

# From science fiction to reality

## for rural communities

Service delivery in underdeveloped and remote areas in southern Africa has always been a major challenge. Community-based service centres are often the only place where people can access information on various topics and are therefore the central point of activity in such communities. This article written by the CSIR's Alida Veldsman during her Technical Leadership Programme, proves that VSAT systems using low-cost satellite terminals with small rooftop or ground-mounted dish antennas can significantly reduce telecommunication expenses.

Information delivery to and from these community-based service centres is one of the key factors in the economic development of rural communities. The challenge is to transfer data to and from these centres as fast and as effectively as possible. The problem, however, is that the majority of these centres are without connectivity which makes electronic data transfer impossible.

Until recently, rural communities had to rely on postal services, radio and where possible, television and telephone as their only means of communication. To use satellites as a communication mechanism is science fiction to communities where life is still untouched by the complexities of technology.

### Why satellite?

Satellite communications connect people through voice, video and computer-based information networks, allowing them fast and secure access to critical business information. Provided that electricity is available, that the satellite dish can 'see' the satellite (clear view of the sky) and is within the satellite's footprint (the area that the transponder covers), permits connectivity to be independent of geographical location or time differences.

Satellite networks are not dependent on cables (which can be stolen or damaged and have fewer points of failure (such as joint boxes and telephone exchanges) between sites.

As Internet traffic continues to grow, Internet Service Providers (ISPs) are challenged to keep up with the demand for network bandwidth. Satellite-based Internet connections are one way of getting more use out of the existing bandwidth.

### What is VSAT?

VSAT stands for Very Small Aperture Terminal, and is a small earth station that is used for satellite communication. The term VSAT, is an indication of the small size of

the antenna (usually less than 2,4 m), and describes both one-way and interactive systems and is used to ensure fast, reliable and cost-effective communication.

VSAT communications were introduced in the early 1980s and have developed into a mature technology. Today there are well over 600 000 VSAT earth station terminals installed and operating successfully around the world serving the needs of corporate businesses and government organisations.

### What is meant by one-way and / or interactive systems?

One-way systems are broadcasting systems only and rely on a transmitting station, which transmits to the satellite, which in turn re-broadcasts the signal over its footprint area. The signal can be received by more than one terminal at a time.

The same data can be distributed to a number of recipients (eg radio or video broadcasts as well as software updates) by using the multicast capabilities of the VSAT networks to send the data once, and being received by multiple sites simultaneously. This has not only major cost benefits, but also prevents outdated information. Broadcast systems are used for voice or data transmissions such as software downloads, file transfers, etc.

Interactive systems are network systems, which link two or more sites. Typical applications for interactive VSAT networks are:

- Intranet communications
- Broadband Internet / Intranet access
- Reservation systems
- Transactional systems
- Point-to-point file transfers
- Email and messaging
- Video conferencing
- Bank and ATM fund transfers
- Credit card verification and credit checks
- Stock control and management, etc

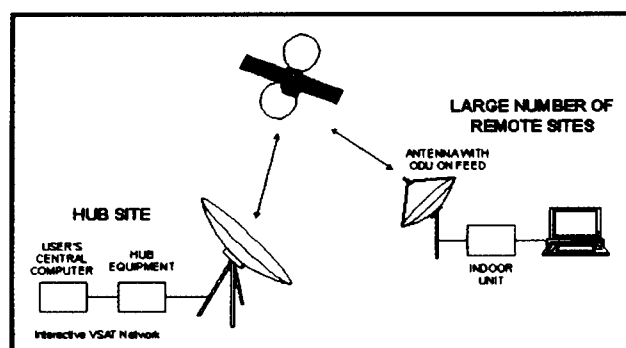
The benefits of these applications for integrated development in rural and underdeveloped areas are phenomenal.

### Setting up a VSAT network

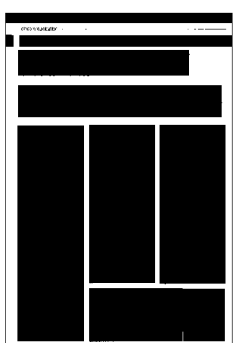
There are two fundamental ways of setting up a VSAT network, namely a star or mesh topology. In a star network, all traffic is routed through a central hub as shown in the diagram below.

A star configuration network has a high bit rate outbound carrier from the hub to the remote earth stations and one or more low or medium bit rate Time Division Multiple access (TDMA) inbound carriers. This means that the data stream from the hub to the satellite is transmitted at a relatively high information rate (typically 56 to 1 025 kbps) using Time Division Multiplex (TDM), whereas the data stream from the VSAT to the hub is relatively smaller.

The reason for this difference is that huge amounts of data are transmitted



*Interactive VSAT networks: In a star network, all traffic is routed through a central hub. The hub is the central point of a network and includes transmit and receive equipment for two-way communication with the RCST (return channel satellite terminal), also referred to as the VSAT, which can be located at a service centre in a rural area.*



to the VSAT service centres at any given time, while the data sent via satellite to the hub is much less. In a mesh configuration network, sites communicate directly with each other with only management actions through the hub. Mesh network equipment is up to ten times more expensive than a star network.

### What is meant by bandwidth?

Bandwidth is the range of frequencies utilised for the transmission of a signal or a group of interrelated signals expressed in Hertz (Hz). A fixed amount of bandwidth is allocated to a specific network and can be utilised by the recipients in one of three ways in which the network is set up:

- Static CIR (committed information rate) by which each recipient (VSAT) gets a predetermined bandwidth, whether it is used or not.
- Contended CIR by which the fixed bandwidth is split between the terminals as required.
- CIR with contention where the sum of all the CIR of the network is less than the guaranteed minimum bandwidth allocated. A VSAT can then burst into spare bandwidth as required.

As satellite connectivity is dependant only on being able to 'see' the satellite, satellite services are ideal for utilising the available bandwidth on demand. This ensures fast set-up time of terminals; the ability to turn the bandwidth on and off at a moment's notice; the sharing of bandwidth between terminals, ie a number of offices in a community-based center, which might include nearby schools and health care clinics; and the ability to burst into whatever bandwidth is available if and when needed.

**In contrast with conventional terrestrial networks where obtaining more bandwidth means having more cables, new equipment and months of lead time, VSAT networks can be done in seconds, which makes satellite connectivity ideal for underserved areas in South Africa and the rest of Africa.**

### What can influence the reliability of satellite communication networks?

Geostationary satellites orbit the earth every 24 hours in order to stay in one place relative to the earth. The physics of gravity and acceleration means that the satellites have to be 36 000 km above the equator or else they will be drawn back into the earth's atmosphere. Microwaves travel at the same

speed as light, giving a latency from terminal-to-satellite-to-hub of just over a quarter of a second.

This means that a terminal-to-hub connection will have a round-trip time delay (terminal > satellite > hub > satellite > terminal) of 0,7 seconds as it has four earth-satellite or satellite-earth legs; while a terminal-to-terminal connection will have a round-trip delay of 1,5 seconds as it will have eight satellite or satellite-earth legs (two satellite hops in a round trip).

This time delay has an impact on timing sensitive traffic, such as voice and certain client-server data applications. Such traffic may be successfully transmitted over a single satellite hop but fail over a multi-satellite hop.

Two other factors that can affect the reliability of satellite communication networks are solar flares and rain.

Solar fade occurs when the sun is directly behind the satellite, swamping the satellite signal. This results in decreasing the bandwidth and finally blacking out totally. Luckily this occurs only a few seconds per

day and a few days per year, which is easy to predict.

Heavy rainstorms can cause signal fading and has similar effects as solar flares. The use of larger antennas and amplifiers can minimise the effects of rain fade, especially in high rainfall areas.

### Cost benefits

VSAT systems using low-cost satellite terminals with small rooftop or ground-mounted dish antennas can significantly reduce costly telecommunication expenses. The potential cost savings and operational advantages of satellite communications over many types of terrestrial carrier services cannot be over-emphasised – it is one of the main reasons for the phenomenal growth of the VSAT industry in the past decade.

And, in communities where wheelbarrows are still used for work and play ... science fiction will be turned into reality. □

*Article courtesy Dr Kelvin Kemm, Technical Leadership Programme. For further details, email stratek@pixie.co.za.*