NO

# THE WIDE AREA NETWORK READINESS SURVEY IN THE REPUBLIC OF ZAMBIA

FINAL REPORT

March 2004

JAPAN INTERNATIONAL COOPERATION AGENCY

NORCONSULT

CENTRAL STATISTICAL OFFICE

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## 1.1 Executive Summary

The assessment aims at evaluating the needs for CSO in its need to establish a wide area network throughout the country. For all intents and purposes, a solution based on VSAT technology has been identified as the most effective technology since CSO hopes to make available the network resources to other government ministries/departments. This can not be easily achieved with terrestrial communications because the services are provided by other parties.

The configuration designs are given in four different parts each with varying costs. Two of these options emphasise that CSO, at least builds some remote sites. These are more appealing than the other two because CSO will have the power to negotiate if it needs to go into partnership with any institution running a VSAT network.

The best recommended option involves a complete new VSAT network in all the provincial centres which will be supported and managed by CSO. This option will give CSO express authority to carry anybody's data on the network based on its decision.

VSAT technology comes along with it the advantage of carrying voice, data and video on the network. Internet connectivity is also carried on the network. The need to have a local ISP for internet connectivity is eliminated; telephone connectivity between all offices on the network is guaranteed and of telephones and faxes costs can be eliminated or tremendously reduced.

It is hoped that the full report bring to light the technologies that exist and their operability. The recommended solution was arrived at after consultations with stakeholders and other organisations that are using the same technology.

## 1.2 Introduction

Central Statistics Office (CSO) is a Government Department under the Ministry of Finance and National Planning (MFNP) in the Republic of Zambia. The department is responsible for coordinating all statistical activities in the country and is a major source of official statistics.

Its operations are spread throughout the country with provincial activities managed from the provincial centres. The provincial offices are in Solwezi, Mansa, Ndola, Kasama, Chipata, Lusaka, Livingstone, Mongu and Kabwe. The provincial offices are mainly responsible for data collection, manual editing and data entry.

There has been a lot of delays in getting relevant data to Lusaka for analysis because this data in conveyed by road transport. The demand for accurate and detailed national statistical information has prompted CSO to seek ways of improving the turnaround time by exploring new and efficient means of data exchange between its offices. A study to identify a reliable and cost effective technology to implement a Wide Area Network (WAN) was agreed upon before making a final decision. CSO intends to make use of professional expertise before deciding on the technology and investment option. It has requested that a study be carried out through out the country to evaluate the provincial offices and the requirements of such a network.

Norconsult, a local consulting company, was tasked to carry out the assessment on the readiness and requirements for the WAN, core and provincial offices requirements throughout the country. It is expected to present the possible technology option and detailed installation costs.

## 1.3 Objectives

The objective of the study is to evaluate existing infrastructure and ascertain its readiness for the deployment of a modern wide area network. The study focuses on the evaluation of existing telecommunication technology in the country and also analyse the least cost configuration against the recommended solution.

A country-wide assessment requires physical presence in all the affected areas. Norconsult must visit all the 9 provincial offices in order to have first hand appreciation of the business and technical environments. Stakeholders must be evaluated on their ability to participate on the WAN. Telecommunication providers must also be assessed on the technology they offer and their presence in the different towns as part of the study.

At the end of the assessment, Norconsult must come up with a document detailing current business and technical situation. The biggest question begging an answer will be: Is CSO ready to go WAN? The document must explain the telecommunication technologies used in the country and which would be best for the type of business CSO is engaged in. It must also contain least-cost and recommended options detailing implementation and maintenance costs.

The staffing will definitely be affected by the choice of telecommunication technology. The document must analyse the current staffing including skills levels and make necessary recommendations. It must address quantities as well as minimum training requirements, if any.

CSO being a government department requires that an investigation be carried out to ascertain whether the recommended telecommunication technology will allow other government ministries and/or departments to use the facilities.

## 1.4 Current Situation/Business Environment

### 1.4.1 Current State of the Network

CSO has a 72-node Local Area Network (LAN) at the HQ that provides data services within the HQ offices. It has been developed as an infrastructure for supporting internal activities. It is also providing a field of information exchange, information storage and statistical information production. A wireless connection links the HQ to the internet.

### 1.4.2 Summary Geographical and Technical Data

The activities of CSO cover the whole country because of the nature of its mandate as the national statistics guardian. Statistics undertaken extend to all the borders with a surface area of 752,614 $km^2$ but for administrative purposes, offices are located in provincial centres.

Geographic Data

| | |
|---|---|
| Total Number of Locations | 10 |
| Centralised vs. Regionalised | Centralised |
| Average Number of Users per Remote Location | 10 |

Organisation

| | |
|---|---|
| Provincial Offices: Rented vs. Owned | Rented |
| Average Establishment per province | 50 |

Telecommunication Technologies

| | |
|---|---|
| ZAMTEL DSL | Present in all except Solwezi, Kasama, Mansa and Mongu |
| ZAMTEL Analogue | Present in all |
| ISP | Present in all |
| Wireless Radio | Feasible in all |
| VSAT | Feasible in all |

Data Environment

| | |
|---|---|
| Data collected | Primary and Secondary Statistical |
| Method of Data Collection | Surveys and Publications |
| Method of Data Storage | Diskettes |
| Format of Data | ASCII |

Provincial Stakeholders Environment

| Name | Access to ISP | Have WAN | Can Share? |
|---|---|---|---|
| Ministry of Agriculture | No | No | No |
| Ministry of Health | No | No | No |
| Ministry of Education | No | No | No |
| Zambia Revenue Authority | Yes | Yes | Yes |
| NAPSA | Yes | Partial | Yes |
| CCSD | No | No | No |
| Local Government | No | No | No |

### 1.4.3 Detailed Provincial Data

#### Lusaka

| | |
|---|---|
| Location | Indeco Building Cairo Road |
| Latitude | 15° 24'S |
| Longitude | 28° 16'E |
| Travel Distance from HQ | 7km |
| Mode of Transport | Road |
| Carriers: Public Operators | ZAMTEL, CELTEL, TELECEL, COPPERNET, ZAMNET |
| Carriers: Private Networks | ZRA, ZESCO, NAPSA |

#### Kabwe

| | |
|---|---|
| Location | Government Building Uganda Road |
| Latitude | 14° 25'S |
| Longitude | 28° 26'E |
| Travel Distance from Lusaka | 138 km |
| Mode of Transport | Road, Rail |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA |

#### Chipata

| | |
|---|---|
| Location | NAPSA Building Umodzi Highway |
| Latitude | 13° 38'S |
| Longitude | 32° 39'E |
| Travel Distance from Lusaka | 567 km |
| Mode of Transport | Road, Air |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA |

#### Ndola

| | |
|---|---|
| Location | NAPSA Building Broadway |
| Latitude | 12° 58'S |
| Longitude | 28° 37'E |
| Travel Distance from Lusaka | 321 km |
| Mode of Transport | Road, Rail, Air |
| Carriers: Public Operators | ZAMTEL, CELTEL, TELECEL |
| Carriers: Private Networks | ZRA, NAPSA |

## Solwezi

| | |
|---|---|
| Location | NAPSA Building |
| Latitude | 12º 10’S |
| Longitude | 26º 24’E |
| Travel Distance from Lusaka | 584 km |
| Mode of Transport | Road, Rail |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA |

## Kasama

| | |
|---|---|
| Location | Compensation House |
| Latitude | 10º 08’S |
| Longitude | 31º 10’E |
| Travel Distance from Lusaka | 852 km |
| Mode of Transport | Road, Rail |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA |

## Mansa

| | |
|---|---|
| Location | NAPSA Building |
| Latitude | 11º 09’S |
| Longitude | 28º 55’E |
| Travel Distance from Lusaka | 561 km |
| Mode of Transport | Road |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA |

## Livingstone

| | |
|---|---|
| Location | NAPSA Building |
| Latitude | 17º 14’S |
| Longitude | 25º 48’E |
| Travel Distance from Lusaka | 473 km |
| Mode of Transport | Road, Rail, Air |
| Carriers: Public Operators | ZAMTEL, CELTEL |
| Carriers: Private Networks | ZRA, NAPSA |

## Mongu

| | |
|---|---|
| Location | NAPSA Building |
| Latitude | 15° 14'S |
| Longitude | 23° 08'E |
| Travel Distance from Lusaka | 583 km |
| Mode of Transport | Road |
| Carriers: Public Operators | ZAMTEL |
| Carriers: Private Networks | ZRA |

## 1.5 Analysis and Comments on the Environment

### 1.5.1 Data

There are two types of data collected; primary and secondary data.

The data collected from primary sources (mostly through surveys) include:

1. Post Harvest Survey (PHS) - Annual
2. Crop Focus Survey (CFS) - Annual
3. Living Conditions and Monitoring Survey (LCMS) - Biannual
4. Consumer Price Index (CPI) - Monthly
5. Population Census - Decennial
6. The Sexual Behaviour Survey - Biannual
7. Demographic and Education Survey - Biannual
8. Demographic and Health Survey – Biannual
9. Manpower and Establishment Survey - Quarterly

The data collected from secondary sources (published reports) include:

1. Immigration Statistics
2. Labour Statistics
3. Public Finance Statistics
4. Tourism Statistics
5. Manpower Statistics

The practice of carrying out surveys will continue regardless of the WAN. There is a general feeling that some of this data be analysed within its location in the province instead of waiting for the analysis from HQ. A central database at HQ with segmented datasets for each province would be the desired scenario for the provinces instead of waiting for the national analysis for them to disseminate locally.

### 1.5.2 Business

The nature of business carried out is basically statistical information management. However, there are some observations made as explained below.

1. SDU

CSO as the provider of official statistics in the country receives requests for published statistics from various interested Statistical Data Users (SDU). These include researchers, non-governmental organisation and international institutions. In the provinces, the requests are referred to HQ for direction. If HQ is able to provide such information, it communicates back to the province usually through fax or telephone. This normally takes three days to two weeks, by then the requested information will have become obsolete in case of researchers.

The provincial offices feel they must do more to satisfy any request that comes to them in this business. They emphasise that they must provide data to their local community for planning purposes there by contributing to development.

The data analysis done at HQ is mostly for national statistics and a small amount of the disseminated analysis benefits the local community. Local surveys should be encouraged to serve the local community.

Most of the information is available to the public for free although some very detailed analysis of information is offered for sale. There is potential for building a statistical market if information is prepared for local communities and in good time.

2. Communication between CSO Offices

Communication between CSO offices in the provinces to HQ is through the use of ZAMTEL facilities such as telephones and faxes. Majority of provinces have found themselves in a situation where they are not able to contact HQ due to disconnected telephone lines. The huge accrued bills have led ZAMTEL to setting up receive-only option on some of the lines.

Modern telecommunication technology allows voice to be carried on the same media as data. The design of a WAN must take this factor into consideration. Such a design will ensure that both data and voice are transmitted using the same infrastructure between all nodes on the network. Using the network for voice will completely zero telephone costs between HQ and the provincial centres. This will enhance internal reporting and will in turn improve policy implementation. There will be no additional charge from the satellite provider.

3. Transportation of Data and Questionnaires

Once surveys have been conducted, the data is keyed into the computer using the CSPro and IMPS software. The programs are used to edit and format the data into pre-formatted ASCII data files. When verification and formatting is done the data files are copied to diskettes and are then sent to HQ by road, usually by public transport. Other related documents such as survey questionnaires are delivered by the same means. There have been cases where DHL has been used but this is sparsely in relation to the general practice. This poses a potential security risk both to the exposure of unpublished data and to the officer assigned to travel to collect this information.

The installation of a network will provide for documents to be transmitted online through scanning, email attachment, and even keying the information directly into the database at HQ. This would immediately eliminate the transport costs and improve the turn-around period from data collection to dissemination.

4. Alliances

All government ministries are represented in all the provincial centres in the country. Alliances with these ministries could be explored so that various information requirements can be under one roof. They will eventually foster distribution and storage of local knowledge and information. By pooling resources together, the alliances can then link the local districts directly on to the network. With positive cooperation, databanks can also be built specifically tailored for the province.

Any one member of the alliance in the province who needs to transmit their data/voice to their Lusaka office would be able to do that directly via the shared WAN. This would in turn free some resources which would be better used to analyse provincial data.

5. Community Communication Shops

There is also a possibility of opening outlets in the provinces where SDU could register for subscription. The outlets could be a combination of statistical information services and a depository where SDU could also provide unsolicited statistical data. Applications would be processed via the network, making it more convenient for SDU who have in the past been incurring very high transportation and security costs to travel to Lusaka. This would also be a source of revenue for the local offices.

The potential of value-added products and services developed by the local office can be an array of computerised databanks containing weather information, population statistics, crop information, census figures, and other data. This can be made available at least to the district level. These data could be converted to locally useful information and make it available to the public for a fee.

### 1.5.3 Technical

The technical environment defines the organisation and management of the technical resources. The technical environment analysis addresses existing and planned technical models, the impact of the WAN assessment on the existing and planned technical models, and the requirements for IT services management.

The major challenges on the LAN include issues of security, external access, and third party support. Although the backup software and the drive work, backup consumables are not readily accessible. The user needs have increased tremendously rendering the 64k connection small. There is a desire that the CSO website be hosted on the network but this is not possible with current environment. There are also difficulties with maintenance that involves third parties e.g. servicing of one of the backup drives has been outstanding for a very long time. Internet access also is intermittent. This creates a problem for the mail delivery service.

The LAN infrastructure is now stable after the initial teething issues. The network has experienced over 98% uptime where local use is concerned.

The workstation environment is Microsoft Windows throughout. The workstation operating system has been standardised to Microsoft Windows 2000. Some PCs however still use Microsoft Windows 98. This enhances support by the technical staff. Hardware has been standardised to minimum of P3 although some older PCs still exist. The brand has been limited to IBM, Dell, HP and Compaq. The preferred workstations are IBM P4. There is documentation of the configuration of the 72 node LAN.

### 1.5.4 Organisation

The provincial offices accommodation is rented from NAPSA, Workmen Compensation Board or ZSIC. The location of the Kabwe office in central province is under review.

Each province is headed by a Regional Statistician (RS) who is the manager of the province. The RS's primary responsibility is to ensure that accurate data is collected and edited in good time. The RS is responsible for the collection of statistical information from all the towns in the province.

The RS also has the responsibility of working with various stakeholders in the province in order to collect statistical data from any designated source.

The types, time and funding of surveys are dictated by the HQ. RS do not have the financial resources to undertake any survey pertinent to the districts or areas in the province. They also do not have the command to raise operational funds locally in order to support ad hoc local surveys. The present establishment does allow for an accounting unit but that has not been implemented yet. The unit will be responsible for locally generated revenue and for the management of provincial resources.

### 1.5.5 Applications

The applications used are CSPro, internet, and email. The internet connections are via dial-up circuits into the local ISP.

CSPro is a tool for entering, editing, and tabulating data from surveys and censuses. It uses data dictionaries to provide a common description of each data file used. It is a Windows based tool for Census and Survey processing. Data is in ASCII format. The GUI is Windows based. The surveys where data entry in CSPro is done in the provinces are Agriculture survey for Post Harvest (PHS) and the Living Conditions Monitoring Survey (LCMS). For these surveys the data is sent to the HQ by diskettes and in the near future by e-mail for those provinces with Dial-Up access.

### 1.5.6 Stakeholders

The stakeholders are mainly government ministries and departments. Those that stood out prominently are Ministry of Agriculture and Co-operatives (MACo), Ministry of Health (MoH) and Ministry of Education (MoE). None of the stakeholders have WAN installation.

## 1.6 Existing Telecommunication Technologies

It is recognised that the practical application of the CSO WAN will be driven by how much it can utilise existing telecommunication technologies available in the country. The system of choice is based on the Global System for Mobile communications (GSM), Digital Subscriber Line (DSL), Wireless Radio and Very Small Aperture Terminal (VSAT) technologies.

1. GSM

GSM is a second-generation (2G) digital wireless technology that provides high-quality voice and circuit-switched data services in a wide variety of spectrum bands. It is a digital technology, and "GSM" is often used as a catch-all term to refer to a family of technologies that includes General Packet Radio Service (GPRS), Enhanced Data-rates for GSM Evolution (EDGE) and Universal Mobile Telecommunication Systems (UMTS)/Wideband Code Division Multiple Access (WCDMA), which provide a smooth, cost-effective evolution to third generation (3G).

It allows multiple users to share a single radio channel through a technique called time division multiplexing (TDM), where a channel is divided into six time slots. Each caller is assigned a specific time slot for transmission, which allows multiple callers to share a single channel simultaneously without interfering with one another. This design makes efficient use of spectrum and provides seven times more capacity than analogue, which is a first-generation (1G) technology. GSM also uses a technique called "frequency hopping" that minimises interference from outside sources and makes eavesdropping virtually impossible.

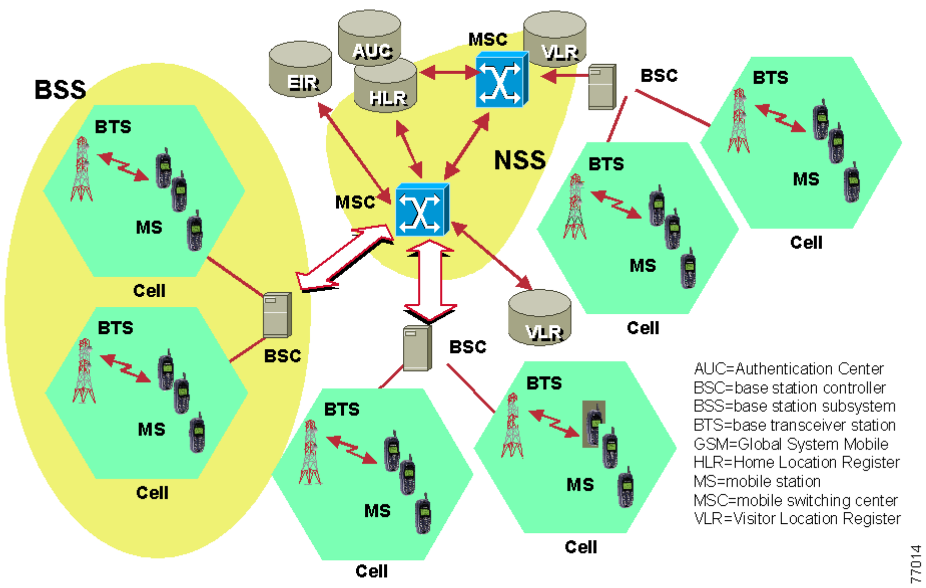



**Figure 1: GSM Network Elements**

The network and switching subsystem (NSS) is the heart of the GSM system. It connects the wireless network to the standard wired network. It is responsible for the handoff of calls from one base station subsystem (BSS) to another and performs services such as charging, accounting, and roaming.

GSM network is essentially a cellular network with each cell being served by a base station (BTS). The GSM base station is basically a radio station. Several base stations are connected to BSC (Base station controller). The BSC controls calls in all the connected base stations. The connection between base stations is usually a microwave link.

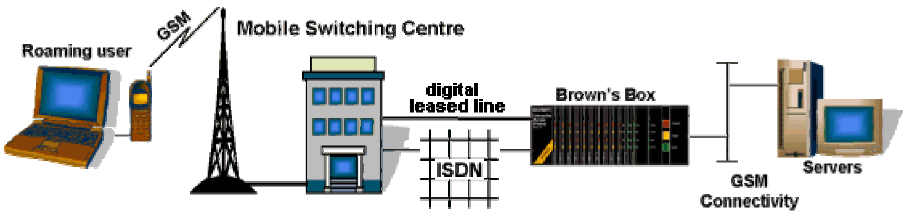


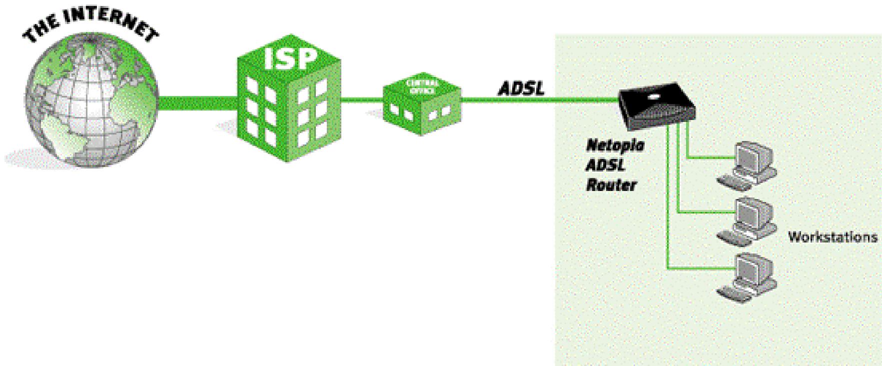

**Figure 2: GSM Connectivity**

The carriers for GSM are ZAMTEL, CELTEL and TELECEL.

2. DSL

DSL service is one of the most exciting technologies to come to market in the area of information access. The concept is as elegant as it is simple - DSL achieves broadband speeds over ordinary phone lines. ZAMTEL offers this service on large-scale in some towns in the country.

DSL is a telecommunications service that makes it possible to transform an ordinary phone line into a high-speed conduit for data, voice and video. As long as your office is close enough to ZAMTEL you'll be able to subscribe to DSL service. Typical connections allow users to receive data at 1.5 Mbps and send data at approximately 256 Kbps, though actual speed is determined by the proximity to the ZAMTEL office. DSL service is always on – users don't need to dial a connection to gain access to the network – and some services even allow users to use the same line for voice and data traffic.




DSL services transfer data at speeds ranging from 128 Kbps (IDSL) to a potential 9.0 Mbps (HDSL) downstream. Up-stream speeds range from 128 Kbps to 1 Mbps and, in some cases, even higher.

There are many advantages to DSL. The most significant advantage is the fact that DSL is more cost-effective because it eliminates the need for extensive and expensive infrastructure upgrades. DSL service requires no new phone lines and little new equipment. Another advantage that is equally important is DSL's blistering speed. DSL technology transforms phone lines into multi-megabyte data pipes capable of speeding digital video and data.

DSL solves many of the problems associated with alternate access technologies by using the existing telecommunications system to remove the bottlenecks often associated with the last mile between the network service provider and the users of those services.

There are some disadvantages to the use of DSL service. The greatest disadvantage at the present time is availability – because DSL is distance sensitive, availability is determined by the distance from the

ZAMTEL office. Although DSL service is widely available on the line of rail and in some towns, it is not available in some provincial areas because of distance sensitivity limitation.

3. Very Small Aperture Terminal (VSAT)

A VSAT is a small-sized telecommunications earth station that transmits and receives via satellite. The terminal size varies from 1.2 to 4.6 meter in diameter. VSAT are becoming increasingly popular, because they are a single, flexible communications platform that can be installed quickly and cost effectively to provide telecoms solutions for consumers, governments and corporations. This technology has been in use for more than 10 years and, with more than 500,000 systems operating in more than 120 countries, VSAT networks are a mature and proven technology.

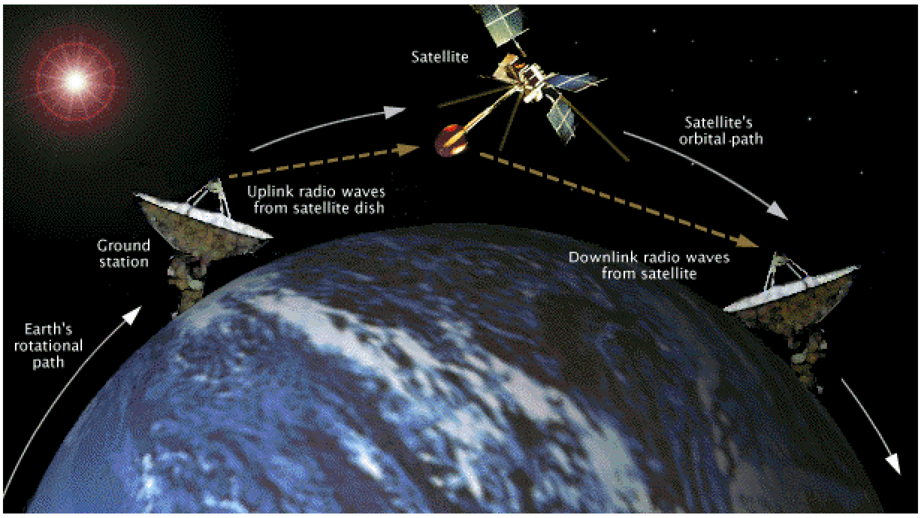



**Figure 3: Satellite Relay System**

Satellites have revolutionized communication by making worldwide telephone links and live broadcasts common occurrences. A satellite receives a microwave signal from a ground station on the earth (the uplink), then amplifies and retransmits the signal back to a receiving station or stations on earth at a different frequency (the downlink). A communication satellite is in geosynchronous orbit, which means that it is orbiting at the same speed as the earth is revolving. The satellite stays in the same position relative to the surface of the earth, so that the broadcasting station will never lose contact with the receiver.

VSAT networks may transmit and receive voice, data, fax, or video conferencing. They represent a cost-effective solution for independent communications network to connect sites, especially sites where any other connectivity options are not possible or realistic to implement.

They offer value-added satellite-based services capable of supporting the Internet, data, LAN, voice/fax communications, and can provide powerful, dependable, private and public network communications solutions. They are used for a wide variety of telecommunications applications, including corporate networks, Internet service provision, rural telecoms, distance learning, telemedicine, cyber cafes, banking, oil and gas exploration, manufacturing, government agencies and departments and much more.

VSAT uses what is known as Voice over Internet Protocol (VoIP) to transmit voice over the network. VoIP is a technology that voice conversations are digitized inside of internet protocol (IP) packets and transported over a data network. The main difference is that the public switched telephone network (PSTN) we have been using for years allows only one caller per channel and VoIP allows many callers per channel. The major international long distance carriers are making plans to move their traffic to VOIP networks. The reason is simple, lower costs for the carriers and the consumer. The call quality is the same and that is why VoIP technology is rapidly gaining market share as it is the future of the industry.

VoIP is different from the PSTN because it does not use dedicated circuits; multiple users share networks. Information is transmitted over the network in packets and the network is often referred to as a packet-switched network. This is extremely efficient because the network is only used when it is transporting packets of information.

A VSAT has certain clear advantages over terrestrial networks and other wireless communications media.

Satellite services are usually activated much more quickly than terrestrial networks since meters or kilometres of cable need not be installed. An antennae, modem and satellite circuit can be installed and made operational in just a few weeks rather than the months installation of cable may take. It is easily implemented due to the wireless nature of connectivity. And as a network grows, additional capacity can be obtained in just as short a time.

Satellite networks offer much higher reliability than terrestrial networks. Network performance is enhanced with satellite by linking directly to an Internet backbone, bypassing congested terrestrial lines, exchanges and numerous interconnections. This reduces the potential points of failure.

The broadcast nature of satellites allows for the simultaneous delivery of information to wide geographic areas without regard to terrestrial infrastructure or geographic barriers. Charges for terrestrial services are nearly always distance-dependent, while VSAT connections cost the same whether sites are one or 1000 Km apart. They are capable of sending and receiving all sorts of video, data and audio content at the same high speed regardless of their distance from terrestrial switching offices and infrastructure.

Telephony and broadband infrastructure require heavy infrastructure and are particularly expensive to deploy and maintain especially to remote and un-serviced locations.

And with most VSAT services the cost-per-connection comes down considerably when a customer adds users. Technology is also changing rapidly to make satellite access to the Internet more affordable.

The key advantage of a VSAT earth station, versus a typical terrestrial network connection, is that the reach of buried cable does not limit the VSAT. Satellite is the only telephony and broadband wide-area network technology that is available everywhere - in even the most remote urban and rural areas, rain forests or concrete jungles, anywhere in the world. A VSAT earth station can be placed anywhere - as long as it has an unobstructed view of the satellite.

Relocating and adding network sites is much simpler and cheaper with a satellite network than with most terrestrial technologies.

VSAT networks are highly scalable, i.e. it provides the ability to scale according to the customer's requirements with low incremental cost. This is especially important as businesses grow over time.

A VSAT network can support thousands of VSAT remotes. Hence, a customer may start with Data services (internet browsing & e-mail) and then adding more bandwidth can be done over time by a simple reconfiguration at the Network Operating Centre. In addition customers are able to add voice capabilities or video applications when the need arises.

VSAT is not without its drawbacks - and these should be considered in the system design:

1. Latency

The speed of light being what it is, and the fact that the satellites are 36,800 km 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 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 any WAN application - be they terrestrial or otherwise.

2. Occasional outages due to the sun

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)

3. Occasional outages due to weather

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 birds building nests in a dish, but proper system design (e.g. installation of covers 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.

4. Failure of the Satellite itself

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.

## 1.7 Analysis and Comments to Staffing in relation to WAN

### 1.7.1 Current Staffing

The current staffing in the IT department is Management (2), Web development (3), LAN support (3), Hardware & Software support (2), and Database development (3). The size of the team is enough to handle the WAN. With specialised training in related technology, the team can meet all the challenges in VSAT support.

### 1.7.2 Training

Most of the training has been focused on the Microsoft Products, for example, MCSE training. There is need for the technical staff to undergo an extensive training in Networking, Routing and VSAT maintenance. This is galvanised by the coming of the new WAN and its technology.

## 1.8 Capacity Building

Most provincial offices are in need of a technical person to help the office with technical matters on computers. The organizational structure provides for this position but it has not been filled up yet.

The computers and printers in the provinces are not connected together on the network making it difficult to share files and print services. With the advent of a wide area network, LANs must be installed so that as many as possible can benefit from the availability of the resources.

There will be more data collected as the delivery methods will be improved. Local offices can be allowed to analyse and process their own data. There must be a statistics analyst in the province to do this for the office.

## 1.9 Least Cost WAN Plan

The least cost plan assumes that CSO and ZRA can get into an agreement where CSO is allowed to use the ZRA VSAT facilities in the provincial centres. A detailed explanation is given under "Option 2: Loosely-Coupled VSAT Network on ZRA"

## 1.10 Proposed Options - Details Specifications

After a number of considerations including the fact that the recommended technology must stand the test of time, the VSAT technology was selected. This is also owing to the fact that satellite networks guarantee much higher reliability than the other technologies discussed above. In the VSAT technology, we have different configurations.

### 1.10.1 Option 1: Standalone VSAT network

The standalone VSAT installation requires that an independent infrastructure be built throughout the country. This will be wholly owned by CSO. A hub will be based at HQ and each of the 8 provincial centres will have a VSAT earth station at the CSO offices. The network will be administered and supported by CSO with high-end technical assistance from the contractor.

The advantage is that the timetable for implementation and commissioning will not be tied to "an agreement" with any government ministry/department. The installation costs could include the running costs for the first three years. This will ensure that the network will run after installation. It will also give CSO a respite before it manages to invite other government departments to join the network and begin to contribute towards the subscriptions. The challenge though is on CSO to sell the idea to the ministries/departments once it is operational. The benefits of own network is that relocation or adding of new network sites can be done at will. It is also a simpler and cheaper exercise than with the terrestrial technologies. Figure 5 shows the outlook of the connection.

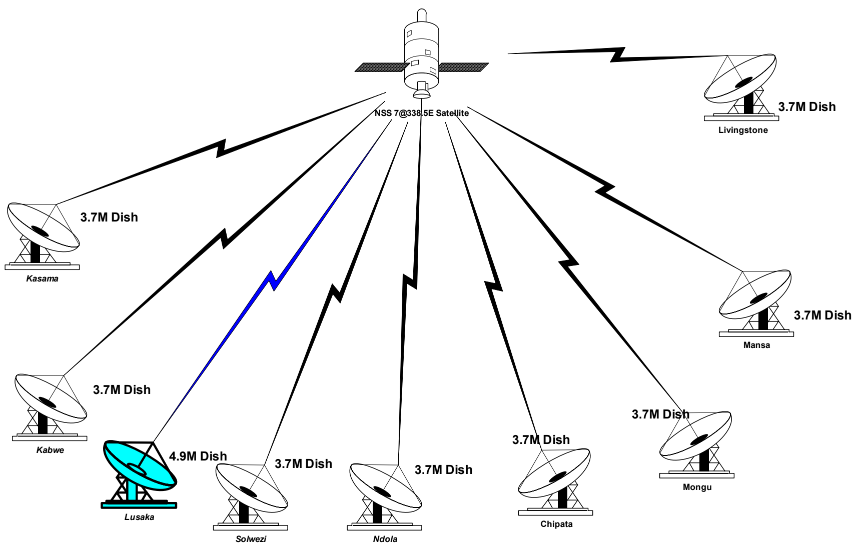



**Figure 4: Standalone VSAT Network**

Estimated Implementation Schedule

| Item | Description | Phase | Man- |
|---|---|---|---|
| 1 | Inception | I | 18 |
| 2 | Hub Installation | II | 11 |
| 3 | Remote Site Installation and | III | 90 |
| 4 | Commission and Handover | IV | 75 |

Equipment Costs and Installation

The ballpark figures for a standalone network are presented in the Table 2 below. These are just indicative figures for budgetary purposes and are not in any way exact costs.

**Table 1: Equipment Costs for Standalone**

| Description | Qt | Cost | Total |
|---|---|---|---|
| **Remote Sites** | | | |
| **Outdoor Unit** | | | |
| 3.7m Antennae | 8 | 29,742.00 | 237,936.0 |
| 5w SSPA Transceiver | 8 | 14,910.00 | 119,280.0 |
| Civil Works | 8 | 6,186.00 | 49,488.00 |
| Engineering | 8 | 16,500.00 | 132,000.0 |
| **Indoor Equipment** | | | |
| Router | 8 | 6,320.00 | 50,560.00 |
| Satellite Modem | 8 | 8,324.00 | 66,592.00 |
| Cable Subsystem | 8 | 1,700.00 | 13,600.00 |
| **Sub Total** | | | **669,456.0** |
| **HUB Station** | | | |
| **Outdoor Unit** | | | |
| 4.9m Antennae | 1 | 62,484.00 | 62,484.00 |
| 40w SSPA Transceiver | 1 | 69,234.00 | 69,234.00 |
| Civil Works | 1 | 6,186.00 | 6,186.00 |
| Engineering | 1 | 21,500.00 | 21,500.00 |
| **Indoor Equipment** | | | |
| Router | 1 | 27,169.00 | 27,169.00 |
| Satellite Modem | 8 | 8,324.00 | 66,592.00 |
| Cable Subsystem | 1 | 3,400.00 | 3,400.00 |
| Combiner Splitter | 1 | 12,307.00 | 12,307.00 |
| **Sub Total** | | | **268,872.0** |
| **Grand Total** | | | **938,328.0** |

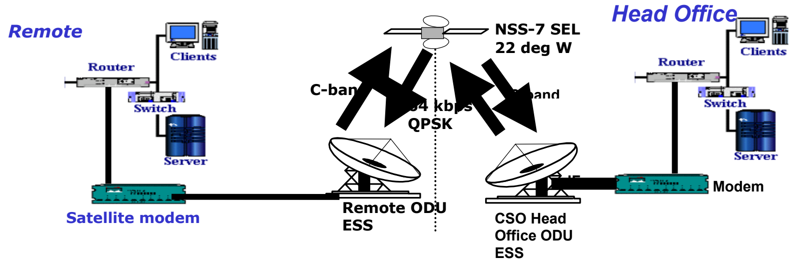



**Figure 5: VSAT Network Design**

## Maintenance and Running Costs

The maintenance and running of a VSAT network besides non-expendable equipment will include satellite charges. These are charged per month for a minimum of eight nodes at 1 MHz (This is the minimum bandwidth allocation by the satellite provider which constitutes the number of nodes calculated in a link budget). The CSO should opt for a payment plan of 3 years as the rates decrease as the number of years in crease on the satellite licence. For the eight remote nodes, CSO will need to pay **$ 198,000.00** for a period of three years.

## Expendable Equipment

| Item | Description | Qty | Cost | |
|---|---|---|---|---|
| 1 | Hub 40W SSPA | 1 | 69,234.00 | 69,234.00 |
| 2 | Remote 5W SSPA | 2 | 14,910.00 | 29,820.00 |
| 3 | Satellite Modem | 3 | 8,324.00 | 24,972.00 |
| | **Total** | | | **124,026.0** |

## Satellite Provider Fees

| Item | Description | Mont | Unit Cost | Total |
|---|---|---|---|---|
| 1 | One Year Plan | 36 | 6,000.00 | 216,000.0 |
| **2** | **Three Year Plan** | **36** | **5,500.00** | **198,000.0** |
| 3 | Five Year Plan | 36 | 5,000.00 | 180,000.0 |

## Communication Authority Fees

Communications Authority has a fixed charge for the use of satellite communication in Zambia. The licence costs **K 200,000.00** per year.

### Human Resource Requirements

This option deals with a new installation and CSO will need to set up a team of VSAT specialists for the support and maintenance of the wide area network. The present number of staff can be able to manage with some specialised training. A provision budget to cater for travel visits to all the sites is given below. The nature of our climate demands that visits are conducted twice a year, before and after the rainy season. The budget figure must therefore be multiplied by 2 with the total amounting to $ 11,240.00.

### Preventive Maintenance Costs

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Lodging - Northern | 6 | 50.00 | 300.00 |
| 2 | Lodging - Southern | 6 | 50.00 | 300.00 |
| 3 | Road Travel – Northern | 0.65 | 3300.00 | 2,145.00 |
| 4 | Road Travel – Southern | 0.65 | 3200.00 | 2,080.00 |
| 5 | Materials – Paint, | 7 | 60.00 | 420.00 |
| 6 | Handyman Labour | 15 | 25.00 | 375.00 |
| | **Total** | | | **5,620.00** |

### Training Costs

The prescribed VSAT training course details is given in Appendix 6. The routing training course details are given in Appendix 7. The tables below give a summary of the costs.

### VSAT Training

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Scheduled Class Per | 5 | 1695.00 | 8,475.00 |
| 2 | Materials | 5 | - | - |
| 3 | Text Books | 5 | 250.00 | 1,250.00 |
| 4 | Per Diem @ $190/Night | 10 | 950.00 | 9,500.00 |
| 5 | Air Travel | 5 | 2000.00 | 10,000.00 |
| | **Total** | | | **29,225.00** |

### Routing Training

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Scheduled Class Per | 4 | 2000.00 | 8,000.00 |
| 2 | Per Diem @ $190/Night | 6 | 950.00 | 5,700.00 |
| 3 | Air Travel | 5 | 400.00 | 2,000.00 |
| | **Total** | | | **15,700.00** |

## Summary Budget

| Item | Description | Cost |
|---|---|---|
| 1 | Civil Works | 55,674.00 |
| 2 | Installation and Configuration | 153,500.0 |
| 3 | Non-expendable Equipment | 729,154.0 |
| 4 | Expendable Equipment | 124,026.0 |
| 5 | Preventive Maintenance | 11,240.00 |
| 6 | Training | 44,925.00 |
| 7 | Satellite Provider Fees | 198,000.0 |
| | **Total** | **1,316,519.** |

### 1.10.2 Option 2: Loosely-Coupled VSAT Network on ZRA

ZRA has a VSAT network comprising 1 hub station and 16 remote sites. The network is installed in Mansa, Kasama, Nakonde, Chipata, Mwami, Katima Mulilo, Kazungula, Chirundu, Kapiri Mposhi, Kabwe, Solwezi, Mongu, Livingstone, Kitwe, Ndola and Kasumbalesa. ZRA has since built competent technical team that supports and maintains the network. The network is used for both voice and data without any compromise on performance.

CSO can agree with ZRA to share the VSAT infrastructure in the remote sites. CSO would only need to build its own hub at HQ. In the province, it would need appropriate indoor equipment excluding the antennas. This will offer a savings on 8 earth stations while having potential to access all the remote sites on the ZRA network. However, this configuration assumes that ZRA and CSO are in the same building or at worst case under a kilometre from the location of the antennae.

CSO cannot bring on board the network any other government ministry/department to the alliance without the consent of ZRA. Equally it will not have a say on who ZRA wishes to invite to the alliance or power to veto anybody. Figure 7 shows the network design.

Estimated Implementation Schedule

| Item | Description | Phase | Man- |
|---|---|---|---|
| 1 | Inception | I | 18 |
| 2 | Hub Installation | II | 11 |
| 3 | Remote Site Installation and | III | 15 |
| 4 | Commission and Handover | IV | 10 |

Equipment Costs and Installation

The equipment cost figures for this network design are presented in the Table 3 below.

**Table 2: Equipment Costs using ZRA Remote Sites**

| Description | Qt | Cost | Total |
|---|---|---|---|
| **Remote Sites** | | | |
| **Outdoor Unit** | | | |
| 3.7m Antennae | 0 | 29,742.00 | - |
| 5w SSPA Transceiver | 0 | 14,910.00 | - |
| Civil Works | 0 | 6,186.00 | - |
| Engineering | 8 | 4,500.00 | 36,000.00 |
| **Indoor Equipment** | | | |
| Router | 8 | 6,320.00 | 50,560.00 |
| Satellite Modem | 8 | 8,324.00 | 66,592.00 |
| Cable Subsystem | 8 | 1,700.00 | 13,600.00 |
| **Sub Total** | | | **166,752.0** |
| **HUB Station** | | | |
| **Outdoor Unit** | | | |
| 4.9m Antennae | 1 | 62,484.00 | 62,484.00 |
| 40w SSPA Transceiver | 1 | 69,234.00 | 69,234.00 |
| Civil Works | 1 | 6,186.00 | 6,186.00 |
| Engineering | 1 | 21,500.00 | 21,500.00 |
| **Indoor Equipment** | | | |
| Router | 1 | 27,169.00 | 27,169.00 |
| Satellite Modem | 8 | 8,324.00 | 66,592.00 |
| Cable Subsystem | 1 | 3,400.00 | 3,400.00 |
| Combiner Splitter | 1 | 12,307.00 | 12,307.00 |
| **Sub Total** | | | **268,872.0** |
| **Grand Total** | | | **435,624.0** |

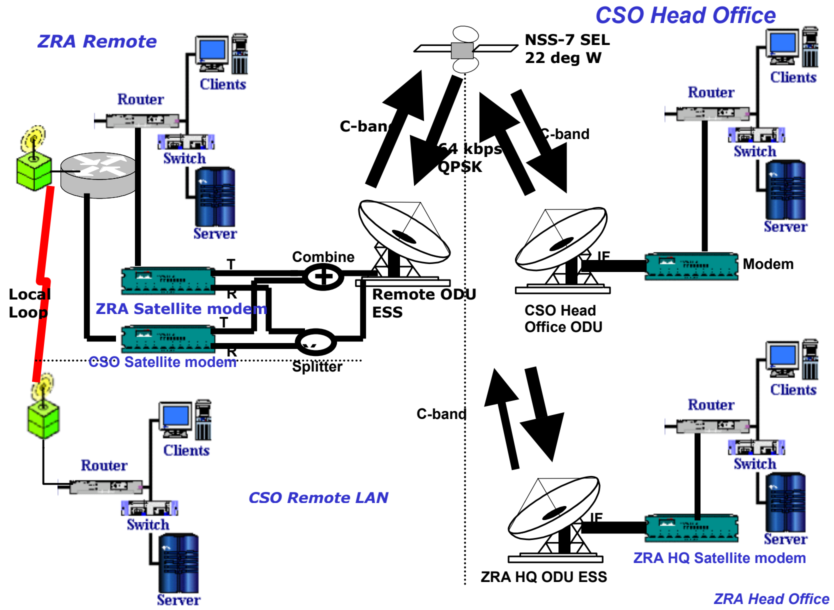



**Figure 6: CSO on ZRA Network Design**

## Maintenance and Running Costs

Satellite charges per month for eight nodes on a 1 MHz capacity are tabulated below. The best payment plan is for 3 years as the rates decrease as the number of years in crease on the satellite licence. The eight remote nodes will calculate to **$ 198,000.00** for a period of three years.

## Expendable Equipment

| Item | Description | Qty | | Cost |
|---|---|---|---|---|
| 1 | Hub 40W SSPA | 1 | 69,234.00 | 69,234.00 |
| 3 | Satellite Modem | 1 | 8,324.00 | 8,324.00 |
| | **Total** | | | **77,558.00** |

## Satellite Provider Fees

| Item | Description | Mont | Unit Cost | Total |
|---|---|---|---|---|
| 1 | One Year Plan | 36 | 6,000.00 | 216,000.0 |
| **2** | **Three Year Plan** | **36** | **5,500.00** | **198,000.0** |
| 3 | Five Year Plan | 36 | 5,000.00 | 180,000.0 |

Communication Authority Fees

Communications Authority has a fixed charge for the use of satellite communication in Zambia. The licence costs **K 200,000.00** per year.

For provincial offices that are not in the same building as ZRA, CSO will need to invest in two DSL modems, and subscription costs to ZAMTEL as illustrated in the table below. There is a one-off installation cost of **K 200,000.00.**

| Item | Description | Qty | Unit Cost | Total |
|---|---|---|---|---|
| 1 | DSL Modem | 12 | 1500.00 | 18,000.00 |
| 2 | Monthly subscription | 6 | 40.00 | 240.00 |
| | **Total** | | | **18,240.00** |

Summary Budget

| Item | Description | Cost |
|---|---|---|
| 1 | Civil Works | 6,186.00 |
| 2 | Installation and Configuration | 57,500.00 |
| 3 | Non-expendable Equipment | 371,938.0 |
| 4 | Expendable Equipment | 77,558.00 |
| 5 | Satellite Provider Fees | 198,000.0 |
| | **Total** | **711,182.0** |

### 1.10.3 Option 3: Loosely-Coupled VSAT Network on ZRA with IFMIS

ZRA has a VSAT network comprising 1 hub station and 16 remote sites. The network is installed in Mansa, Kasama, Nakonde, Chipata, Mwami, Katima Mulilo, Kazungula, Chirundu, Kapiri Mposhi, Kabwe, Solwezi, Mongu, Livingstone, Kitwe, Ndola and Kasumbalesa. It has been running for about 5 years and has experienced no problems except on a few occasions where ZRA had to deal with birds building nests on the feed horn. ZRA has since built competent technical team that supports and maintains the network. The network is used for both voice and data without any compromise on performance.

If CSO together with IFMIS manage to convince ZRA to share the VSAT infrastructure in the remote sites, they would only need to build their own hubs at their respective head office locations. In the province, they would need appropriate indoor equipment excluding the antennas. This will offer a savings on 8 earth stations. This will essentially give both institutions potential to access all the remote sites on the ZRA network. However, this configuration assumes that ZRA, CSO and IFMIS offices are in the same building or at worst case under a kilometre from the location of the antennae.

This implies that CSO and IFMIS cannot invite any government ministry or department to the alliance without the consent of ZRA. Equally they would not have a say on who ZRA wishes to invite to the alliance or power to veto anybody.

Estimated Implementation Schedule

| Item | Description | Phase | Man- |
|---|---|---|---|
| 1 | Inception | I | 18 |
| 2 | Hub Installation | II | 11 |
| 3 | Remote Site Installation and | III | 17 |
| 4 | Commission and Handover | IV | 12 |

Equipment Costs and Installation

Indicative ballpark figures for the equipment costs are given in Table 4.

**Table 3: Equipment Costs using ZRA Remote Sites with IFMIS**

| Description | Qt | Cost | Total |
|---|---|---|---|
| **Remote Sites** | | | |
| **Outdoor Unit** | | | |
| 3.7m Antennae | 0 | 29,742.00 | - |
| 5w SSPA Transceiver | 0 | 14,910.00 | - |
| Civil Works | 0 | 6,186.00 | - |
| Engineering | 8 | 4,500.00 | 36,000.00 |
| **Indoor Equipment** | | | |
| Router | 9 | 6,320.00 | 56,880.00 |
| Satellite Modem | 9 | 8,324.00 | 74,916.00 |
| Cable Subsystem | 9 | 1,700.00 | 15,300.00 |
| **Sub Total** | | | **183,096.0** |
| **HUB Station** | | | |
| **Outdoor Unit** | | | |
| 4.9m Antennae | 2 | 62,484.00 | 124,968.0 |
| 40w SSPA Transceiver | 2 | 69,234.00 | 138,468.0 |
| Civil Works | 2 | 6,186.00 | 12,372.00 |
| Engineering | 2 | 21,500.00 | 43,000.00 |
| **Indoor Equipment** | | | |
| Router | 2 | 27,169.00 | 54,338.00 |
| Satellite Modem | 9 | 8,324.00 | 74,916.00 |
| Cable Subsystem | 2 | 3,400.00 | 6,800.00 |
| Combiner Splitter | 2 | 12,307.00 | 24,614.00 |
| **Sub Total** | | | **479,476.0** |
| **Grand Total** | | | **662,572.0** |

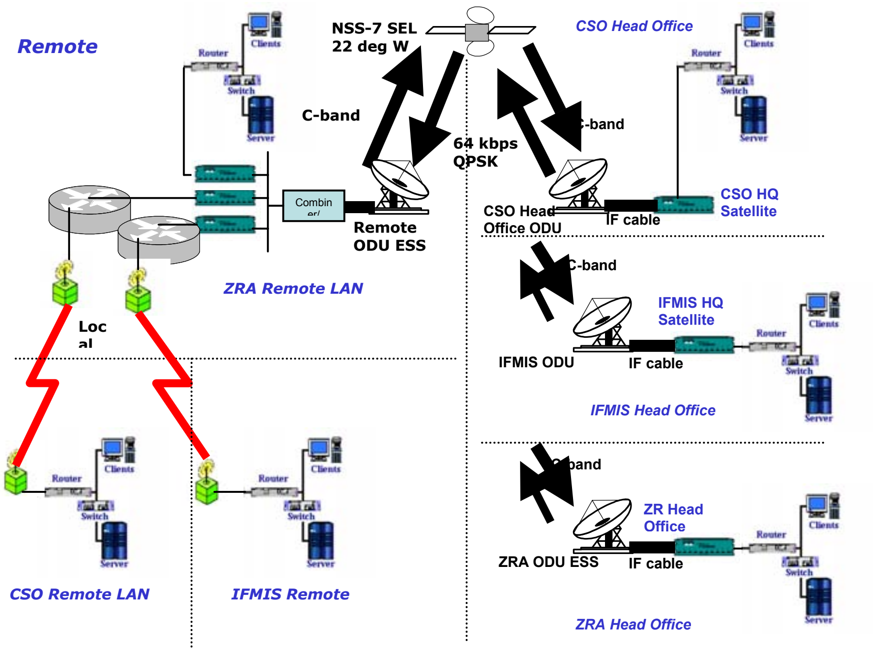



**Figure 7: CSO and IFMIS on ZRA Network Design**

## Maintenance and Running Costs

Satellite charges per month for eight nodes on a 1 MHz capacity are tabulated below. The best payment plan is for 3 years as the rates decrease as the number of years increase on the satellite licence. The eight remote nodes will calculate to **$ 198,000.00** for a period of three years.

### Expendable Equipment

| Item | Description | Qty | Cost | |
|---|---|---|---|---|
| 1 | Hub 40W SSPA | 1 | 69,234.00 | 69,234.00 |
| 3 | Satellite Modem | 1 | 8,324.00 | 8,324.00 |
| | **Total** | | | **77,558.00** |

### Satellite Provider Fees

| Item | Description | Mont | Unit Cost | Total |
|---|---|---|---|---|
| 1 | One Year Plan | 36 | 6,000.00 | 216,000.0 |
| **2** | **Three Year Plan** | **36** | **5,500.00** | **198,000.0** |
| 3 | Five Year Plan | 36 | 5,000.00 | 180,000.0 |

Communication Authority Fees

Communications Authority has a fixed charge for the use of satellite communication in Zambia. The licence costs **K 200,000.00** per year.

Summary Budget

| Item | Description | Cost |
|---|---|---|
| 1 | Civil Works | 12,372.00 |
| 2 | Installation and Configuration | 79,000.00 |
| 3 | Non-expendable Equipment | 571,200.0 |
| 4 | Expendable Equipment | 77,558.00 |
| 5 | Satellite Provider Fees | 198,000.0 |
| | **Total** | **938,130.0** |

### 1.10.4 Option 4: Loosely-Coupled VSAT Network with NAPSA

NAPSA has a VSAT network comprising 1 hub station and 3 remote stations in Kitwe, Ndola and Livingstone. Due to limited funds, NAPSA could not extend the network to the other provincial towns despite having business presence. The towns are, however, currently connected to the network through ZAMTEL leased lines. Apparently, the availability and uptime of these lines have not been to the business satisfaction of NAPSA. The IT department has made suggestions to management that VSAT be installed in the remaining towns as there has been excellent performance on the towns that are on VSAT. Unfortunately, the institution lacks the financial capacity at present to undertake this investment.

CSO can take advantage of NAPSA's position by constructing its own hub station at HQ and 6 remote sites instead of 8 (will be 9 if we include Kitwe). These 6 will be Solwezi, Mansa, Kasama, Chipata, Mongu and Kabwe. For the remaining 2 sites (Ndola and Livingstone), CSO would use the NAPSA antennas and just install the necessary indoor equipment. This design will give CSO access to a total of 9 (6 + 3) remote sites. NAPSA would also have to install the necessary indoor equipment I the 6 remote sites and also have access to 9 (3 + 6) remote sites.

The two institutions must then agree to a memorandum of understanding (MoU) on the administration of satellite subscriptions to the satellite provider. One suggestion is to increase the number of remote nodes on the NAPSA licence than to have separate licences. This kind of arrangement will entail that neither party can invite another government ministry or department without the consent of the other party. Figure 9 illustrates the network configurations.

Estimated Implementation Schedule

| Item | Description | Phase | Man- |
|---|---|---|---|
| 1 | Inception | I | 18 |
| 2 | Hub Installation | II | 11 |
| 3 | Remote Site Installation and | III | 60 |
| 4 | Commission and Handover | IV | 45 |

Equipment Costs and Installation

Indicative ballpark figures for the equipment costs are given in Table 5.

**Table 4: Equipment Costs partnering with NAPSA**

| Description | Qt | Cost | Total |
|---|---|---|---|
| **Remote Sites** | | | |
| **Outdoor Unit** | | | |
| 3.7m Antennae | 6 | 29,742.00 | 178,452.0 |
| 5w SSPA Transceiver | 6 | 14,910.00 | 89,460.00 |
| Civil Works | 6 | 6,186.00 | 37,116.00 |
| Engineering | 6 | 4,500.00 | 27,000.00 |
| **Indoor Equipment** | | | |
| Router | 6 | 6,320.00 | 37,920.00 |
| Satellite Modem | 6 | 8,324.00 | 49,944.00 |
| Cable Subsystem | 6 | 1,700.00 | 10,200.00 |
| **Sub Total** | | | **430,092.0** |
| **HUB Station** | | | |
| **Outdoor Unit** | | | |
| 4.6m Antennae | 1 | 62,484.00 | 62,484.00 |
| 40w SSPA Transceiver | 1 | 69,234.00 | 69,234.00 |
| Civil Works | 1 | 6,186.00 | 6,186.00 |
| Engineering | 1 | 21,500.00 | 21,500.00 |
| **Indoor Equipment** | | | |
| Router | 1 | 27,169.00 | 27,169.00 |
| Satellite Modem | 8 | 8,324.00 | 66,592.00 |
| Cable Subsystem | 1 | 3,400.00 | 3,400.00 |
| Combiner Splitter | 1 | 12,307.00 | 12,307.00 |
| **Sub Total** | | | **268,872.0** |
| **Grand Total** | | | **698,964.0** |

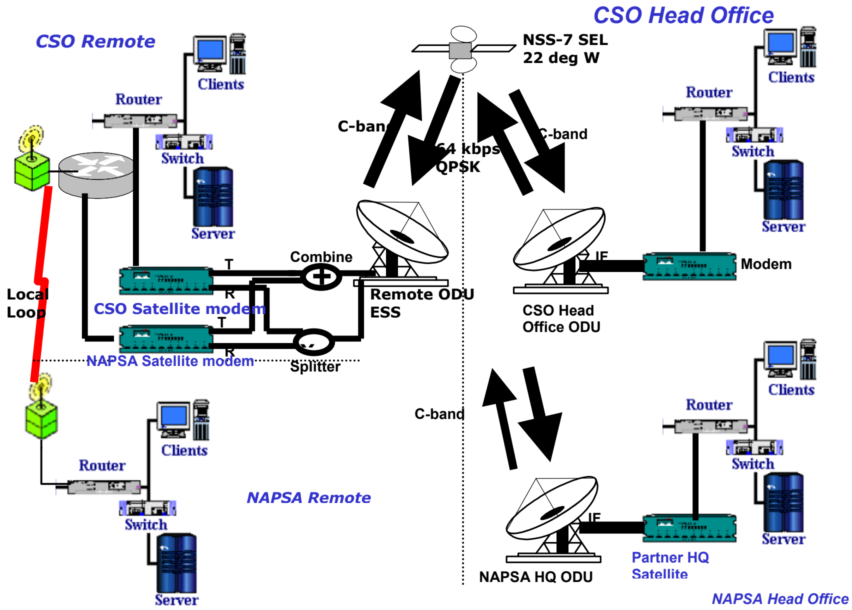



**Figure 8: CSO and NAPSA Networks**

## Maintenance and Running Costs

The satellite charges per month are for eight nodes on a 1 MHz capacity. The charges are tabulated below. The proposed payment plan is for 3 years. The total amount will be **$ 198,000.00** for a period of three years.

## Expendable Equipment

| Item | Description | Qty | | Cost |
|---|---|---|---|---|
| 1 | Hub 40W SSPA | 1 | 69,234.00 | 69,234.00 |
| 2 | Remote 5W SSPA | 2 | 14910.00 | 29,820.00 |
| 3 | Satellite Modem | 3 | 8324.00 | 24,972.00 |
| | **Total** | | | **124,026.0** |

## Satellite Provider Fees

| Item | Description | Mont | Unit Cost | Total |
|---|---|---|---|---|
| 1 | One Year Plan | 36 | 6,000.00 | 216,000.0 |
| **2** | **Three Year Plan** | **36** | **5,500.00** | **198,000.0** |
| 3 | Five Year Plan | 36 | 5,000.00 | 180,000.0 |

Communication Authority Fees

The annual operating licence to Communications Authority for a satellite network is **K 200,000.00**.

Human Resource Requirements

NAPSA already has a VSAT support and maintenance team. CSO will need to set up a team of VSAT specialists for the support and maintenance of the wide area network so as not to over-depend on the NAPSA resource. The two teams could complement one another on the maintenance aspects.

A provision budget to cater for travel visits to all the sites is given below. The nature of our climate demands that visits are conducted twice a year, before and after the rainy season. The budget figure must therefore be multiplied by 2 with the total amounting to $ 9,820.00.

Preventive Maintenance Costs

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Lodging - Northern | 6 | 50.00 | 300.00 |
| 2 | Lodging - Southern | 6 | 50.00 | 300.00 |
| 3 | Road Travel – Northern | 0.65 | 3000.00 | 1,950.00 |
| 4 | Road Travel – Southern | 0.65 | 2800.00 | 1,820.00 |
| 5 | Materials – Paint, | 4 | 60.00 | 240.00 |
| 6 | Handyman Labour | 12 | 25.00 | 300.00 |
| | **Total** | | | **4,910.00** |

Training Costs

The prescribed VSAT training course details is given in Appendix 6. The routing training course details are given in Appendix 7. The tables below give a summary of the costs.

VSAT Training

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Scheduled Class Per | 5 | 1695.00 | 8,475.00 |
| 2 | Materials | 5 | - | - |
| 3 | Text Books | 5 | 250.00 | 1,250.00 |
| 4 | Per Diem @ $190/Night | 10 | 950.00 | 9,500.00 |
| 5 | Air Travel | 5 | 2000.00 | 10,000.00 |
| | **Total** | | | **29,225.00** |

Routing Training

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | Scheduled Class Per | 4 | 2000.00 | 8,000.00 |
| 2 | Per Diem @ $190/Night | 6 | 950.00 | 5,700.00 |
| 3 | Air Travel | 5 | 400.00 | 2,000.00 |
| | **Total** | | | **15,700.00** |

Summary Budget

| Item | Description | Cost |
|---|---|---|
| 1 | Civil Works | 43,302.00 |
| 2 | Installation and Configuration | 48,500.00 |
| 3 | Non-expendable Equipment | 607,162.0 |
| 4 | Expendable Equipment | 124,026.0 |
| 5 | Satellite Provider Fees | 198,000.0 |
| 6 | Maintenance | 9,820.00 |
| 7 | Training | 44,925.00 |
| | **Total** | **1,075,735.** |

## 1.11 Abilities to carry on board key stakeholders

For CSO to have the ability to carry on board its stakeholders, it needs to own the network in total. A VSAT network is a huge investment project and it would be very prudent for CSO to make available for sharing the major components of the infrastructure like remote earth stations to other government ministries and departments. This will prove an effective way of investing government resources as any other ministry that required a VSAT would not have to build new earth stations in the provincial areas.

Option 1: VSAT

Without any redesigning of the network, CSO can host other departments' and/or ministries' data by linking one end in the province to local CSO office and the other end from HQ into their Lusaka office. Figure 9 shows the link between CSO VSAT hub and various government ministries and departments. Equipment costs for stakeholders are detailed in Table 1 below.

**Table 5: Tightly-coupled VSAT network for ministries**

| Description | Qt | Cost | Total |
|---|---|---|---|
| **Remote Sites** | | | |
| **Outdoor Unit** | | | |
| 3.7m Antennae | 0 | 29,742.00 | - |
| 5w SSPA Transceiver | 0 | 14,910.00 | - |
| Civil Works | 0 | 6,186.00 | - |
| Engineering | 0 | 4,500.00 | - |
| **Indoor Equipment** | | | |
| Router | 9 | 6,320.00 | 56,880.00 |
| Satellite Modem | 0 | 8,324.00 | - |
| Cable Subsystem | 0 | 1,700.00 | - |
| **Sub Total** | | | **56,880.00** |
| **HUB Station** | | | |
| **Outdoor Unit** | | | |
| 4.9m Antennae | 0 | 62,484.00 | - |
| 40w SSPA Transceiver | 0 | 69,234.00 | - |
| Civil Works | 0 | 6,186.00 | - |
| Engineering | 0 | 21,500.00 | - |
| **Indoor Equipment** | | | |
| Router | 1 | 27,169.00 | 27,169.00 |
| Satellite Modem | 0 | 8,324.00 | - |
| Cable Subsystem | 0 | 3,400.00 | - |
| Combiner Splitter | 0 | 12,307.00 | - |
| **Sub Total** | | | **27,169.00** |
| **Grand Total** | | | **84,049.00** |

Option 2: Terrestrial

1. Connection to HQ

In order to provide for other ministries and government departments, a fibre-optic ring could be constructed covering the area of government offices between Mulungushi House and Computerised Computer Services Department (CCSD) up to the Ministry of Works and Supply. See diagram below.

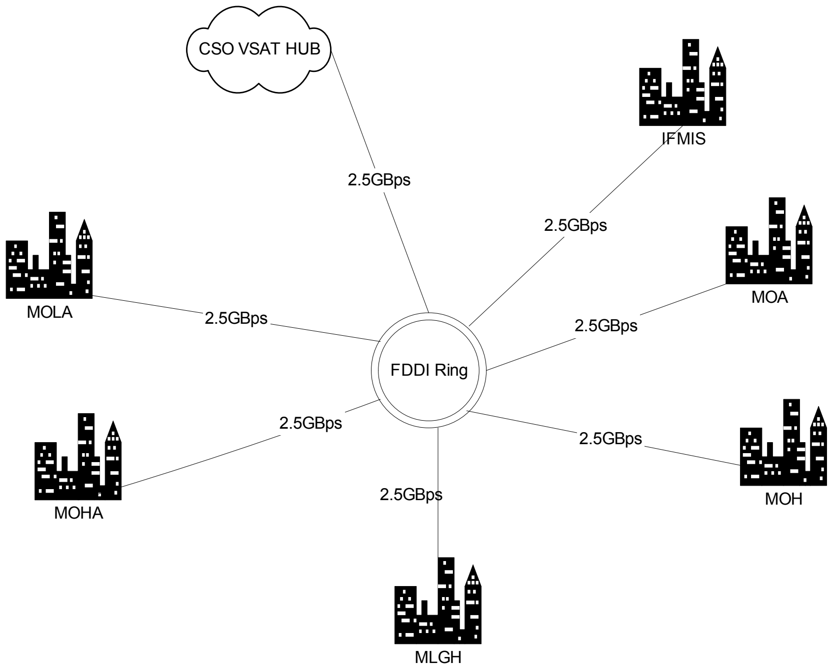



**Figure 9: Fibre Ring on GRZ Park**

The fibre-optic is commonly used as high-speed backbone technology because of its support for high bandwidth and greater distances than copper. It is also generally immune to electrical interference from radio frequency interference (RFI) and electromagnetic interference (EMI). It can span distances of over 2 km between stations depending on the mode of fibre which is more than sufficient for the area in question. The fibre ring can then be connected at the HQ into the WAN. This will immediately grant access into the rest of the country to the other government ministries. Their investment costs will only be limited up to the point that the join the fibre ring.

Equipment Costs

| Item | Description | Qty | Unit Cost | Cost |
|---|---|---|---|---|
| 1 | 24-port 100BFX Switch | 12 | 12492.00 | 149,904.0 |
| 2 | 24 Core Optic Fibre | 9000 | 9.37 | 84,330.00 |
| 3 | 24-port Optic Fibre | 12 | 273.26 | 3,279.12 |
| 4 | ST Connectors | 288 | 23.42 | 6,744.96 |
| 5 | MTRJ-ST Duplex | 72 | 78.08 | 5,621.76 |
| 6 | Installation Accessories | 6 | 240.00 | 1,440.00 |
| 7 | Installation and | | 22800.00 | 22,800.00 |
| | **Total** | | | **274,119.8** |

2. Connection to CSO Provincial Office

In the provincial centres, wireless radio and DSL will be used to connect from the CSO remote station to the government ministries/departments' offices. In most provinces, the offices are either in the same building or within a radius of 1 km.

## 1.12 Compatibility of WAN

### 1.12.1 Existing Infrastructure

There is nothing in total concerning a WAN in government. However, LANs are installed in most of the government ministries/department and are based on the TCP/IP protocol. The proposed WAN would be designed on the same protocol and thus would have no difficulties merging with the existing networks. At CSO, the interconnection will be from the WAN router into the switch on the local area network.

### 1.12.2 Initiatives in Government

A number of government ministries/departments are in the process of deploying WAN throughout the country, among them Zambia Social Investment Fund (ZAMSIF), MoH, MoE and Zambia National Tender Board (ZNTB). The ZRA and NAPSA have already installed VSAT WAN. The intentions of the other initiatives will not affect CSO except those that are already operational like ZRA and NAPSA, and have already been taken into consideration in the design options.

## 1.13 Conclusions and Recommendations

The assessment has established that CSO critically needs to install a WAN. There is an urgent need to link all provincial offices to HQ for easy and speed of conveying statistical data. This will also improve the dissemination times as the time between data collection and data analysis will be greatly reduced.

CSO is responsible for the national statistical systems and as such it needs to build capacity to be able to reach every corner of the country. With this demand CSO requires to build a modern network which will be easy to expand in future as the network grows. VSAT technology fits in very well because of its disregard of distance or geographical barriers.

If CSO has to take the lead in WAN installation and administration within government, building a totally new VSAT network is most recommended. This will also give CSO the leverage to carry on board other stakeholders.

When the WAN becomes a reality, several potential revolutionary applications beyond just secure communication will be identified.

We strongly recommend option one because of its merits. A new network for CSO and government will be in line with the CSO decentralisation plan. It will give CSO autonomy and discretion over the infrastructure which in turn will allow CSO to be able to carry other government ministries/departments data that are in need of the wide area network service.

The proposal is that the installation and commissioning costs will be composed of equipment costs and spares accessories, three-year subscription plan, local licence fees, VSAT and routing training bringing the total to $ 1,316,519.00.

When CSO has its own network infrastructure, it will be easier to relocate any office but this is not possible when in partnership. Being hosted by another institution will mean that when the partner moves offices, CSO will either have to move office or build new infrastructure in that location.

CSO technical team must go for specialised training because they will be responsible for the support and maintenance of both their own network and other government ministries/departments.

The network will be easy to monitor when the equipment and accessories are in the CSO offices.

Discussions between government ministries/departments usually take long to conclude. Going in to partnership might take longer time than CSO has to deploy the network. It would be prudent for CSO to have its own network and there is also the added advantage that the upgrade and maintenance will always be decided upon by CSO itself.

The second best proposal is option four, whose installation and commissioning costs compose of equipment costs and accessories, three-year subscription plan, and local licence fees, without the training, bringing the total to $ 1,075,735.00.

## 1.14 Appendix - Technical Requirement for VSAT Technology

## 1.15 Appendix 1: Performance Specifications for 4.9m Dual-Reflector C-Band Antennae

### 1.15.1 Mechanical Specifications

| | |
|---|---|
| Feed Type: | Dual-Reflector, Gregorian |
| Reflector Material: | Precision-Formed Aluminium |
| Reflector Segments: | 8 |
| Mount Type: | Elevation over Azimuth, Pedestal |
| Antenna Pointing Range, Course/(Continuous) | |
| Elevation:<br>Azimuth:<br>Polarization: | 0-90$^o$ (90$^o$)<br>180$^o$ (180$^o$)<br>180$^o$ (180$^o$) |
| Hub/Enclosure , Diameter/Depth: | 48in (1.22m)/24in (0.61m) |

### 1.15.2 Environmental Conditions

| | |
|---|---|
| Wind Loading: | Speeds of up to 200km/h |

### 1.15.3 Electrical Specifications

| | |
|---|---|
| Frequency Bandwidth: | |
| Transmit:<br>Receive: | 5.850 – 6.425 GHz<br>3.625 – 4.200 GHz |
| Antenna Gain (expected at circular waveguide flange of feed)<br>Receive Antenna Gain:<br>Transmit Antenna Gain: | <br>43.2 dBi at f_min, 54.3 dBi at f_max<br>48.0 dBi at f_min, 55.2 dBi at f_max |
| Typical G/T Performance (C-Band) at 10$^o$ Elevation, 4GHz: | |
| LNA/LNB Noise Temperature:<br>ES46 G/T at 10$^o$ EL (dB/K): | 65K 45K 30K<br>23.3 24.1 24.7 |
| Polarisation:<br>Circular switchable to linear in the filed<br>Isolation: | <br><br>>35 dB across beam width |
| Tracking and Control performance<br>Tracking: | <br>manual hand crank |

## 1.16 Appendix 2: Specifications for a Typical Transceiver

### 1.16.1 Transmit Section

| **IF Input** |
|---|

| | |
|---|---|
| Frequency Range | |
| Narrow BW Option: | 70+/-20 MHz, 140+/-20 MHz selectable |
| Wide BW Option: | 140+/-20 MHz |
| Impedance: | 50/75 Ohms selectable |
| Connector: | N-type female |
| Return Loss: | 20 dB minimum |
| **Gain Specification** | |
| **Gain** | |
| 40 Watt: | 70 dB nominal |
| Attenuator Range: | 0 dB to 30 dB nominal |
| Attenuator Step Size: | 1 dB nominal |
| **Gain Flatness** | |
| Narrow BW Option: | +/-1.0 dB maximum, 40 MHz |
| Wide BW Option: | +/-2.0 dB maximum, 80 MHz |
| Gain Stability: | +/-1.0 dB maximum, 40$^{o}$C to +55$^{o}$C |
| **RF Output** | |
| Frequency Range | |
| Band 1 (Standard): | 5.925 – 6.425 GHz |
| Band 2 (Extended): | 5.850 – 6.425 GHz |
| Band 3 (Insat): | 6.725 – 7.025 GHz |
| Band 4 (Palapa C & Intelsat VIII-A): | 6.425 – 6.725 GHz |
| **SSPA** | |
| Output Power (1 dB GCP) | |
| 40 Watt: | +45.7 dBm minimum |
| Connector: | CPR137-G |
| VSWR: | 1.4:1 maximum |
| **Carrier to inter-modulation ratio** | |
| 40 Watt: | -25dBc, two carriers, each at 6 dB OPBO from 1 dB GCP |
| Spurious Output: | -60 dBc maximum at 6 dB OPBO from 1 dB GCP |
| Synthesiser Step Size: | 1 MHz |
| **Frequency Stability** | |
| -40$^{o}$C to +55$^{o}$C: | +/-1x10$^{-8}$ |
| Aging: | +/-1x10$^{-7}$/year |
| **Cable Compensation Range** | |
| Narrow BW Option: | 0 dB to +1.2 dB nominal, 16 Steps |
| Wide BW Option: | 0 dB to +2.5 dB nominal, 16 Steps |

## 1.16.2 Receive Section (Excluding LNA)

| | |
|---|---|
| **RF Input** | |
| Frequency Range | |
| Band 1 (Standard): | 3.700 – 4.200 GHz |
| Band 2 (Extended): | 3.625 – 4.200 GHz |
| Impedance: | 50 Ohms |
| Connector: | N-type female |
| VSWR: | 1.4:1 maximum |
| Noise Figure: | 18 dB typical |
| | |
| **IF Output** | |
| Frequency Range | |
| Narrow BW Option: | 70+/-20 MHz/140+/-20 MHz selectable |
| Wide BW Option: | 140+/-40 MHz |
| Impedance: | 50/70 Ohms selectable |
| Connector: | N-type female |
| | |
| **Gain Specification** | |
| Gain | |
| Attenuator Range: | 0 dB to 30 dB nominal |
| Attenuator Step Size: | 1 dB nominal |
| Synthesizer Step Size: | 1 MHz |

## 1.17 Appendix 3: Performance Specifications for Low Noise Amplifier (LNA) and Transmit Reject Filter (TRF)

### 1.17.1 LNA Specifications

| | |
|---|---|
| **Input** | |
| Frequency Range: | 3.625 – 4.200 GHz |
| Interface: | CPR229-G |
| Noise Temperature: | 40 K at 25$^{o}$C |
| | |
| Gain Specification | |
| Gain: | 50 dBm minimum |
| Gain Fitness: | +/-1.5 dB maximum full band |
| | |
| **Output** | |
| 1 dB GCP: | +5 dBm minimum |
| 3$^{rd}$ Order Intercept: | +16 dBm minimum |
| Impedance: | 50 Ohms |
| Connector: | N-type female |
| VSWR: | 1.5:1 |

### 1.17.2 TRF Specifications

| | |
|---|---|
| Pass Band: | 3.625 – 4.200 GHz |
| Insertion Loss: | 0.005 dB maximum |
| Reject Band: | 5.850 – 6.425 GHz |
| Rejection: | 55 dB minimum |

## 1.18 Appendix 4: Specifications for a Satellite Modem

### 1.18.1 System Specifications

| | |
|---|---|
| Frequency Range: | 52 – 88 GHz<br>104 – 176 MHz |
| Input/Output Impedance: | 50 and 75 Ohms (front panel selectable) |
| IF Connector: | BNC, female |
| Digital Interface: | DB25 female, providing:<br>EIA422/EIA530 DCE<br>V.35 DCE and DTE<br>Sync/Async EIA232 |
| Scrambler: | ITU V.35 self synchronising |
| **FEC** | |
| Viterbi: | Rate ½, ¾, 7/8 |
| | |
| **Overhead** | |
| Famed EDMAC/AUPC: | 5% overhead |
| | |
| **Modulator** | |
| Frequency Stability: | +/-1.5 ppm, 0 – 50$^{o}$C |
| Output Power: | 0 to -20 dBm, 0.1 dB steps |
| | |
| **Demodulator** | |
| Input Range: | -30 to -60 dBm |
| | |
| **Environmental** | |
| Power Supply: | 100 – 240 volts AC, 50/60 Hz |
| Power Consumption: | 18 W typical, 25 W maximum |

## 1.19 Appendix 5: Specifications for Combiner/Splitter

| | |
|---|---|
| Number of ways: | 4 |
| Insertion Loss: | 8+/-2 dB or better |
| Isolation: | +20 dB or better |
| Return Loss: | 15 dB |
| Frequency Range: | 47 – 2150 MHz |
| Current Consumed: | 0 mA (passive) |

## 1.20 Appendix 6: VSAT Recommended Training Programme

Course Description

Satellite communications systems rely on orbiting satellites to provide reliable wireless transmission in conjunction with the ground-based infrastructure that delivers narrowband and broadband services. This ground segment comprises major earth stations and user terminals that have been configured and optimized for cost-effective fixed and mobile applications. Owing to the diversity of new applications and the availability of high-power satellite capacity on a global basis, these systems have become vital to users in both the commercial and government sectors.

This course presents a comprehensive, up-to-date development of ground segment engineering principles and practical techniques for satellite communications engineers, earth station developers and operators, enterprise network engineers, and providers of voice, data, video, and Internet services. Instruction addresses earth station design, user terminal configuration and production, and facility design and operation, providing a detailed and integrated understanding of how to proceed with complex projects of any scope. Throughout the course, emphasis is on the latest technologies and techniques, particularly in the areas of digital communications, RF and wireless design, and production of a workable ground-based facility that meets both current needs and future requirements. Included is a tour of a modern ground station facility from RF through base-band to systems that manage the elements and deliver reliable power.

Course methodologies and examples come from a variety of applications in satellite communications and networking, including fixed and mobile voice and data, Internet services via satellite, digital video and audio broadcasting, high-speed transmission for broadband and multimedia, and international telecommunications services that integrate both satellite and land-based cable and wireless systems.

Participants learn to:

- Take overall system and network requirements and translate them to the ground segment and earth stations
- Perform trade-off studies to determine the optimal RF terminal design
- Evaluate the critical questions that can hamper the introduction of the ground segment and earth stations, including radio frequency interference and coordination,

achieving a proper interface to user devices, maintainability and survivability, and effective monitor and control of the entire terrestrial infrastructure

- Design an earth station from system requirements (top down) and component and subsystem performance (bottom up), taking into account RF terminal, base band system, and supporting facility needs

- Create detailed performance budgets and allocations using link budgets and RF gain and noise budgeting techniques

- Understand the design and construction of major earth stations used as digital TV broadcast origination centres, VSAT hubs, and mobile gateways

- Select appropriate devices for user terminal implementation, including antenna, RF electronics, base band functions, and the end user interface for fixed installation and mobile terminals for handheld, vehicular, and airborne use

The course is intended for practicing earth station designers and operators in the commercial and government sectors, satellite systems engineers and system architects, network engineers and managers who are implementing earth station networks, and equipment designers and manufacturers. Throughout the course, participants are encouraged to ask questions and discuss the specific issues that they face on the job.

Course Materials

The text, The Satellite Communication Ground Segment and Earth Station Handbook, B. Elbert (Artech House, 2001), and updated lecture notes are distributed on the first day of the course. The notes are for participants only and are not for sale.

Course Program

Ground Segment and Earth Station Fundamentals

- Evolution of satellite communication earth stations-from major international gateways to the home dish installation

- Earth station design philosophy for performance and operation effectiveness

- Integration of space and ground segments-requirements imposed by the satellite-to-ground interface

- Engineering principles

- Review of link budget

- Digital modems and coding for error correction

- Multiple access systems-performance and control

- End-to-end network integration-design and test strategy to minimize risk

- System design analysis

- Service objectives (QoS and capacity)

- Allocation of impairments between space and ground

- Derivation of earth station requirements

- Radio frequency clearance and interference consideration

- RFI prediction techniques

- Interference criteria and coordination

- Site selection

- RFI problem identification and resolution

Service Requirements and Delivery

- Service capabilities of satellite orbits

- GEO

- Non-GEO

- Two-way communications services

- Satellite-based voice networks, speech compression

- VSAT data networks (STAR and MESH)

- Mobile satellite networks (Inmarsat, GlobalStar, ACeS and Thuraya)

- One-way (broadcast) services

- Digital video broadcasting of TV (Echostar/Dish, DIRECTV, and DVB/DTV standards)

- Digital audio broadcast (XM Radio, Sirius Radio, and other approaches)

- Multimedia transmission standards (TCP/IP, MPEG 2, MPEG 4, and streaming video)

Major Earth Station Engineering

- RF terminal design and optimization

- Antennas for major earth stations (fixed and tracking)

- Up-converter and HPA chain (SSPA, TWTA, and KPA)

- LNA/LNB and down-converter chain

- Optimization of RF terminal configuration and performance (redundancy, power combining, and safety)

- Base-band equipment configuration and integration

- FDMA

- TDMA

- VSAT hub

- CDMA

- Designing and verifying the terrestrial interface

- Station monitor and control

- Facility design and implementation

- Prime power and UPS systems

- Developing environmental requirements (HVAC)

- Building design and construction

- Grounding and lightening control

- Broadcast centre case study

- Radio frequency design and configuration

- Redundancy designs and the effect on grade of service

- Base-band systems

- Building design and site layout considerations

- Inter-facility link (fibre/coax) trade-off studies

User Terminals for GEO and Non-GEO Networks

- General configuration of user terminal (UT)

- RF head section (outdoor equipment)

- Base-band section (indoor equipment)

- User interface (common devices and custom features)

- Antennas for UTs

- Fixed directional antennas (dish and array)

- Tracking antenna designs (mechanical and electronic steered)

- Omni-directional antennas for handheld mobile applications

- Base-band functions

- Digital radio design principles

- Software Designed Radio applications

- Fixed terminals

- Receive only digital set-top-box (DVB)

- Two-way VSAT

- Next-generation low-cost VSAT

- Special considerations for portable and handheld UTs

- Analysis of the typical digital mobile phone

- Design of the satellite mobile UT

- Configuration for government services

- Extensions for aeronautical, maritime, and data applications

## 1.21 Appendix 7: Routing Recommended Training Programme

Course Objectives

After completing this course, students will be able to:

- Build a functional configuration to support the specified network operational requirements, given a network design
- Use the appropriate show commands to display network operational parameters so that anomalies are detected
- Use the appropriate debug commands to monitor network operational parameters so that anomalies are detected
- Explain how bridging and switching operates
- Explain the purpose and operations of the Spanning-Tree Protocol
- Build a functional router configuration to support the specified network operational requirements, given a network design
- Describe the features and operation of static routing

Course Outline

Module 1: Extending Switched Networks with VLANs

Module 2: Spanning Tree Protocol Overview

Module 3: Determining IP Routes

Module 4: Managing IP Traffic with Access Lists

Module 5: Establishing Serial Point-to-Point Connections

Module 6: Establishing Frame Relay Connections

Module 7: Completing ISDN Calls

## 1.22 Glossary of Terms

**Analog** - The representation of information in variable intensity and/or frequency by a continuous signal.

**Antenna** - Equipment that sends and/or receives signals from a satellite.

**Aperture** - A cross sectional area of an antenna exposed to the satellite signal.

**ASCII** – This is American Standards Code for Information Interchange. A code with seven information signals and one parity check signal.

**Bandwidth** - The range of frequencies utilized for the transmission of a signal or group of inter-related signals expressed in Hertz (Hz).

**Base-band** - A video or audio signal transmitted at its original frequency.

**Carrier** - A continuous frequency capable of being modulated with a second data-carrying signal.

**C-Band** - Frequencies of approximately 4 to 6 GHz for satellite downlink and uplink transmission, respectively.

**CDMA** – Code Division Multiple Access

**Digital** - The representation of information in binary form (ones and zeros), discontinuous in time.

**Earth Station** - Any system (combination of satellite antenna, amplification, conversion, and reception electronics) that can either transmit to or receive signals from orbiting satellites

**EDGE** - Enhanced Data Rates for GSM Evolution

**GPRS** - General Packet Radio Service

**HDSL** – High bit-rate Digital Subscriber Line

**Hub** - The central earth station satellite transmission facility that is the focal point for communicating to remote locations within a satellite communications network.

**IDSL** – ISDN Digital Subscriber Line

**IF** - Intermediate Frequency. The frequency of a satellite receiver after down-conversion or a satellite modulator before up-conversion

**IFL** - Inter-facility Link. A cable that provides communication between the ODU and IDU

**IP** - Internet Protocol, kbps One thousand bits per second

**kHz** - Kilohertz. One thousand cycles per second. Ku-Band Frequencies approximately in the 12 to 14 GHz range for satellite reception and transmission, respectively.

**LNA** - Low Noise Amplifier. Equipment that receives the satellite signal reflected by the antenna and amplifies it to the level needed by the satellite receiving equipment.

**LNB** - Low Noise Block Down-converter. Satellite receiving equipment that converts all signals from the LNA to the lower IF frequencies.

**LNC** - Low Noise Converter. Part of the earth station transmission subsystem consisting of an LNA and down-converter.

**MHz** - Megahertz. One million cycles per second.

**Modem** - Modulator/Demodulator. Equipment that converts between digital data and audio tones for transmission and reception over analog channels

**Mbps** - One million bits per second

**MTTR** - Mean Time To Respond. Average time taken to arrive on site to correct a fault in a system or component

**Multiplexing** - A technique that combines multiple data channels on a single transmission channel.

**MUX** - Multiplexer equipment

**RF** - Radio Frequency. The frequency range from 10 kHz to 100 GHz used for transmitting data, audio, or video.

**Redundancy** -A secondary system of backup equipment that performs similarly to a primary system, thereby preventing network downtime and system outages.

**Response Time** - The elapsed time between the end of an inquiry and the beginning of the response

**RFI** - Radio Frequency Interference

**Routing** - The process of selecting the correct circuit path for a message.

**SAC** - Satellite Access Controller

**SCPC** - Single Channel Per Carrier

**SDLC** - Synchronous Data Link Control

**SNA** - System Network Architecture

**S/N** - Signal-to-Noise Ratio. Relative power of the signal to the noise in a channel

**SSPA** - Solid-State Power Amplifier. A lower powered transmitter used for amplification of RF signals at a remote site

**SVC** - Switched Virtual Circuit. Synchronous When characters or bits are transmitted at a fixed rate with the transmitting and receiving devices synchronized.

**TCP/IP** - Transmission Control Protocol/Internet Protocol

**TDM** - Time Division Multiplexing

**TDMA** - Time Division Multiple Access

**Transponder** -The circuitry on a satellite that receives the uplink signal, amplifies it, and then retransmits it as the downlink signal.

**Uplink** - Transmission of information from an earth station to a geostationary communications satellite.

**VSAT** - Very Small Aperture Terminal. A small earth station, usually less than 2.4 meters, used for satellite communications

**UMTS** - Universal Mobile Telecommunications System

**WCDMA** - Wideband CDMA