TEC
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Broadband Satellite Services

FOREWORD

It gives me great pleasure to note that TEC Newsletter has completed five years of its publication. During this period, the contents & format have undergone significant changes based on suggestions & feedback from our esteemed readers. Through these Newsletters, efforts have been made to disseminate the information on New Developments in Telecommunications as well as topics of current interest. Solutions to various field problems were also addressed in various issues. I congratulate the editor and the associated team for their keen interest and enthusiasm in bringing out the Newsletter regularly.

I take this opportunity to wish all the readers and their families a very happy and prosperous New Year. Suggestions towards improvements of the Newsletter will be highly appreciated.

N. K. Mangla
Sr. DDG, TEC

BROADBAND SATELLITE SERVICES

Use of Satellite communication technology is advantageous over the terrestrial technology for providing communication in remote and inaccessible areas. The connectivity cost does not depend upon the distance it serves. Moreover the connectivity is not affected by natural calamities and man-made disasters and the connectivity is assured even under adverse conditions. Satellite media is capable of providing routing to meet unforeseen demands and also provides alternate routing in case of system failure due to some major problem.

Though INSAT programme was started with large capacities between metros, over a period of time this programme has been discontinued. The reason could be limited capacity as per the current perspective provided between metros. Following digital techniques are being used in ground segment equipment for increasing the channel capacity and reduce transponder power requirements:

- Low bit rate voice coding technique to reduce bit rate from 64 kbps to 8 kbps, 6.3 kbps and 5.3 kbps. In mobile satellite service, even bit rate of 4.8 kbps is being adopted.
- Digital Circuit Multiplication Equipment (DCME) using digital speech interpolation providing 5 to 20 times enhanced capacity.
- Forward error correction technique in addition to Reed Solomon coding.

The connectivity being provided on INSAT is limited upto 34 Mbps but possibility of connectivity at higher data rates (several STM-4s) is under study. There is a trend to move from C band to Ku and Ka band for broadband applications. Ku and Ka bands require small antenna, low RF power, support higher bandwidth and can be quickly deployed. Rain attenuation is a critical factor and is compensated for by allowing sufficient fade margin during link engineering.

Recently, the interest in Broadband satellite systems has grown rapidly and the advancements in technologies have led to the availability of low cost earth terminals. Access to broadband services via satellites is one of the major issues and depends on the type of orbit of the satellite system. Different technical features can be achieved when the satellite system serves as an access system and also when it serves as an access and transport system. Broadband services need broadband frequency channels which are available at higher frequency bands i.e. Ka and V bands.

Phenomenal growth of Internet in recent years and advances in voice and image compression techniques have raised interest in multimedia services. Multimedia services include data transmission as well as processing and presentation of data from a local source. So far, multimedia services have been carried out via terrestrial networks. In future, access networks

will have to provide multimedia services not only to fixed but also to mobile users. Organisations interested in satellite communications (service providers, satellite operators and manufacturers) would like to make use of global coverage provided by satellite systems.

The frequency ranges assigned to satellite services (137 to 401 MHz) do not include appropriate bandwidth for multimedia services. These bandwidths are used by the small low earth orbit (LEO) systems to provide low bit data rate services. Multimedia services cannot be provided at L band (1610 to 1626.5 MHz) or S band (2483.5 to 2500 MHz) as these are used by the big LEO systems for telephones and short message services. C band (4 to 8 GHz) serves primarily as the feeder link and there is no likelihood of it being used for satellite multimedia services.

The Ku band (10 to 18 GHz) is now being used for satellite broadcasting as well as Internet connections. There are plans for the use of Ku band for multimedia systems providing data communication services. The reverse channel (from the subscriber) will be available in Ka band.

The Ka band, which is deployed for satellite communication (17.7 to 31 GHz) utilises frequency range 19.7 to 21.2 GHz (downlink) and 29.5 to 31 GHz (uplink) for multimedia transmissions.

The V band (40 to 75 GHz) offers much wider bandwidth for multimedia systems. The effect of atmospheric precipitation on the link budget in the V band is far more distinct in comparison to the Ka band and therefore construction of terminals will be more complicated and expensive. It is anticipated that V band will be used for communication with platforms located at an altitude of about 20 Km (Uplink: 47.9 to 48.2 GHz, Downlink: 47.2 to 47.5 GHz).

Multimedia Terminals:

In general, terminals are grouped into the following three classes:

- Fixed terminals providing high quality of service
- Terminals having same properties as the fixed terminals but with a lower quality of service because of poorer electric properties of the antenna.
- Mobile terminals offering a limited range of services with a lower quality of service than that of the two classes.

Services:

Satellite multimedia systems will be able to offer a wide range of services similar to those offered by terrestrial systems. Because of unique properties of satellite communications, the provision of certain services will be much easier and will serve a wider group of users. The most frequently used services can be specified as: access to internet and www pages, electronic transfer of documents, electronic mail, message transmission, data distribution, television to home, television on demand, radio on demand, radio for global service area, distribution of music programmes, books on demand, local publishing and printing of documents, switched broadcasting services, interactive television, high definition television, video conferences, bank services, electronic transactions electronic shops, tele-medical services, remote teaching, wireless LAN, library services, access to data bases etc.

It is anticipated that satellite multimedia systems will employ the following protocols and digital platforms:

- TCP/IP protocol
- ATM protocol
- DVB-S (Digital Video Broadcasting – S band) platform

At present, in India, Ku band space segment is limited and Ka band is not available. With Ka band planned on INSAT IV around the year 2003, it would perhaps be possible to move to Ka band also for broadband applications.

METROPOLITAN AREA NETWORK

Metropolitan Area Network (MAN) is a city wide network used to provide a host of services to the customers using different types of access technologies like Ethernet, xDSL, Optical Fibre etc. The MAN allows extending very high bit rate access links to the customers. The bit rate supported over the access links could vary from 2 Mbps to 100 Mbps. The MAN has a city wide Optical Fibre based core network in Ring architecture with provisions of connectivity to MAN of different cities. This core network has connectivity to aggregation network, other networks and service providers. The multiple aggregation networks connect to the Core network and together provide various services to the customers.

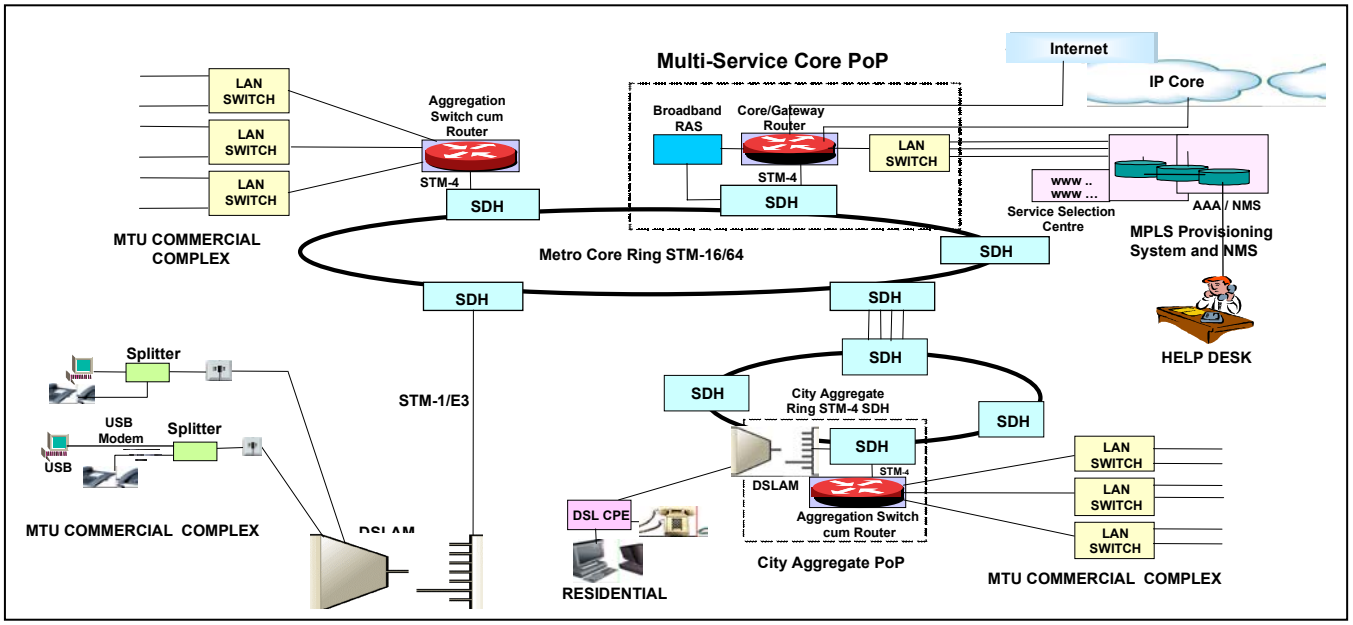
The MAN provides secure, scalable connectivity with guaranteed levels of service. The MAN allows delivering of services economically to the customers. The MAN allows for the security features that customers want to implement to secure their data from other users on the shared network.

The MAN with use of MAN Provisioning Systems, provides the means to economically provision scalable service over an IP network, using traffic separation as the means of securing data between different customers. The traffic engineering, quality of service and connectionless features are supported to allow Service Provider to scale MANs over their infrastructure, while still meeting customer expectations regarding performance. The MAN supports the IP Sec suite of protocols to provide the means to secure data over any links.

Architecture: The detailed architecture showing various components of the MAN is as given below and consist of the following components:

i. **Core Network:** This is a city wide core network based on STM-16 SDH Ring. The core network is built by Multi-service Core Point of Presence (POP) consisting of Gateway Routers, Core Routers, Broadband Remote Access Servers, Optical Networking element like STM-16 SDH multiplexers etc.

ii. **Aggregation Network:** The aggregation network aggregates traffic for various services and feeds to the core network. The aggregation network is based on STM-4 SDH ring. The Aggregation network consists of Aggregation Point of Presence (PoP) which consist of high throughput routers, Aggregation switches, DSL Access Multiplexers (DSLAM) etc. The city can have multiple aggregation networks.



iii. Access Network: The access network is used to provide the last mile connectivity to the customers for various services. This connectivity could be Ethernet on standard Ethernet cable or ADSL on copper cable. It consists of Access Switches cum Routers, DSL concentrators, DSL Customer Premises Equipment etc.

iv. MAN Provisioning System: The MAN provisioning system is an essential component of the MAN. This is used for provisioning of the various services and accounting. It also allows the subscribers to select the service provider and get the service for that duration after getting validated by the service provider's equipment. The billing system is a part of the MAN Provisioning system.

v. Network Management System: The network Management System is an essential part of a MAN and is used to monitor, configure and manage the entire MAN. It provides the diagnostic capabilities to check the health of the entire network or a section of the network under operator control.

SERVICES IN MAN

The MAN is used to provide the basic services as well as the value added services as given below.

Basic Services: The following basic services are provided using the MAN:

i) Internet access.
ii) Transparent LAN connectivity.
iii) Broadband access services.
iv) VLAN (Virtual LAN) and Gigabit Ethernet services.
v) Routing traffic between aggregate rings.

i) The Internet access service has the following features:

- Access to the Internet.
- Accessibility to various Services (http, ftp, etc.).
- Best-effort bandwidth.
- Best-effort priority.

ii) Transparent LAN connectivity service has the following features:

- Creation of closed user groups (One customer having multiple sites on the same MAN who will be a part of this one group).
- All IP services (ftp, http etc) permissible are transported within the closed user group.
- Best-effort bandwidth.
- Best-effort priority.

iii) The VLAN and Gigabit Ethernet Services has the following features:

- Creation of VLANs on the physical ports of the aggregation network.
- Extending the Gigabit Ethernet connectivity to the subscribers.
- All the services as mentioned above are available to the users of VLANs and the Gigabit Ethernet.

The entire network is able to route the traffic from one Aggregation network to another Aggregation network via the Metro Core network of the same city or different city.

Value-added Services: Value-added services are provided in addition to the basic services to enhance revenue potential for the Service Provider. The following value added services are able to be provisioned using the MAN:

i) Differentiated bandwidth access (with Committed Access Rates or Oversubscribed Ratios).
ii) Differentiated priority access (with Quality of Service mechanisms).
iii) Legacy VPN access (with tunneling mechanisms).
iv) MPLS (Multi-protocol label switching) VPN access (with multi-protocol label mechanism).

i) Differentiated bandwidth access service has the following features:

- Separate bandwidth per customer.

- Dedicated bandwidth per customer via Committed Access Rates, which are definable.
- Range of configurable rates from kbps to Mbps (depending on the access mechanism allowances).

ii) Differentiated priority access service has the following features:

- Separate priority per customer.
- Priority per customer via Weighted Random Early Detection (WRED) and Weighted Fair Queuing (WFQ) mechanism which are definable.
- Range of queue depths configurable for differentiated priority.
- Application Recognition and priority for separate applications for one customer also configurable.

iii) Legacy VPN access service has the following features:

- Tunneling mechanism to establish the Legacy VPN.
- A range of mechanisms are supported – IPSec (Internet Protocol Security, L2TP (Layer 2 Terminal Protocol), GRE (Generic depending on the customer requirement.
- Encryption mechanism is allowed within the tunnel.
- Site-Site and Client-Site configurations are supported.

iv) MPLS VPN access service has the following features:

- Labeling mechanism to establish the VPN.
- The mechanism for this Multiprotocol label switching VPN allows various scenarios depending on the customers' requirement.
- The mechanism to implement this is three tiered consisting of:
  - ♦ Customer Edge.
  - ♦ Provider Edge.
  - ♦ Provider.

Separation of the various edges allows for scalability and avoids the problems of provisioning meshed tunnels.

MULTI-CHANNEL MULTI-POINT DISTRIBUTION SYSTEM

Multi-channel Multi-point Distribution System (MMDS) was originally developed as a wireless cable television system. The idea was to do away with installation and maintenance of expensive coaxial cable, which is prone to damage and theft. However, over the years, with the advances in digital technology and convergence of various communication services, it has evolved as a broadband wireless network capable of transmitting two way audio, video and high speed data signals very reliably. The Local Area Network (LAN) and Internet services can be also provided through this technology.

Frequency Band

The MMDS generally operates in the 2-3 GHz band, which is less susceptible to interference. Further, line of sight requirement is not very strict. This enables the MMDS to cover a radius of 20-40 km from the base station depending on the terrain. Normally, only 200MHz bandwidth from 2.5 – 2.7 GHz or 2.7 – 2.9 GHz is available for MMDS due to scarcity of frequency spectrum. This constraint may limit the number of channels. With higher digital modulation techniques, 99 channels can be accommodated in the 200 MHz frequency band.

Higher frequency bands may provide good bandwidth due to less congestion in frequency spectrum but at the same time, it limits the coverage distance as free space attenuation increases with frequency.

Overview of MMDS System

The typical set up of an MMDS system is shown in Figure given on next page. The wireless system consists of head-end equipment (satellite signal reception equipment, radio transmitter, or broadcast equipment, and transmission antenna) and reception equipment at each subscriber location (antenna, frequency conversion device, and set-top device).

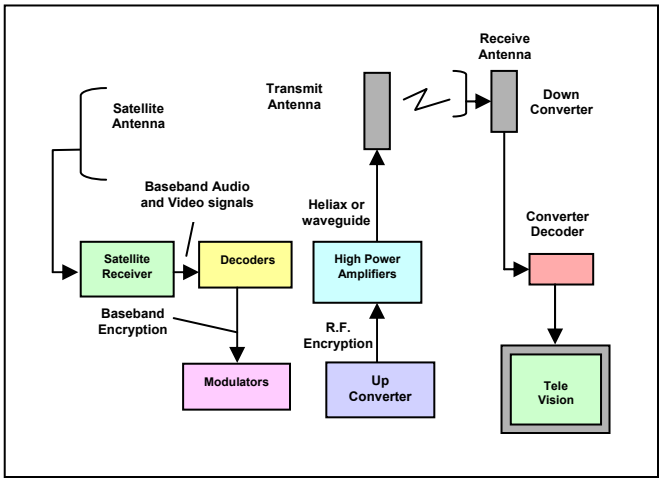
Signals for MMDS broadcast at the transmitter site originates from a variety of sources, just like at cable head-ends. If the signal is received from satellite, its delivered base band formats are remodulated and subsequently up-converted to microwave frequencies. Terrestrially delivered signals are usally passed through a heterodyne processor prior to up-conversion to the desired MMDS frequencies.

The MMDS channels are transmitted from an omni-directional or directional antenna having extensive line of sight in all directions.

Repeater stations can be used to redirect MMDS signals to screened areas. Transmitting antenna can reach upto 40 kms depending on the broadcast power. Transmission power used is usualy in the 1 to 100 watt range which is substially below the transmission power requirements of VHF and UHF terrestrial broadcasting station.

A rectangular parabolic shaped antenna is conditioned to receive vertically polarized or horizontally polarized signals, or both, at each end user's premises. The microwave signals are then passed through a down converter, which converts the signal frequencies to standard cable VHF or UHF channel frequencies. TV signals can subsequently be fed directly to a TV set or a set-top converter (i.e. descrambler decoder) box.

MMDS signals may be encrypted to allow the operator to control and bill the offered services. In an encrypted MMDS system, a decoder is installed between the antenna and the TV set.



Advantages

(i) The large coverage area makes MMDS cells very appropriate for accessing geographically diverse customer bases with minimal investment. For example, a business with multiple locations can link simultaneously with employees' homes in the area, for a private network, carrying voice, video and data. This kind of network will be much more expensive if built with wired technology.

(ii) MMDS frequency band of 2-3 GHz is very reliable. Further its coverage area is large and it is immune to rain fades and other weather effects.

(iii) MMDS can provide speeds up to 10 Mbps using IP technology and therefore may be used for high-speed data transfer to home and business.

Being a wireless technology, services can be deployed at a very fast pace and thus on demand.

Approvals issued by TEC during the period October 2001 to December 2001

Type Approvals.....	155
Interface Approvals.....	77
Service Test Certificates.....	60
Total	**292**

Approvals issued by TEC upto 31.12.2001

Type Approvals.....	5355
Interface Approvals.....	3216
Service Test Certificates.....	1373
Grand Total	**9944**

IMPORTANT ACTIVITIES OF TEC DURING THE 3rd QUARTER OF 2001 - 2002

A. Preparation of GRs/IRs & Technical documents

Following GRs and Technical documents issued:

- GR for 1/10/16 Pairs Screened PCM Cable for Digital equipment wiring to work up to 2Mbps.
- GR for 128 Kbps data Interface I Primary Rate.
- GR for Channel Iron Brackets of different types.
- GR for Customer Relationship Management System.
- GR for Digital Data Distribution Frame.
- GR for Internet Data Centre
- GR for Local Multi Point Distribution System in 10.5 GHz & 26 GHz frequency band.
- GR for Main rack, sub rack for Data Communication equipment.
- GR for Metropolitan Area Network.
- GR for Non-Zero Dispersion Shifted Single Mode Armoured & Metal Free Optical Fibre Cable.
- GR for VoIP Performance Analyser.
- Revised GR for 40 M Narrow base lightweight tower.
- Revised GR for 50°K (Type A) / 65°K (Type B) Low Noise Amplifiers Subsystem Operating in C Band.
- Revised GR for Multi-channel per carrier very small aperture terminal (MCPC-VSAT) operating in C band.
- Revised GR for TCP/IP.
- Revised Standard for Electromagnetic Compatibility for Telecom Systems.
- IR for NLDO Gateway.
- IR on Remote Station (Subscriber terminal) based on CDMA technology.
- Test Schedule for Cadmium-Copper PVC Drop Wire.
- Licence agreement for GMPCS services.

B. Tests and Field trials

Tests have been carried out for:

- AXE-10 DTAX at Coimbatore.
- Billing platform of CDOT IMPCS.
- IN services of C-DOT S/W version 2_2_1_3.
- R24 version of OCB 283 system.
- STM-16 of M/s ITI.

C. Other Activities

- Manufacturer Forum conducted for:
- 2 GHz 2/8 Mbps Digital microwave equipment.
- ATM/Frame Relay Protocol Analyser.
- Frequency Counter (40 GHz).
- FRP CD Cabinets.
- G.703 Interface Converter card and adapters.
- High Speed Data Tester for Digital parameters.
- Interactive Voice response system.
- IR for RAS.
- Line Driver with Ethernet Interface.
- Power Meter (40 GHz).
- SHDSL.
- Synthesized Signal Generator (40 GHz).
- Spectrum Analyser (40 GHz).
- Wireless LAN.
- Uninterrupted Power Supply (UPS).
- X.25 Data equipment to connect to I-Net.
- Review of National Numbering Plan.

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