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Article 3

Access to Education in Africa via Satellite

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Issue 12: Africa - Overview

The potential of satellite technologies to improve access to education in Africa is discussed in this paper. Education contributes to sustainable development in Africa. However, accessibility to quality education has been stalled by many barriers, including lack of infrastructure, lack of trained teachers, high teacher/student ratios and shortage of educational materials. Satellites are among the information and communication technologies (ICTs) with the potential to by-pass terrestrial barriers to deliver educational services to scattered users.

The situation of education in Africa is discussed in terms of Direct Broadcast Services (DBS), Internet via satellites and VSAT networks. Also covered are the principal satellite providers with access to the African continent and African projects making use of satellite technology to improve access to education. Regulatory and economic constraints are also discussed.

Education in Africa

Education plays a fundamental role in African development. Education is needed to ensure sustainable economic and social development.

The situation of primary education in Africa is not promising. The region's educational indicators are the lowest in the world; adult literacy rate is 60.3% compared to 79.7% as the world. For primary education the net ratio (percentage of pupils in the official age group for a given level of education enrolled in that level to the total population in that age group) is 58.2% compared to 83.8 % in the world (UNESCO, 2004). The primary teacher/student ratio in 2001/02 was 1/45, which is the highest in the world (World Bank, 2004).

In tertiary and higher education, Africa faces different sorts of problems. Association of African Universities (AAU) data shows that while enrollment is growing, the quality of tertiary education is waning as a result of deteriorating resources (Beebe et al, 2003, p.2). African higher education has been at a critical stage since the 1980s as a result of economic deterioration in most countries. "The inadequacy of funding combined with an enrollment explosion resulted in a reduction in the capacity of most African universities to provide for effective research and learning, and a general drop in the quality of higher education in Africa" (AAU, 2004, p.1). The meeting of higher education partners in Dakar in 2003 acknowledged that in spite of the rapid increase in enrollment rates in higher education in Sub-Sahara Africa, the gross enrollment ratios gap between sub-

Saharan Africa and developed countries has continued to broaden (UNESCO, 2004). Higher education in sub-Saharan Africa is currently the least developed of all the regions of the world. Accessibility to quality education has been stalled by many barriers. Among these are lack of infrastructure, lack of trained teachers, high teacher/student ratios and shortages of educational materials.

Information and Communication Technologies (ICTs)

In Sub-Saharan Africa new and innovative approaches to teaching and learning are being adopted by many to address their lack of development. One of these approaches is the use of distance education and open learning (DEOL) (Rumajogee, 2003, p. 292). New information and communication technologies (ICTs) have the potential to foster education by overcoming distance barriers. They also can supplement classroom teaching, even in remote rural areas.

Services can be extended and more learners can be reached at a reduced cost by using distance education. However, the issue of insufficient technical infrastructure for ICTs in remote areas is a large impediment that prevents the region and the continent from diffusing ICTs. The requirement of dial-up access to the Internet and lack of computers and telephone lines within the continent show the limitation of Internet connection via traditional means.

In 2003, the teledensity in Sub-Saharan Africa was 6.6 phones per 100 inhabitants on average (ITU, 2004). An estimated 50 percent of available lines were located in capital cities, where only 10 percent of the population lives (Dooley, 2004).

Fortunately, "space platforms are logical ways to bring access to users where telecommunication infrastructures are not yet in place" (Flournoy, 2004, p. 210). Developments in Satellite Communications Technology and rapid technological innovations drive the availability of one and two-way satellite services and "these services are comparable to those of terrestrial providers" (Flournoy, 2004, p. 210).

Satellite Applications in Education

Satellite communication systems have the potential to surmount national boundaries and distance barriers. Satellite communication has certain advantages over terrestrial means of communication; since satellites are positioned in space, they are able to serve a very large geographical area. Three geostationary satellites can cover almost the whole of the earth's surface (with the exclusion of the Polar Regions). To achieve the same coverage by terrestrial means would require a very large and expensive network of ground-based cabling and transmitters (Vanbuel, 2003, p. 24).

Satellite communication can be used effectively to reach geographically isolated and remote areas. Connection is possible almost anywhere instantly within the footprint of the satellite, with no cabling work or delays depending on terrestrial infrastructure. In a large region such as Africa, satellites can overcome the lack of infrastructures that hinder diffusion of information through terrestrial means.

Moreover, services can be established quickly, since coverage is available for everyone from the day transmissions start. There is no need for a long-term phased introduction as is the case with ground-based transmissions where infrastructure will need to be built to bring service to the area. With satellite communications, even users in very remote locations can enjoy the same level of service as users in more populated areas (Vanbuel, 2003, p. 24).

There are several distinct applications that can effectively contribute to improved access to education in Africa. In this paper the applications to be discussed are Direct Broadcasting Services (DBS), Internet Access (IP via Satellite) and VSAT Networks.

Direct Broadcasting Services (DBS)

The most common use of satellites is in direct broadcasting. Categorized by its ability to address large prospective groups of users, direct broadcasting via satellite has great potential to improve access to education, and it has been a common means to provide educational service to potential learners for many years. ITU in the late 1970s set aside specific frequencies for DBS services. These frequencies are located in the Ku-band (12-17 GHz) (Flournoy, 2004, p. 228).

DBS-delivered educational content, whether live or pre-recorded, can be prepared in a central location. The content is transmitted to the space-base satellite platform via an uplink facility. For instance, the African Virtual University currently contracts with Netsat Express hub, New York, USA (AVU, 2004, p. 1) to transmit its educational programming up to the satellite. This content is then broadcast down to end user terminals via a satellite located over the African region.

Delivery is usually a one-way transmission, as in broadcasts of educational television and radio stations to home users, at a fixed time and according to a set schedule. It is posible to add an element of interactivity in the satellite configuration. For example, the learners watching a broadcast program at home or school can interact with those in the studio or support network via telephone, Internet email and messaging or via a separate videoconferencing link.

Limitations to the satellite solution are the delivery costs, that can be relatively high, the cost of producing educational programs that will serve the purposes of a large number of learners and the limited opportunities for interaction. Increasingly however, educational broadcasters are looking to set this medium in a learning environment supported by other telecommunications links, such as telephone return channels amd associated web sites (Vanbuel, 2003, p. 39).

Internet Over Satellite

Access to Internet is only recently a commodity service among the satellite networks. Although the number of satellite providers supporting IP applications is still small (Flournoy, 2004, p. 233), increasing business and consumerdemand for reliable and high-speed Internet is driving its growth.

Satellite providers can deliver Internet content directly to the network endpoint, whether to ISPs, to businesses, schools or to homes. Such services are particularly helpful in regions where the terrestrial telecommunications infrastructure is poor, as in many parts of Africa. An advantage of Internet via satellite is that the congestion within the public switched telephone network can be bypassed. Signal quality is often better than fixed wire and wireless because space-based signals are not routed through miles of cable and multiple stages of signal degrading amplification. Service reliability is greater because there are fewer failure points between the transmission facility and reception sites (Vanbuel, 2003, p. 43).

Next generation IP-satellites will offer services in other frequency bands, as with the government-controlled X-band and the newly opened Ka-band (Flournoy, 2004, p. 324). Although Ka-band satellites are about twice as expensive to build as Ku-band, the Ka-band offers significantly greater capacity. "Onboard digital processing and spot-beam technologies permit operators to multiplex the traffic of several customers onto a single circuit, providing three or four times the efficiency" (Flournoy, 2004, p. 236). Service operators typically target the SoHo (Small Office/Home Office) end-users but they can as easily target educational users (Vanbuel, 2003, p. 43).

Bearing in mind the poor infrastructure and low teledensities in Africa, Internet over satellite has a great potential to improve access to education in the continent. One example of a prospective educational use is the virtual classroom and the other is greater learner access to digital resources.

In virtual classrooms, the learner station is part of an educational network. Learning activities can include synchronous communications (such as live instruction and online chat), or asynchronous communications using a closed board system and a common store of resources available to the user on demand. The virtual classroom can be part of a multicast set-up where digital materials are sent via satellite to the end user's storage device, such as a PC, and accessed when needed. The server-based Blackboard local storage and distribution system is an example of this type of application. The African Virtual University (AVU) is using this technology.

Internationally, the most common model of Internet over satellite access is when the teacher and learners are in the same location and use the satellite service to acquire distant resources when required. These resources can be accessed either with an open Internet type connection through a browser searching distant websites or via a closed Intranet hosted remotely at the location of the satellite uplink server. Digital libraries are an example of this application. The World Links project in Uganda is an example of this type of service.

VSAT Networks

Very Small Aperture Terminals are rapidly being adopted around the world as a powerful means for providing telecommunication services that are independent of terrestrial infrastructures. Using relatively small size dishes "VSAT networks consist of user located terminals and software pointing to affiliated satellites that have been programmed to seamlessly interconnect large and small organizations" (Flournoy, 2004, p. 221).

Low cost VSAT services for Africa have been launched that radically cut the cost of Internet bandwidth. VSAT networks enable two-way data access using satellite in the Ku-band frequencies (Jensen, 2003, p.57). In the educational context, VSAT networks have significant advantages and allow organizational flexibility in controlling the educational environment to create learning settings with the precise media mix required (Jensen, 2003). A good example of this kind of network is the Global Development Learning Network (GDLN) set up by the World Bank.

Satellite-Based Education Projects in Africa

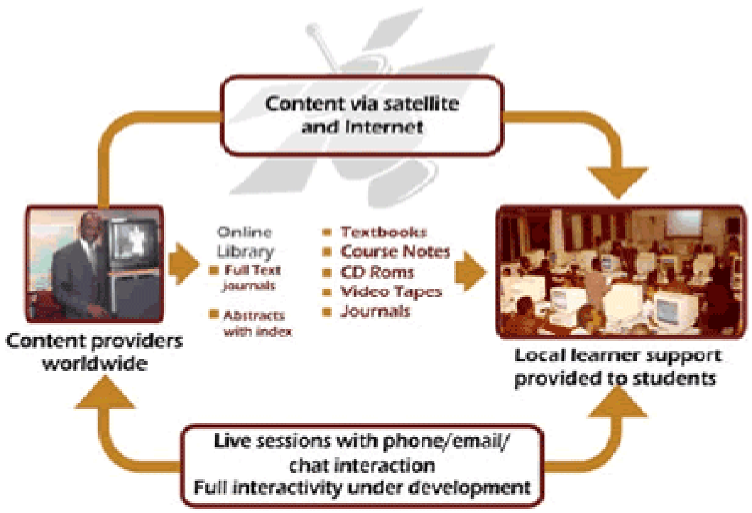
This section will provide examples of projects that use satellite applications to improve access to education in Africa:

African Virtual University: The AVU technology model consists of a mix of on-line and satellite video broadcast courses. The video portion of the courses is also a mix of synchronous and asynchronous delivery. The satellite broadcast network has been redesigned and upgraded to provide both video broadcasting and Internet access.

Interaction between the student and lecturer relies more on Internet-based communication such as email, chat and discussion forums. AVU is also considering the adoption of VSAT technologies to improve general connectivity, enable delivery of other content such as video and also enable the linking of learning centers without having to depend on the local telecommunication system for service.

Role of Satellite Technology: The AVU infrastructure currently consists of a broadcast network and an Online Learning Management System (LMS). The satellite up-link is located at the Netsat Express hub, New York, USA, with multiple downlink sites at AVU learning centers spread across Sub-Saharan Africa.

This network utilizes a mixed mode of delivery that includes one-way digital video and audio broadcast and asymmetric Internet access over the New Skies Satellite (NSS) 7 C-Band. Considering the large area of coverage and poor infrastructure in many parts of Africa; the cheapest way to distribute video content is to use satellite in broadcast mode. For on-line learning, satellite technology also plays a role in providing good quality Internet access to the learning centers, as the local terrestrial infrastructure is often poor, unreliable and expensive (AVU, 2004).



AVU instructional model

First Voice International/Africa Learning Channel: First Voice, an initiative of the WorldSpace Foundation, started its work in Africa with the launching of the Africa Learning Channel (ALC) in 1999. First Voice has exclusive access to five percent of the WorldSpace Network. ALC aims to provide access to information for disadvantaged people in the developing regions to help them improve their lives. Today, the ALC has the potential to reach as many as 100 million people through AM/FM rebroadcast. In addition, more than 100,000 people have participated in listening groups organized by the partners around ALC broadcasts.

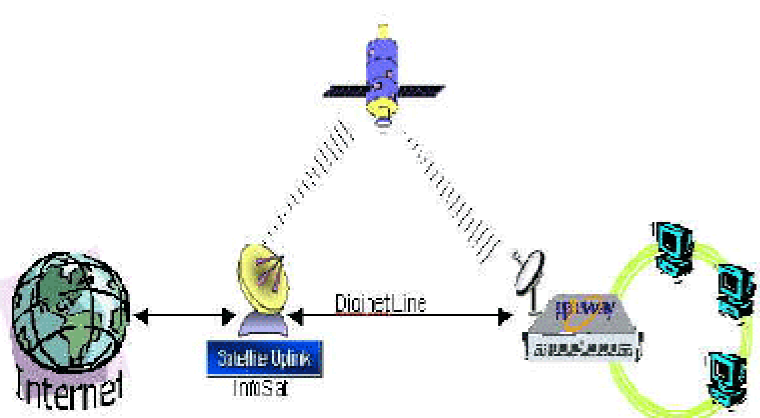
Role of Satellite technology: WorldSpace Foundation produces programs for the Africa Learning Channel by collecting content from African groups on a variety of topics and then post-producing the material for transmission on the satellite. In addition, the Foundation places low cost receivers with partner groups that ensure the distribution of programming to a much wider audience than through traditional means. These satellite radio receivers can receive text and data as well as audio. Listening groups and community radio stations are the primary users of First Voice services. The listening groups typically receive the programming directly from the satellites, using the WorldSpace satellite radio receiver.

Community radio stations can also take programming from the satellite and rebroadcast it over local AM and FM transmitters. In addition, the WorldSpace satellite radios also have data ports, which, when connected to a computer via adapter cards, allow users to download web-based text and images directly to their computers from the space transmitter. In this way, WorldSpace's First Voice Multimedia Service (MMS) can be used to transmit multimedia materials to targeted audiences in regions of Africa where Internet access is unavailable, unreliable or very expensive (First Voice International).

Myeka School-South Africa: The Myeka School project illustrates how a previously disadvantaged rural school has been able, through the use of satellite, to overcome hardware and infrastructural barriers. Myeka High School in South Africa has no electricity, running water or telephones. The local area is mountainous and the population widely dispersed, thereby rendering grid electrification uneconomical. Through the convergence of solar, cellular and satellite technologies in 1998, Myeka created a computer laboratory consisting of five PCs linked to 20 monitors. Solar panels were erected by Solar Engineering Services, and were connected to Dell PCs in a configuration that is said to be saving 44% of the power that would be required if they were connected individually (Myeka School, 2004; Vanbuel, 2003).

Role of Satellite Technology: InfoSat, a South African Service Provider based in Johannesburg, provided the school with the equipment to downlink an incoming satellite signal. The school uses cellular technology for the outgoing signal.

InfoSat provides education technology to South African high schools in partnership with the Learning Channel Campus (LCC). This technology enables the data-casting of educational content to the school's computer centre, using satellite technology to bypass the need for a traditional land communications infrastructure.



InfoSat Internet Connectivity

Constraints

Although satellite has great potential to improve access to education and to contribute toward sustainable development in Africa, the use of satellites for communications within and between African countries has remained relatively limited despite the rapid advances in satellite technology over the past two decades. Many reasons can be given to explain this situation:

Affordability. The high cost of satellite time and compatible earth terminals is a serious impediment to Africa's access to these networks. Poverty and general lack of development creates a vicious circle of weak demand and limited access. Without an economic base, competition among communication industries does not appear to drive prices down.

Regulations and Public Policy. National governments can play a role in creating environments that will foster adoption and use of advanced technologies. If Africa is to bridge its digital divide, it is important for the governments of African nations to have a long-term-strategy for implementing laws and policies that support the widespread use of technologis that can support development.

Unfortunately there has been little progress because government policy-makers are preoccupied addressing short term needs of their ocieties. African governments will have to make information and communication technology (ICT) development a policy priority if universal access to education is to be a reality in Africa.

Capacity. Understanding the broader potential for technology applications is essential. Most of the designed capacity and capability of satellite technologies are not fully utilized by African users today.

Conclusion

Satellite technologies have great potential to improve access to education in Africa. The variety of applications that can be applied in educational contexts and the ability to overcome limitations of poor infrastructures make this technology one of the most reliable and applicable technologies for communication in Africa's development.

So far, the use of satellites for communication and distribution of information within and among African countries has remained relatively limited despite the rapid advances in satellite technology. Poverty and lack of development contribute to its lack of affordability and poor demand. Outdated regulations affecting telecommunications and public access also contribute negatively to the fostering of workable satellite communication systems in Africa.With the advent of NEPAD (New Partnership for Africa's Development), greater emphasis on collaboration at the Sub-regional levels could reduce the overhead cost incurred by individual countries. Such a large scale initiative using ICTs and satellite technologies to speed social and economic development could help the region to break-out of the vicious circle of underdevelopment.

APPENDIX

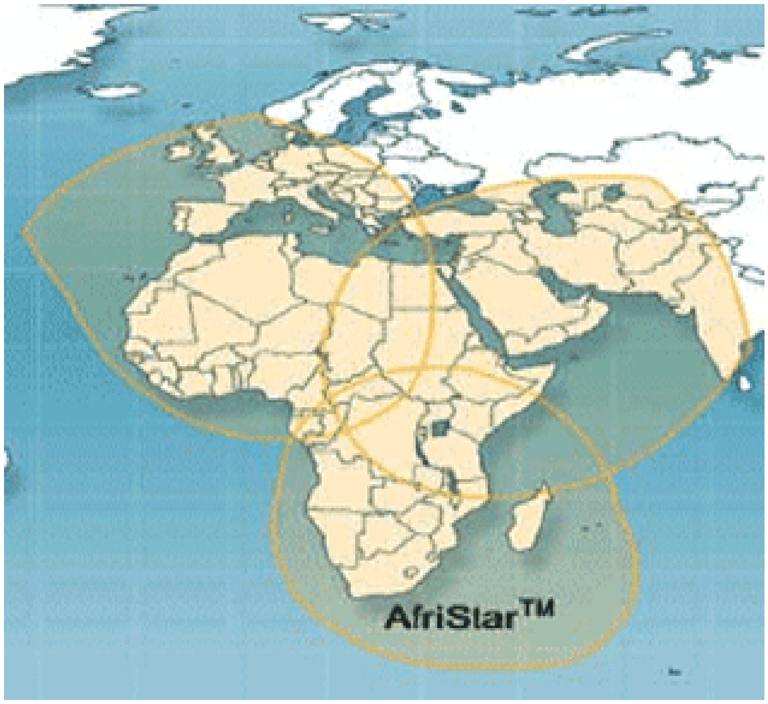
Main Satellite Services Providers in Africa:

- RASCOM: African States meeting in Abidjan in May 1992 decided to create the Regional African Satellite Communications Organization. Established in 1993, RASCOM 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. RASCOM provides integrated telephony, thin route trunking services and transponder lease services (RASCOM, 2004).
- WORLDSPACE: WorldSpace Foundation is a not-for-profit corporation founded in 1990. WorldSpace built the first radio satellite in the world (Worldspace, 2004) to provide international digital satellite radio service to Africa, Asia and Latin America serving an area that includes 502 billion people (Flournoy, 2004, p.217). WorldSpace runs the Africa Learning Channel (ALC), launched in December 1999. A collective audio channel combines educational and social development programming from African NGOs and producers for broadcast to rural communities in Africa (Vanbuel, 2003).
- PANAMSAT: PanAmSat is a 16 satellite GEO system that provides broadcast and telecommunications services to customers worldwide. Its 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, video-conferencing, paging, satellite newsgathering and special event and sports broadcasting (PanAmSat, 2004).
- INTELSAT: Intelsat has a fleet of 21 satellites, soon to be expanded to 28. It provides Internet access to 150 ISP's, as well as television transmission (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 operates several satellites that have footprints covering parts of Africa. Intelsat 704 (at 66 degrees E) is representative of its satellite operation in Africa. IS-704 is used by several South African virtual teaching institutions including the University of Stellenbosch and the African Virtual University (INTELST, 2004; Vanbuel, 2003).
- ARABSAT: the Arab Satellite Communication Organization (ARABSAT) was established in 1976 by the member states of the Arab League to serve the needs of telecommunication, information, culture and education sectors. ARABSAT offers customers multi-mission satellite services, such as television, telephony, Internet and the provision of VSAT and other interactive services. ARABSAT owns and operates two control stations to control the satellites in orbit: The Primary Control Facility (PCF) in Dirab, Riyadh, Saudi Arabia, and the Secondary Control Facility (SCF) in Tunis, Tunisia. (ARABSAT, 2004). ARABSAT is working with some local governments to provide Internet to schools, connecting them to

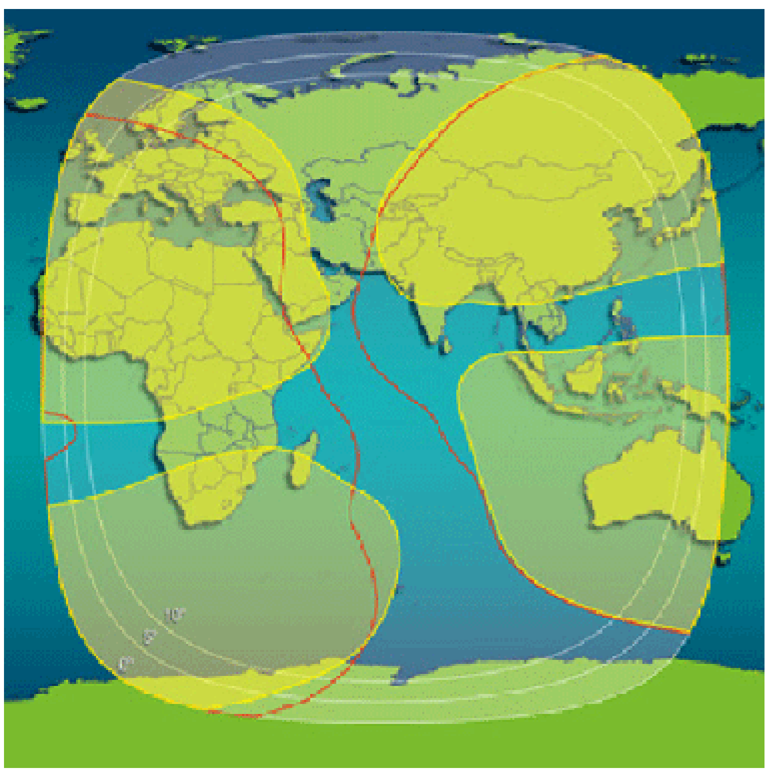
the main centers via satellite. In Africa, Egypt is using ARABSAT services for education (Vanbuel, 2003).

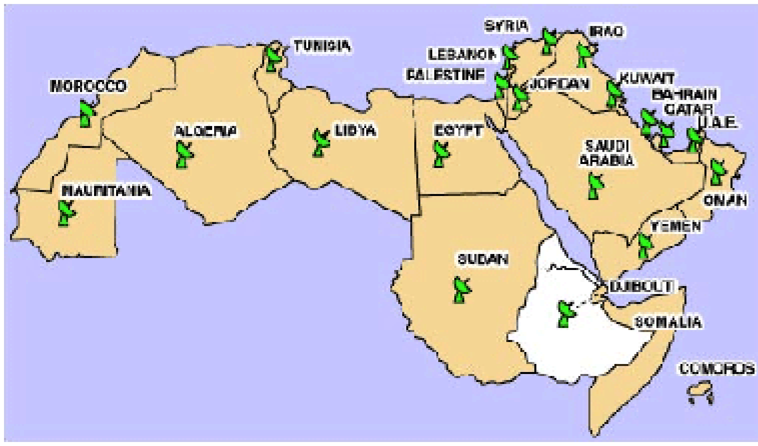
- INMARSAT: Inmarsat's primary satellite constellation consists of four Inmarsat I-3 satellites in geostationary orbit. These are currently backed up by a fifth spacecraft to provide additional capacity. The main "global" beams of the satellites provide overlapping coverage of the whole surface of the Earth apart from the poles. With its March 2005 launch of the first of its I-4 series satellites, Inmarsat will begin offering global IP networking over shared channels running at speeds of 432Kbps and higher. Inmarsat's I-4 satellites, using its Broadband Global Area Network (BGAN) will enable unprecedented worldwide broadband access in all application areas including education. BGAN is a mobile satellite service that combines high-speed data and voice telephony simultaneously through one device. The service can be accessed via lightweight portable or fixed terminals. Initially to be available throughout Europe, Africa, the Middle East and Asia, in 2006 coverage will be extended to include the Americas, providing broadband to mobile users everywhere (INMARSAT, 2005).
- EUTELSAT: Eutelsat's system is based on 23 satellites, of which 18 are fully owned by the company. Eutelsat provides TV and radio broadcasts, Internet backbone support, satellite newsgathering, telephony, mobile voice, data and positioning services. Eutelsat serves Africa through its three ATLANTIC BIRD satellites. Their mainline mission is to offer connectivity between the Americas, Europe, Africa and western Asia for Internet backbone connections, interconnection of private networks and content distribution. ATLANTIC BIRD 3 carries a C-band payload of 10 transponders with pan-African coverage. (Eutelsat, 2004).
- New Skies: New Skies Satellites owns and operates five geostationary communications satellites to provide complete global coverage at C-band, and high-powered Ku-band spot beams over most of the world's principal population centers. New Skies delivers video, Internet, voice and data transmissions services virtually anywhere in the world. Through its satellite NSS-703 at 57† East, New Skies provides connectivity to Europe, Africa and Asia. NSS-703's coverage includes a global beam, and two C-band hemispheric beams that cover Africa and the triangle from Eastern Iran to Japan and Australia, including all of India and China. (New Skies, 2004).

Graphics of Satellite Coverage in Africa:

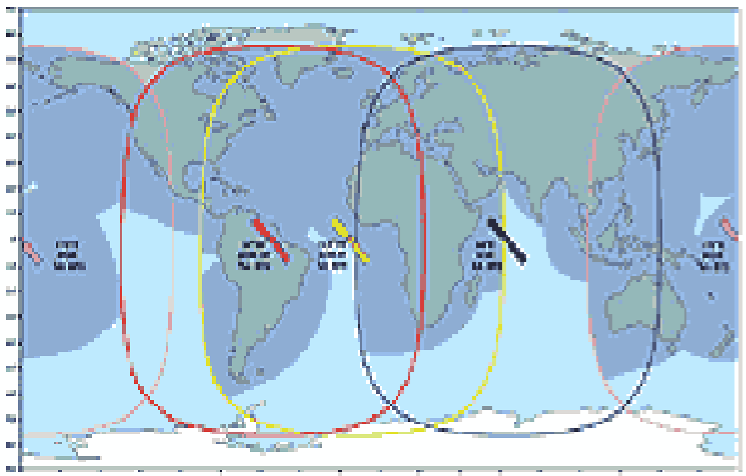


AfriStar coverage area
Source: WorldSpace website

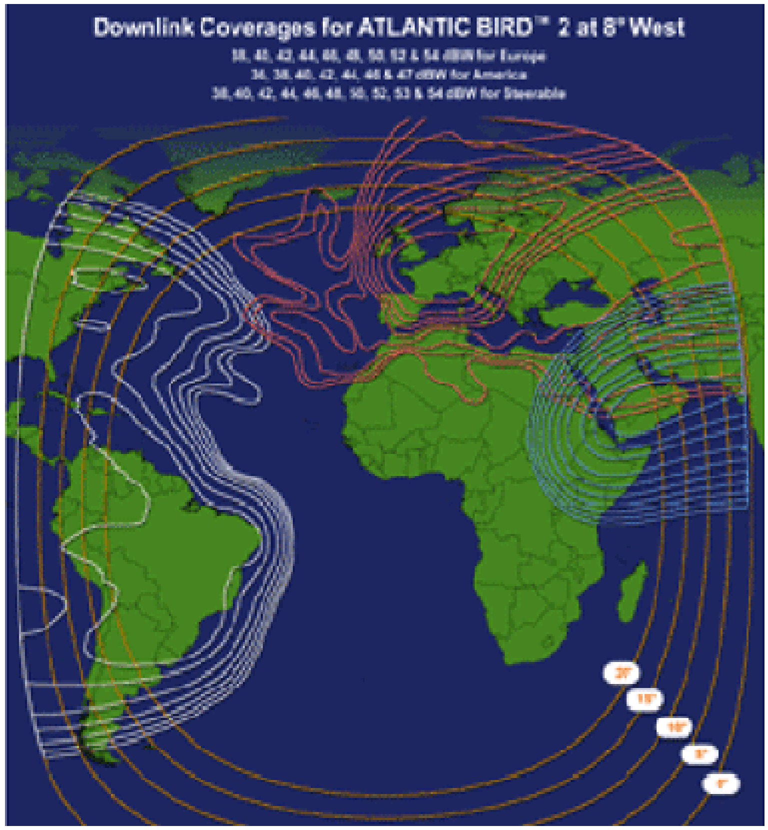

IS704 satellite coverage map
Source: INTELSAT website



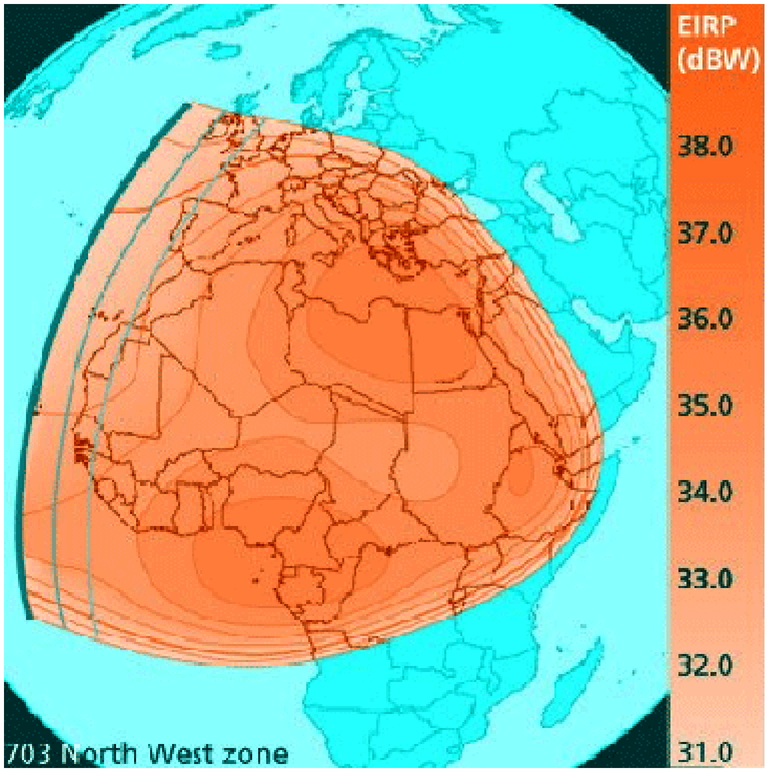
ARABSAT Systems
Source: ARABSAT website



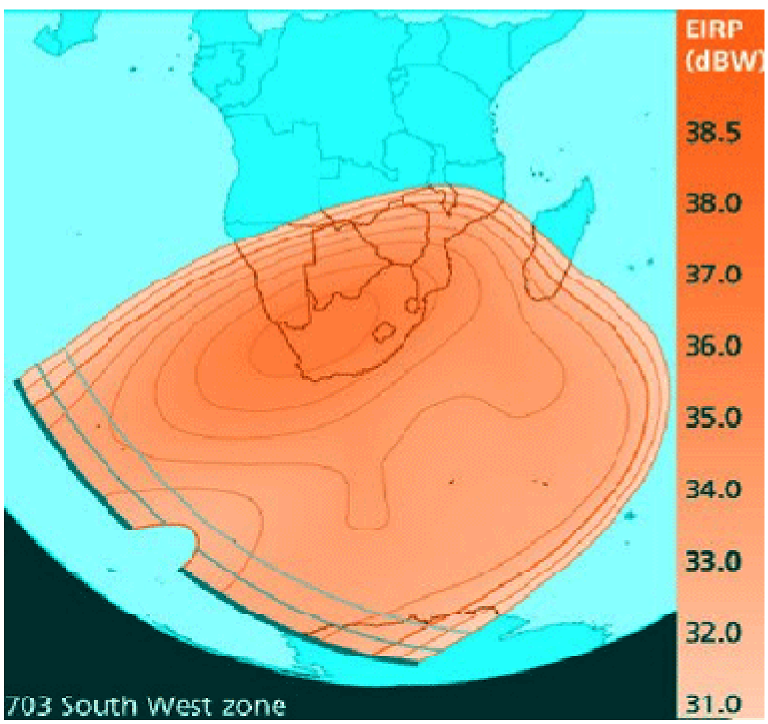
INMARSAT Global Coverage
Source: INMARSAT website



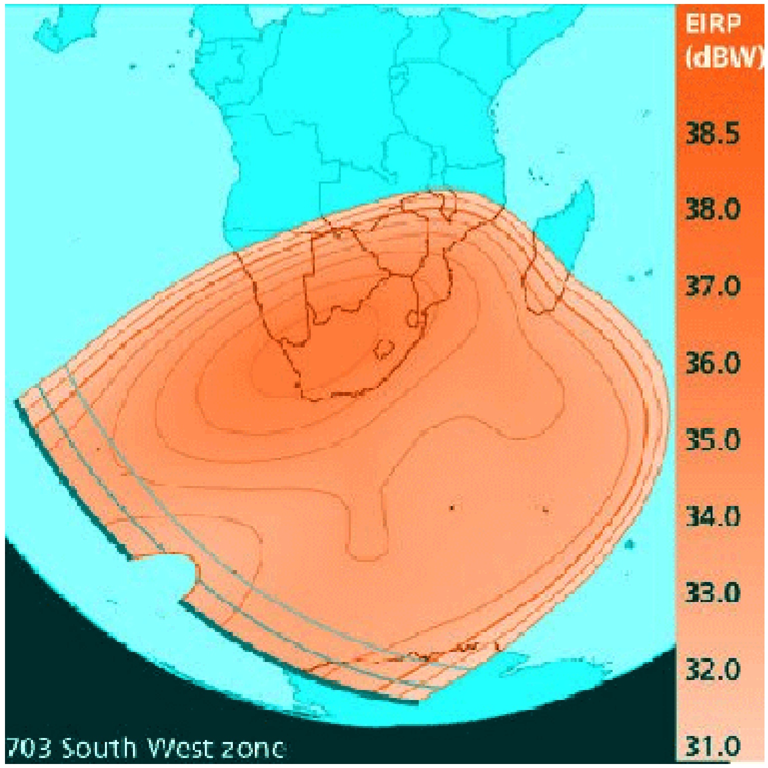
EUTELSAT Atlantic Bird- 2 Coverage map
Source: EUTELSAT website



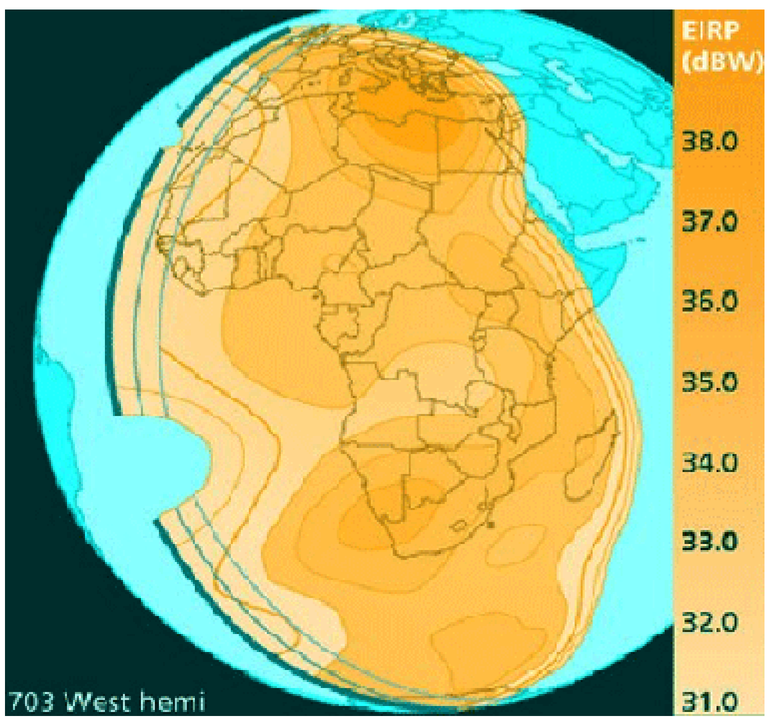
New Skies 703 satellite -North West Zone
Source: New Skies website



New Skies 703 satellite -South West Zone
Source: New Skies website



New Skies 703 satellite -North West Zone
Source: New Skies website



New Skies 703 satellite -West Hemisphere
Source: New Skies website

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