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Satellite Communications: *Impact on Developing Economies*

AAA. Atayero, *Member IEEE*

Matthew K. Luka, Orya M. Kwaghdoo,Adeyemi A. Alatishe

Department of Electrical and Information Engineering
Covenant University, Nigeria,
Corresponding Author: atayero@ieee.org

ABSTRACT

Access to information and communication infrastructure greatly enhances economic growth. When a reliable and affordable medium for information exchange is available, previously unanticipated developments ensue. Most areas in developing countries are sparsely populated and highly rural. Satellite communication is an excellent option for meeting this and many other pressing communication needs of developing economies. This paper examines the impact of satellite communication on developing economies, using popular examples as case study.

Keywords: *Developing economies, E-Health, GPS, ISP, Satellite communications, Telemedicine, VSAT*

1. INTRODUCTION

Satellite communications represents the commercialization of space. Every £1 of public funding invested in Satellite Communication technology generates downstream returns of £47 [1]. It is aimed at achieving ever increasing communication ranges and capacities at the lowest possible costs. In addition to being a means of exploiting space, it offers some features that are not readily available with terrestrial methods of transmissions such fibre, coaxial cable and microwave networks. Some of these advantages include: distance independent costs, fixed broadcast cost, relatively high capacity and low error rates. Others include universality, versatility, flexibility and ease of deployment.

Developing Economies are actively implementing data networks, and have undertaken policy reforms to facilitate such networks [2]. This is due to the undeniable fact that optimizing satellite communications can accelerate national development and bring an economy out of the woods. The impact on developing economies is increasing daily. Satellite communication offers a good platform for providing an Information and Communication Technology (ICT) platform to drive economic development, by providing a cost effective solution and affordable access to meet the telecommunications, broadcast, maritime, defence, security and revenue diversification needs of these economies. It is often the only viable network in special situations where difficult terrain, climatic conditions, or territories separated by large bodies of water, renders conventional telecommunications impossible. A number of developing economies, including India, Indonesia, Brazil, and Mexico, have launched their own satellites with a view to accelerate economic viability.

This discourse looks into the impact of satellite communication on developing economies and reviews case studies of how the use of satellite communications has influenced national and economic changes in some developing countries.

A. Impact of Satellite Applications on Developing Economies

Technology and economy are links of the same chain. Technology fosters economy and economy in turn, fosters technology. Though the intensity of linkage between the two studs are undoubtedly firm, the alignment of the chain varies. The cascading effect of either an up gradation or a down gradation is a trait of this bond. Technology has seamlessly attempted to align this system towards a progressive direction. For which purpose, many instruments have been tried out. One such instrument has been communication and information technology. Internet, mobile services and satellite services are all that surrounds us as we think of information technology today. Satellite communications being extremely versatile, greatly impacts developing economies by affording services that enhance rapid growth. Developing nations that are yet to fully utilize this versatile technology are paying an expensive price of capital flight. For instance, the Nigerian Minister of Science and Technology, decried the huge annual expenditure of over $450m on foreign bandwidth [3]. He contends that such huge sums amounts to capital flight that could be channelled into other areas of national development, if the country takes the business of communications satellite

seriously. He noted that the revenue to be saved from importation of bandwidth if satellite business is generally supported can also help the in the bid to reduce dependency on oil.

Pioneering efforts in developing countries like Indonesia and India allowed them to introduce nationwide TV distribution even before the United States had made the conversion from terrestrial microwave [4]. Facts like this naturally casts a shadow of doubt on the criteria employed by the UN in classifying countries as developed, developing, or underdeveloped.

Considering that commercial TV is the largest segment of the entertainment industry, these developments brought about an attendant economic growth. Satellites are used to carry network signals from central studios to multiple receive earth stations, each connected to a local TV transmitter. When equipped with forward-link equipment, the remote Earth Station can transmit a signal back to the central studio allow the station originate programming for the entire network. This reverse point-to-point feature can be used for enhanced services such as on-location news reports. Revenue for local broadcast operations is available from monthly subscription by TV watchers. Advertisement and public taxes are additional sources of revenue generation for local broadcast operations.

Furthermore, satellite networks are able to meet a wide variety of communications needs of businesses, government agencies and non-governmental organizations (NGOs), which include charities and religious groups. For example, the Living Faith Worldwide (a.k.a Winners Church) employs the use satellite communications for communication with its branches worldwide. The wide-area coverage feature combined with ability to deliver relatively wide bandwidths with a consistent level of service makes satellite links attractive in the developing world. In addition, the point-to-multipoint features render Geosynchronous Earth Orbit (GEO) satellites superior to terrestrial Internet for the distribution of IP-based multimedia content such as web pages, movies and VOIP.

The subsequent sub-sections outline a few areas of impact on some *developing* economies. The list, albeit not exhaustive, is representatively comprehensive.

2. INTERNET ACCESS

There has been increasing hope of access to the information world through rapid expansion of the Internet. This holds substantial promise for developing nations since the advent of broadband services through the satellite. Communication and information delivery capabilities of the Internet have helped to develop the knowledge base of individuals and organizations in the developing countries to a level where both personal and business needs can be met professionally. Access to electronic networks also improves the effectiveness of the development community, comprising representatives of international agencies, nongovernmental organization staff, and others working locally and abroad. Satellite links maintain an important position as part of the backbone of the Internet. These are particularly valuable for hooking Internet Service Providers (ISPs) in developing countries to major nodes in Japan, United States and other popular access points. The links provide bi-directional data transfer at rates ranging from 256 Kbps to 155 Mbps, depending on the expected demand

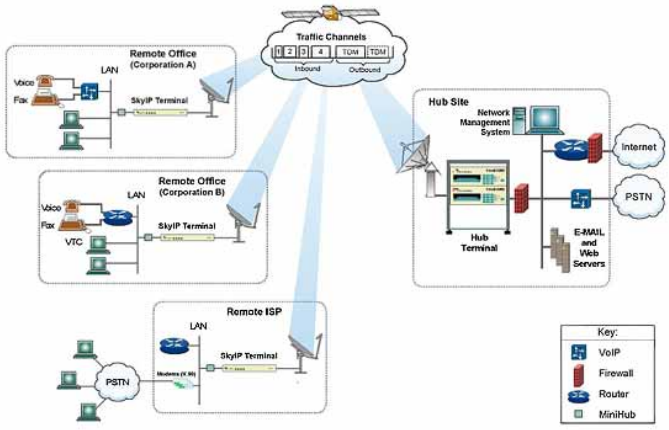

Fig. 1: Satellite Communication deployment scenario for Internet Access

and financial capacity of the particular ISP. Fig. 1 illustrates a typical satellite communication deployment scenario by an ISP.

Private companies also use such point-to-point links as part of an internal Wide Area Network (WAN) to bypass points of congestion in public networks and to allow medium and high data rate services such as video tele-conferencing.

Israel is a leader in developing Internet applications and products, for which Israeli companies have earned an international reputation. The Internet in Israel currently has more than one million users, 30,000 domains, 800,000 dial-up and 5,000 direct-connect customers. Thirty percent of households and 60 percent of businesses use the Internet. Four major and about 30 smaller Internet service providers who utilize the VSAT technology for high-speed

connection serve them. Israeli banks, fast food chains, retail operators, and hotels are utilizing VSAT technologies for voice and data communications, database updates and replications, financial management and corporate training. Some Israeli corporations are using VSATs for backup systems and disaster recovery.

A major beneficiary of VSAT technologies has been the Israeli military. Information and communication technologies are changing the way military conflicts are conducted. Satellite-based VSAT technology is providing military commanders with improved command, control and communications capabilities vital to support military operations. The advantage of this technology for the military is that a wide range of diverse communication solutions can be deployed quickly and economically. VSAT technologies provide a secure network of voice and broadband data services for command and control. The development of portable VSAT terminals has enabled the military to carry reception/ transmission equipment into the field.

Liberia – Africa's oldest republic, currently has four portable satellite internet services that connect users. These services include Broadband Global Area Network (BGAN), Regional Broadband Global Area Network (RBGAN) Services, *Thuraya* Internet Services and Iridium Data Services.

The BGAN is the world's most sophisticated satellite Internet service. It uses a variety of small lightweight portable satellite terminals, which allow travellers and remote users to connect to the Internet without the need of infrastructure such as phone lines, cellular networks or Wi-Fi hotspots. BGAN allows connection just by pointing a small portable modem to the sky for a connection speed of upto 492 Kbps. These modems can be configured according to the need of the user. RBGAN terminal allow users to connect to the Internet at speeds up to 144Kbps upload and download. Attaching a laptop to the RBGAN terminal and pointing the terminal to the sky do connectivity. Connection can be achieved where there is no conventional infrastructure and it is provided via two satellites that operate covering most of Europe, Asia, Africa and South America,

The Thuraya Internet Services satisfies multiple users with speed apt to 144Kbps with unlimited usage. It is widely used for office where services are needed on a continual basis. While the Iridium Data Services uses the Low Earth Orbit satellite connection where no antenna alignment is required to connect to the satellite. The antenna only needs to be outside and up. However, the speed achieved is 9Kbps thus it is not very ideal for web surfing but good for SMS and e-mail.

On the 28th of September 2011, the Liberian government through the Liberian Telecommunication Authority (LTA) commissioned a launch of the West Africa Regional Communication Infrastructure Program (WARCIP) in the country. This project was designed to boost connectivity to the sub-regions around the country. Before the launch of the project, satellite services had closed the gap for internet services but because of the poor telecommunication infrastructure, access to bandwidth in Liberia was among the lowest in the region with internet penetration as low as 0.5% of the Regional average. Satellite service providers have however slashed their prices as the market has become competitive.

These services have brought about development in different sector of the economy in the developing countries. Satellite communication services in these countries have been used in locations where terrestrial Internet and voice access is not available especially for mobile users. The communication via satellite is available worldwide, including vessels at sea and mobile land vehicles.

3. TELEMEDICINE AND E-HEALTH

A healthy nation is said to be a wealthy one. The number of medical cases needing expert judgement in the developing countries over the years has outgrown the number of experts available in these countries. More lives will be saved in cases of emergency, where the right diagnosis needs to be given in the shortest possible time to administer the right treatment.

India currently employs e-Health systems for the transmission of digital images over long distances using satellite connectivity as the platform of choice. X-rays, computer tomograms (CT) and magnetic resonance images (MRI) are sent across the world for the purpose of diagnostic interpretation and/or consultation. As well as for obtaining a second professional opinion in cases with spurious or indeterminate local diagnosis. This increases the efficiency of a doctor by ensuring that he spends the most part of his time delivering quality care to the maximum number of patients. One doctor based in a particular location can simultaneously provide services to several hospitals in diverse locations.

The concepts of telemedicine and e-Health have broken geographical and time barriers and help to achieve accurate diagnoses in the shortest possible time at relatively

low cost. The Indian health imaging market is expected to double from the existing $350 million in the next five years, according to estimates by London-based market intelligence firm, Tekplus. The research reported in '*Indian Health Imaging Market*' by the same firm states that in 2009, the imaging modalities of X-ray, ultrasound, CT, and MRI were collectively estimated to account for 68.6 per cent of the health imaging market [5].

4. DISTANCE LEARNING

Education is a critical component of economic growth and development. The continuous absence of quality education in developing countries means dependence on other developed countries for its provision.

Satellite-linked Internet services have played a tremendous role in distance learning through video conferencing, where participants are tutored remotely for the same quality of education. Online degree has successfully produced graduates in various fields today from different universities across the world at a fraction of the cost of attending the same schools abroad.

Case in point: EgyptSAT has created an interactive environment that enables students communicate with their lecturers. This has reduced cost in the area of infrastructure provision for the students as they remotely form a forum for learning without converging at a point. A system of distance learning using interactive satellite services was developed using satellite communications to suit different scenarios of learning and provide maximum cost benefit. The service Platform facilitates recording of lectures. This further enhances learning by allowing students to re-watch the lectures when needed as well as to use them as reference thereafter.

5. RAPID DISASTER MANAGEMENT

Satellite telephony has helped in bridging rural to urban access. There has been a major change in service needs when we talk about rural telephony, several years ago it was strictly telephony service, now it is telephony and Internet service. Satellite-based digital networks provide efficient long-distance service to rural communities at lower cost than similar land-based wired networks with acceptable quality. Low-cost Very Small Aperture Terminals (VSAT) technology and high-powered satellites at ku- and ka-bands are used to provide the quickest and cheapest way to reach remote areas, where terrestrial facilities are not available. This has been favoured by the continuous drop in the price of VSAT, which dropped from the $10,000 level in 1995 to as low as $1,500 in 2003 [4]. Fixed Telephony Satellite Networks (FTS) has increased in popularity due to rise in demand for good quality telephone service in the developing regions of the world, for transportable applications and for emergencies. Techniques such as: Bandwidth Management and Multiplexing, Multiple-Channel per Carrier Transmission and ability to interface to terrestrial telephone networks makes FTS a very versatile problem solver in remote areas where it is too expensive or difficult to extend the terrestrial PSTN.

One big advantage of satellite system deployment is that once satellite capacity is available in a particular country, the network can be installed in a matter of weeks. The network then services smaller cities, villages and even individual locations with all the capabilities of modern digital PSTN. A well-designed FTS can enhance the quality of life and economic opportunity in these regions as many of the more advanced features of the intelligent public network become available to almost anyone.

The most difficult period of a disaster is the immediate aftermath, which is the period that calls for action within an exceptionally short period of time. In the aftermath, a significant number of individuals are injured and require quick medical attention. Victims at this point always need the help of third parties. Satellite communication has proved to be a useful tool in bridging this gap.

The United Nations Institute for Training and Research Operational Satellite Application Programme (UNOSAT) provides developing countries and the international community with enhanced access to satellite imagery and GIS services, which are used mainly in disaster prevention, humanitarian relief and post-crisis reconstruction [6]

In 2004, UNOSAT played a major role in disaster response during the Indian Ocean Tsunami. A team made up of UN fieldworkers as well as imagery experts, geographers, database programmers and Internet communication specialist provided suitable and tailored solutions for the victims.

During the sad incidence, UNOSAT provided an immediate overview of the situation prior to triggering the international Charter Space and Major disaster the day after, they also immediately created regional maps of the potential impact and focused the map on the areas reported to be heavily affected in the early days of the disaster. The

first user map was on-line distributed to field users three days after the disaster.

6. AFFORDABLE DIRECT SATELLITE SERVICES

Satellite communications supports broadcast and multicast of digital content. This greatly reduces national spending on data transmissions using Frequency Modulation (FM) - which transmits signals in its original analogue form. Signals transmitted in digital form can be compressed appreciably without impairing their quality. With satellite communications, a bandwidth compression factor of 20 to 30 is now common, with the primary benefit of reducing transponder occupancy per channel of transmission, thereby increasing useful capacity. Rather than paying, say $1.8 million per TV channel per year, transponder cost is reduced to $300,000 or less. Without doubt, this is the ideal technology to deliver telecommunication and broadcast services cost effectively. Consequently, there are several free channels, which enhance access to information to the predominantly low-income groups in developing nations.

Brazil is a large country with very diverse geography that benefits immensely from the cost saving factor of satellite communication. Her terrestrial networks have not always been able to provide the highest quality of service to all who needed it. It is in this respect that VSAT deployment became necessary in Brazil. VSAT networks provide rapidly deployable, reliable satellite transmission of data, voice, and video to an unlimited number of geographically dispersed sites or from the sites to a specified point. VSAT was chosen as a solution. This accelerated economic activities and access to information. For example, the percentage of Internet users grew from 4.8% in 2001 to 12.3% in 2004.

Another area in which satellite communication has impacted on developing economies has been in global mobile personal communication. In recent years, a number of consortia have planned to launch constellation of satellites, to provide continuous global data and telephony services at affordable. This impetus will come about due to the burgeoning market for and development of terrestrial cellular systems and the availability of new frequency bands for this service.

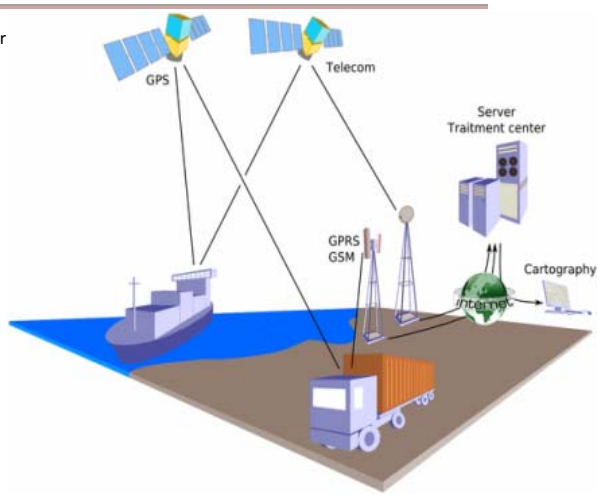

Fig. 2: Application of Satcom for tracking

7. TRACKING FOR THEFT MANAGEMENT AND CRIME CONTROL

Geographic Positioning System (GPS) is a satellite service that is very crucial for object tracking. GPS satellite has become a widely used aid to navigation worldwide, which has been of great benefit in monitoring and theft control. Applications like recovery of stolen vehicles, fleet management, Asset tracking, field service management, field sales, Trailer tracking and even wildlife tracking, map-making, land surveying, commerce, scientific uses etc have enjoyed this benefit to a very large scale. It has played a role in providing precise time reference used in many applications including scientific study of earthquakes, and synchronization of telecommunications networks.

South Africa: suppliers of Fleet Management and vehicle tracking systems have gained considerable momentum in vehicle tracking for theft management. Satellite, cellular and radio technology have been harnessed by the tracking industry to track stolen vehicles. Some tracking companies use GPS satellite to monitor vehicle location. A device fitted to the car picks up the signals from several satellites orbiting the earth, the vehicle needs to see at least three of the satellites for its position to be located after which its information is related to the security company's base station. This form of tracking is fairly cheap because the satellite has been put in place by the US military and public access to their signals is free. The tracker system can compare the legal speed limit on the route a vehicle is travelling and report when over- speeding.

8. AGRICULTURAL BENEFITS

In some developing countries, broadband access through satellite telephony has linked farmers in remote areas. A significant trend in South America, Asia, Brazil and Australia has shown that more and more countries are increasing the emphasis on establishing networks to provide enhanced communication access on their farms especially farmers working in partnership for export. These networks collect and collate data from satellite, aerial sensing and surveillance, fixed and mobile radar, radio-localization, meteorological stations and altitude weather balloons. The data collected helps to detect environmental changes such as deforestation.

Vehicle Navigation as a Precision Agricultural tool has the greatest impact to date on Australian farm management. Advances in Global Navigation Satellite System (GNSS) technology since 1999 have opened the door for steering guidance, steering-assist and auto-steering systems for use on agricultural vehicles. A network of Continuously Operating Reference Stations (CORS) was established to provide state-wide differential coverage known as 'GPSnet'. This system worked towards enabling local farming groups to join the network and receive broadcast corrections [7].

9. CONCLUSION

In summary, communication challenges of developing nations require a range of suitable country-specific solutions. Solutions appropriate to prevailing economic, geographical and technological conditions, appropriate to end user requirements, and taking into account local price structure and cultural idiosyncrasies. The use of satellite communication in developing economies for meeting communications needs such as broadcast and multicast of digital content, entertainment television, voice and telephony networks, data communications and the Internet as well as mobile and personal communication has a positive impact on the development of these economies. As explored in this paper, the impact is tremendous in critical areas of the economy such as medicine, agriculture, education, commerce *et cetera*.

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