider in Ghana, using initially mainly VSAT for international connectivity.
- AfricaOnline (<http://www.africaonline.com.gh>) is part of the continent wide ISP AfricaOnline using Ghana based GS Telecom satellite services for international connectivity.
- Intercom Data Network IDN (<http://www.idngh.com>)
- GDT Ghana (<http://ghana.g-d-t.com>) is part of the US-based but Africa oriented Global Data Technology Corporation
- The Ghana Telecom owned ISP Ghanatel (<http://www.ghanatel.net>) gets its gateway and management services provided by NCS.
- InternetGhana (<http://www.internetghana.com>) deliver what they claim to be Ghana's largest dedicated Internet Bandwidth. Part of the backbone is now via SAT-3/WASc submarine cable from Accra, Ghana to Sesimbra, Portugal and further via TAT 14 to the Sprint point of presence in NYC, USA. They retain satellite access for resilience.
- Simbanet (<http://www.simbanet.net>) is a company with offices in various African countries providing enterprise level internet solutions based on VSAT Satellite technologies.

Regulations governing the deployment of two-way satellite-based Internet services using very small aperture terminals (VSATs) have allowed 2-way satellite Internet providers to start offering services in Ghana. However the cost of these (5000US\$ installation cost, 150US\$/month running cost) have not resulted in a massive deployment so far.

Last update: October 2003





Kenya

	Kenya
Population	31,930,000
Rural population (% of total population)	65
Urban population (% of total)	35
Households	6,938,000
GNI per capita, PPP (current international US\$)	990
Gross domestic product (GDP) (in Million US\$)	10,356
Public spending on education, total (% of GDP)	6
Primary education, pupils	5,699,956
Pupil-teacher ratio, primary	30
Secondary education, pupils	1,251,205
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	51
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	221
Television sets (per 1,000 people)	26
Television equipped households	697,683
Cable television subscribers	15,000
Television receivers	812,928
Personal computers (per 1,000 people)	6
Main telephone lines per 100 inhabitants	1
Total telephone subscribers per 100 inhabitants	5
Residential monthly telephone subscription (US\$)	6
Residential telephone connection charge (US\$)	29
Telephone mainlines, waiting list	133,981
Telephone mainlines, waiting time (years)	8
Business telephone monthly subscription (US\$)	5.59
Business telephone connection charge (US\$)	29
Mobile phones (per 1,000 people)	19
Cellular connection charge (US\$)	32
Cellular monthly subscription (US\$)	10
Cellular - cost of 3 minute local call (peak) (US\$)	0.07
ISDN subscribers	N/A
Internet users (estimated)	500,000
Internet hosts	2,963
Internet service provider access charges (US\$ per 30 off-peak hours)	66
Internet telephone access charges (US\$ per 30 off-peak hours)	0.46

Kenya has one of the more advanced Internet environments and infrastructures in Africa. DTT consulting estimates that there are 16 ISP operators currently offering a service. Estimates of the numbers of end users vary a great deal, but it is clear that there are at least 20,000 subscribers in the country. As with all African countries it is difficult to estimate given the number of shared resources, addresses and facilities. Africa Online alone estimate that as many as 250,000 Kenyans use their services to go online. Access to the International backbone however still remains officially in the hands of the Kenyan PTT, Kenya Telecom²⁸, and all ISPs are required by law to use their JamboNet service to do this. Kenya Telecom itself however has not been granted a licence to operate an ISP service from the independent regulatory body, the Communications Commission of Kenya (CCK). All international traffic goes via satellite and there has been lobbying in Kenya to allow ISPs have their own satellite earth stations and connections but to date this has not been successful. DTT estimates that Kenya Telecom has about 2Mbps of inbound capacity through Teleglobe, and an asymmetric

²⁷ Kenya Telecom was granted this monopoly of service for 5 years in 1999.



link with British Telecom at 512 Kbps upstream and 8 Mbps downstream. However despite regulations, some Kenyan ISPs may be using two-way satellite links independently of Kenya Telecom.

Last update: June 2001

Mozambique

	Mozambique
Population	18,234,000
Rural population (% of total population)	67
Urban population (% of total)	33
Households	4,270,000
GNI per capita, PPP (current international US\$)	N/A
Gross domestic product (GDP) (in Million US\$)	3,569
Public spending on education, total (% of GDP)	2
Primary education, pupils	2,315,547
Pupil-teacher ratio, primary	64
Secondary education, pupils	352,083
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	47
Daily newspapers (per 1,000 people)	
Radios (per 1,000 people)	66
Television sets (per 1,000 people)	34
Television equipped households	240,000
Cable television subscribers	N/A
Television receivers	250,000
Personal computers (per 1,000 people)	3
Main telephone lines per 100 inhabitants	1
Total telephone subscribers per 100 inhabitants	1
Residential monthly telephone subscription (US\$)	8
Residential telephone connection charge (US\$)	23
Telephone mainlines, waiting list	21,332
Telephone mainlines, waiting time (years)	3
Business telephone monthly subscription (US\$)	8.38
Business telephone connection charge (US\$)	23
Mobile phones (per 1,000 people)	8
Cellular connection charge (US\$)	55
Cellular monthly subscription (US\$)	11
Cellular - cost of 3 minute local call (peak) (US\$)	0.08
ISDN subscribers	0
Internet users (estimated)	30,000
Internet hosts	16
Internet service provider access charges (US\$ per 30 off-peak hours)	N/A
Internet telephone access charges (US\$ per 30 off-peak hours)	N/A

Mozambique is spending a great deal of resources on improving its telecommunications infrastructure and has taken steps to privatise the state PTT, Telecommunications de Mozambique (TDM). There is a telecoms regulatory agency, the National Telecommunications Institute of Mozambique (INCM). Although the ISP situation is constantly undergoing change, there appears to be 7 operational ISPs including the Universidade Eduardo Mondlane which are using 4 satellite links to the International backbone. The Leland Initiative (USAID) is funding the link which the Universidade Eduardo Mondlane uses to cable and Wireless USA provided by Lyman Bros. The University did have a satellite link to South Africa provided by Transtel and which used PanAmSat but this seems to have been dropped. TDM is not an ISP itself and in fact much of the backbone within Mozambique is provided by another organisation, Teledata de Mozambique in which TDM has a 50% stake. It has its own satellite connection to Portugal through Portugal Telecom International. Mozambique is





planning to install a 1000 km optical fibre connection along the Mozambique coast and 3 new satellite links are planned for 2001 with funding from USAID. Regulations to allow for two-way satellite-based Internet services using very small aperture terminals (VSATs) to connect directly the US or Europe have also been adopted in Mozambique which should see a rapid expansion in the offer of these types of services in the near future.

Last update: June 2001

Kenya

	Kenya
Population	8,171,000
Rural population (% of total population)	93
Urban population (% of total)	6
Households	2,271,143
GNI per capita, PPP (current international US\$)	1,210
Gross domestic product (GDP) (in Million US\$)	1,650
Public spending on education, total (% of GDP)	3
Primary education, pupils	1,475,572
Pupil-teacher ratio, primary	51
Secondary education, pupils	129,620
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	N/A
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	N/A
Television sets (per 1,000 people)	N/A
Television equipped households	N/A
Cable television subscribers	N/A
Television receivers	N/A
Personal computers (per 1,000 people)	N/A
Main telephone lines per 100 inhabitants	0
Total telephone subscribers per 100 inhabitants	1
Residential monthly telephone subscription (US\$)	2
Residential telephone connection charge (US\$)	31
Telephone mainlines, waiting list	8,000
Telephone mainlines, waiting time (years)	4
Business telephone monthly subscription (US\$)	2.10
Business telephone connection charge (US\$)	31
Mobile phones (per 1,000 people)	8
Cellular connection charge (US\$)	5
Cellular monthly subscription (US\$)	19
Cellular - cost of 3 minute local call (peak) (US\$)	0.09
ISDN subscribers	250
Internet users (estimated)	20,000
Internet hosts	1,233
Internet service provider access charges (US\$ per 30 off-peak hours)	38
Internet telephone access charges (US\$ per 30 off-peak hours)	0.36

There appear to be two Rwandan satellite links to the backbone, both provided by C&W USA. One is for the PTT, RwandaTel (<http://www.rwanda1.com>) and the other for the National University of Rwanda (<http://www.nur.ac.rw>). The RwandaTel link was part financed by the USAID's Leland Initiative and initially ran at 128 Kbps connecting to MCI. According to DTT Consulting, RwandaTel operates one of the most modern telecommunications networks throughout Africa in that it is wholly digital, however penetration is limited in the countryside.

Last update: June 2001



South Africa

	Kenya
Population	45,454,000
Rural population (% of total population)	42
Urban population (% of total)	58
Households	10,200,000
GNI per capita, PPP (current international US\$)	9,870
Gross domestic product (GDP) (in Million US\$)	113,263
Public spending on education, total (% of GDP)	5
Primary education, pupils	7,444,802
Pupil-teacher ratio, primary	33
Secondary education, pupils	4,141,946
Personal computers installed in education	364,722
Annual telecommunication investment (in Million US\$)	1,394
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	N/A
Television sets (per 1,000 people)	152
Television equipped households	6,783,000
Cable television subscribers	0
Television receivers	8,053,000
Personal computers (per 1,000 people)	69
Main telephone lines per 100 inhabitants	11
Total telephone subscribers per 100 inhabitants	37
Residential monthly telephone subscription (US\$)	7
Residential telephone connection charge (US\$)	24
Telephone mainlines, waiting list	50,000
Telephone mainlines, waiting time (years)	1
Business telephone monthly subscription (US\$)	9.68
Business telephone connection charge (US\$)	24
Mobile phones (per 1,000 people)	252
Cellular connection charge (US\$)	11
Cellular monthly subscription (US\$)	20
Cellular - cost of 3 minute local call (peak) (US\$)	0.07
ISDN subscribers	24,112
Internet users (estimated)	3,100,000
Internet hosts	238,462
Internet service provider access charges (US\$ per 30 off-peak hours)	30
Internet telephone access charges (US\$ per 30 off-peak hours)	0.33

The situation in South Africa is rather unique on the continent, the infrastructure is quite advanced and there are a very high number of Internet users, one recent estimate is that there are more than 750,000 dial-up subscriber accounts. Unlike most other African countries, South Africa now has points of presence (PoPs) in about 100 cities and towns. The addition of fibre connectivity in 2002 via SAT 3, the 120-Gigabit fibre cable that runs from Cape Town up the West African coast and terminating in Europe, is expected to bring a new era of connectivity for Africa in general and South Africa in particular.

Several companies are currently offering an asymmetric ISP connection to backbone service for ISPs in Southern Africa. This is a system whereby they use a basic satellite dish to receive a stream of popular web data for caching locally, as well as encoded broadcasts of their private traffic. It can deliver up to 8Mbps incoming, while the normal terrestrial phone circuit or leased line is used for all outgoing traffic. They include Infosat (<http://www.infosat.co.za>) and GIT (<http://www.git.co.za>). A similar service covering larger regions of Africa via different satellites is provided by Interpacket (<http://www.interpacket.net>).





The official Telkom monopoly ended at the end of a 5 year exclusivity period in 2002. Despite having the option to further extend the monopoly for another year as the operator had met its prescribed universal service rollout obligations, it decided not to extend its monopoly. However, there has been no real or significant change in the telecommunications environment with a second national operator still pending appointment.

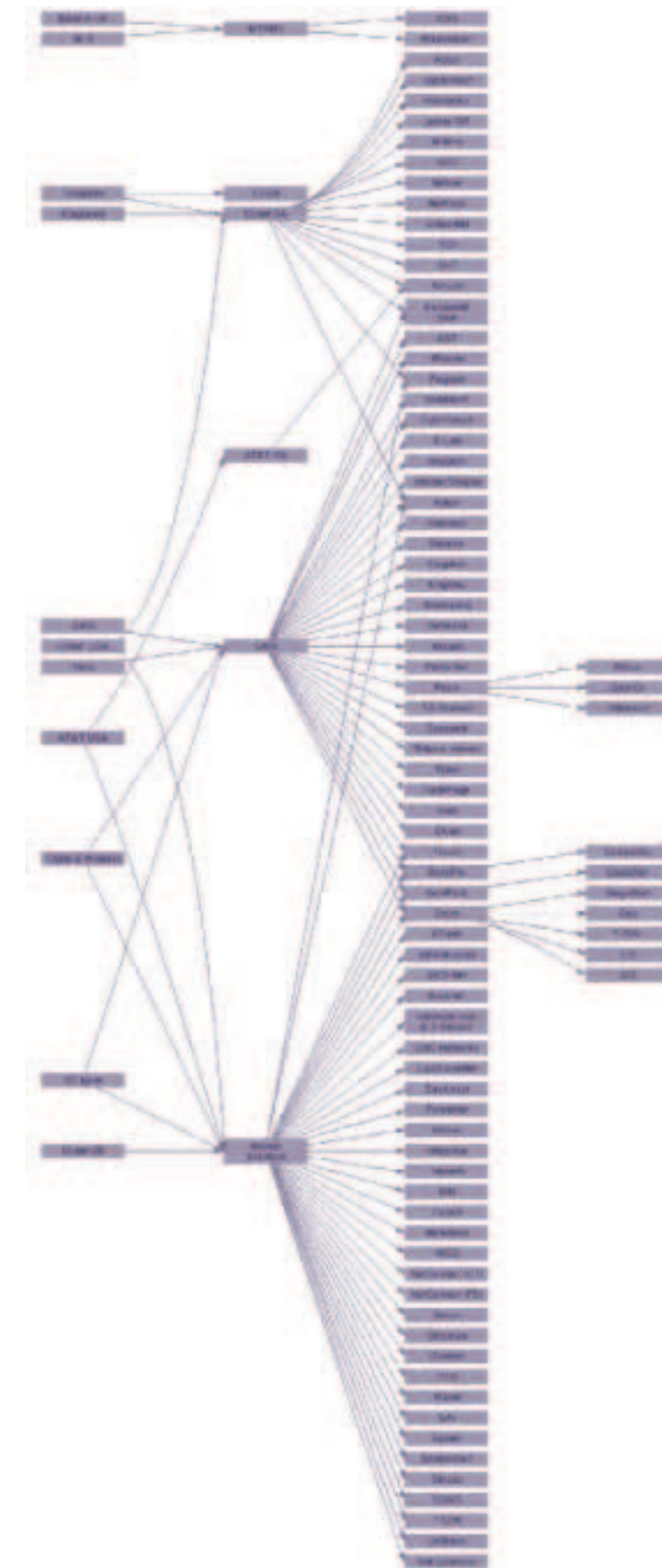
There have been many changes recently regarding ISPs in South Africa with a lot of consolidation. It appears that M-Web and World Online have emerged from this process as market leaders. The local PTT, Telkom SA owns 2 ISPs and a number of free ISPs have emerged. Of the estimated 154 commercial ISP operators in South Africa, about 60 are estimated to be using satellite links, the rest are using Telkom SA's SAIX network and international fibre. SAIX is the PTTs Internet exchange and backbone operation which uses a mix of mainly fibre and satellite. Some of the other ISPs use satellite connectivity of one type or another. Virtually all the satellite capacity used by ISPs in South Africa is on Intelsat. More information about the situation regarding Internet access in South Africa generally can be found at the Internet Service Providers' Association (ISPA) web site, <http://www.ispa.org.za>

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Topological map of Southern African Internet Access Providers

Thanks for additional input to this report to Bridges.Org in South Africa, <http://www.bridges.org>

Last update: July 2003





Tanzania

	Tanzania
Population	34,569,232
Rural population (% of total population)	66
Urban population (% of total)	34
Households	6,996,036
GNI per capita, PPP (current international US\$)	550
Gross domestic product (GDP) (in Million US\$)	9,119
Public spending on education, total (% of GDP)	N/A
Primary education, pupils	4,280,012
Pupil-teacher ratio, primary	40
Secondary education, pupils	279,162
Personal computers installed in education	N/A
Annual telecommunication investment (in Million US\$)	9
Daily newspapers (per 1,000 people)	N/A
Radios (per 1,000 people)	406
Television sets (per 1,000 people)	42
Television equipped households	1,400,000
Cable television subscribers	8,000
Television receivers	1,500,000
Personal computers (per 1,000 people)	3
Main telephone lines per 100 inhabitants	0
Total telephone subscribers per 100 inhabitants	2
Residential monthly telephone subscription (US\$)	4
Residential telephone connection charge (US\$)	41
Telephone mainlines, waiting list	7,291
Telephone mainlines, waiting time (years)	N/A
Business telephone monthly subscription (US\$)	3.50
Business telephone connection charge (US\$)	41
Mobile phones (per 1,000 people)	12
Cellular connection charge (US\$)	18
Cellular monthly subscription (US\$)	N/A
Cellular - cost of 3 minute local call (peak) (US\$)	0.07
ISDN subscribers	0
Internet users (estimated)	100,000
Internet hosts	1,478
Internet service provider access charges (US\$ per 30 off-peak hours)	69
Internet telephone access charges (US\$ per 30 off-peak hours)	0.79

There is a lot of Internet activity in Tanzania where the PTT has been partly privatised. There appear to be 15 operational ISPs and probably well in excess of 100,000 users. There is competition in the supply of satellite links to backbone. Four local carriers were licensed by Tanzania Communications Commission which also has jurisdiction over Zanzibar to offer satellite links; these are Tanzania Data Communications Company (part of the PTT), Sita, Wilkens Afsat and Datel. The University of Dar es Salaam also has an international data license but only for a closed academic user group and has a direct satellite link with UUNet in the UK. Wilkens Afsat has a link through ATC teleports in the US of approximately 704 Kbps. Datel is partnered with Taide Norway for SCPC links to backbone. Other ISPs are using Teleglobe's Laurentides teleport in Canada, New Skies direct, Interpacket/Star Telecom and ATC Teleports. Zanzibar Internet has a satellite link with the United Arab Emirates. Tanzania is another African country which has adopted regulations to allow for two-way satellite-based Internet services using very small aperture terminals (VSATs) to connect directly the US or Europe.

Last update: June 2001



Satellite service providers in Africa 7.3

This section will provide information about satellite service providers currently and potentially active in the African continent according to the following:

- Company and product name and contact details
- Service and functionality offered
- Equipment and bandwidth costs if available

It is important to note that some of these companies already have a presence in Africa as they are offering a service to ISPs in individual countries. In addition, a couple of them are running projects using small-dish VSAT systems and when this is the case it is indicated in the Comments section. Some of the projects in which they are involved are further elaborated in Chapter 5.

It is important to point out that this is a highly dynamic environment and most companies working in this area are investigating opportunities all over the world to develop markets for these kinds of services. Many are interested in creating partnerships with potential end user network representatives in order to build up critical mass to make the provision of such a service worthwhile. As such services depend on relatively large numbers of potential end users, the marketing and business development representatives are worth contacting in companies even when they are not currently offering a service in Africa.





Company Name and product	Contact details	Comments
AlphaStar	AlphaStar International Corporate Office 88 South Water Street Greenwich, CT 06830 U.S.A. Tel: +1 203 531 5555 Fax: +1 203 531 6903 Email: marketing@alphastar.com URL: http://www.alphastar.com/	2-way satellite Internet provider combines satellite for the backbone and broadband wireless to the consumer. It targets users in unserved and under served geographical areas globally where the terrestrial network cannot or will not go. It has 2 different pricing packages: one for the bandwidth on demand option and the other for unlimited use. Services include internet connectivity, VPN, multicasting, video on demand, videoconferencing.
Armstrong Electronics Web-Sat	Douglas Armstrong Managing Director Web-Sat Ltd., Unit 3, Bluebell Industrial Estate, Bluebell Dublin 12 Ireland Tel: +353 1 450 1711 Fax: +353 1 450 5725 Email: doug@web-sat.com, info@websat.com URL: http://www.web-sat.com	Web-Sat Ltd is an internet service provider that uses its own designed and developed innovative satellite-based DVB technology to deliver high-speed two-way Internet access via satellite, at competitive prices, to primarily corporate users, who require fast, always-on broadband internet access, but have no access to cable or DSL. Founded in 1999 Web-Sat currently provides Internet services via satellite throughout Europe, the Middle East and North Africa, within the footprint of Eutelsat W3. Customers include international organisations in Kosovo and Afganistan, embassies, oil companies, post-primary schools in Ireland etc. In July 2002 Web-Sat launched services in West Africa, in partnership with Nigerian company Direct On PC, a Broadband VSAT based Internet Service Provider, within the footprint of Panamsat PAS-1R.
Astrolink		Astrolink is committed to deliver a system that provides high-value broadband multimedia and virtual private networks with mesh connectivity into any enterprise's full or partial mesh network. The Astrolink Ka-Band satellites will provide users with a wide range of network and managed services that support existing and next-generation data networks capable of 20Mbps transmit and 155Mbps receive transmission rates to small antennas. These services include Internet access/Internet service, point-to-point connectivity, multicasting, and IP virtual private networks (VPN). The closing of their test phase that began in September 2001 is expected by 31 October 2003.



Business Satellite Solutions	Business Satellite Solutions 1969 Oakland Drive Maidens, VA 23102 Phone: 1-804-556-3069 Email: info@bsatellite.com URL: http://www.bsatellite.com	Within Africa, Business Satellite Solutions have services available on two satellite beams: New Skies NSS-7 East Hemi C-band and Loral Skynet's T-10 C-band beam. Choice of service depends on the location. T-10 has better pricing, but may require larger dishes in many areas. NSS-7 uses the same hardware for the entire continent. In general, Africa requires a 2.4 meter dish, a 2 or 5 watt BUC (transmitter) and a NetModem satellite router. Services are available from 512 Kbps x 64 Kbps up to 4 Mbps x 1 Mbps with many levels of service. There are 3 service levels: Standard Access, which includes no CIR; Upgraded and Premium Access which include CIR. CIR is 'committed information rate' or dedicated bandwidth. This is often required for VoIP or Video/IP traffic in order to ensure enough bandwidth when the satellite network is busy. QoS is also used to ensure prioritization and bandwidth allocation for important traffic.
Cidera	Cidera Corporate Headquarters 8037 Laurel Lakes Court Laurel, MD 20707 USA Tel: +1 301 598 0500 Fax: +1 301 561 7150 Email: info@cidera.com URL: http://www.cidera.com/index.shtml	Cidera is a company offering satellite delivery of broadband content to the edge of the Internet. They are expanding their international network infrastructure to improve movement of Internet Web site content, streaming video and audio, live Web casts, large databases, and Usenet news to ISPs. They currently serve customers in North America and Europe.
Gilat Starband Other products: Skystar Advantage, Skystar 360E, Dialaw@yIP, FarAway VSAT, Sky Blaster 360	SOUTH AFRICA Gilat Satellite Networks (South Africa) (Pty) Ltd. 747 Park Street Arcadia, Pretoria 0002 P.O. Box 11503 Maroelana 0161 Tel: +27 12 344-0240 Fax: +27 12 343-7691 info.southafrica@gilat.com URL: http://www.gilat.com	Gilat state that unlike the US market where the target is the consumer, they do not see a consumer market in Africa for this service but rather a SoHo market. In the US, the business model is that the consumer pays under US\$100 a month and a small start payment. In Africa Gilat believe the numbers will be different and the user will pay US\$2 to 3000 for the equipment and then something like US\$220 to per month. Gilat's VSAT equipment is used at many thousands of sites supporting cost-effective, reliable rural telephony, Internet access and corporate networking applications. Gilat VSAT networks are already well established in several African regions as a reliable solution for toll-quality telephony service, even in the most remote villages.





Gilat Starband Continued...		Two of the best-known large satellite telephony networks are the 3,500-site VSAT networks which are operated by Telkom South Africa and the Ethiopian Telecommunications Corporation. Gilat also serves as a VSAT equipment provider for a significant number of small and mid-size satellite telephony networks in Africa. Gilat offers high-speed data networks to corporations, SME's, government agencies and NGO's across Africa based on the Skystar 360E, DialAw@y IP and FaraWay platforms.
Hughes Network Systems Spaceway and Direcway	South Africa (for English-speaking Africa) Hughes Network Systems Independent Contractor Postal Address: P.O. Box 101 518 Moreleta Plaza 0167 Midrand, South Africa Phone: 27-82-881-0058 Fax: 27-82-131-881-0058 English-speaking Africa: Phone: 27-11-655-1616 Fax: 27-11-655-1614 French-speaking Africa Phone: 33-14-110-4090 Fax: 33-14-110-4096 URL: http://www.hns.com/ RL: http://www.hns.com/default.asp?CurrentPath=products/direcway_terminals/intro.htm	This is a Ku System that is available commercially in North America where it is called Direcway. Suitable for South Africa mainly. Direcway offers 2-way Internet for home, SME and large companies.
Internet SkyWay	Internet SkyWay Gesellschaft für Satellitengestützte Internet-Dienste GmbH Oderstrasse 55 D-14513 Berlin-Teltow Tel: +49 3328 3032 47 Fax: +49 3328 3032 50 Email: sales@internet-skyway.com URL: http://www.internet-skyway.com	Offering 2-way Internet backbone service via Eutelsat. European and North African coverage. Services not for private usage. The Internet linkup for Europe is SkyWay. Euro-Backbone from Internet SkyWay provides direct one-step satellite linkup to European Internet Backbones. End-to-end via satellite with full IP connectivity and high transmission rates.



IWayonline Communications	American Headquarters: Noble Forest Drive Atlanta, Georgia 30092 U.S.A. Tel: 1-770-575-0662 email: info@iwayonline.com URL: http://www.iwayonline.com Distributor Africa: Usman Yahaya (Banash) PremierNet Nigeria Limited FCT, Abuja, Nigeria GSM: +234 80 44106422 +234 80 35967413 Tel:+234 9 5231903 email: ousmanys@yahoo.com URL: www.banash.8m.net	Iwayonline Communication is a telecommunications company specialising in providing two-way Satellite broadband Internet all over Africa. Their two way satellite broadband Internet is in two options, the C-band option and the Ku band option The C-band option is built around the 1.8m or 2.4m antenna, 5w BUC, Satellite Modem, DVB, Router, LNB, Cables and connectors. The cost for new equipment is \$8,740. A monthly bandwidth charge for a starting bandwidth of 64k Tx/128k Rx is \$750. The Ku-band option is built around the 1.2m or 1.8m antenna, 2w BUC, Satellite Modem, DVB, Router, LNB, Cables and connectors. The cost for the entire brand new equipment starts from \$4,540. A monthly bandwidth charge for a starting bandwidth of 64k Tx/128k Rx is \$250. The equipment and service are especially for voice, video, and VPN services.
Loral - Skynet	Loral Skynet Headquarters 500 Hills Drive - PO Box 7018 Bedminster, NJ 07921 USA Telephone: 1.908.470.2300 Fax: +1 301 258 3222 Email: info@loralskynet.com URL: http://www.skynet.com	2-way satellite Internet provider covering the Americas, Europe, Asia and Africa. Together with Alcatel. Multinational businesses use their satellite network services to implement point-to-point or point-to-multipoint business and data networks, international meshed networks or Internet access.
NetSat Express	NetSat Express, Inc. (Globecom Systems Inc.) 45-19 Oser Avenue Hauppauge, New York 11788 USA Phone: +1 631 231-9800 Fax: +1 631 231-1557 Email: sales@netsatx.net URL: http://www.netsatx.net/	NetSat Express, Inc., a wholly-owned subsidiary of Globecom Systems Inc, provides end-to-end satellite-based Internet solutions, including network connectivity, broadband connectivity to end users, Internet connectivity, intranet extension, media distribution and other network services on a global basis. NetSat Express' customers include communication service providers, multinational corporations, Internet Service Providers, content providers and government entities.





Redwing Satellite Solutions Ltd Redwing Satellite Solutions	<p>Redwing Satellite Solutions Ltd Redwing Satellite Solutions Ltd. Transmission Station Great North Road Brookmans Park Herts AL9 6NE United Kingdom Tel: +44 1707 642 184 Fax: +44 1707 642 185 Email: sales@redwingsat.com</p> <p>Redwing Satellite Solutions (Pty) Ltd. Regent Hill Office Park Block C (Corner of : Leslie & Turley Roads), Lonehill 2062 PO Box 4950 Rivonia 2128 Republic of South Africa Tel: +27 11 467 3851 Fax: +27 11 467 1476 Email : africasaes@redwingsat.com URL: http://www.redwingsat.com/</p>	<p>Redwing Satellite Solutions specialises in the supply and delivery of full turnkey VSAT services. These are used by multinationals, private companies, Non-Governmental Organisations, carriers and ISPs to provide high quality telecommunication links with their sites that are not well served by terrestrial delivered communication services. Applications include the transfer of corporate data between sites through Internet and Intranet traffic and voice.</p> <p>The company delivers a significant amount of traffic into and out of Africa. This includes Internet traffic for ISPs, Corporate users and Internet Cafes; telephony traffic for carriers and data for corporate clients. It also provides a pan African network for medical research for the US Government.</p>
Satellite Media Services	<p>Satellite Media Services Lawford Heath Teleport Lawford Heath Lane Rugby Warwickshire CV23 9EU UK Tel: +44 (0)1788 523 000 Fax: +44 (0)1788 523 001 Email: info@sms-internet.net, sales@sms-internet.net URL: http://www.sms-internet.net/</p>	<p>This company uses Eutelsat for European, Asian, and Middle East coverage. Geared to provide backbone connectivity for ISPs. Services support digital audio, video and voice applications using Internet and Intranet via satellite from its UK Teleport. SMS' existing Internet customers include PTT's, Cable operators and ISP's.</p>
SES Global ASTRA Broadband Interactive	<p>ASTRA Société Européenne des Satellites S.A. L-6815 Château de Betzdorf Luxembourg URL: http://www.astra.lu/</p>	<p>The ASTRA Broadband Interactive System (BBI) is offering two-way broadband connectivity over satellite. BBI supports all standard IP-based business needs such as file transfers, email, database access/updates and Internet access. BBI extends terrestrial connectivity to remote locations throughout Europe via the ASTRA Satellite System using a combination of Ku and Ka satellites. ASTRA covers 29 European Countries.</p>



Redwing Satellite Solutions Ltd Redwing Satellite Solutions	<p>Redwing Satellite Solutions Ltd Redwing Satellite Solutions Ltd. Transmission Station Great North Road Brookmans Park Herts AL9 6NE United Kingdom Tel: +44 1707 642 184 Fax: +44 1707 642 185 Email: sales@redwingsat.com</p> <p>Redwing Satellite Solutions (Pty) Ltd. Regent Hill Office Park Block C (Corner of : Leslie & Turley Roads), Lonehill 2062 PO Box 4950 Rivonia 2128 Republic of South Africa Tel: +27 11 467 3851 Fax: +27 11 467 1476 Email : africasaes@redwingsat.com URL: http://www.redwingsat.com/</p>	<p>Redwing Satellite Solutions specialises in the supply and delivery of full turnkey VSAT services. These are used by multinationals, private companies, Non-Governmental Organisations, carriers and ISPs to provide high quality telecommunication links with their sites that are not well served by terrestrial delivered communication services. Applications include the transfer of corporate data between sites through Internet and Intranet traffic and voice.</p> <p>The company delivers a significant amount of traffic into and out of Africa. This includes Internet traffic for ISPs, Corporate users and Internet Cafes; telephony traffic for carriers and data for corporate clients. It also provides a pan African network for medical research for the US Government.</p>
Satellite Media Services	<p>Satellite Media Services Lawford Heath Teleport Lawford Heath Lane Rugby Warwickshire CV23 9EU UK Tel: +44 (0)1788 523 000 Fax: +44 (0)1788 523 001 Email: info@sms-internet.net, sales@sms-internet.net URL: http://www.sms-internet.net/</p>	<p>This company uses Eutelsat for European, Asian, and Middle East coverage. Geared to provide backbone connectivity for ISPs. Services support digital audio, video and voice applications using Internet and Intranet via satellite from its UK Teleport. SMS' existing Internet customers include PTT's, Cable operators and ISP's.</p>
SES Global ASTRA Broadband Interactive	<p>ASTRA Société Européenne des Satellites S.A. L-6815 Château de Betzdorf Luxembourg URL: http://www.astra.lu/</p>	<p>The ASTRA Broadband Interactive System (BBI) is offering two-way broadband connectivity over satellite. BBI supports all standard IP-based business needs such as file transfers, email, database access/updates and Internet access. BBI extends terrestrial connectivity to remote locations throughout Europe via the ASTRA Satellite System using a combination of Ku and Ka satellites. ASTRA covers 29 European Countries.</p>





SkyBridge	<p>Herve Sorre SkyBridge L.P Vice President Business Development Tel : +33 5 34 35 50 36 Fax : +33 5 34 35 69 48 Email: herve.sorre@space.alcatel.fr URL: http://www.skybridgesatellite.com/</p>	<p>A Ku band system that will use a constellation of 80 LEO satellites, due to be launched although the current status is not clear. Aiming to deliver broadband services for high-speed Internet access, videoconferencing and multimedia. Ground coverage will be determined by the placement of ground access stations, similar to Globalstar. Alcatel and Loral are the main investors. Skybridge also offers GEO-based services.</p> <p>Quoting from SkyBridge; "SkyBridge will deploy the offer according to demand and market forecasts, booking capacity on satellites that have the geographical coverage required to serve our customers needs. Within European Space Agency and European Union Contracts, we are experimenting services all around the Mediterranean sea and are ready to consider operational services as soon as market conditions allow it."</p>
Station Africa	<p>South African Office Suit e 308 Postnet x4 Menlo Park 0102 South Africa Telephone: +27 12 483-0000 Fax: +27 12 346-1486 Email: hq@stationafrica.com URL: http://www.stationafrica.com</p>	<p>Station Africa Telecoms is a Seychelles based telecommunications operator specializing in VSAT services and satellite carrier to carrier communications in Europe, Africa and the Middle East.</p>
Tachyon	<p>Tachyon Incorporated Worldwide Headquarters & US Sales 5808 Pacific Centre Boulevard San Diego, California 92121 USA</p> <p>Tachyon Europe B.V. European Headquarters Orly Plaza Orly Plein 149 1043 DV Amsterdam The Netherlands Tel: +31 (0) 20 581 7790 Fax: +31 (0) 20 682 2578</p> <p>UK, Ireland Tel: +44 (0) 870 745 0000 Email: uk.sales@tachyon.net contact Mike Carroll Business Development Executive Email: mcarroll@tachyon.net URL: http://www.Tachyon.net</p>	<p>Providers of various levels of IP connectivity to the Internet. Currently covers the Americas and Europe with global coverage soon. They hoped to have a service available in 2002. A quote from a Tachyon representative in 2003: "At this point, Tachyon's rollout schedule is largely dependent on the perceived business opportunity in the uncovered regions. We've recently changed our rollout model, whereby we're now entertaining joint venture relationships to aggressively develop the infrastructure required to offer our services in uncovered territories. In any event, until we've fully analysed the markets, and received firm partner commitments, we are unable to give estimates of service availability in any uncovered area."</p>



Teledesic/ICO	<p>URL: http://www.teledesic.com</p>	<p>Another proposed LEO constellation using the Ka band. Teledesic merged with ICO, the bankrupt LEO Satphone provider. On their web site they are still in the process of creating the communications network.</p>
Teleglobe	<p>Teleglobe Headquarters 1000 de La Gauchetiere West Montreal, Quebec H3B 4X5 Canada Tel: 514.868.7272 Tel: +800 9333.3999 (tollfree worldwide) Fax: 514.868.7234 URL: http://www.teleglobe.com/</p>	<p>2-way satellite Internet provider covering the globe via Intelsat, New Skies and other satellite providers. They have a range of service options. Teleglobe offers international ISPs and carriers a suite of satellite-based Internet transit and IPL services. Both one-way (receive only) as well as two-way internet access.</p>
Thaicom Internet	<p>Piyanuch Sujpluem Shin Satellite Plc. 41/103 Rattathibet Road Nonthaburi 11000 Thailand (662) 591-0736 to 49 Ext. 427 Fax: 591-0714 Email: press@thaicom.net URL: http://www.thaicom.net/</p> <p>See footprint at http://www.thaicom.net/eng-thaicomsatellite/thaicomsatellite.html</p>	<p>Provides various 2-way satellite Internet services covering Eastern Europe, Eastern Africa, all of Asia and Australia. Its services include: satellite broadcasting, global digital TV, business and educational TV. The internet via satellite service is called ProTrunk, which is a high speed Internet trunk connection to the global Internet network designed for carriers/IAPs/ ISPs. ProTrunk provides Internet trunk connections from one of Thaicom gateways directly to the customer's network via satellite, bypassing congested terrestrial lines. Thaicom gateways are located in Thailand, Hong Kong and the United Arab Emirates. African customers are located in Cameroon, Tanzania, Ethiopia, Kenya.</p>
Verestar	<p>Verestar Hazel no 5 Ground Floor 160 Witch Hazel Avenue Highveld Techno Park Centurion South Africa tel: +27 12 663 4223 fax: +27 12 663 4255 Email: info@verestar.com URL: http://www.verestar.com</p>	<p>Verestar is an operator of full-service domestic and international satellite communications gateway hubs in the United States and around the world. Verestar sets up networks that carry voice, data, fax, internet and telemetry.</p>



Improving Access to Education via Satellites in Africa: A Primer



Glossary

8.0



ADSL	Asymmetric Digital Subscriber Line is a technology for transmitting digital information at a high bandwidth on existing phone lines to homes and businesses. Unlike regular dial-up phone service, ADSL provides continuously-available, "always-on" connection. ADSL is asymmetric in that it uses most of the channel to transmit downstream to the user and only a small part to receive information from the user. ADSL simultaneously accommodates analogue (voice) information on the same line. (source http://www.whatis.com)
Analogue	Information represented by a measurable physical quantity with continuous values, as opposed to information in digital form.
Beam	This is essentially the signal or group of signals that is sent from the satellite to the surface of the earth. This surface, defined by the beam, is the satellite 'footprint' i.e. the area on earth where the beam can be captured and used. No one satellite can transmit a beam to the entire earth, though theoretically 3 equally spaced satellites in a network could cover the entire earth.
Broadcasting	A means of one-way, point-to-multipoint transmission where the end receiver is not known to the broadcaster, i.e. it is an 'open' system. Broadcasting is typical for radio and television transmission where the audience are only defined by virtue of having the correct receive equipment.
Caching	Using a buffer within your own computer's fast memory to hold recently accessed data. It is designed to speed up access to the same data later.
Cellular network	Mobile radio system most often used nowadays for telephony which has rapidly supplemented landline telecommunications as a means of two-way personal communications. Cellular networks works on the principle and use the physics of two-way radio communications and is named after the unit "cell" into which an area is divided. As a mobile radio telephone moves through this pattern of cells, its user's calls, made as on an ordinary telephone, are switched from one cell to the next by a computerised system.
Compression	Reduce the number of bits required for data storage or transmission with special software. Decompression reverses the result of compression.
Contention	Contention is the case when multiple users vie for the right to use a communication channel within a multiplexed connection. The contention rate is in that case the number of users that in the worst case have to share the connection. If a connection has a bandwidth potential of 1000 Kbps with a contention rate of 20:1 it is possible that in the worst case users will fall back to a connection speed of $1000/20 = 50$ Kbps.
Dark Fibre	Dark fibre is optical fibre infrastructure (cabling and repeaters) that is currently in place but is not being used.
Data Broadcasting	Data can be broadcast or transmitted to users over various wireless and cable mediums. The most typical being radio broadcasts (VHF, UHF, satellite) and cable broadcasts (such as simple cable television).
dBW	Decibel Watts gives an indication of transmit power: the higher the value, the higher the signal strength.
Digital	Information represented as discrete numeric values, e.g. in binary format (zeros or ones), as opposed to information in continuous or analogue form. Binary digits (bits) are typically grouped into "words" of various lengths – 8-bit words are called bytes.





DVB	DVB stands for Digital Video Broadcasting, the European standard for digital TV. This standard provides a very high-speed, robust transmission chain capable of handling the many megabytes per second needed for hundreds of MPEG-2 digital TV channels.
Encryption	Encryption is the process of altering a video and/or audio signal from its original condition to prevent unauthorised reception. This is done electronically at a place in the supply chain between the contribution point (for example the originating studio) and the uplink towards the satellite. Decryption is the process of returning the video and/or audio to its original condition. Decryption is mostly done at the side of the end user.
Fixed Wireless Local Loop	Local connections that link customer equipment to the switching system in the central office using wireless connectivity mostly used for broadband data purposes.
Geostationary orbit or Clarke Belt	Named after its founder Arthur C. Clarke, the Clarke Belt is an orbit used by satellites at a height of 22,250 miles, in which satellites make an orbit in 24 hours, yet remain in a fixed position relative to the Earth's surface.
LNB	The Low Noise Block is an essential part of a satellite receiver which receives the signal and amplifies it for use. It is always located with the satellite antenna.
Mirroring servers	Network server maintaining an identical copy of its files in (a) another network server, or (b) a redundant drive in the same server. Note: Mirroring can be used as a rudimentary backup system for the original files, but is more often used to spread out the access load for popular sites, e.g., Web sites, by offering users several different locations from which identical files can be accessed.
Mono	One or single channel as opposed to stereo or dual channel.
MPEG	MPEG is the "Moving Picture Experts Group", working under the joint direction of the International Standards Organisation (ISO) and the International Electro-Technical Commission (IEC). This group works on standards for digital video compression and file formats. The purpose is to standardise compressed moving pictures and audio. The most notable current MPEG standards are MPEG-1, MPEG-2 and MPEG-4.
Multicasting	Transmitting information to a well-defined and controlled group of users on your network.
Multiplexer	Combines several different signals (e.g. video, audio, data) onto a single communication channel for transmission. De-multiplexing separates each signal at the receiving end.
Narrow-band	A low-bandwidth (low capacity) communications path. Narrow-band networks are designed for voice transmission (typically analogue voice), but which have been adapted to accommodate the transmission of low-speed data.
Orbit	The path taken by a satellite. A satellite is usually kept in its orbit through a combination of natural forces, mainly the force of gravity and on-board resources.
PoP (Point of Presence)	The specific physical place where you make connection to the Internet.
Proxy	A proxy server can serve several purposes; it can hold the most commonly and recently used content from the World Wide Web for users, (versus having to go all the way to the server on which it was originally stored) thus providing quicker access. Also it can filter Web content (so it's used sometimes by schools and libraries) and it can convert Web pages to match the capabilities of the receiving software and/or hardware.
Rain attenuation	Loss of signal at Ku or Ka Band frequencies due to absorption and increased sky-noise temperature caused by heavy rainfall. Attenuation is the decrease in the amplitude of a signal. In video communications this usually refers to the loss of power of electromagnetic signals between a transmitter and the receiver during the process of transmission. Thus the received signal is weaker or degraded when compared to the original transmission.



Revolution	The cycle that a satellite normally takes around earth.
SoHo	Small Office - Home Office: term to describe professional office solutions of the smallest scale: offices for people that work from home like teleworkers, home based professionals like GPs, lawyers, but also small enterprises (shops, workshops etc.)
	SOHO also exists as a satellite related term but in this context refers to the scientific SOLar and Heliospheric Observation Satellite.
Stereo	Two or more independent channels of information. Separate microphones are used in recording and separate speakers in reproduction.
Sub-carrier	A second signal sent alongside a main signal to carry additional information. In satellite television transmission, the video picture is transmitted over the main carrier. The corresponding audio is sent via an FM sub-carrier. Some satellite transponders carry as many as four special audio or data sub-carriers whose signals may or may not be related to the main programming.
Thrusters	Small axial jets used by the satellite to maintain its orbit. These are often fuelled by drazine or bi-propellant. In time ion-engines will probably replace such thrusters.
Two-way	Operating method in which transmission is possible in both directions of a telecommunication channel.
Unicasting	Data is delivered to only one user within a network as opposed to multicasting. Each packet in a unicast contains a user ID number. The user's ID must match the ID in the header of the unicast packet, only then can data be received.
VSAT	Meaning literally "Very Small Aperture Terminal", the term refers to any fixed satellite terminal that is used to provide interactive or receive-only communications. VSATs are used for a wide variety of telecommunications applications, including corporate networks, rural telecoms, distance learning, telemedicine, disaster recovery, ship-board communications, transportable "fly-away" systems, and much more.





Support Organisations and Web Sites

9.1

Further Resources

9.0



Acacia Initiative

http://www.idrc.ca/acacia/acacia_e.htm

Acacia is aimed at establishing the potential of Information and Communications Technologies to empower poor African communities. The initiative stresses the need for mutually reinforcing action on four fronts: infrastructure, tools for local content creation, applications related to community needs, and policy. Their website contains resources on ICTs in development.

Africa Action

<http://www.africapolicy.org>

Africa Action incorporates the American Committee on Africa, the Africa Fund, and the Africa Policy Information Centre (APIC). It is devoted to education and mobilization to change US policies to support justice in Africa. The website contains a lot of links about the issue "Africa on the Internet"

Africa Bookcase

www.africabookcase.org

Africa Bookcase was founded in 1997 with the remit of supplying educational resources to Africa and providing a basis for continued multilateral & bilateral aid through the promotion of development awareness in UK schools. Recently they moved to the IT field and have begun to develop a software solution (Gemini) to enable schools around the world to work together online. They specialise in enabling schools in the Developing World to access the Internet and arranging online synchronous projects.

African Connection

<http://www.africanconnection.org>

The African Connection (AC) is a region-wide African-led and managed initiative to improve telecommunications, broadcasting and information technology infrastructure and applications in Africa.

African Distance Learning Association

<http://unicorn.ncat.edu/~michael/adla>

Contains links to everything that has to do with distance learning and distance learning projects in Africa.

AfricaEducation

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

This is a site about what's happening in the area of education and development in Africa. It contains a digital library of resources and a database of projects.

African News

<http://italy2.peacelink.org/africanews2/index.html>

Africa news is a press agency entirely run by young African journalists and writers circulating news and comments on events occurred in Africa which also functions as the voice of over 300 groups arisen in Africa to defend and protect human rights.

African Technology Forum

<http://web.mit.edu/africantech/www/>

African Technology Forum (ATF) publishes a magazine on science and technology in Africa, and provides consulting services and networking opportunities for technical and business professionals involved in African development.

African Telecommunications Union

<http://www.atu-uat.org>

ATU is focused on unlocking the ICT investment potential in Africa. The mission of the Union is to promote the rapid development of info-communications in Africa in order to achieve universal service and access, in addition to full inter-country connectivity, in the most effective manner.





African Trade Consultants Network

<http://www.atcnet.org>

The African Trade Consultants Network (ATCnet) is a network of networks who strengthen the efforts of African businesses and non-governmental and governmental agencies by linking, collaborating, connecting, sharing and advising them on trade and development issues in other African countries, and the rest of the world. Connectivity Starting with East, Central and Southern African countries, ATCnet is working to promote connectivity for under served rural and rural urban populations.

Africa's Information Society Initiative (AISI)

<http://www.uneca.org/aisi/>

The High-Level Working Group consisted of eleven experts on Information Technology in Africa. The result of its work is the document entitled "Africa's Information Society Initiative (AISI): An Action Framework to Build Africa's Information and Communication Infrastructure".

Afrol News

http://www.afrol.com/ms_index.htm

Afrol News is a news agency, established in 2000. It exclusively covers the African continent, both in English and in Spanish.

ANAIS

<http://www.anais.orgs>

ANAIS is an African-European network aimed at Francophone countries for information distribution and exchange of experiences in the use of the Internet for development.

Association for Progressive Communications

<http://www.apc.org>

APC advocates and facilitates the use of information and communications technologies by civil society in a variety of ways.

Association for the development of Education in Africa(ADEA)

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

ADEA is a network of partners promoting the development of effective education policies based on African leadership and ownership.

Balancing Act

<http://www.balancingact-africa.com>

Balancing Act is facilitating the development of content for the internet and other new media technologies in Africa that will have an impact on people's lives and that they will want to use, in the three fields of economic, social and cultural development.

Bridges.org

<http://www.Bridges.org>

Bridges.org is an international non-profit organisation with a mission to help people in developing countries use information and communications technology (ICT) to improve their lives

CATIA: Catalysing Access to ICTs in Africa

<http://www.catia.ws/>

The Catalysing Access to ICTs in Africa (CATIA) programme aims to enable poor people in Africa to gain maximum benefit from the opportunities offered by Information and Communication Technology (ICT) and to act as a strong catalyst for reform. CATIA is a three year programme of the Department for International Development (DFID) in close collaboration with other donors and players (e.g. Sida, IDRC, CIDA, USAID and Cisco).

Digital Divide

<http://www.digitaldividenetwork.org>

This web site, supported by the Benton Foundation, examines the digital divide from many perspectives and offers a range of information, tools and resources that help practitioners stay on top of digital divide developments. It also serves as a forum where practitioners can share their experiences with colleagues around the world.



Distance Education in Africa

<http://communicationculture.freesevers.com/>

This web site about "Africa: Education, communication and development" contains lots of links to organisations and resources.

EDUSUD

<http://www.edusud.org/index.html>

Education portal focussed on the integration of ITC in African countries aimed at Francophone countries.

Global VSAT Forum

<http://www.gvf.org>

The Global VSAT Forum is an association of key companies involved in the business of delivering advanced digital fixed satellite systems and services to consumers, and commercial and government enterprises worldwide. The Forum is independent and non-profit and has a global remit. It is also non-partisan - any companies or organisations with an interest in the VSAT industry are encouraged to join.

iConnect

<http://www.icconnect-online.org>

iConnect is a starting point for information on the application of knowledge and ICTs in sustainable development. Developed in association with the "bridging the digital divide" programme funded by DFID and DGIS in the UK, it draws content from its partners, iConnect links resources and expertise and encourages collaboration.

International Development Research Centre

<http://www.idrc.ca>

The International Development Research Centre is a public corporation created by the Canadian government to help communities in the developing world find solutions to social,

economic, and environmental problems through research. The aim of the IDRC is to initiate, encourage, support, and conduct research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical, and other knowledge to the economic and social advancement of those regions.

International Institute for Communication and Development (IICD)

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

The International Institute for Communication and Development (IICD) assists developing countries to realise locally owned sustainable development by harnessing the potential of information and communication technologies (ICTs). IICD works with its partner organisations in selected countries, helping local stakeholders to assess the potential uses of ICTs in development.

Kabissa

<http://www.kabissa.org>

Kabissa is a non-profit capacity-building organisation that seeks to further democratic change and social justice in Africa by providing a space on the Internet for the African non-profit sector.

National Information Technology Forum

<http://www.sn.apc.org/nitf/>

The NITF is a South-African organisation committed to developing and advocating clear policy positions and policy options for the creation and advancement of the South African Information Society.

NSRC-Africa

<http://www.nsrc.org/AFRICA/africa.html>

Internet availability in Africa on a country-by-country basis.





Power Line Connectivity

The following web sites provide further information about Power Line Connectivity

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

This is the web site for the Power Line Forum, which is an International Association that represents the interests of manufacturers, energy utilities and research organisations active in the field of access and in-home PLC (power line communications) technologies.

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

This is for Powerline World, which is a global online community facilitating the development and deployment of Powerline Communications (PLC) products and services.

<http://www.endesa.es/english/index.html>

This is a link to Endesa which is offering commercial PLC to their customers.

http://www.homeplug.com/index_basic.html

HomePlug is the alliance of industrial partners providing PLC products, services and content complying with the emerging industry HomePlug Standard.

SANGONeT

<http://www.wn.apc.org/corporate/index.shtml>

SANGONeT is a facilitator in the effective and empowering use of information communication technology (ICT) tools by development and social justice actors in Africa. They aim to share information, build capacity and link people and organisations through the use of ICTs.

SchoolNet South Africa

<http://www.schoolnet.org.za/>

SchoolNet SA is an organisation formed to create Learning Communities of Educators and Learners that use Information and Communication Technologies to enhance education.

Sustainable Development Department of the Food and Agriculture Organisation

http://www.fao.org/waicent/faoinfo/sustdev/KNdef_en.htm

FAO's Sustainable Development Department helps to strengthen the capabilities of national and regional research, extension, education and communication systems so that rural people have the knowledge and skills they need to improve their productivity, incomes and livelihoods, and manage the natural resources on which they depend in sustainable ways.

UNESCO Global Watch on ICT in Africa

http://www.unesco.org/webworld/portal_observatory/Action_Plans_-_Policies/Africa/

Presents a database of documents related to ICT developments in each African country.

USAID/The Leland Initiative

<http://www.usaid.gov/regions/afr/leland>

The Leland Initiative is a five-year, US\$15 million U.S. government effort to extend full Internet connectivity to 20 or more African countries. The Leland Initiative builds on existing capacity with the ultimate aim of facilitating Internet access throughout each country. This effort to extend connectivity is pledged in return for agreements to liberalise the market to 3rd party Internet service providers and to adopt policies that allow for the unrestricted flow of information.



Mailing Lists, Newsletters and Discussion Lists **9.2**

AFAGRICT

<http://www.bellanet.org/lyris/helper/index.cfm?fuseaction=Visit&listname=afagrict-l>

Discussion list about the use of Information and Communication Technology in Agriculture and Natural Resource Management in Africa.

African Distance Learning Association

<http://www.physics.ncat.edu/~michael/adla>

This association co-ordinates existing educational technologies and the skill of African expatriates to assist African scientific and social institutions via traditional collaborations, volunteer teaching, information exchange and student exchange. ADLA also runs an online news service.

Aftidev

<http://www.aftidev.net/en/index.html>

Aftidev provides a forum on "Africa, Technology, Information and Development"

Balancing Act News Update

<http://www.balancingact-africa.com>

Balancing Act provides a News Update service that covers access and technology issues. Their web site also contains a range of useful reports.

Benton News Headlines

<http://www.benton.org/news>

The Benton Foundation works to realise the social benefits made possible by the public interest use of communications. Benton provides a very useful almost daily electronic news service.

Distance-Educator.com

<http://www.distance-educator.com>

This site provides a daily electronic news services that deals with all aspects of distance education

including important technical and other developments of interest and relevance for developing countries

Distance Learning and Developing Countries DLDC

<http://groups.yahoo.com/group/dldc>

This is a discussion list for researchers, teachers and students interested in distance learning in developing countries.

iConnect-Africa

<http://www.uneca.org/aisi/iconnectafrica/>

This is a quarterly web, paper and email service that aims to raise awareness in the wider African development community regarding the possibilities offered by ICTs in development.

Kabissa newsletter

<http://lists.kabissa.org/mailman/listinfo/>

Kabissa hosts various public mailing lists related to development work in Africa.

Pan-African News Agency (PANA)

<http://allafrica.com/pana>

PANA, providing news from around the continent, is considered Africa's largest news-gathering operation.

SANTEC - Educational Technology and eLearning for Development

<http://www.santecnetwork.org>

SANTEC aims to be an enabling network of educational technology practitioners with an interest in educational technology and eLearning in developing environments. It has begun with an initial focus on Southern Africa in order to facilitate and support collaborative ventures, and effect synergies amongst members.



	Egypt	Ethiopia	Gambia	Ghana	Kenya	Mozambique	e Rwanda	South Africa	Tanzania	U.K.
Population	65,643,000	67,347,000	1,372,000	21,674,000	31,930,000	18,234,000	8,171,000	45,454,000	34,569,232	59,088,000
Rural population (% of total population)	57	84	68	63	65	67	93	42	66	10
Urban population (% of total)	43	16	32	37	35	33	6	58	34	90
Households	14,033,000	12,874,000	175,000	4,463,000	6,938,000	4,270,000	2,271,143	10,200,000	6,996,036	24,410,000
GNI per capita, PPP (current international US\$)	3,710	720	1,680	2,000	990	N/A	1,210	9,870	550	25,870
Gross domestic product (GDP) (in Million US\$)	86,120	N/A	434	4,380	10,356	3,569	1,650	113,263	9,119	1,416,091
pupils	856,340	6,650,841	156,839	2,477,990	5,699,956	2,315,547	1,475,572	7,444,802	4,280,012	4,596,110
Pupil-teacher ratio, primary	22	55	37	33	30	64	51	33	40	18
Secondary education, pupils	8,323,597	1,495,445	56,179	1,031,402	1,251,205	352,083	129,620	4,141,946	279,162	8,374,404
Personal computers installed in education	48,816	N/A	N/A	N/A	N/A	N/A	N/A	364,722	N/A	1,824,106
Annual telecommunication investment (in Million US\$)	608	35	7	38	51	47	N/A	1,394	9	13,772
Daily newspapers (per 1,000 people)	31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radios (per 1,000 people)	N/A	189	N/A	N/A	221	66	N/A	N/A	406	N/A
Television sets (per 1,000 people)	217	6	3	118	26	34	N/A	152	42	950
Television equipped households	12,407,000	250,000	19,000	920,000	697,683	240,000	N/A	6,783,000	1,400,000	23,800,000
Cable television subscribers	0	N/A	N/A	6,000	15,000	N/A	N/A	0	8,000	3,850,000
Television receivers	15,400,000	370,000	20,000	1,100,000	812,928	250,000	N/A	8,053,000	1,500,000	57,100,000
Personal computers (per 1,000 people)	15	1	13	3	6	3	N/A	69	3	366
Main telephone lines per 100 inhabitants	11	1	3	1	1	1	0	11	0	59
Total telephone subscribers per 100 inhabitants	18	1	10	2	5	1	1	37	2	144
Residential monthly telephone subscription (US\$)	1	1	2	-	6	8	2	7	4	14
Residential telephone connection charge (US\$)	126	36	51	56	29	23	31	24	41	143
Telephone mainlines, waiting list	583,254	155,208	10,884	154,782	133,981	21,332	8,000	50,000	7,291	N/A
Telephone mainlines, waiting time (years)	2	8	6	N/A	8	3	4	1	N/A	0
Business telephone monthly subscription (US\$)	1.57	2.01	2.23	0.35	5.59	8.38	2.10	9.68	3.50	22.39
Business telephone connection charge (US\$)	252	36	51	56	29	23	31	24	41	169
Mobile phones (per 1,000 people)	43	0	41	9	19	8	8	252	12	770
Cellular connection charge (US\$)	126	99	19	37	32	55	5	11	18	52
Cellular monthly subscription (US\$)	16	6	16	7	10	11	19	20	N/A	26
Cellular - cost of 3 minute local call (peak) (US\$)	0.01	0.02	0.05	0.03	0.07	0.08	0.09	0.07	0.07	0.17
ISDN subscribers	9,766	0	N/A	156	N/A	0	250	24,112	0	855,000
Internet users (estimated)	1,500,000	50,000	18,000	40,520	500,000	30,000	20,000	3,100,000	100,000	24,000,000
Internet hosts	3,061	43	568	313	2,963	16	1,233	238,462	1,478	2,865,930
Internet service provider access charges (US\$ per 30 off-peak hours)	9	94	18	36	66	N/A	38	30	69	14
Internet telephone access charges (US\$ per 30 off-peak hours)	0.14	0.24	2.70	0.38	0.46	N/A	0.36	0.33	0.79	N/A

²⁸ Data source: ITU World Telecom Indicators 2003 and WorldBank ODCI 08/2003 (most recently available data 2002).

Reports and Reference Documentation

9.3

Acacia Initiative

http://www.idrc.ca/acacia/acacia_e.htm

Acacia aims to establish the potential of Information and Communications Technologies to empower poor African communities. The initiative stresses the need for mutually reinforcing action on four fronts: infrastructure, tools for local content creation, applications related to community needs, and policy.

Connectivity and Access to the Internet in Africa

<http://www3.sn.apc.org/>

This website gives an overview of the current status of ICT, Internet and computer Infrastructure in Africa. There is also a database of articles and data on connectivity and access to the Internet. It also contains summaries of Internet projects in Africa.

Human Development Report 2001

<http://www.undp.org/hdr2001/>

The central theme of this report is "making new technologies work for human development". It focuses on how technology networks are transforming the traditional map of development, expanding people's horizons and creating the potential to realize in a decade progress that required generations in the past.

Mike Jensen's Wireless Cookbook

<http://www.idrc.ca/acacia/03866/wireless>

A Guide to using low-cost radio communications for Telecommunications in Developing Countries.

UNESCO Global Watch on ICT in Africa

http://www.unesco.org/webworld/portal_observatory/Action_Plans_-_Policies/Africa/

Presents a database of documents related to ICT developments in each African country.

Department for International Development

The Department for International Development (DFID) is the UK Government department responsible for promoting sustainable development and reducing poverty.

The central focus of the Government's policy, based on the 1997 and 2000 White Papers on International Development, is a commitment to the internationally agreed Millennium Development Goals, to be achieved by 2015.

These seek to:

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality

- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

DFID's assistance is concentrated in the poorest countries of sub-Saharan Africa and Asia, but also contributes to poverty reduction and sustainable development in middle-income countries, including those in Latin America and Eastern Europe.

DFID works in partnership with governments committed to the Millennium Development Goals, with civil society, the private sector and the research community. It also works with multilateral institutions, including the World Bank, United Nations agencies, and the European Commission.

DFID has headquarters in London and East Kilbride, offices in many developing countries, and staff based in British Embassies and High Commissions around the world. DFID's headquarters are located at:

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