SET A LIGHT

In orbit for social change

VSAT: Social Implications of Satellite Technology

CCTP 506

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Introduction

Set a Light is a team initiative that seeks to implement satellite technology in specific social scenarios. VSAT is an abbreviation for “Very Small Aperture Terminal”, a specific communications technology that will be referred to throughout the document.

VSATs are commonly used to transmit narrowband data (point of sale transactions such as credit card, polling or RFID - radio frequency ID data), or broadband data (for the provision of Satellite Internet access to remote locations, VoIP or video). VSATs are also used for transportable, on the move (with phased-array antennas) or mobile and maritime (such as Inmarsat or BGAN) communications.

The largest VSAT network (more than 12,000 sites) ever deployed was a joint venture by Spacenet and MCI for the US Postal Service. Other large VSAT network users include Walgreens Pharmacy, Dollar General, Wal-Mart, CVS, Rite Aid, Yum! Brands, and vendors contracted to install and maintain lottery terminals. VSATs are also used by car dealerships affiliated with manufacturers such as Ford and General Motors for transmitting and receiving sales figures and orders, as well as for receiving internal communications, service bulletins, and interactive distance learning courses from manufacturers. The FordStar network, used by Ford and its local dealers, is an example.

VSAT technology is also used for two-way satellite Internet providers such as HughesNet, StarBand and WildBlue in the United States; and Bluestream, SatLynx and Technologie Satelitarne in Europe, among others. These services are used across the world as a means of delivering broadband Internet access to locations which cannot get less expensive broadband connections such as ADSL or cable internet access; usually remote or rural locations.

Nearly all VSAT systems are now based on IP, with a very broad spectrum of applications. As of December 2005, the total number of VSATs ordered stood at over 1 million, with nearly 650,000 in service. Annual VSAT service revenues were $3.88 billion (source: www.comsys.co.uk).

For the purposes of this project, the focus is primarily on the use of the technology in social applications. There are four specific scenarios: disaster rescue, humanitarian communication, universal access, and the provision of Internet access in conflict zones. It is expected that by using VSAT there are benefits to be derived in these economically, politically, and/or socially stressed situations.

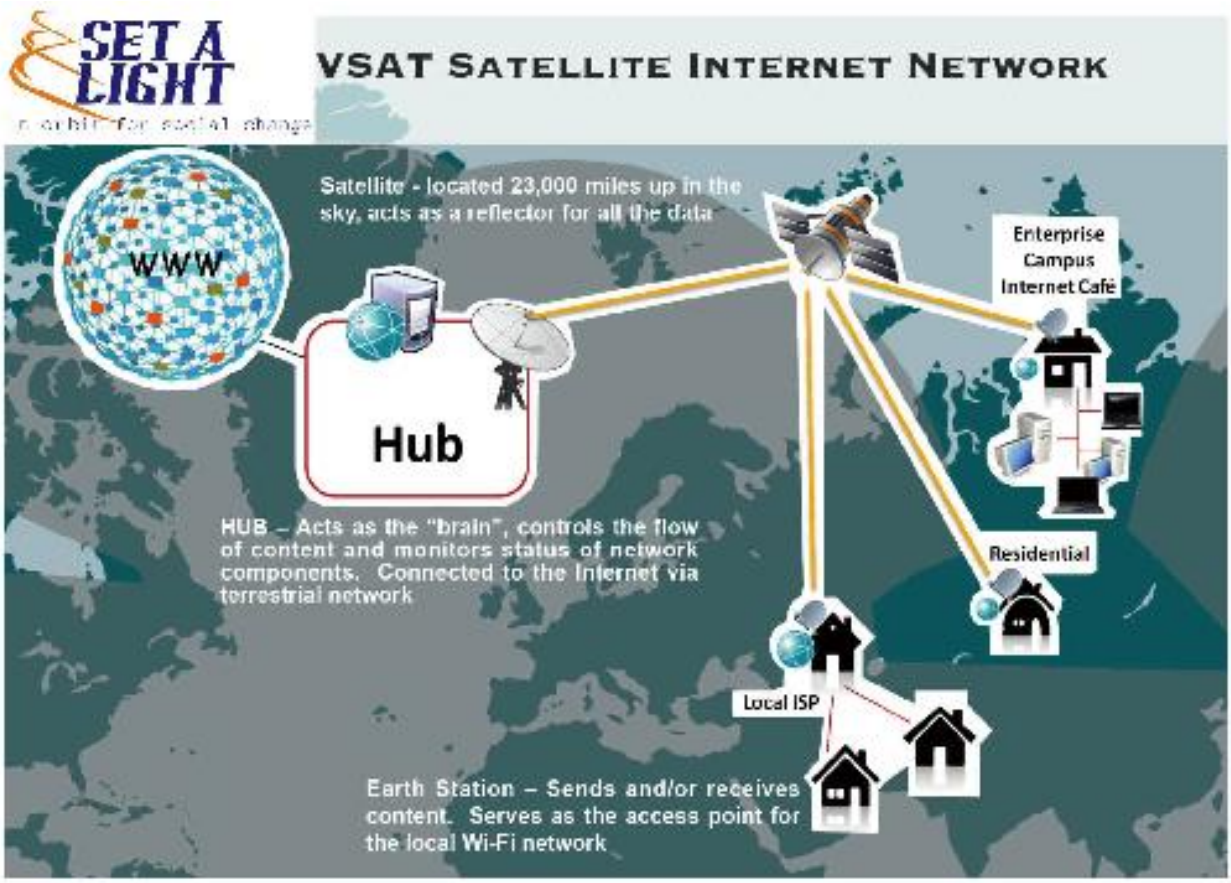
Each one of these share special communications requirements that would be hard to satisfy by conventional means, i.e. traditional Telco solutions like landline or broadband communications. Since this is a technology that is easily deployable, location independent, easy to operate, and

robust, it can be set up to be operational in places where other solution alternatives cannot, with little experience or expertise.

What is VSAT and how does it work?

VSAT is a technology used to define two-way-satellite communications, which transmits and receives data from a relatively small satellite dish on Earth and communicates with an orbiting geostationary satellite 22,300 miles above Earth's Equator.A VSAT network has three components:

- A central hub (also called a master earth station)
- The satellite which is in a geostationary orbit 22,236 miles above the earth's orbit, following the direction of the earth's rotation. This makes it appear as if it is stationary, always at the same point in the sky at all times. This allows for the antenna of the VSAT to remain fixed in one position with no need for repositioning.
- A virtually unlimited number of VSAT earth stations in various locations across countries or continents or on stabilized antennas on a ship at sea.



Depending on bandwidth requirements (data speed and/or communications channels), VSAT systems can be relatively small, using small dish antennas less than 3 meters and generally operate in the Ku-Band, Ka Band, and C-Band frequencies. A majority of VSAT antennas range from 75 cm to 2.4 meters in diameter. C-Band requires larger antennas while Ku-Band and Ka-Band uses smaller antennas.

Content originates at the hub, which features a very large antenna. The hub controls the network through a Network Management System (NMS) server, which allows a network operator to monitor and control all components of the network. The NMS operator can view, modify and download individual configuration information to the individual VSATs.

Outbound information (from the hub to the VSATs) is sent up to the communications satellite's transponder, which receives it, amplifies it and beams it back to earth for reception by the remote VSATs. The VSATs at the remote locations send information inbound (from the VSATs to the hub) via the same satellite transponder to the hub station.

Since a ship installed with VSAT at sea moves with the water, the antenna needs to be stabilized with reference to the horizon and True North, so that the antenna is constantly pointing at the satellite it uses to transmit and receive signals. It takes about 500ms (half a second) for a signal to travel from the ship, to the satellite, to the earth station and back. This is known as satellite latency and can affect the performance of voice and data communications.

Satellite communications require “line of site” so the antenna must have an unobstructed view of the satellite. Mountains or buildings on land, or structures on the ship can often block the satellite and affect link performance. Satellite antennas must be pointed at the satellite with about 1 degree of accuracy. On moving ships, sophisticated stabilized antennas are used to track the satellite and compensate for the movement of the vessel.

The arrangement where all network communication passes through the network's hub processor is called a "star" configuration, with the hub station at the center of the star. One major advantage of this configuration is that there is virtually no limit on the number of remote VSATs that can be connected the hub.

VSAT System Characteristics

The use of VSAT systems is growing throughout the world as a way of establishing private satellite communications networks and providing high bandwidth needs for critical communications for businesses that have several widely dispersed locations. VSAT networks may transmit voice, data, fax, or video conferencing. They are also used for backup to traditional broadband circuits for

mission critical applications. While VSAT can be used as a two-way satellite ground station, VSATs are also used for transportable, on-the-move, emergency mobile communications.

Advantages

- **Rapid deployment:** Once the Satellite is put in orbit, the deployment at the customer premises can be done (usually in hours) if the equipment is available, with minimum training. And the deployment can be done in any region, irrespective of location.

- **Global Coverage:** This is the most significant advantage of using satellite links - coverage at any location on Earth. A single satellite in the geostationary orbit can cover distances as large as whole oceans or continents.

- **Location independent - mobile solution:** Having a broadband connection at any location is great; the advantage of taking it anywhere is even better. Internet via satellite is possible through fixed and mobile equipment. The end user location is connected to the Internet as long as the VSAT dish has a clear line of sight (i.e. a clear view of the southern sky).

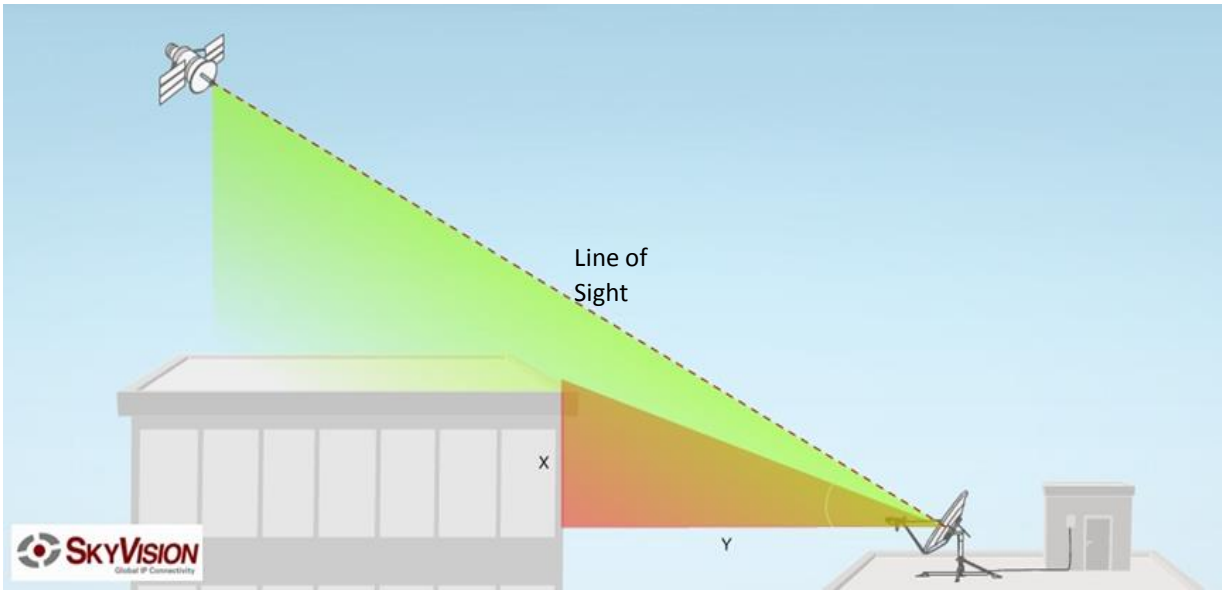
- **Instant installation and deployment:** The satellites antennas can be instantly deployed and installed within a matter of a few hours. For mobile and transportable solutions, you can set-up and connect to the Internet in less than 45 minutes.

Disadvantages

- **Latency:** The speed of light being what it is, and the fact that the satellites are 23,000 miles above the equator, it takes the signal approximately 0.26 seconds to get to the satellite and back. This bit of delay can play havoc with certain types of applications. Some interactive applications (such as dumb terminal with remote echo) can be nearly unusable unless appropriate measures are taken. There are also non WAN-friendly applications out there (*including ones that purport to be WAN-friendly*) that require an inordinate number of data exchanges for even the most trivial of functions: It should be pointed out that these applications are typically poor candidates for <u>any</u> WAN application - be they terrestrial or otherwise.
- **Solar outages:** Twice a year, there are brief periods (lasting a few minutes) where the Sun moves directly inline with the satellite. The Sun, being a very powerful source of radio signals, temporarily jams the satellite signal. These outages can be predicted very precisely

and last only a short time. (*Most users can tolerate "scheduled" outages - it is those "unscheduled" ones that cause the most problem...*)

- **Weather outages:** Occasionally, very heavy precipitation will block the signal for short periods. These outages are fairly rare and don't normally last for more than a few minutes. Another possibility is that of snow building up in a dish, but proper system design (e.g. installation of covers, heaters, and occasional vigilance and, in a worst-case scenario, the use of a broom) can prevent such outages from ever happening in the first place.
- **Satellite failure:** Fortunately, this is extremely rare. Satellites are some of the most reliable pieces of equipment made - and they are loaded with redundant systems. Even in the event of a failure, it is practical to restore service simply by pointing the antenna at a different satellite.
- **Needs "line of sight":** The entire field of geostationary satellites can therefore be found in an arc across the sky. In order to communicate with the satellite you wish to downlink from or uplink to, the antenna must be able to "see" the location in the sky above the equator in which the satellite is located. The situation of an unobstructed view between the satellite and the antenna is known as having a "line-of-sight" to the satellite. This condition is necessary in order for the VSAT terminal to communicate and transfer data to and from the satellite.



VSAT System Applications

VSAT was originally intended for sporadic store-and-forward data communications but has evolved into real-time Internet services. An innovative feature of VSAT is that the technology has matured to the point where what could previously be achieved only with large high-powered dishes can now be accomplished with much smaller, low powered antennas anywhere in the world. The use of VSAT systems is growing throughout the world as a way of establishing private satellite communications networks and meeting bandwidth needs for critical communications. VSATs are also used for transportable, on the move, emergency mobile communications, especially in remote areas where other means of connectivity are non-existent or compromised. Below are special cases, social scenarios where VSAT has been proven to be instrumental in providing critical need communications.

Universal Access

VSAT technology continues to be a tool that promotes regional development and economic inclusion in meeting demand for telephony and Internet in rural areas. Nowhere is this more evident than in the market for fixed rural telephony. In fact, the rural telephony market is one of the fastest-growing segments of the VSAT industry. In this market, GSM cellular and 3G cellular providers cannot compete with VSAT networks. While a rural telephony, VSAT network costs the operator between two and three cents per minute, whereas mobile satellite systems cost more than 50 cents per minute. Similarly, CDMA and GSM have very high base-station costs. Therefore, unless the number of lines number at least 100 within a short radius, the capital expense for wireless alternatives is prohibitively high. Conversely, VSAT networks can cost the operator as little as USD $500 per line in very low-density areas. This type of cost effectiveness has been demonstrated in several large VSAT networks of 2,000 sites or more in Latin America, in countries such as Colombia, Peru and Mexico.

Fulfilling the promise of Universal Access by making a phone call, surfing the Internet or receiving a fax are everyday functions of life taken for granted - by about half of the world's population. For the other half, access to communication systems is far more elusive. The United Nations has designated VSATs as a pivotal technology for developing countries because they can use it to deliver on their promise of universal access. Universal Service Obligations (USOs) are implemented by governments to ensure that operators move forward with the development of communications infrastructure in rural areas. Many governments face an ongoing challenge to provide basic

telephony services throughout their country. To meet this challenge, many have turned to VSAT networks for a low-cost, reliable public telephony solution. VSAT networks represent the most cost-effective solution for communities in areas where POTS (Plain Old Telephone Service) is unavailable, overloaded or too expensive. Access to telecoms provides not only the ability to interact on a personal level, but perhaps more importantly allows remote and rural communities to deal directly with the marketplaces that traditionally resell their produce and products. It also provides urgently needed access to tele-medicine, e-government, MOOC (massive online open courses), and direct to home broadcasting. The establishment of VSAT platforms has led to greater efficiencies and higher margins for these communities through closer coordination of what is in demand and what is produced.

The most advanced VSAT products support multiple telephone channels and an Ethernet port for a personal computer (PC) connection. Delivering toll-quality voice and IP transmission, these VSAT networks are an ideal solution for small office/home office (SOHO) users and Internet Café services. Meanwhile, as the introduction of a broadband-enabled infrastructure in major metropolitan areas progresses steadily, millions of homes and small companies will still remain without high-speed Internet service for years to come. VSAT providers are leading the effort to eliminate this "digital divide". However, broadband, two-way satellite Internet services have already been successfully introduced at thousands of sites in Australia (Cable & Wireless Optus), India (Bharti Broadband), China, the Philippines (Textron), the United States, Europe and Latin America.

Humanitarian Communication

A good case study of VSAT technology in action for humanitarian communication is Télécoms Sans Frontières (TSF). This idea was the result of a simple observation made after many years of experience with general humanitarian charities, based on listening to those in need. During missions responding to the crisis in the Balkans and in Kurdistan during the 1st Gulf War, TSFs founders realized that, in addition to medical and food aid, there was a critical need for reliable emergency telecommunications services. Conflicts and emergencies often led to massive civilian displacement and separated families. And affected populations are often left with no communications infrastructure in place to find assistance and loved ones.

During early missions, TSFs founders were often approached by refugees with scraps of paper asking them, for example: “When you go home, please call my family at this number, tell them I’m alive, uncle has been killed but I’m alive and I’m at the refugee camp in Stenkovec”. To address the need for communications services, TSF bought its first satellite phone and the organization was born. Since then, TSF has offered a 3-minute call to any affected family on every mission. TSF soon

found that the international response teams that deploy to emergencies also had a critical need for reliable telecommunications services in the first days after an emergency. TSF continued to expand its operations, improved its technology, and began to establish rapidly deployable satellite emergency telecommunications centers to serve UN, government, and NGO humanitarian workers, and developed a reputation for being among the first to arrive after disasters.

The typical equipment kit that TSF deploys to a disaster area consists of:

1. A **BGAN** (Broadband Global Area Network) – a device that deploys a satellite Internet network with telephony using portable terminals. The terminals usually connect to a laptop computer in order to access the Internet in remote locations. The advantage of a BGAN terminal is that it is much less bulky than traditional VSAT equipment. It connects to a specialized network provided by *Inmarsat* and uses three geostationary satellites called *I-4* for almost global coverage.
2. **VSAT Ka and Ku** – the standard VSAT gear in two frequency ranges, Ka, which covers the frequencies of 26.5–40 GHz., and Ku that operates between 12-18 GHz. Two bands are used for reliability and fault tolerance.
3. **Isatphone Pro** – a ruggedized, general purpose, satellite phone that has global coverage, clear voice quality, a long battery life and is simple to use. It has been tried and proven in the field under harsh conditions. It also utilizes the *Inmarsat* network.
4. **GSM Phones** – GSM (Global System for Mobile) communications is a standard set of protocols designed to work with second-generation (pre-smartphone) mobile handsets. These are deployed to the target population once a local GSM network has been established through the VSAT and/or BGAN network.

Disaster Recovery

A great example is disaster areas, where communication infrastructure is damaged, not functioning, or in many cases, non-existent. Satellite Internet connectivity can make a difference in the coordination and cooperation efforts of rescue and disaster teams. In addition, Internet access played a key role for social activists, dissidents and protesters during the Arab Spring events and in protests for other non-democratic countries. Authorities in those places understood it and responded by shutting down networks to make it harder for protesters to coordinate. In addition the authorities used the networks to track dissidents and arrest them. For example, Syria's main mobile phone operator, Syriatel, was being used to identify rebels and punish them. Technologies as the VSAT circumvent the control that regimes have over data transportation and therefore can be a crucial factor in the process of social and political revolutions across the globe.

- In Haiti, 2009, traditional channels of communication collapsed - terrestrial networks either stopped working or were highly congested. Immediately after the first reports, VSAT systems were established for the President's office and local police to coordinate logistics. Many additional networks were installed later on and by humanitarian agencies to provide Internet and voice services.
- There is an acute growth in number of cellphones in developing countries (according to the World Bank – 5 billion devices in developing countries) additional devices exist. Establishment of ad hoc GSM and Wi-Fi networks for small range of areas, and routing of networks via VSAT to a worldwide connectivity is common practice.
- TSF operated in the border of Thailand and Myanmar, where there is malaria epidemic, and in Managua, Nicaragua where there is a Dengue fever epidemic. Local teams transfer data to a European based medical staff, as well as to local doctors via local GSM networks.
- In Congo – where woman that goes to the woods to search for fresh water and food is constantly raped by the militia – that are in the woods (half a million women were raped at least once, about 50 are being raped every hour in average) they now take cell phones as security measure so they could call for help

Internet Access in Conflict Zones

The US government also provides emergency, satellite based, telecom services in conflict ravaged areas, like the one taking place these days in Syria and in other war zones. The US State Department had budgeted funds since 2008 to promote new technologies for social activists, “focusing both on circumvention technology to help them work around government-imposed firewalls and on new strategies to protect the free flow of data communications from government intrusion”. It is part of the U. S. Secretary of State charter to expand Internet freedoms and pointing out its role in pro-democracy shifts.

- Satellite communications gradually redesigned the balance of power between rulers and tyrants to society. Satellite TV broadcast from different countries allowed the circumvention of local bands. Nowadays, dissidents use BGANS well as VSAT to bypass blocked networks in countries like Iran, North Korea and in Arab spring countries as Syria and Libya.

- Allegedly no one take responsibility, however the New York Times has published many stories regarding the involvement of the US State department in developing shadow networks in these countries, and officially, a budget of USD 50 Million was allocated for these purposes.

Conclusion

VSAT continues to improve as satellite capacity becomes more abundant and emerging technologies make it affordable. In addition, because satellites are becoming more powerful they enable the use of smaller, and therefore cheaper, antennas on the ground. These advantages explain why VSAT networks have also gaining adoption in socially responsible ways for corporate applications. For more than 20 years, many of the world's largest retailers, petroleum marketers, auto makers and financial services firms have made VSAT networks their platform of choice for a wide range of interactive data, audio and video applications - including IP networking and broadband applications.

A good example is China's Hebei Sky Data Networks & Communications Co. Ltd. (Sky Networks). Hebei is now deploying a satellite communications network to thousands of sites throughout the country. The network is expected to be one of China's largest and, as a shared-hub service, is expected to provide wide-area and thin-route data communications for end users in the enterprise market - including, most notably, the Chinese Postal Service. This will dramatically cut the time it takes to deliver mail services to remote areas of the country. The VSAT network will enable Sky Networks' customers to deploy the very latest interactive data applications, including: credit and check authorization, inventory management, enterprise-wide e-mail, and Internet Protocol (IP) multicasting. Sky Networks is also working closely with Ericsson to provide PDAs (personal digital assistants) to mobile communications networks throughout China. While the use of two-way satellite networks for business-critical applications mentioned above is certainly prevalent, VSAT providers are also meeting the sizeable demand specifically for high-speed Internet connectivity from small to medium-size enterprises.

VSAT is vital for delivering badly needed emergency communications in a disaster areas, and helping notify loved ones of their relatives' condition in war stricken zones. It has proven effective in giving students in small rural areas to ability to take courses of big city universities, and improving economic conditions globally by better coordination of demand and supply of goods. In the constant effort to bring high-speed reliable communications solutions to everyone - no matter where they are located, VSAT is the technology that can provide the link to indispensable communication resources.

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