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1. PON (GPON & GEAPON)

1.1 LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- Concept of PON.
- Network Architecture of PON based FTTH
- GPON and GEAPON technology.

1.2 INTRODUCTION

The revolution in Internet started by connecting millions of people over copper wire and through dial-up modems at data rates of a few thousands of bits per second. Today's, there is an increasing demand for high bandwidth services in market around the world. However, traditional technologies, like Digital Subscriber Line (DSL) and cable modem technologies, commonly used for "broadband access," which have access speeds to the order of a megabit per second, with actual rates strongly dependent on distance from the exchange (central office) and quality of the copper infrastructure, cannot fulfill today's customer demand for bandwidth hungry applications such as high-definition TV, high-speed Internet access, video on demand, IPTV, online gaming, distance learning etc. Fortunately, the Ethernet technology with Passive Optical Network (PON) that revolutionized enterprise networks promises to do the same for access to high speed applications. There are several "flavors" of PON technology, i.e. new access technology named BPON (Broadband Passive Optical Networking), EPON (Ethernet Passive Optical Networking) and GPON (Gigabit Passive Optical Networking) which delivers gigabit-per-second bandwidths while offering the low cost and reliability that have become synonymous with Ethernet. The most significant differences between each type of PON technology are the supported line rates and the type of packet processing used. The Full Service Access Network (FSAN) Group, a forum of the world's leading telecommunications service providers and equipment suppliers met in March 2005 and decided to create a Common Technical Specification (CTS) Task Group with goal to identify the broadest common system specification consensus for the GPON standard. One of the first decisions of that group was to focus effort on the 1.25 / 2.5 Gbps line rate as the preferred line rate. Major service providers are starting mass deployment of PON systems, and it is emerging as the next broadband access technology.

1.3 WHAT IS PON?

Passive Optical Network is essentially a cost effective optical fiber based access system for providing multi-play (voice, video, data etc) services, being rolled out by BSNL shortly, to both business and residential customers. A Passive Optical networks (PON) use optical fibre and optical power splitters to connect the Optical Line Terminal (OLT) at the local exchange to the subscriber's Optical Network Unit (ONU) on his premises. No electrical or electronic components are used between these points. This approach greatly simplifies network operation & maintenance, and reduces the cost. Another advantage is that much less fiber is required than in **point-to point topologies**.

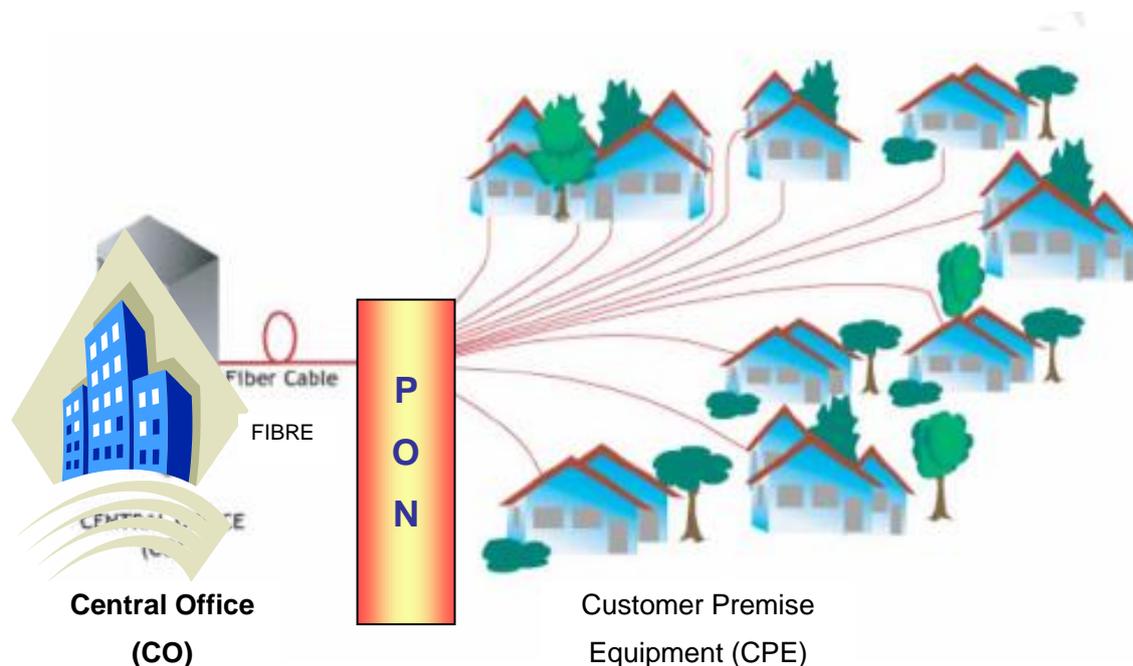


Fig : 1 PON (PASSIVE OPTICAL NETWORK)

Using Ethernet technology to create a passive optical infrastructure, PONs build a **point-to-multipoint** fiber topology that supports a speed of Gbps for up to 20 km. While subscribers are connected via dedicated distribution fibers to the site, they share the Optical Distribution Network (ODN) trunk fiber back to the Central Office.

The figure 2 shows the less fiber requirement for **PON (EPON & GPON)** as compared to the topologies of **point-to-point Ethernet** and **point-to-multipoint switched Ethernet**.

Point-to-point Ethernet might use either N or $2N$ fibers, and would have $2N$ optical transceivers. Point-to-multipoint switched Ethernet uses one trunk fiber and thus would save fiber and space in the Central Office (CO). But it would use $2N+2$ optical transceivers and would require electrical power in the field. PON also uses only one trunk fiber and thus minimizes fibers and space in the CO, and it also uses only $N+1$ optical transceivers. It requires no electrical power in the field. The drop throughput can be up to the line rate on the trunk link. EPON can support downstream broadcast such as video. EPON is typically deployed as a tree or tree-and-branch topology, using passive 1: N optical splitters.

Time Division Multiplexed (TDM) data is broadcast downstream from the OLT towards each ONU where the appropriate portion is extracted for local use. In the Upstream direction a Time Domain Multiple Access (TDMA) protocol allocates slots for data transmitted from each ONU to communicate back to the OLT without any contention between different subscribers.

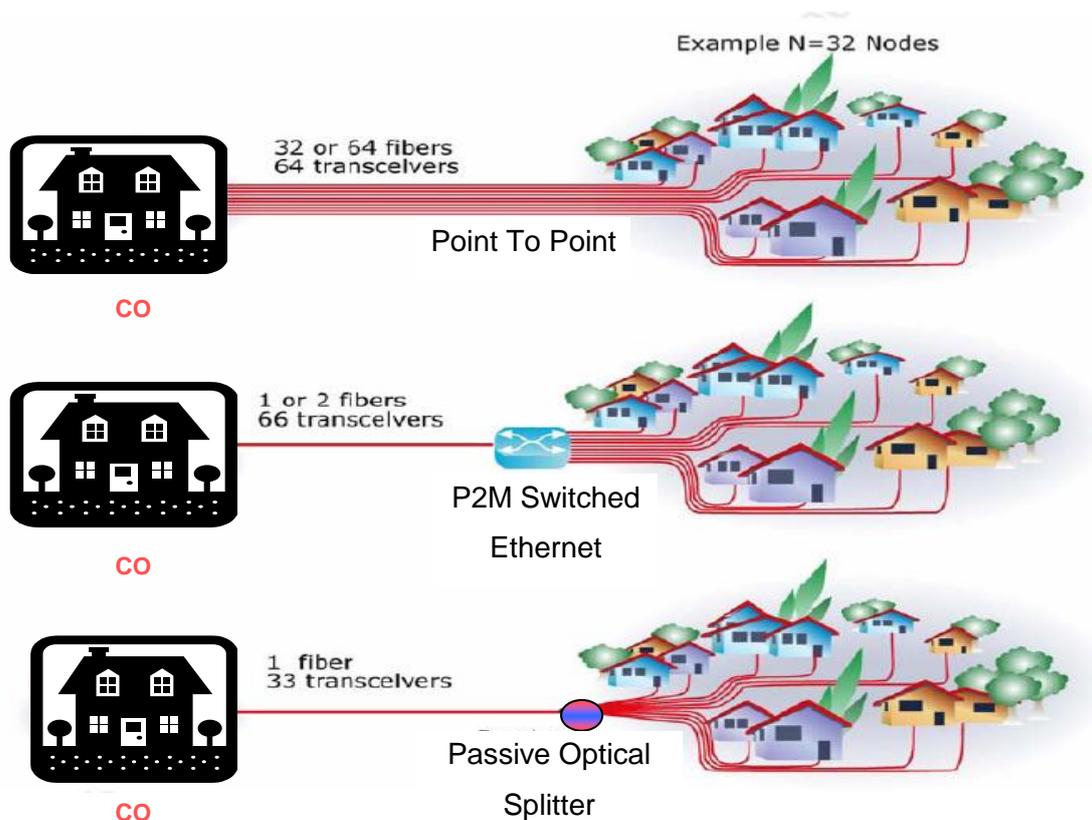


Fig : 2 Point-to-Point Ethernet, Point-to-Multipoint Switched Ethernet, and PON

1.4 APPLICATION OF PON TECHNOLOGY

Today, fiber networks come in many varieties, depending on the termination point: building (FTTB), home (FTTH), curb (FTTC) etc. For simplicity, most people have begun to refer to the fiber network as **FTTx**, in which x stands for the termination point. As telecommunications providers consider the best method for delivering fiber to their subscribers, they have a variety of FTTx architectures to consider. FTTH, FTTB, and FTTC each have different configurations and characteristics.

1.4.1.1 FTTH (Fiber To The Home):

FTTH is now a cost-effective alternative to the traditional copper loop. "Fiber to the Home" is defined as a telecommunications architecture in which a communications path is provided over optical fiber cables extending from an Optical Line Terminal (OLT) unit located in central office (CO) connects to an Optical Network Terminal (ONT) at each premise. Both OLTs and ONTs are active devices. This communications path is provided for the purpose of carrying telecommunications traffic to one or more subscribers and for one or more services (for example Internet Access, Telephony and/or Video-Television). FTTH consists of a single optical fiber cable from the base station to the home. The optical/electrical signals are converted and connection to the user's PC via an Ethernet card. FTTH is the final configuration of access networks using optical fiber cable.

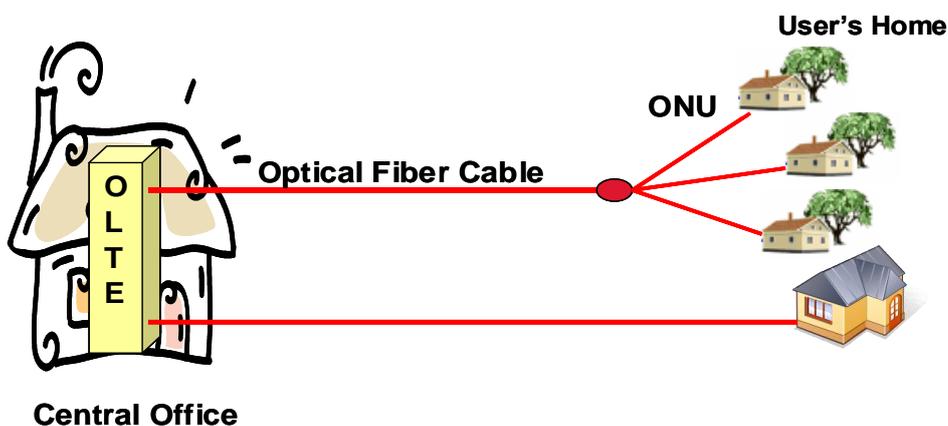


Fig : 3 FTTH Configuration

1.4.1.2 FTTB (Fiber To The Building):

“Fiber to the Building” is defined as a telecommunications architecture in which a communications path is provided over optical fiber cables extending from an Optical Line Terminal (OLT) unit located in central office (CO) connects to an Optical Network Unit (ONU at the boundary of the apartment or office or building enclosing the home or business of the subscriber or set of subscribers, but where the optical fiber terminates before reaching the home living space or business office space and where the access path continues to the subscriber over a physical medium other than optical fiber (for example copper loops).

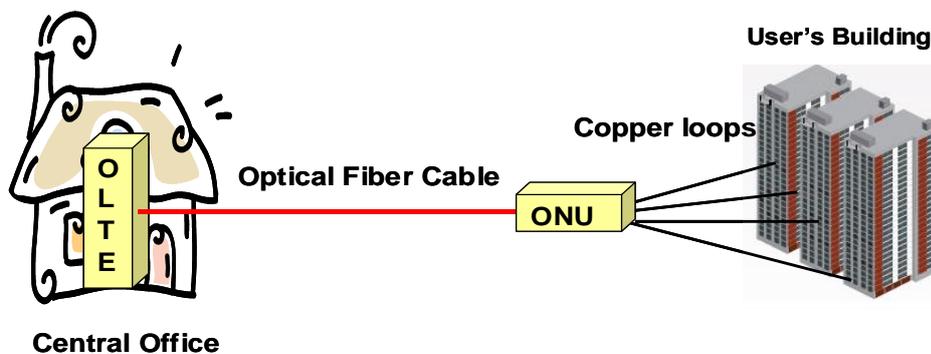


Fig : 4 FTTB Configuration

FTTB regarded as a transitional stage to FTTH. By introducing fiber cables from the fiber termination point to the home living space or business office space FTTB can be converted to full FTTH. Such a conversion is desirable as FTTH provides better capacity and longevity than FTTB. Optical fiber cable is installed up to the metallic cable installed within the building. A LAN or existing telephone metallic cable is then used to connect to the user.

1.4.1.3 FTTC (Fiber To The Curb):

A method of installing optical fiber cable by the curb near the user's home. An optical communications system is then used between the ONU installed outside (such as near the curb or on Street Cabinet) from the installation center. Finally, copper cable is used between the ONU and user.

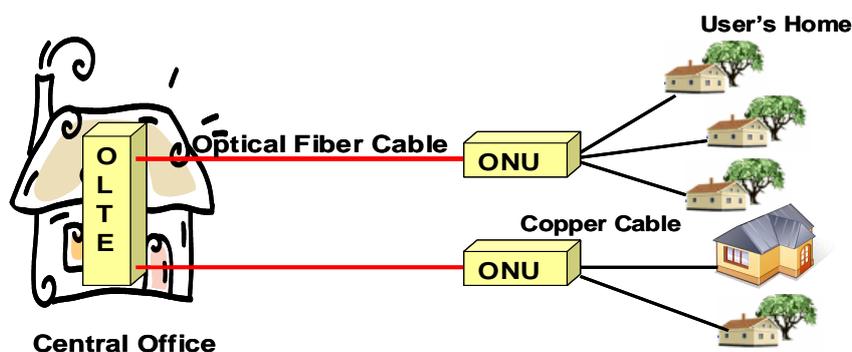


Fig. 5 FTTC Configuration

1.5 WHY FTTH?

FTTH is a true multi-service communications access which simultaneously handles several phone calls, TV/video streams, and Internet users in the home/office. There are several advantages of deploying FTTH over other traditional access technologies as given below:

- FTTH provides end-users with a broad range of communications and entertainment services, and faster activation of new services.
- Competition is beginning to offer a “multi-play” (i.e., voice, video, data etc) bundle.
- FTTH provides Service Provider’s with the ability to provide “cutting edge” technology and “best-in-class” services.
- Deploying a fiber optic cable to each premise will provide an extraordinary amount of bandwidth for future services.
- FTTH provides carriers with an opportunity to increase the average revenues per user (ARPU), to reduce the capital investment required to deliver multiple services, and to lower the costs of operating networks (fewer outdoor electronics, remote management, ..) will result in less operational expense.
- FTTH provides the community in which it’s located with superior communications which enhance the efficiency of local business and thus deliver economic advantage for the community.
- Around the world FTTH is viewed as strategic national infrastructure similar to roads, railways, and telephone networks.

1.6 TECHNOLOGY OPTIONS FOR FTTH ARCHITECTURE:

When deciding which architecture to select a provider has many things to consider including the existing outside plant, network location, the cost of deploying the network, subscriber density and the return on investment (ROI). At present different technology options are available for FTTH architecture .The network can be installed as an **active optical network**, or a **passive optical network (PON)**.

1.6.1 ACTIVE OPTICAL NETWORK The active optical network implementation is

known as the “Active Node” and is simply described as a “point-to-point” solution. Subscribers are provided a dedicated optical cable and the distribution points are handled by active optical equipment. These active architectures have been setup as either “**Home Run Fiber**” or “**Active Star Ethernet**”.

1.6.1.1 Home Run Fiber (Point-to-Point) Architecture

A Home Run Fiber architecture is one in which a dedicated fiber line is connected at the central office (CO) to a piece of equipment called an Optical Line Terminator (OLT). At the end user location, the other side of the dedicated fiber connects to an Optical Network Terminal (ONT). Both OLTs and ONTs are active, or powered, devices, and each is equipped with an optical laser. The Home Run fiber solution offers the most bandwidth for an end user and, therefore, also offers the greatest potential for growth. Over the long term Home Run Fiber is the most flexible architecture; however, it may be less attractive when the physical layer costs are considered. Because a dedicated fiber is deployed to each premise, Home Run Fiber requires the installation of much more fiber than other options, with each fiber running the entire distance between the subscriber and the CO.

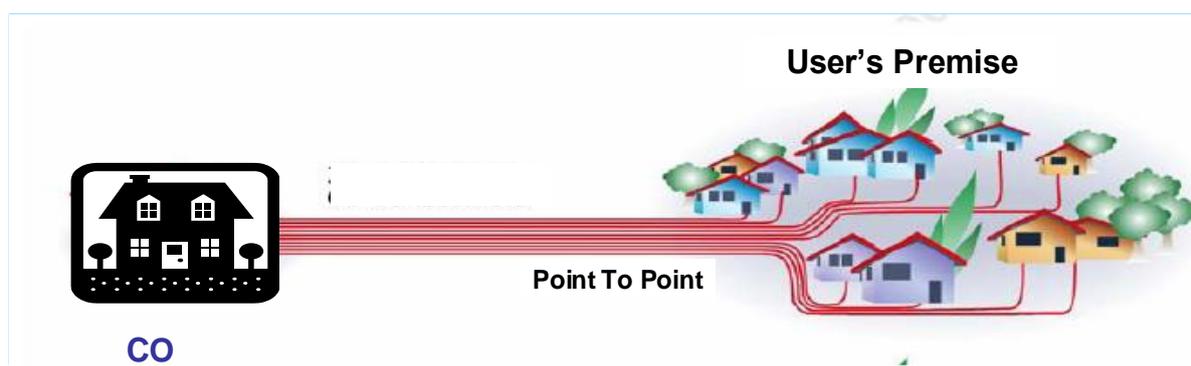


Fig. 6 Home Run Fiber (Point-to-Point) architecture

1.6.1.2 Active Star Ethernet (Point-to-Multi Point) Architecture

Active Star Ethernet (ASE) architecture is a point-to-Multi-point architecture in which multiple premises share one feeder fiber through a Ethernet switch located between the CO and the served premises.

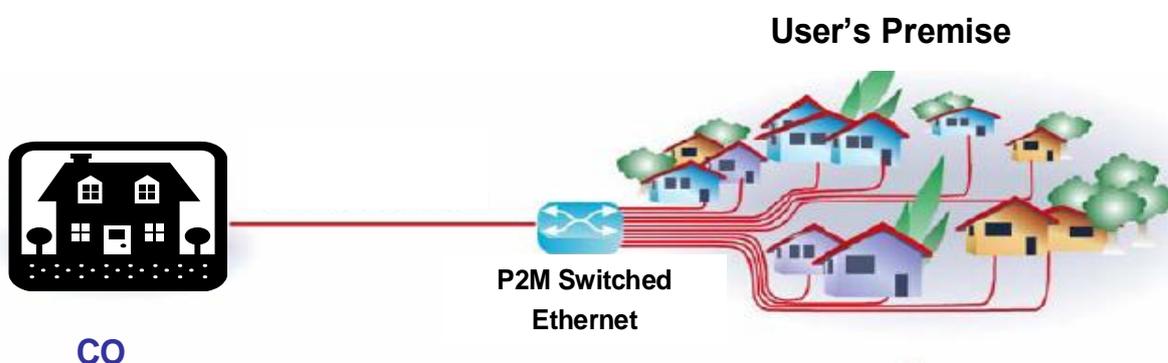


Fig.7 Active Star Ethernet (ASE) architecture

With Active Star Ethernet (ASE) architecture, end users still get a dedicated fiber to their location; however, the fiber runs between their location and Ethernet switch. Like Home Run Fiber, subscribers can be located as far away from the Ethernet switch and each subscriber is provided a dedicated “pipe” that provides full bidirectional bandwidth. Active

Star Ethernet reduces the amount of fiber deployed; lowering costs through the sharing of fiber.

1.7 PASSIVE OPTICAL NETWORK (POINT-TO-MULTIPOINT) ARCHITECTURE

The key interface points of PON are in the central office equipment, called the OLT for optical line terminal, and the CPE, called ONU for optical network unit (for EPON) and ONT for optical network terminal (for GPON). Regardless of nomenclature, the important difference between OLT and ONT devices is their purpose. OLT devices support management functions and manage maximum up to 128 downstream links. In practice, it is common for only 8 to 32 ports to be linked to a single OLT in the central office. On the other hand the ONT (or ONU) devices in the CPE support only their own link to the central office. Consequently, the ONT/ONU devices are much less expensive while the OLTs tend to be more capable and therefore more expensive.

1.7.1 OLT: The OLT resides in the Central Office (CO). The OLT system provides aggregation and switching functionality between the core network (various network interfaces) and PON interfaces. The network interface of the OLT is typically connected to the IP network and backbone of the network operator. Multiple services are provided to the access network through this interface.,

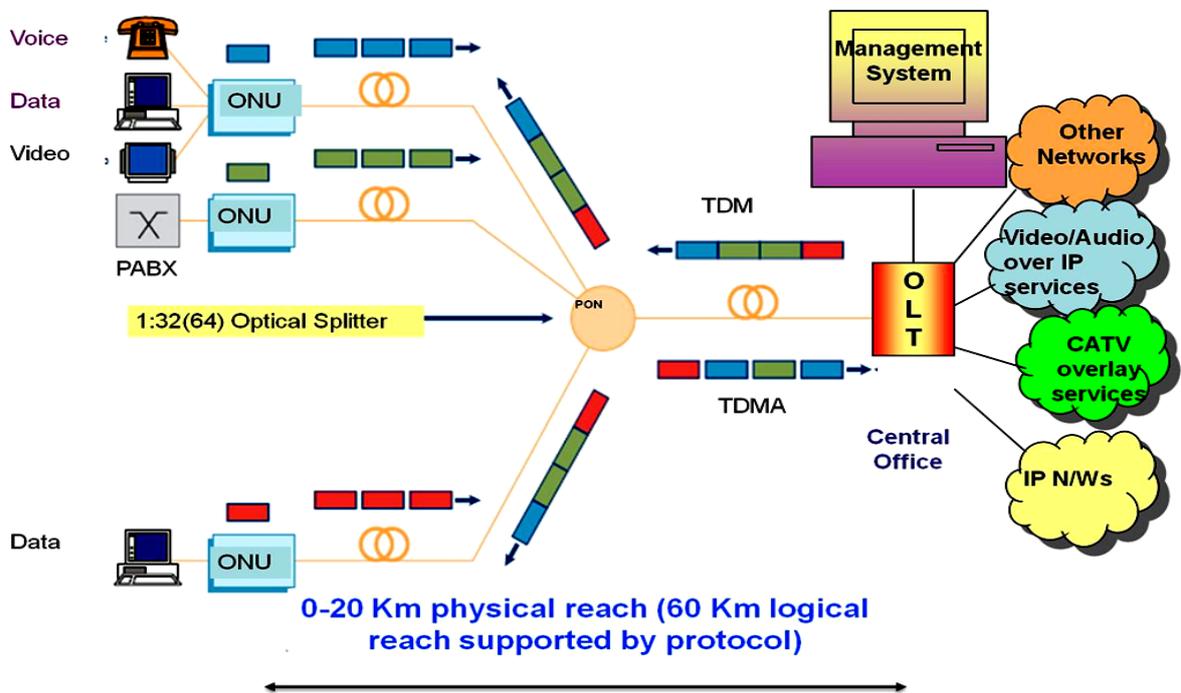


Fig. 8 PON Architecture

This provides access to the users i.e. an External Plant / Customer Premises equipment

1.7.2 ONU/ONT: providing user interface for many/single customer. The access node installed within user premises for network termination is termed as ONT. Whereas access node installed at other locations i.e. curb/cabinet/building,

are known as ONU. The ONU/ONT provide, user interfaces (UNI) towards the customers and uplink interfaces to uplink local traffic towards OLT.

1.7.3 PON: Distributed or single staged passive optical splitters/combiners provides connectivity between OLT & multiple ONU/ONTs through one or two optical fibers. Optical splitters are capable of providing up to 1:64 optical split, on end to end basis. These are available in various options like 1:4, 1:8, 1:16, 1:32 and 1:64.

1.7.4 NMS: Management of the complete PON system from OLT.

- One OLT serves multiple ONU/ONTs through PON
- TDM/TDMA protocol between OLT & ONT
- Single Fiber/ Dual Fiber to be used for upstream & downstream
- Provision to support protection for taking care of fiber cuts, card failure etc.
- Maximum Split Ratio of 1:64
- Typical distance between OLT & ONT can be greater than 15Km (with unequal splitting - up-to 35Km)
- Downstream transmission i.e. from OLT to ONU/ONT is usually TDM
- Upstream traffic I.e. from ONU/ONT to OLT is usually TDMA
- PON system may be symmetrical or asymmetrical
- PON and fiber infrastructure can also be used for supporting any one way distributive services e.g. video at a different wavelength

PON is configured in full duplex mode in a single fiber point to multipoint (P2MP) topology. Subscribers see traffic only from the head end, and not from each other. The OLT (head end) allows only one subscriber at a time to transmit using the Time Division Multiplex Access (TDMA) protocol. PON systems use optical splitter architecture, multiplexing signals with different wavelengths for downstream and upstream.

1.8 SPLITTER CONFIGURATIONS

There are two common splitter configurations are being used for PON architecture i.e. **centralized and the cascaded** approaches.

In Centralized Splitter Approach typically uses a 1x32 splitter in an outside plant enclosure, such as a fiber distribution terminal.

1.8.1 CENTRALIZED SPLITTER APPROACH In the case of a 1x32 splitter, each device is connected to an OLT in the central office. In this approach, optical splitters are concentrated in a single location from which all customer's optical network terminals (ONTs) at 32 homes are connected as shown in fig. 9.

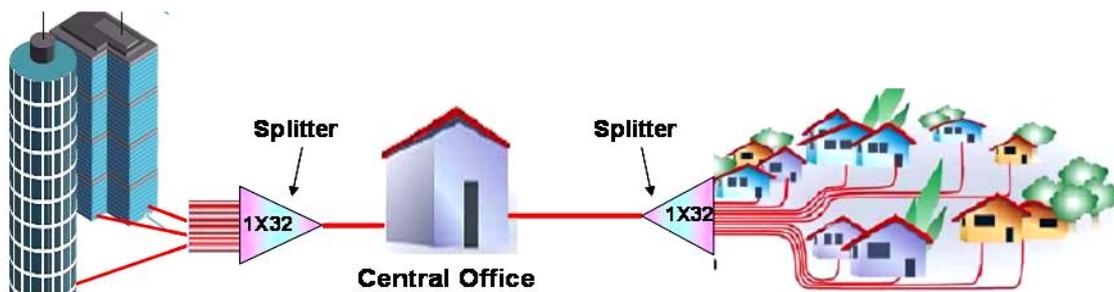


Fig. 9 Centralized Splitter Approach

A cascaded split configuration results in pushing splitters deeper into the network as shown in fig.8. **1.8.2 CASCADED SPLITTER APPROACH** Passive Optical Networks (PONs) utilize splitter assemblies to increase the number of homes fed from a single fibre. In a Cascaded PON, there will be more than one splitter location in the pathway from central office to customer. Currently, standard splitter formats range from 1 x 2, 1 x 4, 1 x 8, 1 x 16 and 1 x 32 so a network might use a 1 x 4 splitter leading to a 1 x 8 splitter further downstream in four separate locations. Optimally, there would eventually be 32 fibers reaching the ONTs of 32 homes.

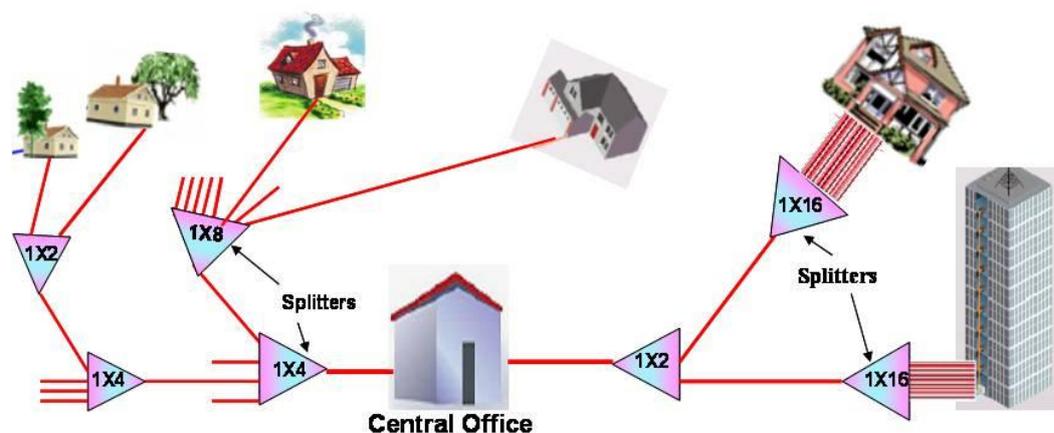


Fig.10 Cascaded Splitter Approach

There are several “flavors” of PON technology, i.e. new access technology named **APON** (ATM Passive Optical Network), **BPON** (Broadband Passive Optical Networking), **EPON** (Ethernet Passive Optical Networking) and **GPON** (Gigabit Passive Optical Networking) which delivers gigabit-per-second bandwidths while offering the low cost and reliability.

ATM PON (APON) was standardized by the ITU in 1998 and was the first PON standard developed. **1.8.3 APON** It uses ATM principles as the transport method and supports 622 Mbps downstream services and 155 Mbps upstream service shared between 32-64 splits over a maximum distance of 20 km.

Shortly after APON, Broadband PON (BPON) followed and is very similar to APON. **1.8.4 BPON** BPON also uses ATM, but it also boasts superior features for enhanced broadband services like video. BPON has the higher performance numbers than APON pre-splitting maximum of 1.2 Gbps downstream and 622 Mbps upstream.

The IEEE standardized Ethernet PON (EPON) in the middle of 2004. It uses Ethernet **1.8.5 EPON** encapsulation to transport data over the network. EPON operates at rates of 1.25Gbps both downstream and upstream (symmetrical), using 8B/10B encoding over a maximum reach of 20. EPON is also called now as Gigabit Ethernet PON (GE-PON). It is defined as a single fiber network using Wavelength Division Multiplexing (WDM) operating at a wavelength of 1490 nm downstream and 1310 nm upstream. This leaves the 1550 nm window open for other services, such as analog video or private WDM circuits.

1.9 GPON

Gigabit PON (GPON) is the next generation of PON's from the line of APON and BPON. The ITU has approved standard G.984x for it. GPON will support both ATM and Ethernet for Layer 2 data encapsulation so is clearly an attractive proposition. GPON supports two methods of encapsulation: the ATM and GPON encapsulation method (GEM). GEM supports a native transport of voice, video, and data without an added ATM or IP encapsulation layer. GPONs support downstream rates as high as 2.5 Gbits/sec and an upstream rate from 155 Mbits/sec to 2.5 Gbits/sec. BSNL is procuring the GPON that will support downstream rate 2.5Gbps and upstream 1.25 Gbps.

1.10 THE FEATURES OF DIFFERENT PON STANDARD

Features	BPON	GPON	EPON
Responsible Standard body	FSAN & ITU-T SG15 (G-983 Series)	FSAN & ITU-T SG15 (G-984 Series)	IEEE 802.3ah
Bandwidth	Down Stream up to 622 Mbps Up Stream up to 155.52 Mbps	Down Stream up to 2.5 Gbps Up Stream up to 2.5 Gbps	Down Stream up to 1.25 Gbps Up Stream up to 1.25 Gbps
Downstream λ	1490 nm & 1550 nm	1490 nm & 1550 nm	1490 nm
Upstream λ	1310 nm	1310 nm	1310 nm
Layer-2 Protocols	ATM	ATM, Ethernet, TDM over GEM	Ethernet
Frame	ATM	GPON Encapsulation Method	Ethernet Frame
Max. Distance (OLT to ONU)	20 km	20 Km(supports logical reach up to 60 Km)	10 and 20 Km.
Split Ratio	1:16, 1:32 and 1:64	1:16, 1:32 and 1:64	1:16 and 1:32
Line Codes	NRZ (Scrambled)	NRZ (Scrambled)	8B/10B
Downstream Security	AES: Advanced Encryption Standard -128 bit key	AES: Advanced Encryption Standard (Counter mode)	Not Defined
FEC	None	Yes	Yes
No. of fibers	1 or 2	1 or 2	1
Protection Switching	Support multiple protection configuration	Support multiple protection configuration	None

1.11 CONCLUSION

From the BSNL network point of view GPON, being the TDM based technology, shall integrate into the existing switching network. While the VOIP feature in the GE-PON provides easy migration path to the **Next Generation Network (NGN)** of the BSNL. Since TDM switches and the NGN are to coexist for up to 2015 as per the NGN vision plan both GPON and GE-PON are the most suitable PON technologies for BSNL.

2. OPTICAL TRANSPORT NETWORK

2.1 LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- OTN Hierarchy.
- Multiplexing Structure of OTN
- Advantages of OTN
- OTN Interfaces and layer architecture of OTN

2.2 INTRODUCTION

With the growing demand for services and bandwidth, now telecom operators are trying to converge their networks in order to reduce Operational Expenses (OPEX), and also to eliminate additional Capital Expenditures (CAPEX) on multiple parallel networks. The amount of data traffic relative to voice traffic on optical networks and the total traffic volume keeps increasing. These factors are the drivers behind emerging, flexible technologies to supplement the mature, voice optimized, SONET/SDH transport infrastructure and help manage network complexity. The aim of the optical transport network (OTN) is to combine the benefits of SONET/SDH technology with the bandwidth expandability of DWDM. OTN (Optical Transport Network) provides a vehicle to enable convergence, and for providing a common and SONET/SDH-like operational model for network operations, administration, maintenance and provisioning (OAM&P) functionality, without altering the individual services. This newly developed OTN is specified in ITU-T G.709 Network Node Interface for the Optical Transport Network (OTN).

Since the 1980s, SONET/SDH is supporting a flexible and transparent mix of traffic protocols including IP, Fiber Channel, Ethernet and GFP by providing protection and performance monitoring. Whilst deployment of dense wavelength division multiplex (DWDM) networks during the following decade served to increase existing fiber bandwidth, it severely lacked the protection and management capabilities inherent in SONET/SDH technology.

The optical transport network (OTN) was created with the intention of combining the benefits of SONET/SDH technology with the bandwidth expansion capabilities offered by dense wavelength-division multiplexing (DWDM) technology.

2.3 WHAT IS OTN?

Networks employing OTN technology are designed and optimized to support current applications employing massive network capacity, and OTN is increasingly recognized as the transport standard of choice to meet the growing demand for network capacity. The ITU Telecommunication Standardization Sector (ITU-T) defines OTN in a set of standards, with the G.709 specification acting as the core technology definition. The ITU-T standards cover the encapsulation format, multiplexing, switching, management, supervision, and survivability of optical channels carrying client payloads. OTN also provides the ability to measure network

performance across multiple service providers' domains and to provide seamless, end-to-end monitored services.

An Optical Transport Network (OTN) is composed of a set of Optical Network Elements connected by optical fiber links, able to provide functionality of transport, multiplexing, routing, management, supervision and survivability of optical channels carrying client signals. A distinguishing characteristic of the OTN is its provision of transport for any digital signal independent of client-specific aspects, i.e. client independence.

ITU Standard G.709 is commonly called Optical Transport Network (OTN)–sometimes referred to as **digital wrapper (DW)**, allows network operators to converge networks through seamless transport of the various types of legacy protocols while providing the flexibility required to support future client protocols.

OTN provides transport for all digital payloads with superior performance and support for the next generation of dynamic services with operational efficiencies not expected from current optical wavelength division multiplexing (WDM) transport solutions and support for a wide range of narrowband and broadband services like

- SDH/SONET
- IP based services
- Ethernet services
- ATM services
- Frame Relay services
- Audio/Video services etc.

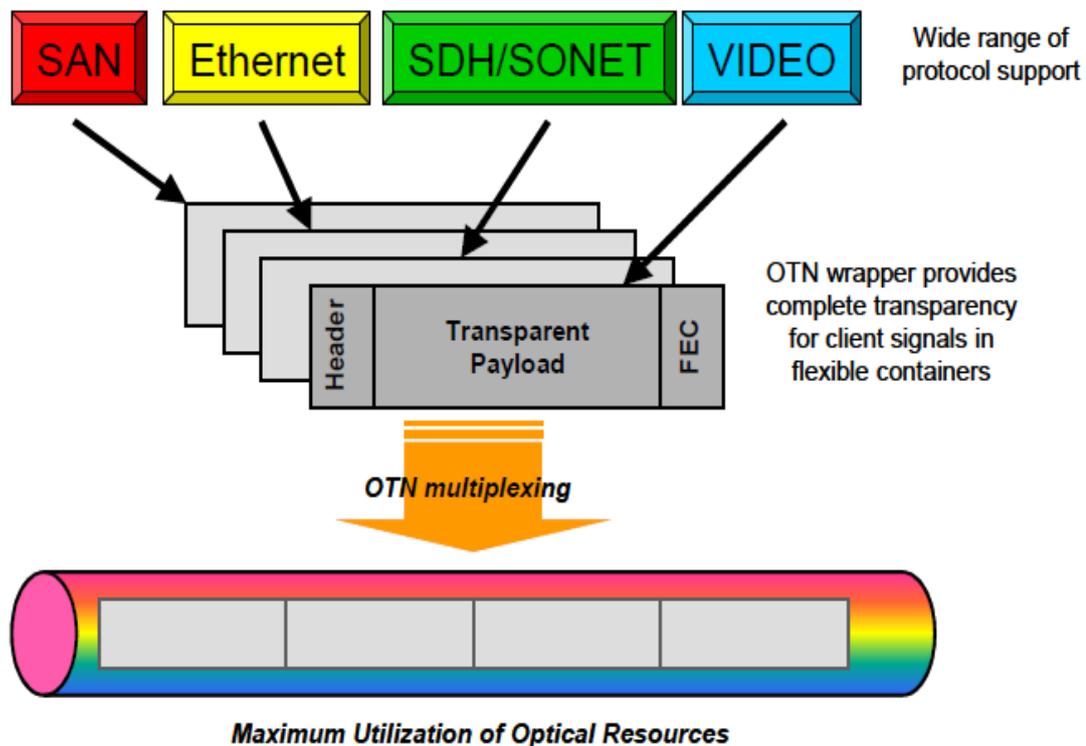


Fig 1: Converged transport over OTN

2.4 KEY ADVANTAGES OF OTN

Unlike SONET/SDH, OTN was designed to be an efficient transport layer for packet services such as Ethernet. At the same time, OTN is able to support the multiplexing of many different protocols including SONET/SDH, video, and storage protocols such as Fiber Channel.

OTN offers a number of advantages over legacy transport networks and the primary advantages of OTN include:

- **Reduction in transport costs:** By allowing multiple clients to be transported on a single wavelength, OTN provides an economical mechanism to fill optical network wavelengths.
- **Efficient use of optical spectrum:** OTN facilitates efficient use of DWDM capacity by ensuring fill rates are maintained across a network using OTN switches at fiber junctions.
- **Determinism:** OTN dedicates specific and configurable bandwidth to each service, group of services, or each network partition. This means that network capacity and managed performance (throughput, latency, jitter, and availability) are guaranteed for each client, and there is no contention between concurrent services or users.
- **Virtualize network operations:** The ability to partition an OTN-switched network into private network partitions, also referred to as Optical Virtual Private Networks (O-VPNs), provides a dedicated set of network resources to a client, independent of the rest of the network. Each network tenant sees only the resources associated with that tenant's private partition. Other resources associated with other tenants will not be visible. O-VPNs also ease network evolution because network upgrades can be tested or introduced in a protected network partition or 'sandbox,' without the risk of impacting day-to-day network operations in production partitions.
- **Flexibility:** OTN networks give operators the ability to employ the technologies needed now to support transport demands while enabling operators to adopt new technologies as business requirements dictate.
- **Secure by design:** OTN networks ensure a high level of privacy and security through hard partitioning of traffic onto dedicated circuits. This segregation of network traffic makes it difficult to intercept data transferred between nodes over OTN-channelized links. And because OTN-switched networks keep all applications and tenants separate, organizations can effectively stop hackers who access one part of the network from gaining access to other parts of the network.
- **Robust yet simple operations:** OTN network management data is carried on a separate channel completely isolated from user application data. This means OTN network settings are much more difficult to access and modify by gaining admittance through a client interface port.
- **Better Forward Error Correction:** OTN has increased the number of bytes reserved for Forward Error Correction (FEC), allowing a theoretical

improvement of the Signal-to-Noise Ratio (SNR) by 6.2 dB. This improvement can be used to enhance the optical systems in the following areas:

- Increase the reach of optical systems by increasing span length or increasing the number of spans.
- Increase the number of channels in the optical systems, as the required power theoretical has been lowered 6.2 dB, thus also reducing the non-linear effects, which are dependent on the total power in the system.
- The increased power budget can ease the introduction of transparent optical network elements, which can't be introduced without a penalty. These elements include Optical Add-Drop Multiplexers (OADMs), Optical Cross Connects (OXC), splitters, etc., which are fundamental for the evolution from point-to-point optical networks to meshed ones.
- **Tandem Connection Monitoring (TCM):**TCM enables the user and its signal carriers to monitor the quality of the traffic that is transported between segments or connections in the network.

2.5 OTN VS. SONET/SDH

Although OTN and SONET/SDH have similarities, there are also some significant design differences. Perhaps the biggest difference is that SONET/SDH was defined with fixed frame rates, while OTN was defined with fixed frame sizes.

Table-1: Comparison of SDH/SONET and OTN

OTN	SONET/SDH
Asynchronous mapping of payloads	Synchronous mapping of payloads
Timing distribution not required	Requires tight timing distribution across networks
Designed to operate on multiple wavelengths (DWDM)	Designed to operate on multiple wavelengths
Scales to 100 Gb/s (and beyond)	Scales to a maximum of 40 Gb/s
Performs single-stage multiplexing	Performs multi-stage multiplexing
Uses a variable frame size and increases the frame size as client size increases	Uses a fixed frame rate for a given line rate and increases frame size (or uses concatenation of multiple frames) as client size increases
FEC sized for error correction to correct 16 blocks per frame	Not applicable (no standardized FEC)

The G.709 standard defines client payload encapsulation, OAM overhead, FEC, and a multiplexing hierarchy. These functions deliver optical transport

capabilities as robust and manageable as SONET/SDH, but with greater suitability for current traffic demands, and data center interconnection circuits in particular.

OTN is asynchronous and thus does not require the complex and costly timing distribution and verification of SONET/SDH. Instead, OTN includes per-service timing adjustments to carry both asynchronous (GbE, ESCON) and synchronous (OC-3/12/48, STM-1/4/16) services. OTN can additionally multiplex these services into a common wavelength.

Like SONET/SDH, OTN also offers comprehensive OAM, but with standardized FEC. OAM is used to efficiently manage network resources and services. FEC enables service providers to extend the distance between optical repeaters, reducing expenses and simplifying network operations.

2.6 OPTICAL TRANSPORT NETWORK (OTN) LAYERS

The optical transport hierarchy (OTH) is a new transport technology for optical transport networks developed by the ITU. It is based on the network architecture defined in various recommendations (e.g., G.872 on architecture; G.709 on frames and formats; and G.798 on functions and processes). OTH combines electrical and optical multiplexing under a common framework. The electrical domain is structured in a hierarchical order just like SONET/SDH, and the optical domain is based on DWDM multiplexing technology but with standardized interfaces and methods to manage the network. ITU-T recommendation G.872, Architecture for the Optical Transport Network (OTN), defines two classes of OTN interfaces:

- **OTN inter-domain interface (IrDI):** This interface connects the networks of two operators, or the sub networks of one or multiple vendors in the same operator domain. The IrDI interface is defined with 3R (reshape, regenerate and retime) processing at each end. Since the IrDI is the interface for interworking, it was the focus of the initial standard development.
- **OTN intra-domain interface (IaDI):** This interface connects networks within one operator and vendor domain. Since the IaDI is typically between equipment of the same vendor, it can potentially have proprietary features added such as a more powerful FEC

The transport of a client signal in the OTN (shown in Figure i.e. Basic OTN Transport Structure) starts with the client signal (SONET/SDH, ATM, GFP, Ethernet etc.) being adapted at the optical channel payload unit (OPU) layer by adjusting the client signal rate to the OPU rate. The OPU overhead itself contains information to support the adaptation process of the client signal. Once adapted, the OPU is mapped into the optical channel data unit (ODU) with the necessary ODU overhead to ensure end-to-end supervision and tandem connection monitoring. Finally, the ODU is mapped into an OTU, which provides framing, as well as section monitoring and FEC.

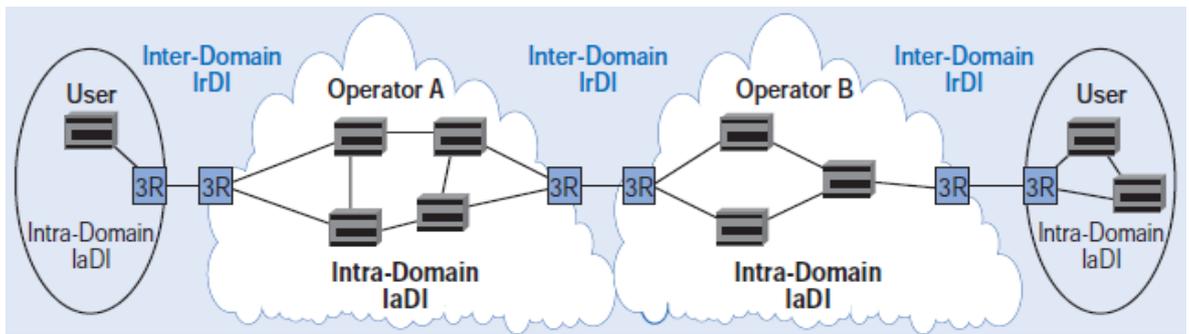


Fig 2: IrDI Vs IaDI

Additional OH may be added to the OCh to enable the management of multiple colors in the OTN. The OMS and the OTS are then constructed. The result is an OCh comprising an OH section, a client signal, and a FEC segment.

The OCh OH, which offers the OTN management functionality, contains four substructures: the OPU, ODU, OTU, and frame alignment signal (FAS).

Each OPU_k (k=0,1,2,2e,3,4,flex) is transported using an optical channel (OCh) assigned to a specific wavelength of the ITU grid. Several channels can be mapped into the OMS layer and then transported via the OTS layer. The OCh, OMS and OTS layers each have their own overhead for management purposes at the optical level. The overhead of these optical layers is transported outside of the ITU grid in an out-of-band common optical supervisory channel (OSC). In addition, the OSC provides maintenance signals and management data at the different OTN layers.

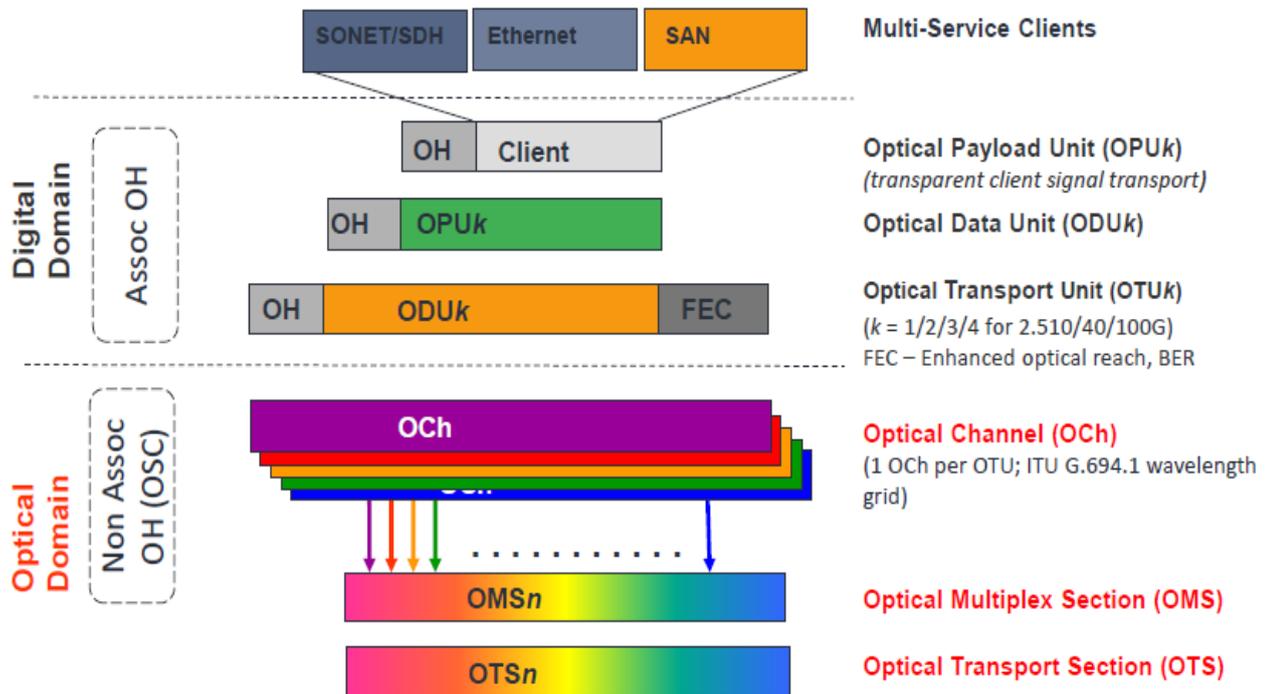


Fig 3: Basic OTN Transport Structure

2.7 OTN LAYER TERMINATION POINTS

The ITU G.872 recommendation also defines the optical network architecture based on the optical channel (OCh) carried over a specific wavelength. Different from that of legacy DWDM systems, the structure of this signal is standardized. The OTN architecture is composed of three layers, shown in Figure - OTN Layer Termination Points, and constructed using the OCh with additional overheads.

- **Optical Channel (OCh)** – represents an end-to-end optical network connection with the encapsulated client signal in the G.709 frame structure.
- **Optical Multiplex Section (OMS)** – refers to sections between optical multiplexers and demultiplexers.
- **Optical Transmission Section (OTS)** – refers to sections between any network elements in the OTN, including amplifiers.

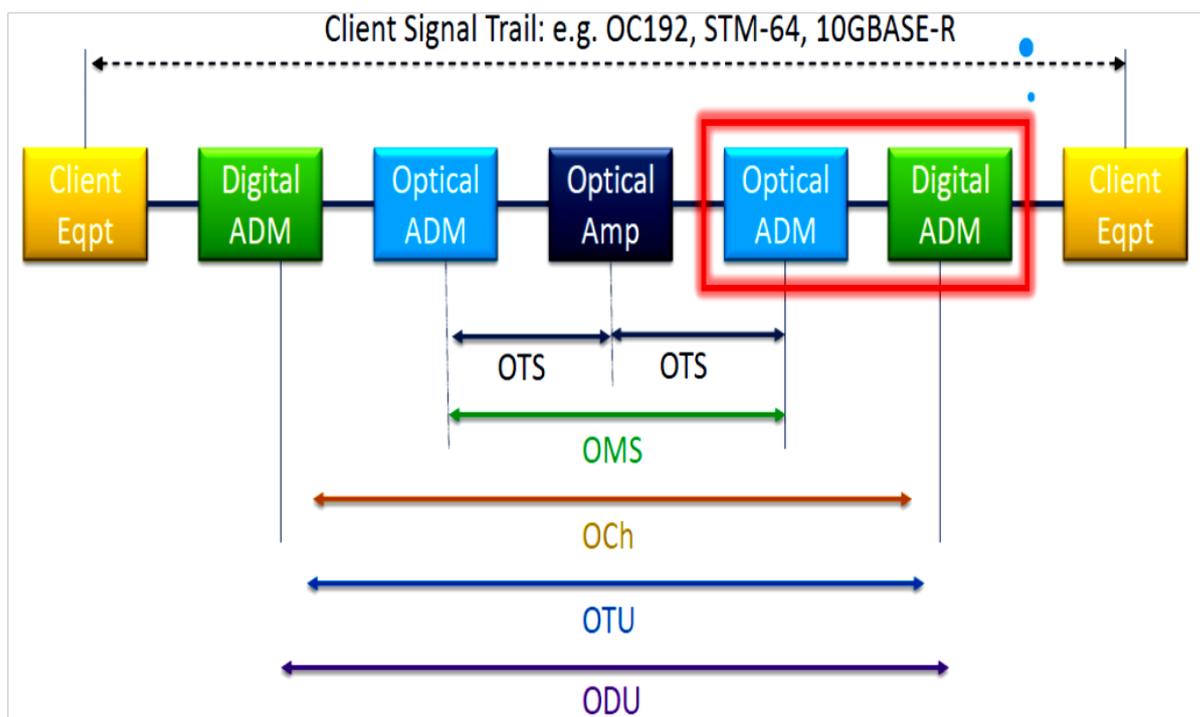


Fig 4: OTN Layer Termination Points

The termination of the OTS, OMS and OCh layers is performed at the optical level of the OTN. The OCh payload consists of an electrical substructure, where the optical channel transport unit (OTU) is the highest multiplexing level. This layer is the digital layer — also known as the “digital wrapper” - which offers specific overhead to manage the OTN’s digital functions. The OTU also introduces a new dimension to optical networking by adding forward error correction (FEC) to the network elements, allowing operators to limit the number of required regenerators used in the network and in turn reduce cost.

2.8 STANDARD OTN LINE RATES

G.709 defines standard interfaces and rates. OTN rates are equal to or higher than the bit rates of the client traffic. Typical client signals and corresponding to G.709 rates are listed in Table-2.

Table 2

Client Type	Signal	Client Signal	OTN Line Signal (G.709)	OTUk Line Rate (kbit/s) ^l	OPUk Payload Rate (kbit/s)	OTUk frame period (μs)	OTUk frequency accuracy (ppm)
SONET/SDH		STS-48/STM-16	OTU1	2,666,057	2,488,320	48.971	± 20
SONET/SDH		STS-192/STM-64	OTU2	10,709,225	10,037,629	12.191	± 20
Ethernet/Fibre Channel		10GBASE-R/10GFC	OTU2e	11,095,727	10,356,012	11.766	±100
SONET/SDH/Ethernet		STS-768/STM-256/Transcoded 40GBASE-R	OTU3	43,018,413	40,150,519	3.034	±20
Ethernet		Up to 4 10GBASE-R	OTU3e2	44,583,355	41,611,131	2.928	±20
Ethernet		100GBASE-R	OTU4	111,809,973	100,376,298	1.167	±20
ODUflex signals are transported over ODU2, ODU3, ODU4							±100

Note:ODU0 signals are to be transported over ODU1, ODU2, ODU3, ODU4 or ODUCn signals, ODU2e signals are to be transported over ODU3, ODU4 and ODUCn signals and ODUflex signals are transported over ODU2, ODU3, ODU4 and ODUCn signals

Unlike SDH/SONET, the line rate is increased by maintaining the G.709 frame structure (4 rows x 4080 columns) and decreasing the frame period (in SDH/SONET the frame structure is increased and the frame period of 125 μs is maintained).

2.9 OTN FRAME STRUCTURE

There are three overhead areas in an OTN frame: the Optical Payload Unit (OPU) overhead, the Optical Data Unit (ODU) overhead, and the Optical Transport Unit (OTU) overhead. These overhead bytes provide path and section performance monitoring, alarm indication, communication, and protection switching capabilities.

One additional feature is the inclusion of a Forward Error Correction (FEC) function for each frame. The FEC improves the Optical Signal-to-Noise Ratio (OSNR) by 4 to 6 dB, resulting in longer spans and fewer regeneration requirements.

Figure illustrates the three parts that constitute the G.709 OTN frame; **namely the overhead, the payload, and the FEC.**

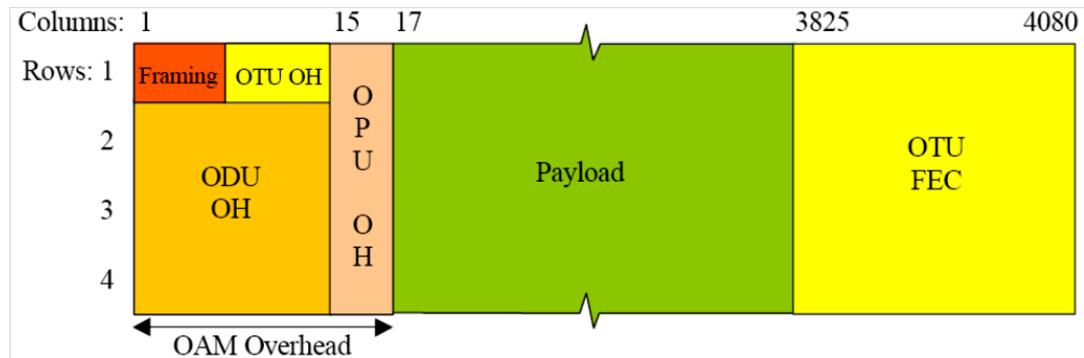


Fig 5: OTN Frame

Although OTN and SONET/SDH have similarities but the biggest difference in respect of frame structure is that SONET/SDH was defined with fixed frame rates, while OTN was defined with fixed frame sizes. Perhaps the biggest difference is that SONET/SDH was defined with fixed frame rates, while OTN was defined with fixed frame sizes.

2.10 OPTICAL TRANSPORT NETWORK EQUIPMENT

There are several different types of optical transport network equipment being deployed based on the OTN standards. The most common types include:

- Regenerators,
- OTN terminal equipment
- Optical Add/Drop Multiplexer (OADMs),
- Optical cross connect (OXC).

OTN terminal equipment is used for point-to-point connections through WDM networks, mapping the client signals into OPUs, sometimes multiplexing multiple signals in the electrical domain, and finally performing mapping/multiplexing in the optical domain. OADMs, OXCs, and some types of regenerators primarily process the OTN signals in optical domain.

2.11 CONCLUSION

OTN-based backbones and metro cores offer significant advantages over traditional WDM transponder-based networks, including increased efficiency, reliability, and wavelength-based private services. The IP-over-OTN infrastructure also offers better management and monitoring, reduced hops, increased protection of services, and reduced costs for equipment acquisition. In addition to scaling the network to 100G and beyond, OTN plays a key role in making the network an open and programmable platform, enabling transport to become as important as computing and storage in intelligent data center networking.

3. CONVERGED PACKET ACCESS NETWORK

3.1 LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- Limitation of circuit switched network signals.
- CPAN Technology.
- Network Architecture of CPAN.

3.2 INTRODUCTION

The purpose of a transport network is to provide a reliable aggregation and transport infrastructure for any client traffic type. With the growth of packet-based services, operators are transforming their network infrastructures while looking at reducing capital and operational expenditures. In this context, a new technology is emerging: a transport profile of Multi-Protocol Label Switching called MPLS-TP.

Transport network requirements of BSNL in the present scenario requires packet transportation, as all the new network elements are generating IP Traffic which is to be reliably transported. Based on this requirement, Packet Transport Network Planning guidelines have been prepared which outlines the basic concepts, technology & network architecture for the future transport network of BSNL. The network basically comprises of MPLS-TP based nodes.

- In BSNL transport network was designed and deployed to carry basically TDM traffic comprising of Els, STM-1s & STM-16s. The network elements such as Switches, BTSs, BSCs& MSCs etc utilized TDM interfaces for transportation of information from one place to the other as part of service delivery. With the introduction of Broadband for which large number of DSLAMs were installed for high speed Broadband delivery, transport of Ethernet traffic was also introduced in BSNL network, through RPR Switches deployed in metro districts.
- To carry TDM traffic efficiently & reliably SDH network comprising of STM-1 CPE, STM-1 ADM, STM-4, STM-16 ADM, STM-16 MADM and STM-64 has been extensively deployed which carried all type of TDM traffic. For long distance transport, linear DWDM systems (2.5G& 10G) were deployed which carried mostly SDH traffic through its lambdas(STM-1, STM-4, STM-16). During 2009 Digital Cross Connect (DXCs) were also introduced in BSNL network with granularity of STM-1 Cross Connect along with aggregation and ASON capability. Thus SDH, DXC and DWDM is presently the backbone of the transport network of BSNL.
- From 2006 onwards, with the advent of Ethernet over SDH (EoSDH) all SDH,DWDM& DXC Equipment procured by BSNL had the capability of transporting Ethernet traffic over SDH frame through Generic Framing Protocol (GFP) and Virtual Concatenation. This technology enabled BSNL to adapt to the transition phase in the technological development curve where the network elements were progressively switching towards Ethernet Interfaces (FE, GE) but continued to support TDM interfaces too. Further with deployment of large numbers of RPR Switches and OCLAN Switches with

Broadband network the requirement of Ethernet transport through traditional TDM transport backbone was minimal. Even the routers of MPLS network (P&PE) had substantial TDM interfaces to enable the transportation of traffic in secure reliable media, utilizing BSNL's traditional TDM transport backbone.

- But the situation depicted above is rapidly changing with 100% network elements being deployed by Mobile, Broadband and NGN for fixed access supporting only Ethernet interface for interconnection. Thus the volume of transport requirement for Ethernet Interfaces has exponentially increased while requirement of TDM transport is rapidly vanishing. The network transportation requirement has clearly shifted from TDM with smaller portion of Packet to almost 100% Packet transport. As we move in the era of Packet transport, utilizing TDM network for the same becomes inefficient and costly. Moreover, the packet network gives support to different class of services, aggregation and dynamic statistical multiplexing etc. in transport layer for efficient delivery of services.

3.3 WHAT IS PACKET TRANSPORT NETWORK?

Attributes required for Ethernet transport.

Attributes	Packet network	Transport network	Packet transport network
Connection mode	Connectionless	Connection oriented	Connection oriented
OAM/Operation & maintenance	Out of band	In band	In band
Protection switching	Control plane depend	Data plane switching	Data plane switching
BW efficiency	Statistical multiplexing	Fixed bandwidth	Statistical multiplexing
Data rate granularity	Flexible	Rigid SDH hierarchy	Flexible
QoS	QoS differentiation	Single class	QoS differentiation

Packet Transport->Packet efficiency + Transport grade

3.4 MPLS-TP

The goal of MPLS-TP is to provide connection-oriented transport for packet and TDM services over optical networks leveraging the widely deployed MPLS technology. Key to this effort is the definition and implementation of OAM and resiliency features to ensure the capabilities needed for carrier-grade transport

networks – scalable operations, high availability, performance monitoring and multi-domain support.

Objective of MPLS-TP is:

- To enable MPLS to be deployed in a transport network and operated in a similar manner to existing transport technologies (SDH/SONET/OTN)
- To enable MPLS to support packet transport services with a similar degree of predictability, reliability, and OAM to that found in existing transport networks

Current transport networks (e.g. SONET/SDH) are typically operated from a network operation center (NOC) using a centralized network management system (NMS) that communicates with the network elements (NEs) in the field via the telecommunications management network (TMN). The NMS provides well-known FCAPS management functions which are: fault, configuration, accounting, performance, and security management. Together with survivability functions such as protection and restoration, availability figures of >99,999% have been achieved thanks to the highly sophisticated OAM functions that are existing e.g. in SONET/SDH transport networks. This well proven network management paradigm has been taken as basis for the development of the new MPLS-TP packet transport network technology.

Moreover, MPLS-TP provides dynamic provisioning of MPLS-TP transport paths via a control plane. The control plane is mainly used to provide restoration functions for improved network survivability in the presence of failures and it facilitates end-to-end path provisioning across network or operator domains. The operator has the choice to enable the control plane or to operate the network in a traditional way without control plane by means of an NMS. It shall be noted that the control plane does not make the NMS obsolete – the NMS needs to configure the control plane and also needs to interact with the control plane for connection management purposes.

One of the major motivations for developing MPLS-TP was the need for the circuits in Packet Transport Networks. Traditionally packet transport switches each packet independently. However with connection oriented transport a ‘connection’ is first setup between the end points and then all the traffic for that connection follows only that path through the network. This makes the Packet Transport Network very similar to the TDM networks and simplifies management and migration of the transport network.

The concept of Label Switched Paths or LSPs from MPLS technology is already tried and tested and successful in the internetworking world. It made sense to adapt it for use in Packet Transport Networks. However there was a need to simplify the working of MPLS to make it more suitable for use in the Packet Transport World.

With this in mind, some features were removed from the traditional MPLS, since it was felt that these were not needed in Transport World and would simply the network. The features from MPLS that are not supported by MPLS-TP are:

- MPLS Control Plane:** MPLS-TP does not require LDP or any other control plane protocol to set up the circuits. Instead a user provisioned model

is followed. The user can provision a circuit from a centralized Network Management System in a way similar to TDM networks.

b) Penultimate Hop Popping (PHP) : PHP is used by MPLS Edge Routers to reduce the load of two label lookups. However this causes problems with QoS and was disabled in MPLS-TP

c) LSP Merge: Merging two LSPs (going to the same destination) reduces the number of labels being used in the network. However it makes it impossible to differentiate between traffic common from two different sources before the merging happened. To simplify things in transport networks, LSP merge was also disabled.

d) Equal Cost Multi Path: In traditional IP/MPLS networks different packets between a source-destination pair can take different paths. This is especially true when multiple equal cost paths exist. However this is in conflict with the concept of a circuit where all the traffic should follow the same path. Hence ECMP is disabled.

3.5 DIFFERENCES BETWEEN MPLS AND MPLS-TP

When it comes to the major differences between MPLS and MPLS-TP, here's what you need to know.

- **Bidirectional Label Switched Paths (LSPs).** MPLS is based on the traditional IP routing paradigm -- traffic from A to B can flow over different paths than traffic from B to A. But transport networks commonly use bidirectional circuits, and MPLS-TP also mandates the support of bidirectional LSPs (a path through an MPLS network). In addition, MPLS-TP must support point-to-multipoint paths.
- **Management plane LSP setup.** Paths across MPLS networks are set up with control-plane protocols (IP routing protocols or Resource Reservation Protocol (RSVP) for MPLS Traffic Engineering (MPLS-TE). MPLS-TP could use the same path setup mechanisms as MPLS (control plane-based LSP setup) or the traditional transport network approach where the paths are configured from the central network management system (management plane LSP setup).
- **Control plane is not mandatory.** Going a step farther, MPLS-TP nodes should be able to work with no control plane, with paths across the network computed solely by the network management system and downloaded into the network elements.
- **Out-of-band management.** MPLS nodes usually use in-band management or at least in-band exchange of control-plane messages. MPLS-TP network elements have to support out-of-band management over a dedicated management network (similar to the way some transport networks are managed today).
- **Total separation of management/control and data plane.** Data forwarding within an MPLS-TP network element must continue even if its management or control plane fails. High-end routers provide similar functionality with non-

stop forwarding, but this kind of functionality was never mandatory in traditional MPLS.

- **No IP in the forwarding plane.** MPLS nodes usually run IP on all interfaces because they have to support the in-band exchange of control-plane messages. MPLS-TP network elements must be able to run without IP in the forwarding plane.
- **Explicit support of ring topologies.** Many transport networks use ring topologies to reduce complexity. MPLS-TP thus includes mandatory support for numerous ring-specific mechanisms.

3.6 MPLS AND MPLS-TP COMPONENTS

As mentioned previously, MPLS refers to a suite of protocols, and MPLS-TP refers to a set of compatible enhancements to the MPLS protocol suite. These protocols and new enhancements can be separated into the following categories:

- Network Architecture—Covers the definition of various functions and the interactions among them.
- Data Plane—Covers the protocols and mechanisms that are used to forward the data packets. This can further be divided into the following subcategories:
 - Framing, forwarding, encapsulation
 - OAM
 - Resiliency (protection and restoration)
- Control Plane—Covers the protocols and mechanisms used to set up the label-switched paths (LSPs) that are used to forward the data packets.
- Management Plane—Covers the protocols and mechanisms that are used to manage the network.

A list of protocols and mechanisms in each of these categories is provided in Figure 1. The figure also highlights the set of enhancements that are being pursued by MPLS-TP. The protocol and mechanisms highlighted in blue are being added to the MPLS/GMPLS protocol suite as part of the MPLS-TP effort. In Figure 1, the protocols and mechanisms highlighted in red might not be needed for the transport networks and are, therefore, being made optional. Note that these mechanisms will remain as part of the MPLS/GMPLS protocol suite. It is IETF's guidance to vendors that these mechanisms do not need to be supported on the platforms that are being targeted towards transport networks.

Advantages of CPAN Technology:-

- Efficient bandwidth utilization, sharing bandwidth between services
- Includes the benefits of RPR.
- SDH packet switching based on statistical multiplexing.
- Path protection & recovery within 50 ms for any topology-Ring, Linear
- Support for TDM interfaces(E1,STM-1) & Multiservice traffic
- Both UNI & NNI interface upto max 100G capacity
- Access to last mile connectivity bandwidth upto 100G capacity.

- bandwidth scalability -from 6G,40G to 100G
- OAM & Performance Monitoring-Proactive & Reactive
 - Resiliency-1:1,1+1;Linear & Ring.
 - GUI EMS provisioning.

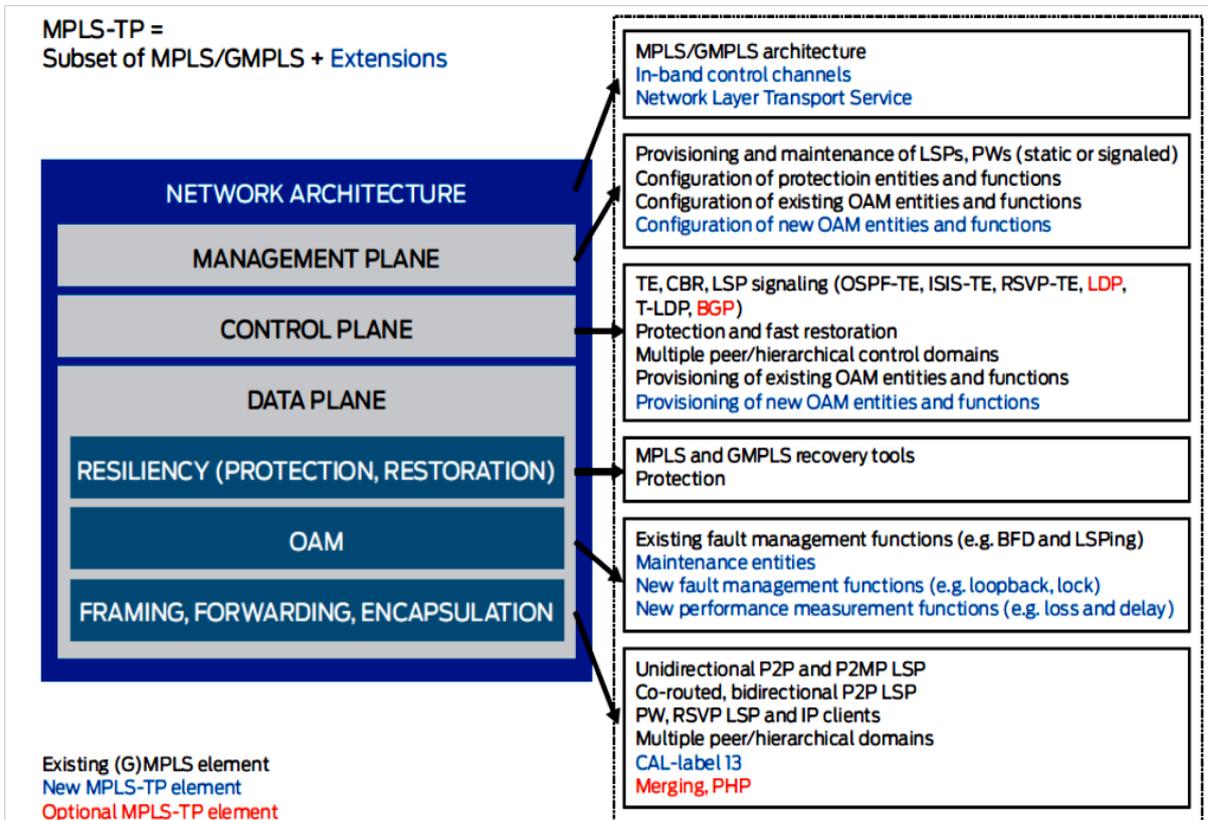


Fig:1 Components of MPLS and MPLS-TP

3.7 APPLICABILITY AND DEPLOYMENT OPTIONS FOR CPAN

MPLS-TP enhancements are primarily applicable to the access and aggregation networks, where the majority of the migration from circuit-switched networks to packet-based networks is currently occurring, and where higher scale and lower cost is required. Juniper believes that the OAM enhancements to the MPLS protocol suite, however, will be extremely valuable to all MPLS networks, especially in the MPLS-based core networks. These OAM enhancements will allow service providers to have better visibility into their existing MPLS-based core networks, which will allow further optimization. The new OAM capabilities will also help the wholesale business by improving the tools required to measure and enforce strict SLAs. Juniper, therefore, is prioritizing the implementation of these OAM enhancements, such as the enhancements to BFD and LSP ping. Figure 2 illustrates how IP/MPLS and MPLS-TP can be deployed together and are very complementary in nature.

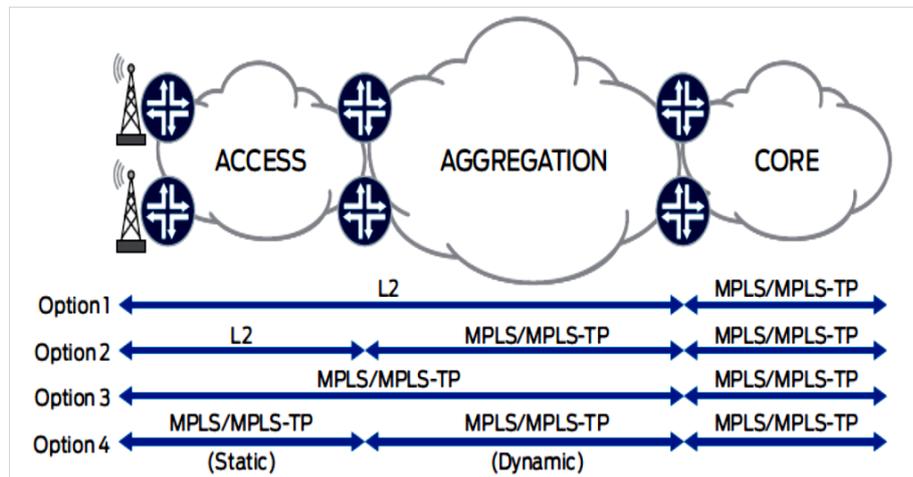


Fig:2 MPLS and MPLS-TP Deployment Options

3.8 BSNL NETWORK EVOLUTION:

It is seen that BSNL requires immediate introduction of Packet Transport Network in order to provide reliable connectivity to the additional network elements and to meet the exponential growth in IP traffic. MPLS-TP enabled nodes with different configurations (as per the network requirement) maybe planned for transportation requirements in place of STM-1,16,64 MADMs etc. where ever transport of packets is required. There is provision of carrying STM1 and E1 also in such devices.

3.8.1 FEATURES:-

- As these equipments are going to be used in place of SDH/TDM devices , which will be capable of servicing both TDM as well as packet (FE,GE etc.) clients, we need to have functionality similar to them and at the same time inefficiency of utilization of available bandwidth is to be minimized Hence for the user it should look like a SDH equipment. OAM (operation administration and maintenance) like SDH are available in these equipment. Some of them are:-
 - Point to point circuits can be provisioned.
 - The devices can be connected in ring /mesh.
 - End to end monitoring of each circuit is possible.
 - Protection 1 : 1(PW) or even 1 :n(LSP) can be provisioned.
 - It can transport synchronization information.
- As switching in these devices are packet based ,it has features of packet based devices also. Some of these are:-
 - Point to multipoint or multipoint to multipoint circuits can be created.
 - Services can be provisioned at L1 or L2 layer.
 - QoS can be defined for individual customers.

3.8.2 PROPOSED CONFIGURATION OF NODES:-

Type-A1: (DC Powered Type)

Uplink		1GE	(optical)	-	2
Downlink		FE-4			
		FX-4			
		GE-2(Electrical)			
		STM1-2			
		E1-8			
Cross Connect Capacity	-	Minimum 5Gbps			

Type-A2: (AC Powered Type)

Uplink	-	1GE (optical)	- 2
Downlink	-	FE-4	
		FX-4	
		GE-2(Electrical)	
		STM1-2	
		E1-8	
Cross Connect Capacity	-	Minimum 5Gbps	

Type-B1:

Uplink	-	10 GE(optical)- 2
Downlink	-	1GE-16 (8Electrical+8 optical)
		FE -16
		FX -16
		STM1 -8
		E1 -64
Cross Connect Capacity	-	40 Gbps

Type-B2:

Uplink		10GE	(optical)	-	2
Downlink		10GE (optical)	- 2		
		GE-32(16 Electrical + 16 Optical)			
		FE-16			
		FX-16			
		STM1-8			
		E1-64			
Cross connect capacity	-	80 Gbps			

Type C:

Uplink		40 GE(optical)-2
Downlink		10GE(optical)-12
		FE/GE—64(32 optical + 32 electrical)
		(10/100/1000)
		STM 1-8
		E1-64
Cross connect capacity	-	240 Gbps
		(Uplink- Line side,Downlink-Traffic side)

3.8.3 DISTANCE BETWEEN TWO NODES:-

Type A1/A2	-	30 Km.
Type B1/B2	-	50 Km.
Type C	-	50 Km.

3.8.4 POWER SUPPLY:-

Type A1 /A2- AC Type or DC Type.
Type B1 /B2- DC Type.
Type C- DC Type.

3.9 TYPICAL NETWORK TOPOLOGY FOR MPLS-TP NODES

- Co-located network elements connected directly while the traffic between non co-located ones is transported through packet transport network.
- Nodes to comply to the MPLS TP standards for OAM, Protection, Architecture, Synchronization etc.
- There will be minimum TDM interface and the existing infrastructure of SDH/DWDM will cater to the existing TDM traffic of BSNL where ever possible.
- Lower type nodes can be directly terminated on the interfaces of the higher level nodes i.e. 1 GE Uplink of Type-A node can be terminated on the 1 GE interface of Type-B nodes similarly 10GE Uplinks of Type-B node can be terminated on 10GE interface of Type-C nodes.
- Type-A,B& C shall have control card, switching fabric and power supply redundancy while Type-A will have only power supply redundancy.
- Exchange of traffic with MPLS will be through PE Routers on UNI interface at multiple points of connectivity.

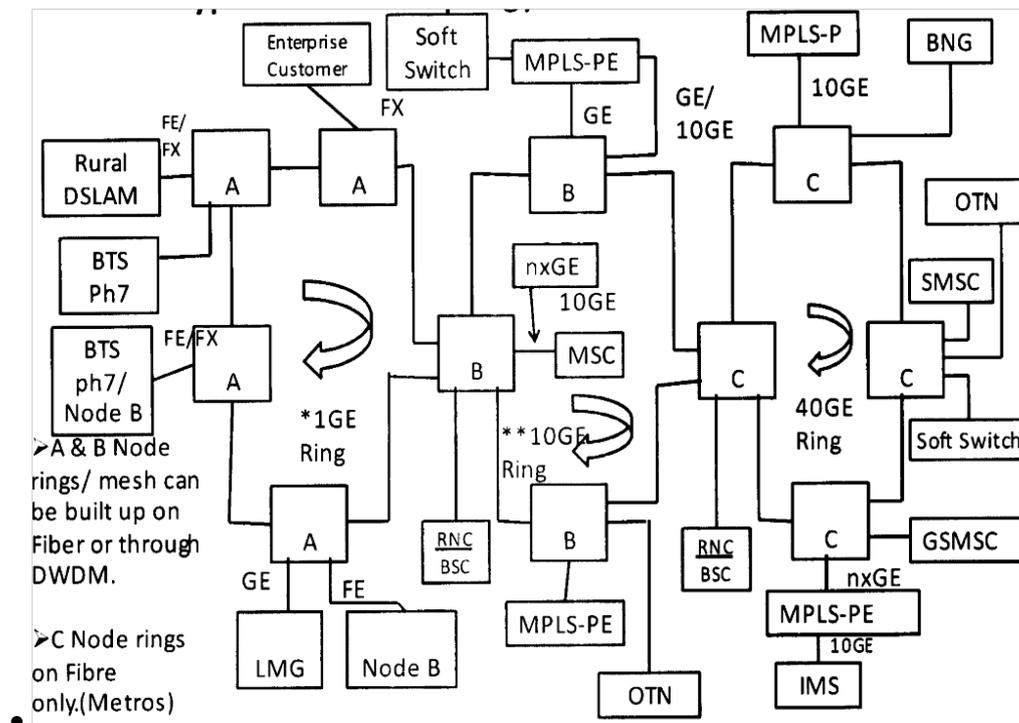


Fig:3 Typical Network Topology for MPLS-TP Nodes

The planned A,B & C Nodes will perform the function of transport & aggregation of traffic from all access points such as HTS, Node Bs, RNCs, MSCs, MPLS-PE Routers, FTTH OLTs, DSLAMs etc. All the traffic aggregation in major cities with high traffic between POPS located within same city will be served by Type C nodes. Thus the functions presently being done by STM-I CPE, STM-1 ADM, STM-16 MADM and STM-64 will be done by MPLS-TP enabled packet transport nodes with configurations as shown above for all the future packet transport requirements. Number of nodes in a ring will depend on the amount of client traffic at each node.

Type A nodes can be very effectively used to replace present CPEs. Normally it will be used to give connectivity to standalone small capacity nodes like BTSs, consumers demanding higher BW, small capacity DSLAMs etc. In such cases they can be used in linear mode also.

3.10 CONCLUSION

MPLS-TP is a set of enhancements to the already rich MPLS protocol suite. The current MPLS suite has successfully served packet-based networks for more than a decade. The MPLS-TP enhancements will increase the scope of MPLS overall, allowing it to serve both the transport and the services networks.

The biggest and most important enhancements that are being developed under the MPLS-TP effort are OAM related (e.g., fault management and performance monitoring). These OAM enhancements will prove to be very valuable for the existing MPLS networks, as they will allow operators to improve the efficiency and effectiveness of their networks by enabling full end-to-end integration with the existing and the next-generation MPLS networks.

4. FREE SPACE OPTICS

4.1 LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- Concept of FSO
- Advantages of FSO
- Application areas of FSO
- Limitation of Free Space Optical Communication

4.2 INTRODUCTION

Free Space Optics (FSO) communication technology can be deployed in many enterprise applications including building-to-building connectivity, disaster recovery, mobile carrier backhaul, network redundancy and temporary connectivity for applications such as data, voice and data, video services, fixed-line carrier bypass etc. The technology does not require any spectrum licensing and protocol-independent so will happily carry Ethernet, SDH, ATM signals etc. FSO technology delivers cost-effective optical wireless connectivity and a faster return on investment (ROI) for Service providers. ITU-T is also going to publish the first ITU-T Recommendation in the area of free-space optics.

Communications using light is not a new technology. Historically, the first Free Space Optics (FSO) or optical wireless communications occurred more than 120 years ago and was demonstrated by Alexander Graham Bell with his "Photophone" (prior to his demonstration of the telephone!). Bell's "Photophone" was used for voice communications only by converting voice sounds into telephone signals and transmitted them between receivers through free space along a beam of light for a distance of some 600 feet.

4.3 WHAT IS FSO?

Free-space optics (FSO), also called free-space photonics (FSP), is a line-of-sight (LOS) technology that transmits a modulated beam of visible or infrared light through the atmosphere. Like fiber, Free Space Optics (FSO) uses lasers to transmit data, but instead of enclosing the data stream in a glass fiber, it is transmitted through the space and can function over distances of several kilometers. As long as there is a clear line of sight between the source and the destination, and enough transmitter power, Free Space Optics (FSO) communication is possible. Free Space Optics (FSO) works on the same basic principle as Infrared television remote controls. Free Space Optics (FSO) is protocol independent and transmits any higher-layer protocol including Ethernet, SDH, ATM and TCP/IP.

Free space optical communications offer data rates comparable to fiber optical communications at a fraction of the deployment cost while extremely narrow laser beam widths provide no limit to the number of free space optical links that may be installed in a given location. Commercially available systems offer capacities in the range of 100 Mbps to 10 Gbps, and demonstration systems report data rates as high as 160 Gbps.

4.4 HOW FSO WORKS?

FSO systems comprise paired transmitter and receiver and working in the full duplex mode as shown in Fig. 1. At transmitter Network traffic is converted in to pulses of infrared light representing 1's and 0's. Transmitter projects the carefully aimed light pulses into air. A receiver at the other end of the link collects the light on a receiving lens connected to a high sensitivity receiver through an optical fiber. Received signal are converted back in to fibre and connected to the network. Reverse direction data is transported in the same way.

The transmitted light beam is not perfectly collimated (i.e., parallel). Rather, it naturally spreads out from the transmitting terminal at a divergence angle and may well be several meters wide by the time it reaches the receiving terminal as shown in Fig. 1. Therefore, only a small amount of the transmitted light signal strikes the receive aperture, with the balance of the signal being wasted.

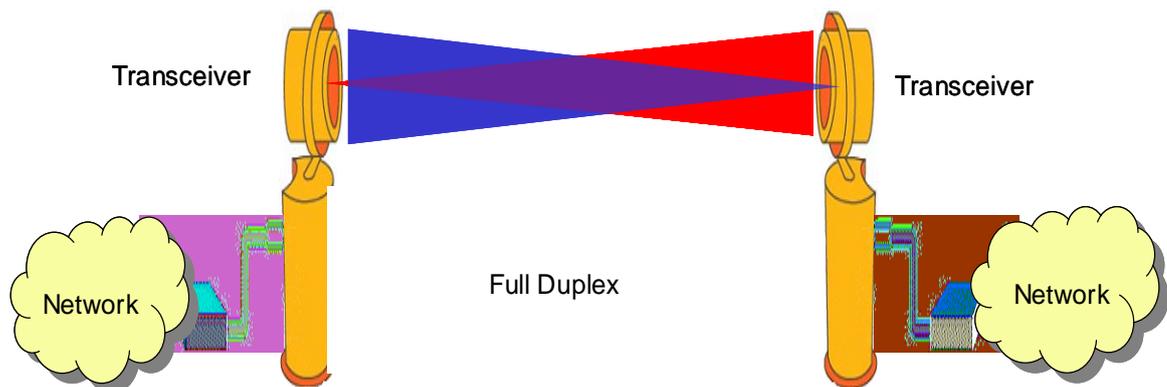


Fig:1 Principle of Working of FSO

4.5 OPERATING WAVELENGTH FOR FSO

FSO networks are based on either 780-nm to 850-nm or 1,550-nm laser wavelength systems, which have very different power and distance characteristics. Lasers of much higher power can safely be used with 1,550-nm systems than with 780-to-850-nm systems. This is because wavelengths less than about 1,400 nm are focused by the cornea into a concentrated spot falling on the retina, which can cause damage to eyes while 1550-nm systems are less likely to cause damage to the eye, even at much higher power levels.

4.6 WHY FSO COMMUNICATION?

Only very few percentage of commercial buildings in our country have fiber optics to their door, although most are within a mile of a fiber-optic connection. This "last mile" is proving to be a major bottleneck to expanding broadband and other high bit rate services to many potential customers. Free-space optics (FSO) systems could be a viable option for many applications as well as supplement to the fiber optic connectivity. They can be installed along any line of sight up to a little more than a mile. While bandwidth is available on most metro fiber rings, carriers often can't justify laying fiber to each and every building in an area, which can limit revenue potential, and frustrate business customers. FSO technology allow service providers

to increase their fiber ring revenue base by installing lateral links to off-net buildings, responding quickly and cost efficiently to the need of any customer.

The technology is protocol-independent. Transceivers can be located on a rooftop, on a corner of a building or indoors behind a window. The range for optical wireless systems varies depending upon local weather conditions. FSO operates in an unregulated section of the spectrum, so no spectrum licenses are required. Because there's no need to dig trenches to lay cable, so the deployment is very fast.

The business advantages of FSO technology for network extensions include deployments at an average of one-fifth the cost of fiber-optic cable and in one-tenth the time. Optical wireless systems are a flexible investment that can be re-deployed to meet changing customer needs.

4.7 NETWORK ARCHITECTURE OF FSO

A common configuration involves a central hub, or node, positioned on the roof of a high-rise building with good lockdown for achieving line-of-sight to buildings of lesser stature within the coverage area. The hub building can be connected to the service provider's backbone via FSO or point-to-point microwave. Transceivers can be located on a rooftop, on a corner of a building or indoors behind a window.

More commonly the hub building is a node of the backbone fiber optic network as shown in Fig. 2. The buildings served by the high-speed FSO links may be single user or multi-user and even mixed use in nature. Within the building, the bandwidth can be subdivided to serve individual users or user groups. BTS can also be connected through the FSO link to the hub building. The network can even assume a mesh or partial mesh configuration, perhaps in consideration of redundancy and media diversity, which yields considerably enhanced network resiliency.

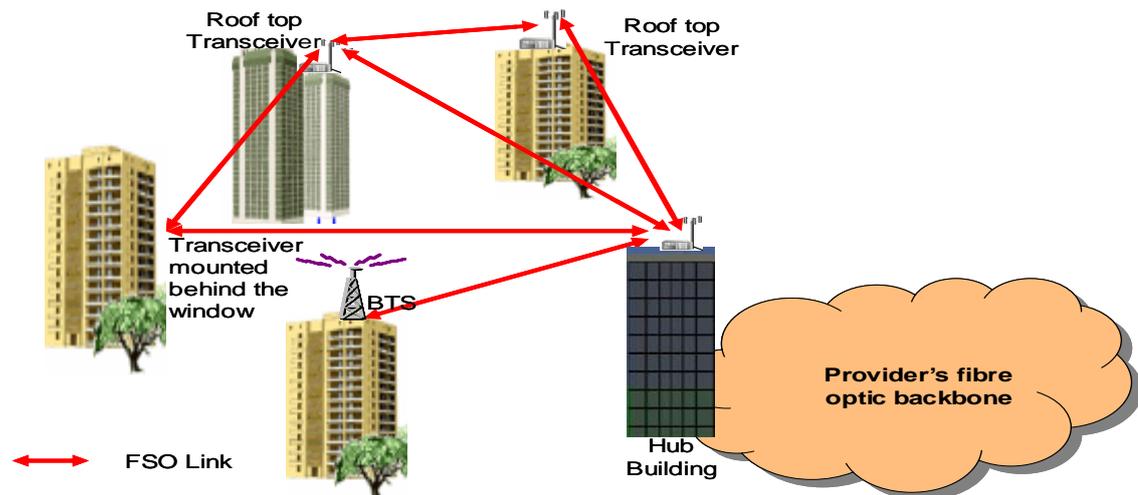


Fig:2 FSO Configuration

4.8 TECHNOLOGICAL ADVANTAGES OF FSO

FSO and fiber are the two optical technologies today that deliver high-speed optical bandwidth to meet market needs. The FSO offers several technological advantages.

- Because of cost-effective and high-bandwidth qualities, FSO technology is an alternative transport technology to interconnect high capacity networking segments.
- **Free Space Optics (FSO) is protocol independent and transmits any higher-layer protocol including Ethernet, SDH, ATM and TCP/IP**
- Use of infrared light for communication means no interference issues.
- FSO is unaffected by EMI (Electro-Magnetic Interference). This is a great advantage when compared with RF systems, which definitely suffer from EMI.
- Data rates comparable to optical fiber transmission can be carried by Free Space Optics (FSO) systems with very low error rates, while the extremely narrow laser beam widths ensure that there is almost no practical limit to the number of separate Free Space Optics (FSO) links that can be installed in a given location.
- Can transmit at distances around 4 km (almost 2 and one half miles).
- FSO technology and fiber can utilize the same system components such as lasers, receivers and amplifiers.
- FSO technology can transmit digital information using a range of protocols.
- Since Free Space Optics (FSO) transceivers can transmit and receive through glass windows, it is possible to mount Free Space Optics (FSO) systems inside buildings, reducing the need to compete for roof space, simplifying wiring and cabling, and permitting Free Space Optics (FSO) equipment to operate in a very favorable environment.
- Free Space Optics (FSO) technology is highly **secured** as the laser beams generated by Free Space Optics (FSO) systems are narrow and invisible, making them harder to find and even harder to intercept and crack as well as data can be transmitted over an encrypted connection adding to the degree of security available in Free Space Optics (FSO) network transmissions.
- Highly reliable, some manufacturers claiming 99.999% availability.
- Because there's no need to dig trenches to lay cable, the permits associated with digging up streets, disrupting traffic and the like also are eliminated, and installation normally is complete in a few days.
- FSO systems can be deployed in a wide variety of network architecture applications, including point-to-point, ring architecture and mesh systems. They can be installed roof to roof, window to window or window to roof.

4.9 APPLICATIONS OF FSO

As a transmission technology, FSO systems are agnostic when it comes to the underlying applications supported. Voice, fax, data, video, image and even multimedia all can ride over the system. FSO systems can effectively be used in short-haul, bandwidth-intensive applications where cabled systems either are not available or are too costly.

FSO technology can be used for different type of applications:

- Interconnect high-speed LAN segments
- Metro network extension
- Fiber backup
- Enterprise connectivity
- Building to building computer data links; supporting very high data rates.
- In local loop applications as an alternative to RF-based systems to extend the reach of optical fiber.
- Ship to ship communications; high data rates with complete security.
- Disaster recovery applications, and for temporary connectivity
- Campus wide computer networks
- Inter-office data links etc.

4.10 LIMITATION OF FREE SPACE OPTICAL COMMUNICATION

The fundamental limitation of free space optical communications arises from the environment through which it propagates. Although relatively unaffected by rain and snow, free space optical communication systems can be severely affected by fog and other environmental factor as shown in Fig 3. The main design challenges in free space optical communications are as follows:

1. Fog

Fog is vapor composed of water droplets, which are only a few hundred microns in diameter but can modify light characteristics or completely hinder the passage of light through a combination of absorption, scattering, and reflection which causes a decrease in the power density of the transmitted beam and hence decreasing the effective distance of a free space optical link.

2. Physical Obstruction

Since light can't penetrate trees, hills or buildings or any physical obstruction. As the clear Line-of-sight is an absolute requirement between the light transmitter and the receiver for FSO so any physical obstruction will completely absorb, deflect, reflect and otherwise render the signal useless.

3. Scintillation

Scintillation is the variation in light intensity caused by atmospheric turbulence. Such turbulence is caused by temperature gradients that create air pockets of varying temperature, density, and index of refraction. These air pockets act like lenses with time-varying properties and can lead to sharp increases in the bit-error-rates of free space optical communication systems but not complete outage, particularly in the presence of direct sunlight.

4. Beam Wander

Beam wander arises when turbulent wind current (eddies) larger than the diameter of the transmitted optical beam cause a slow, but significant, displacement of the transmitted beam. Beam wander may also be the result of seismic activity that causes a relative displacement between the position of the transmitting laser and the receiving photo-detector.

5. Low Clouds

The effect is very much similar to fog and may accompany rain and snow.

6. Rain

Relatively unaffected by rain as drop sizes of water larger than fog and wavelength of light but extremely heavy rain (can't see through it) can take a link down. (Severe rain may have up to 100 dB/km attenuation)

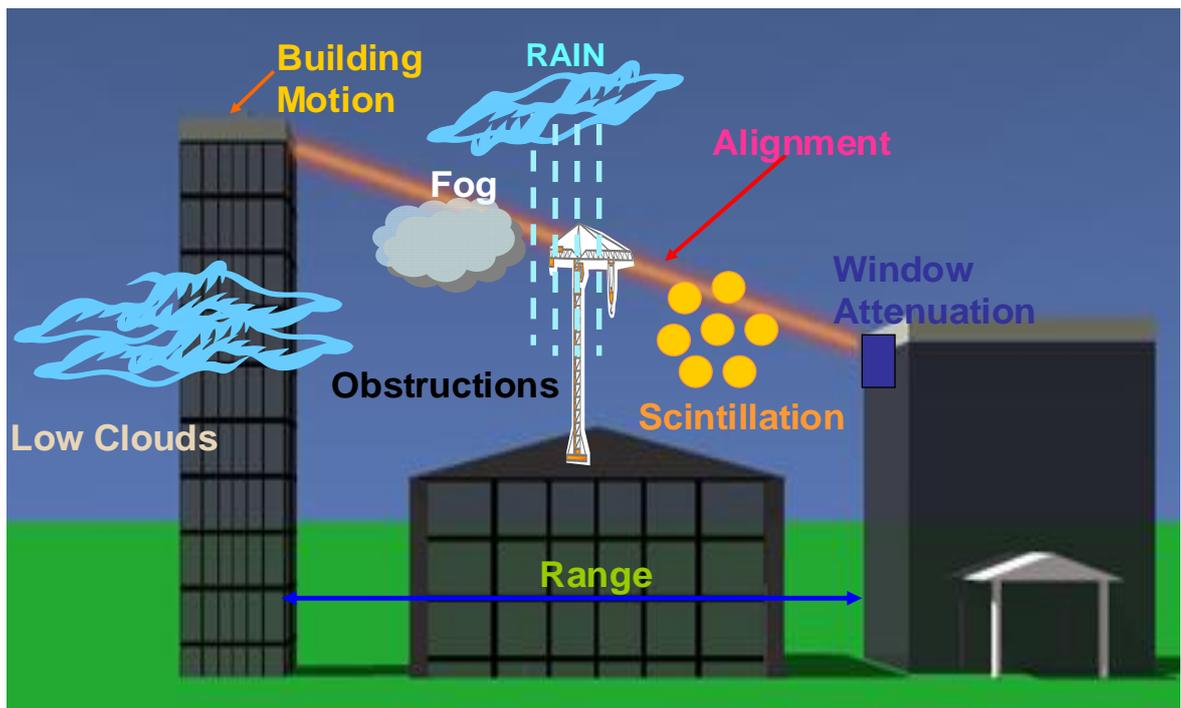


Fig:3 Environmental factors

7. Heavy Snow

A heavy ice build-up on windows may cause a link failure.

8. Building movement

Movement of the building due to thermal expansion, wind, and vibration can affect a FSO transceiver's alignment and interrupt communication.

Each of these factors can "attenuate" (reduce) the signal. However, there are ways to mitigate each environmental factor.

4.11 ITU-T DEVELOPMENT IN FSO

ITU-T will publish the first ITU-T Recommendation in the area of free-space optics. FSO is an area dominated by proprietary solutions, the new Rec. means that users of FSO systems will be able to co-locate FSO solutions provided by different manufacturers for the first time. FSO systems use lasers or LEDs to transmit data between two points with line of sight up to 2 km. Typically this means between the top of buildings. Data rates of up to 1.25 Gbps are available

As well as use in fixed settings like between tall office buildings, FSO systems have proven useful in disaster relief where telecoms infrastructure has been damaged and a quick fix is necessary. Equally FSO systems are used where there is no existing infrastructure as a way of avoiding disruptive and expensive cable laying. **They are spectrum license free and protocol independent so will happily carry Ethernet, SDH signals etc.**

The ITU-T Rec. G.640 will allow the co-location of FSO systems without interference with each other.

4.12 CONCLUSION

Free-space optical networking provides easy, fast deployment and lower link costs for service providers spell better service to homes and businesses. Many of the benefits are experienced through better, faster, more ubiquitous service. Free-space optical networking provides freedom from licensing requirements and government regulations, freedom from digging restrictions and freedom from waiting for fiber. Indeed, waiting for bandwidth can become a thing of the past as the path with the advent of FSO systems.

5. IP ADDRESSING AND ROUTER CONFIGURATION

5.1 LEARNING OBJECTIVE

The objectives of this chapter is

- To understand the concept of router configuration fundamentals.
- To understand concept of different types of router configuration and modes of routers
- To understand the concept of static, dynamic and default routing.

5.2 INTRODUCTION

Each host on the internet is assigned a 32-bit integer address called its internet address or IP address. The clever part of internet addressing is that the integers are carefully chosen to make routing efficient. Every host and router on the internet has an IP address, which encodes its network number and host number. The combination is unique: no two machines have the same IP address. The address is coded to allow a variable allocation of bits to specify network and host.

The IP address scheme is to break up the binary number into pieces and represent each piece as a decimal number. A natural size for binary pieces is 8bits, which is the familiar byte or octet (octet is the telecommunication term, but two words can be used interchangeably). So let's take our binary number, write it using groups of 8 bits, and then represent each group as a decimal number:

Example1:140.179.220.200

It is sometimes useful to view the values in their binary form.140.179.220.200

10001100.10110011.11011100.11001000

Every IP address consists of two parts, one identifying the network and one identifying the host. The Class of the address and the subnet mask determine which part belongs to the network address and which part belongs to the host address.

10111100 00011010 00011110 00111100

156 26 30 60

We can use a dot as a separator. Now our IP address has the form

Example2:156.26.30.60

This is referred to as the dotted decimal notation.

5.2.1 IP Address should be hierarchical

For a protocol to be routable, its address structure must be hierarchical, meaning that the address must contain at least two parts: the network portion and the host portion. A host is an end station such as a computer workstation, a router or a printer, whereas a network consists of one or more hosts.

5.2.2 Address Classes

This encoding provides flexibility in assigning addresses to host and allows a mix of network sizes on an internet. In particular, the three network classes are best suited to the following conditions:

The Following table shows the capabilities for classA, B and C addresses.

Class	Networks	Hosts
A	126	16,777,214
B	16,384	65,534
C	2,097,152	254

- Class D: Reserved for IP Multicasting.
- Class E: Reserved for future use. Addresses beginning with 1111 are reserved for future use.

5.2.3 Private Subnets

There are three IP network addresses reserved for private networks. The addresses are:

- **10.0.0.0/8,**
- **172.16.0.0/12,and**
- **192.168.0.0/16.**

They can be used by anyone setting up internal IPnetworks,such as a labor home.

5.2.4 Sub netting

Sub netting an IP Network can be done for a variety of reasons, including organization, use of different physical media (such as Ethernet, FDDI, WAN, etc.), preservation of address space, and security. The most common reason is to control network traffic.

5.2.5 Subnet Masking

Applying a subnet mask to an IP address allows you to identify the network and host parts of the address. The network bits are represented by the 1s in the mask, and the hostbitsarerepresentedbythe0s.

Performing a bitwise logical AND operation between the IP address and the subnet mask results in the Network Address or Number.

For example, using our test IP address and the default Class B sub netmask, we get:

```

10001100.10110011.11110000.11001000      140.179.240.200 Class B IP Address
11111111.11111111.00000000.00000000      255.255.0.0Default Class B S/N Mask
10001100.10110011.00000000.00000000      140.179.0.0 Network Address

```

5.2.6 Default Subnet masks:

- **Class A -255.0.0.0-11111111.00000000.00000000.00000000**
- **Class B-255.255.0.0-11111111.11111111.00000000.00000000**
- **ClassC -255.255.255.0-11111111.11111111.11111111.00000000**

5.2.7 Super netting:

The "classful" system of allocating IP addresses can be very wasteful; anyone who could reasonably show a need for more than 254 host addresses was given a Class B address block of 65533 host addresses. Even more wasteful were companies and organizations that were allocated Class A address blocks, which contain over 16 Million host addresses! Only a tiny percentage of the allocated Class A and Class B address space has ever been actually assigned to a host computer on the Internet.

Under super netting, the classful subnet masks are extended so that a network address and subnet mask could, for example, specify multiple Class C subnets with one address. For example, If I needed about 1000 addresses; I could supernet 4 ClassC networks together:

192.60.128.0	(11000000.00111100.10000000.00000000)Class C subnetaddress
192.60.129.0	(11000000.00111100.10000001.00000000)Class C subnetaddress
192.60.130.0	(11000000.00111100.10000010.00000000)Class C subnetaddress
192.60.131.0	(11000000.00111100.10000011.00000000)Class C subnetaddress

 192.60.128.0(11000000.00111100.10000000.00000000) Superneted address

255.255.252.0(11111111.11111111.11111100.00000000) Subnet Mask

192.60.131.255(11000000.00111100.10000011.11111111) Broadcast address

In this example, the subnet 192.60.128.0 includes all the addresses from 192.60.128.0 to 192.60.131.255. As you can see in the binary representation of the subnet mask, the network portion of the address is 22 bits long, and the host portion is 10 bits long.

Instead of spelling out the bits of the subnet mask, it is simply listed as the number of 1s bits that start the mask. In the above example, instead of writing the address and subnet mask as 192.60.128.0, Subnet Mask 255.255.252.0 the network address would be written simply as: 192.60.128.0/22 which indicates starting address of the network, and number of 1s bits (22) in the network portion of the address. If you look at the subnet mask in binary (11111111.11111111.11111100.00000000), you can easily see how this notation works.

5.3 ROUTER CONFIGURATION

A hardware device designed to take incoming packets, analyzing the packets and then directing them to the appropriate locations, moving the packets to another network, converting the packets to be moved across a different network interface, dropping the packets, or performing any other number of other actions. In the picture to the right, is a Linksys BEFSR11 router and it shows, most home routers look like.

A **router** has a lot more capabilities than other network devices such as a hub or a switch that are only able to perform basic network functions. For example, a hub is often used to transfer data between computers or network devices, but does not analyze or do anything with the data it is transferring. Routers however can analyze the data being sent over a network, change how it is packaged and send it to another

network or over a different network. For example, routers are commonly used in home networks to share a single Internet connection with multiple computers.

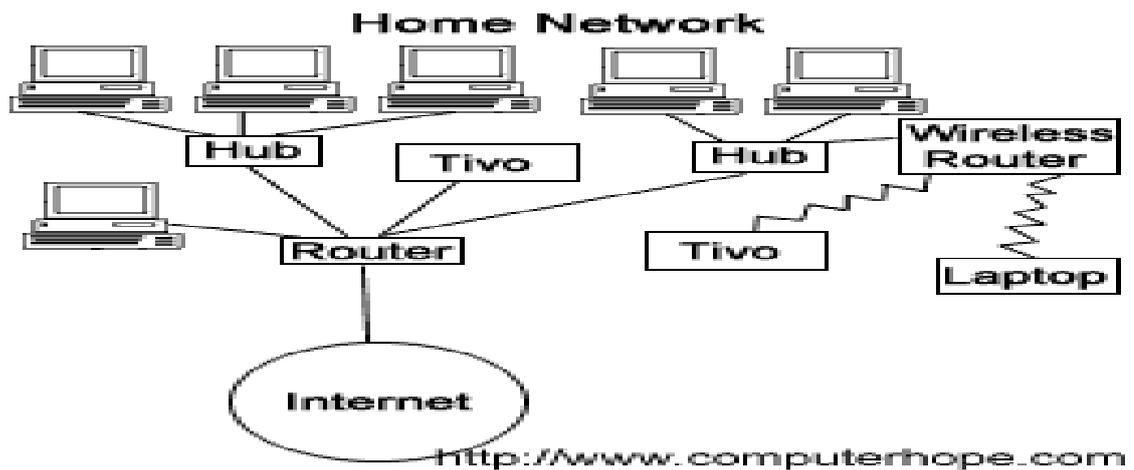


Fig:1

In the above example of a home network there are two different examples of a router, the router and the wireless router. As can be seen in the example the router is what allows all the computers and other network devices access the Internet. Below are some additional examples of different types of routers used in a large network

B router

Short for Bridge Router, a "b router" is a networking device that serves as both a bridge and a router.

Core router

A core router is a router in a computer network that routes data within a network but not between networks.

Edge router

An edge Router is a router in a computer network that routes data between one or more networks.

Cisco IOS Modes of Operation

The Cisco IOS software provides access to several different command modes. Each command mode provides a different group of related commands.

User EXEC Mode:

When you are connected to the router, you are started in user EXEC mode. The user EXEC commands are subset of the privileged EXEC commands.

Privileged EXEC Mode:

Privileged commands include the following:

Configure –Changes the software configuration.

Debug –Display process and hardware event messages.

Setup – Enter configuration information at the prompts.

Enter the command `disable` to exit from the privileged EXEC mode and return to user EXEC mode.

Configuration Mode

Configuration mode has a set of sub modes that you use for modifying interface settings, routing protocol settings, line settings, and so forth. Use caution with configuration mode because all changes you enter take effect immediately.

To enter configuration mode, enter the command `configure terminal` and exit by pressing `Ctrl-Z`.

Getting Help

In any command mode, you can get a list of available commands by entering a question mark (?).

```
Router> ?
```

To obtain a list of commands that begin with a particular character sequence, type in those characters followed immediately by the question mark (?).

```
Router# co?
```

```
Configure connect copy
```

To list keywords or arguments, enter a questionmark in place of a keyword or argument. Include a space before the questionmark.

```
Router# configure?
```

```
Memory Configure from NV memory Network Configure from a TFTP network host  
Terminal Configure from the terminal
```

You can also abbreviate commands and keywords by entering just enough characters to make the command unique from other commands. For example, you can abbreviate the show command to `sh`.

Configuration Files

Any time make changes to the router configuration must save the changes to memory because if do not they will be lost if there is a system reload or power outage. There are two types of configuration files: the running (current operating) configuration and the startup configuration.

Use the following privileged mode commands to work with configuration files.

`Setup` – Enter configuration information at the prompts.

Enter the command `disable` to exit from the privileged EXEC mode and return to user EXEC mode.

- `Configure terminal` – modify the running configuration manually from the terminal.
- `Show running-config` – display the running configuration.
- `Show startup-config` – display the startup configuration.
 - `Copy running-config startup-config` – copy the running configuration to the startup configuration.

- Copy startup-config running-config – copy the startup configuration to the running configuration.
- Erase startup-config – erase the startup-configuration in NVRAM.
- Copy tftp running-config – load a configuration file stored on a Trivial File Transfer Protocol (TFTP) server into the running configuration.

Copy running-config tftp –store the running configuration on a TFTP server.

5.4 IPADDRESSCONFIGURATION

Take the following steps to configure the IP address of an interface.

Step 1: Enter privileged EXEC mode:

```
Router>enable password
```

Step2:Enter the configure terminal command to enter global configuration mode.

```
Router#config terminal
```

Step 3: Enter the interface type slot/port (for Cisco 7000 series) or interface type port (for Cisco2500 series) to enter the interface configuration mode.

Example:

```
Router(config)#interfaceEthernet0/1
```

Step4:Enter the IP address and subnetmask of the interface using the ip address ip address subnet mask command.

Example,

```
Router (config-if)#ip address 192.168.10.1 255.255.255.0
Step 5: Exit the configuration mode by pressing Ctrl-Z
Router(config-if)#[Ctrl-Z
```

Configuration mode has a set of submodes that you use for modifying interface settings, routing protocol settings, line settings, and so forth. Use caution with configuration mode because all changes you enter take effect immediately.

To enter configuration mode, enter the command **configure terminal** and exit by pressing **Ctrl-Z**.

Note:

Almost every configuration command also has a no form. In general, use the no form to disable a feature or function. Use the command without the keyword no to re-enable a disabled feature or to enable a feature that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, enter the no IP routing command and enter IP Re routing to re-enable it.

NLabModule:1(Preliminary Configuration)

5.4.1 Preliminary configuration

User Access Verification

```
Password: xxxxxP-1>en
Password:xxxxxP-1#conf
```

```
P-1(config)#interface Loopback0
```

```

P-1(config-if)#description**P-1'sLoopback0Interface**P-1(config-
if)#ipaddress192.168.0.254255.255.255.255
P-1(config-if)# no shutdownP-1(config-if)# exit
P-1(config)#interfaceGigabitEthernet2/1
P-1(config-if)#description**P-1-PE-1GigElink**
P-1(config-if)# ip address 172.16.16.17 255.255.255.252P-1(config-if)#noshutdown
P-1(config-if)#exit
P-1(config)#interfacePOS3/1
P-1(config-if)#description**P-1-P-3STM-1link**
P-1(config-if)# ip address 172.16.16.14 255.255.255.252P-1(config-
if)#encapsulationppp
P-1(config-if)# clock source internalP-1(config-if)# noshutdown
P-1(config-if)#exit
P-1(config)#interfacePOS3/2
P-1(config-if)# description ** P-1-P-2 STM-1 link **P-1(config-if)# ip address
172.16.16.1 255.255.255.252P-1(config-if)#encapsulationppp
P-1(config-if)# no shutdownP-1(config-if)#end
P-1#writememoryBuilding configuration...[OK]
P-1#

```

5.4.2 PE-1Preliminaryconfiguration

User Access Verification

Password:

PE-1>en

Password:

PE-1#conf

```

PE-1(config)#interface Loopback0
PE-1(config-if)#description**PE-1'sLoopback0Interface**PE-1(config-if)#ip
address192.168.1.254255.255.255.255
PE-1(config-if)# no shutdownPE-1(config-if)# exit
PE-1(config)#interfaceGigabitEthernet2/1
PE-1(config-if)#description**PE-1-P-1GigElink**
PE-1(config-if)# ip address 172.16.16.18 255.255.255.252PE-1(config-
if)#noshutdown
PE-1(config-if)#exitPE-1(config)# endPE-1#writememory
Building configuration...[OK]
PE-1#

```

5.5 Preliminary configuration

User Access Verification

Password: xxxxxP-2>enPassword:xxxxxP-2#conf

```
P-2(config)#interface Loopback0
P-2(config-if)#description**P-2'sLoopback0Interface**P-2(config-
if)#ipaddress192.168.2.254255.255.255.255
P-2(config-if)# no shutdownP-2(config-if)# exit
P-2(config)#interfaceGigabitEthernet2/1
P-2(config-if)#description**P-2-PE-2GigElink**
P-2(config-if)# ip address 172.16.16.21 255.255.255.252P-2(config-if)#noshutdown
P-2(config-if)#exit
P-2(config)#interfacePOS3/1
P-2(config-if)# description ** P-2-P-4 STM-1 link **P-2(config-if)# ip address
172.16.16.5 255.255.255.252P-2(config-if)#encapsulationppp
P-2(config-if)#noshutdown
P-2(config-if)#exit
P-2(config)#interfacePOS3/2
P-2(config-if)# description ** P-2-P-1 STM-1 link **P-2(config-if)# ip address
172.16.16.2 255.255.255.252P-2(config-if)#encapsulationppp
P-2(config-if)# clock source internalP-2(config-if)# noshutdown
P-2(config-if)#endP-2#writememory
Building configuration...[OK]
P-2#
```

5.5.1 PE-2Preliminaryconfiguration

User Access Verification Password:

PE-2>en

Password:

PE-2#conf

```
PE-2(config)#interface Loopback0
PE-2(config-if)#description**PE-2'sLoopback0Interface**
PE-2(config-if)# ip address 192.168.2.254 255.255.255.255PE-2(config-
if)#noshutdown
PE-2(config-if)#exit
PE-2(config)#interfaceGigabitEthernet2/1
```

```

PE-2(config-if)#description**PE-2-P-2GigElink**
PE-2(config-if)# ip address 172.16.16.22 255.255.255.252PE-2(config-
if)#noshutdown
PE-2(config-if)#exitPE-2(config)# endPE-2#writememory
Building configuration...[OK]
PE-2#

```

5.6 Preliminary configuration

User Access Verification

```

Password: xxxxxP-3>enPassword:xxxxxP-3#conf
t

```

```

P-3(config)#interface Loopback0
P-3(config-if)#description**P-3'sLoopback0Interface**P-3(config-
if)#ipaddress192.168.4.254255.255.255.255
P-3(config-if)# no shutdownP-3(config-if)# exit
P-3(config)#interfaceGigabitEthernet2/1
P-3(config-if)#description**P-3-PE-3GigElink**
P-3(config-if)# ip address 172.16.16.25 255.255.255.252P-3(config-if)#noshutdown
P-3(config-if)#exit
P-3(config)#interfacePOS3/1
P-3(config-if)#description**P-3-P-1STM-1link**
P-3(config-if)# ip address 172.16.16.13 255.255.255.252P-3(config-if)#encapsulation
ppp
P-3(config-if)# no shutdownP-3(config-if)# exit
P-3(config)#interfacePOS3/2
P-3(config-if)#description**P-3-P-4STM-1link**
P-3(config-if)# ip address 172.16.16.10 255.255.255.252P-3(config-
if)#encapsulationppp
P-3(config-if)# clock source internalP-3(config-if)# noshutdown
P-3(config-if)#endP-3#writememory
Building configuration...[OK]
P-3#

```

5.6.1 PE-3Preliminaryconfiguration

User Access Verification

```

Password:

```

```

PE-3>en

```

```

Password:

```

PE-3#conf

```

PE-3(config)#interface Loopback0
PE-3(config-if)#description**PE-2'sLoopback0Interface**PE-3(config-if)#ip
address192.168.5.254255.255.255.255
PE-3(config-if)# no shutdownPE-3(config-if)# exit
PE-3(config)#interfaceGigabitEthernet2/1
PE-3(config-if)#description**PE-2-P-2GigElink**
PE-3(config-if)# ip address 172.16.16.26 255.255.255.252PE-3(config-
if)#noshutdown
PE-3(config-if)#exitPE-3(config)# endPE-3#writememory
Building configuration...[OK]
PE-3#

```

5.7 Preliminaryconfiguration

UserAccessVerification

Password: xxxxxP-4>enPassword:xxxxxP-4#conf

```

P-4(config)#interface Loopback0
P-4(config-if)#description**P-4'sLoopback0Interface**P-4(config-
if)#ipaddress192.168.6.254255.255.255.255
P-4(config-if)# no shutdownP-4(config-if)# exit
P-4(config)#interfaceGigabitEthernet2/1
P-4(config-if)#description**P-4-PE-4GigElink**
P-4(config-if)# ip address 172.16.16.29 255.255.255.252P-4(config-if)#noshutdown
P-4(config-if)#exit
P-4(config)#interfacePOS3/1
P-4(config-if)# description ** P-4-P-2 STM-1 link **P-4(config-if)# ip address
172.16.16.6 255.255.255.252P-4(config-if)#encapsulationppp
P-4(config-if)# clock source internalP-4(config-if)# noshutdown
P-4(config-if)#exit
P-4(config)#interfacePOS3/2
P-4(config-if)# description ** P-4-P-3 STM-1 link **P-4(config-
if)#ipaddress172.16.16.9255.255.255.252
P-4(config-if)#encapsulationpppP-4(config-if)# noshutdown
P-4(config-if)#endP-4#writememory
Building configuration...[OK]
P-4#

```

5.7.1 PE-4 Preliminary configuration

User Access Verification

Password:

PE-4>en

Password:

PE-4#conf t

```
PE-4(config)#interface Loopback0
```

```
PE-4(config-if)#description **PE-4's Loopback0 Interface**
PE-4(config-if)#ip address 192.168.7.254 255.255.255.255
PE-4(config-if)#no shutdown
```

```
PE-4(config-if)#exit
```

```
PE-4(config)#interface GigabitEthernet2/1
```

```
PE-4(config-if)#description **PE-4-P-4 GigE link**
```

```
PE-4(config-if)#ip address 172.16.16.30 255.255.255.252
PE-4(config-if)#no shutdown
```

```
PE-4(config-if)#exit
PE-4(config)#end
PE-4#wr
```

Building configuration...[OK]

PE-4#

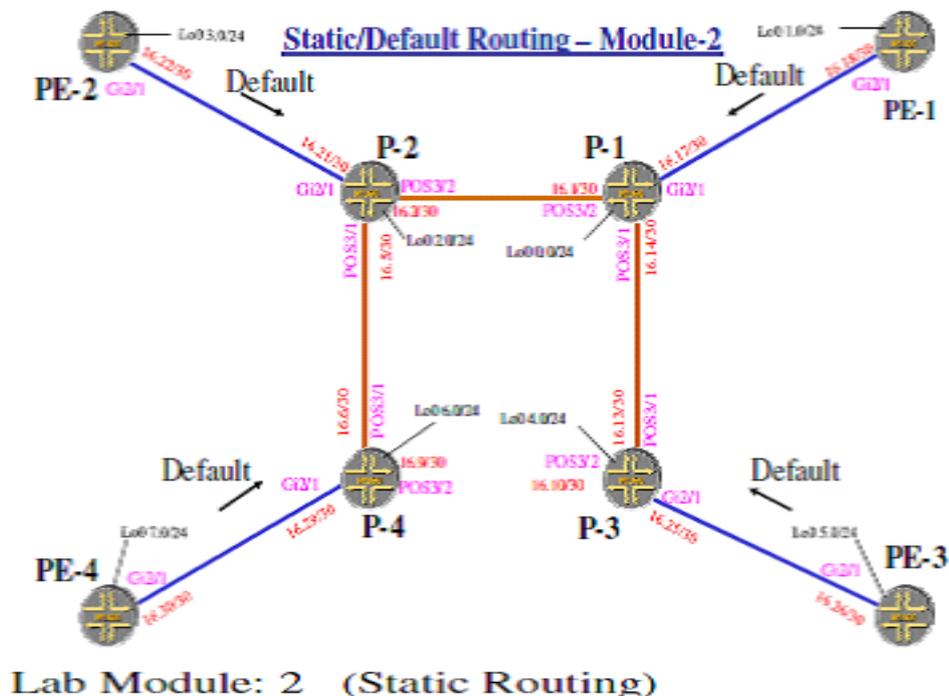


Fig:2

5.8 Configuration:-

Syntax:

P-1(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

P-1(config)#ip route192.168.4.0255.255.255.0POS3/1

5.8.1 PE-1Configuration:-

Syntax:

PE-1(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>

Eg:

PE-1(config)#iproute192.168.0.0255.255.255.0GigE2/1

5.9 Configuration:-

Syntax:

P-2(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>

Eg:

P-2(config)#ip route192.168.4.0255.255.255.0POS3/1

5.9.1 PE-2Configuration:-

Syntax:

PE-2(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

PE-2(config)#iproute192.168.0.0255.255.255.0GigE2/1

5.10 Configuration:-

Syntax:

P-3(Config)# iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

P-3(config)#ip route192.168.0.0255.255.255.0POS3/1

5.10.1PE-3Configuration:-

Syntax:

PE-3(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

PE-3(config)#iproute192.168.0.0255.255.255.0GigE2/1

+P-4Configuration:-

Syntax:

P-4(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

P-4(config)#ip route192.168.2.0255.255.255.0POS3/1

PE-4Configuration:-

Syntax:

PE-4(Config)#iproute<NWNNo.><SubnetMask><NextHopAdd. |Interfacename>Eg:

PE-4(config)#iproute192.168.0.0255.255.255.0GigE2/1

Commands:

• **Config :-**

P-1#conf t

P-1(config)#iproute192.168.1.0255.255.255.0gigabitEthernet2/1

P-1(config)#iproute192.168.2.0255.255.255.0pos3/2

P-1(config)#iproute192.168.3.0255.255.255.0pos3/2

P-1(config)#iproute192.168.4.0255.255.255.0pos3/1

P-1(config)#iproute192.168.5.0255.255.255.0pos3/1

P-1(config)#iproute192.168.6.0255.255.255.0pos3/2

P-1(config)#iproute192.168.7.0255.255.255.0pos3/2

P-1(config)#ip route 172.16.16.8255.255.255.252pos3/1

P-1(config)#iproute172.16.16.24255.255.255.252pos3/1

P-1(config)#ip route 172.16.16.4255.255.255.252pos3/2

P-1(config)#iproute172.16.16.20255.255.255.252pos3/2

P-1(config)#ip route 172.16.16.28 255.255.255.252 pos 3/2P-1(config)#end

P-1#write

Building configuration...[OK]

P-1#

PE-1Config :-

PE-1#conf t

PE-1(config)#iproute192.168.0.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.2.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.3.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.4.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.5.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.6.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute192.168.7.0255.255.255.0gigabitEthernet2/1

PE-1(config)#iproute172.16.16.0255.255.255.252gigabitEthernet 2/1

PE-1(config)#iproute172.16.16.4255.255.255.252gigabitEthernet 2/1

PE-1(config)#iproute172.16.16.8255.255.255.252gigabitEthernet 2/1

PE-1(config)#iproute172.16.16.12255.255.255.252gigabitEthernet 2/1

PE-1(config)#iproute172.16.16.20255.255.255.252gigabitEthernet 2/1

```
PE-1(config)#iproute172.16.16.24255.255.255.252gigabitEthernet 2/1
PE-1(config)#ip route 172.16.16.28 255.255.255.252 gigabitEthernet 2/1PE-
1(config)#end
PE-1#write
Building configuration...[OK]
PE-1#
• Config:-
P-2#conf t
```

```
P-2(config)#iproute192.168.3.0255.255.255.0gigabitEthernet2/1
P-2(config)#iproute192.168.0.0255.255.255.0pos3/2
P-2(config)#iproute192.168.1.0255.255.255.0pos3/2
P-2(config)#iproute192.168.4.0255.255.255.0pos3/1
P-2(config)#iproute192.168.5.0255.255.255.0pos3/1
P-2(config)#iproute192.168.6.0255.255.255.0pos3/1
P-2(config)#iproute192.168.7.0255.255.255.0pos3/1
P-2(config)#iproute172.16.16.16255.255.255.252pos3/2
P-2(config)#ip route 172.16.16.8255.255.255.252pos3/1
P-2(config)#iproute172.16.16.12255.255.255.252pos3/2
P-2(config)#iproute172.16.16.24255.255.255.252pos3/1
P-2(config)#ip route 172.16.16.28 255.255.255.252 pos 3/1P-2(config)#end
P-2#
```

PE-2Config:-

```
PE-2#conf t
PE-2(config)#iproute192.168.2.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.0.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.1.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.4.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.5.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.6.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute192.168.7.0255.255.255.0gigabitEthernet2/1
PE-2(config)#iproute172.16.16.0255.255.255.252gigabitEthernet 2/1
PE-2(config)#iproute172.16.16.4255.255.255.252gigabitEthernet 2/1
PE-2(config)#iproute172.16.16.8255.255.255.252gigabitEthernet 2/1
```

```
PE-2(config)#iproute172.16.16.12255.255.255.252gigabitEthernet 2/1
PE-2(config)#iproute172.16.16.16255.255.255.252gigabitEthernet 2/1
PE-2(config)#iproute172.16.16.24255.255.255.252gigabitEthernet 2/1
PE-2(config)#ip route 172.16.16.28 255.255.255.252 gigabitEthernet 2/1PE-
2(config)#end
PE-2#
```

- **Config :-**

```
P-3#conf t
P-3(config)#iproute 192.168.0.0255.255.255.0pos3/1
P-3(config)#iproute192.168.1.0255.255.255.0pos3/1
P-3(config)#iproute192.168.2.0255.255.255.0pos3/1
P-3(config)#iproute192.168.3.0255.255.255.0pos3/1
P-3(config)#iproute192.168.5.0255.255.255.0gigabitEthernet2/1
P-3(config)#iproute192.168.6.0255.255.255.0pos3/2
P-3(config)#iproute192.168.7.0255.255.255.0pos3/2
P-3(config)#iproute172.16.16.16255.255.255.252pos3/1
P-3(config)#ip route 172.16.16.0255.255.255.252pos3/1
P-3(config)#iproute172.16.16.20255.255.255.252pos3/1
P-3(config)#iproute172.16.16.28255.255.255.252pos3/2
P-3(config)#ip route 172.16.16.4 255.255.255.252 pos 3/2P-3(config)#end
P-3#write
Building configuration...[OK]
P-3#
```

PE-3Config :-

```
PE-3#conf t
PE-3(config)#iproute192.168.0.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.1.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.2.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.3.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.4.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.6.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute192.168.7.0255.255.255.0gigabitEthernet2/1
PE-3(config)#iproute172.16.16.0255.255.255.252gigabitEthernet 2/1
PE-3(config)#iproute172.16.16.4255.255.255.252gigabitEthernet 2/1
PE-3(config)#iproute172.16.16.8255.255.255.252gigabitEthernet 2/1
```

```
PE-3(config)#iproute172.16.16.12255.255.255.252gigabitEthernet 2/1
PE-3(config)#iproute172.16.16.16255.255.255.252gigabitEthernet 2/1
PE-3(config)#iproute172.16.16.20255.255.255.252gigabitEthernet 2/1
PE-3(config)#ip route 172.16.16.28 255.255.255.252 gigabitEthernet 2/1PE-
3(config)#end
PE-3#write
Building configuration...[OK]
PE-3#
```

- **Config:-**

```
P-4#conf t
P-4(config)#iproute192.168.7.0255.255.255.0gigabitEthernet2/1
P-4(config)#iproute192.168.0.0255.255.255.0pos3/2
P-4(config)#iproute192.168.1.0255.255.255.0pos3/2
P-4(config)#iproute192.168.2.0255.255.255.0pos3/1
P-4(config)#iproute192.168.3.0255.255.255.0pos3/1
P-4(config)#iproute192.168.4.0255.255.255.0pos3/2
P-4(config)#iproute192.168.5.0255.255.255.0pos3/2
P-4(config)#ip route 172.16.16.0255.255.255.252pos3/1
P-4(config)#iproute172.16.16.24255.255.255.252pos3/2
P-4(config)#iproute172.16.16.20255.255.255.252pos3/1
P-4(config)#iproute172.16.16.12255.255.255.252pos3/2
P-4(config)#ip route 172.16.16.16 255.255.255.252 pos 3/2P-4(config)#end
P-4#
```

PE-4Config:-

```
PE-4#conf t
PE-4(config)#iproute192.168.2.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.0.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.1.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.4.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.5.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.6.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute192.168.3.0255.255.255.0gigabitEthernet2/1
PE-4(config)#iproute172.16.16.0255.255.255.252gigabitEthernet 2/1
PE-4(config)#iproute172.16.16.4255.255.255.252gigabitEthernet 2/1
PE-4(config)#iproute172.16.16.8255.255.255.252gigabitEthernet 2/1
PE-4(config)#iproute172.16.16.12255.255.255.252gigabitEthernet 2/1
```

```
PE-4(config)#iproute172.16.16.16255.255.255.252gigabitEthernet 2/1
PE-4(config)#iproute172.16.16.24255.255.255.252gigabitEthernet 2/1
PE-4(config)#ip route 172.16.16.20 255.255.255.252 gigabitEthernet 2/1
PE-4(config)#end
PE-4#
```

LabModule:3 (DefaultRouting)

Removing the static routes and replacing with a Default route command:-

- show running-config
- Select and copy all the static routes into the clip-board
- Paste into Notepad
- Keep the lines containing the static routes which is to be removed
- Negate all commands with “no”
- Begin with “conf t” end with “write memory”
- Copy into clip board and run the script at Hash prompt of the router

Eg Notepad script for P-1 Router:-

```
conf t
noip route192.168.2.0255.255.255.0
noip route192.168.3.0255.255.255.0
noip route192.168.6.0255.255.255.0
noip route192.168.7.0255.255.255.0
noiproute172.16.16.20255.255.255.252
noiproute172.16.16.4255.255.255.252
noiproute172.16.16.28255.255.255.252
ip route0.0.0.0 0.0.0.0POS3/2
end
write memory
```

- **Configuration:-**

Syntax:

P-1(Config)# iproute<NWNNo.><Subnet Mask><Next Hop Add. |Interface name>Eg:

P-1(config)# ip route0.0.0.00.0.0.0POS3/2

5.11 CONCLUSION : The router is the key network element works at layer no 3, all the IP packet movement is done through this device, so, better understanding of routing fundamental and router configuration will make easy the handling of the network.

6. OVERVIEW OF MPLS VPN

6.1 LEARNING OBJECTIVE:

The objectives of this chapter is

- To describe the MPLS VPN
- To understand the VPN Categories
- To understand the MPLS-VPN Architecture and Terminology
- MPLS-VPN Routing Model
- VRF
- Route Distinguisher, Route Target N

6.2 MPLS VPN OVERVIEW:

MPLS technology is being widely adopted by service providers worldwide to implement VPNs to connect geographically separated customer sites. Previous chapters introduce the basic concepts of MPLS and its operation, as well as configuring MPLS for data forwarding. This chapter builds on that foundation and shows how to use MPLS to provide VPN services to customers. This chapter also presents the terminology and operation of various devices in an MPLS network used to provide VPN services to customers.

The following topics will be covered in this chapter:

- Overlay and peer-to-peer VPN models
- Overview of MPLS VPN components and architecture
- VRFs, route distinguishers, and route targets
- MP-BGP operation and interaction

6.3 VPN CATEGORIES

VPNs were originally introduced to enable service providers to use common physical infrastructure to implement emulated point-to-point links between customer sites. A customer network implemented with any VPN technology would contain distinct regions under the customer's control called the *customer sites* connected to each other via the *service provider (SP)* network. In traditional router-based networks, different sites belonging to the same customer were connected to each other using dedicated point-to-point links. The cost of implementation depended on the number of customer sites to be connected with dedicated links. A full mesh of connected sites would consequently imply an exponential increase in the cost associated.

Frame Relay and ATM were the first technologies widely adopted to implement VPNs. These networks consisted of various devices, belonging to either the customer or the service provider, that were components of the VPN solution. Generically, the VPN realm would consist of the following regions:

- **Customer network**— Consisted of the routers at the various customer sites. The routers connecting individual customers' sites to the service provider network were called *customer edge (CE)* routers.
- **Provider network**— Used by the service provider to offer dedicated point-to-point links over infrastructure owned by the service provider. Service provider devices to which the CE routers were directly attached were called *provider edge (PE)* routers. In addition, the service provider network might consist of devices used for forwarding data in the SP backbone called *provider (P)* routers.

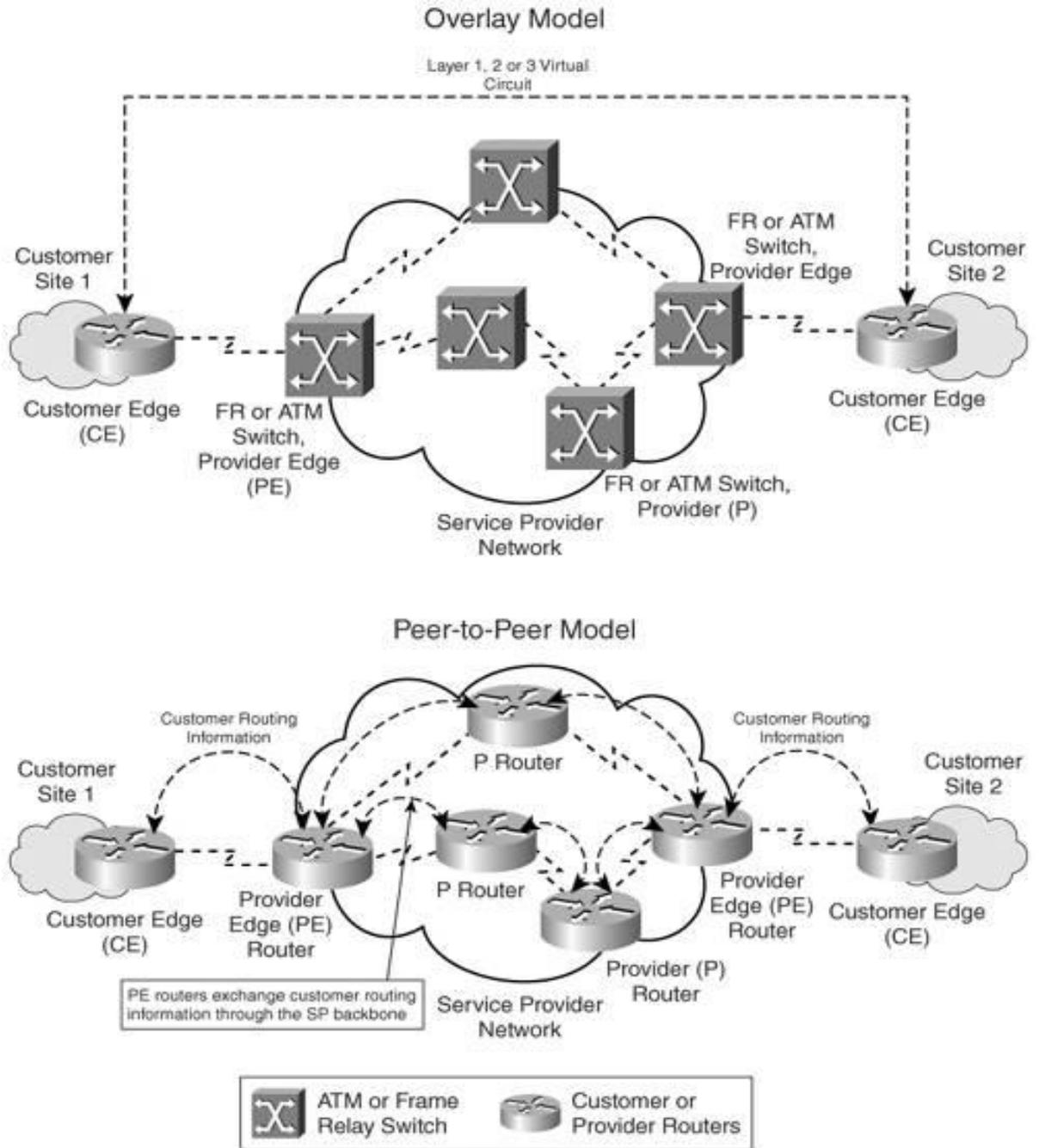
Depending on the service provider's participation in customer routing, the VPN implementations can be classified broadly into one of the following:

- **Overlay model**
- **Peer-to-peer model**

When Frame Relay and ATM provided customers with emulated private networks, the provider did not participate in customer routing. The service provider was only responsible for providing the customer with transport of customer data using virtual point-to-point links. As a result, the service provider would only provide customers with virtual circuit connectivity at Layer 2; this implementation was referred to as the *Overlay model*. If the virtual circuit was permanent or available for use by the customer at all times, it was called a permanent virtual circuit (PVC). If the circuit was established by the provider on-demand, it was called a switched virtual circuit (SVC). The primary drawback of an Overlay model was the full mesh of virtual circuits between all customer sites for optimal connectivity (except in the case of hub and spoke or partial hub and spoke deployments). If the number of customer sites was N , $N(N-1)/2$ was the total number of circuits that would be necessary for optimal routing.

Overlay VPNs were initially implemented by the SP by providing either Layer 1 (physical layer) connectivity or a Layer 2 transport circuit between customer sites. In the Layer 1 implementation, the SP would provide physical layer connectivity between customer sites, and the customer was responsible for all other layers. In the Layer 2 implementation (depicted in Figure 1), the SP was responsible for transportation of Layer 2 frames (or cells) between customer sites, which was traditionally implemented using either Frame Relay or ATM switches as PE devices. Therefore, the service provider was not aware of customer routing or routes. Later, overlay VPNs were also implemented using VPN services over IP (Layer 3) with tunneling protocols like L2TP, GRE, and IPSec to interconnect customer sites. In all cases, the SP network was transparent to the customer, and the routing protocols were run directly between customer routers.

Fig:1. Overlay and Peer-to-Peer Models

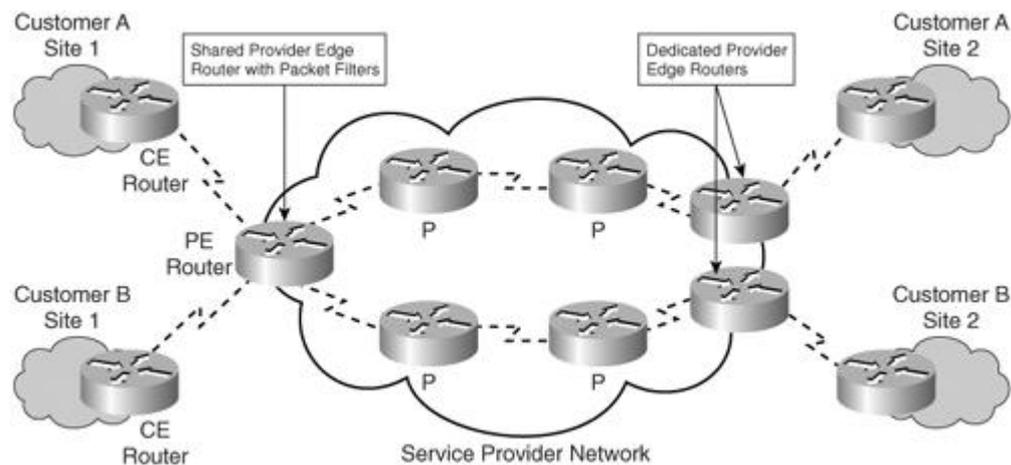


The *peer-to-peer model* was developed to overcome the drawbacks of the Overlay model and provide customers with optimal data transport via the SP backbone. Hence, the service provider would actively participate in customer routing.

In the peer-to-peer model, routing information is exchanged between the customer routers and the service provider routers, and customer data is transported across the service provider's core, optimally. Customer routing information is carried between routers in the provider network (P and PE routers) and customer network (CE routers). The peer-to-peer model, consequently, does not require the creation of virtual circuits. As illustrated in Figure 1, the CE routers exchange routes with the connected PE routers in the SP domain. Customer routing information is propagated across the SP backbone between PE and P routers and identifies the optimal path from one customer site to another.

Separation of customer-specific routing information is achieved by implementing packet filters at the routers connecting to the customer network. Additionally, IP addressing for the customer is handled by the service provider. This process is also referred to as the shared PE peer-to-peer implementation. Figure 2 depicts the various implementations of the peer-to-peer model.

Fig : 2. Peer-to-Peer Model Implementations



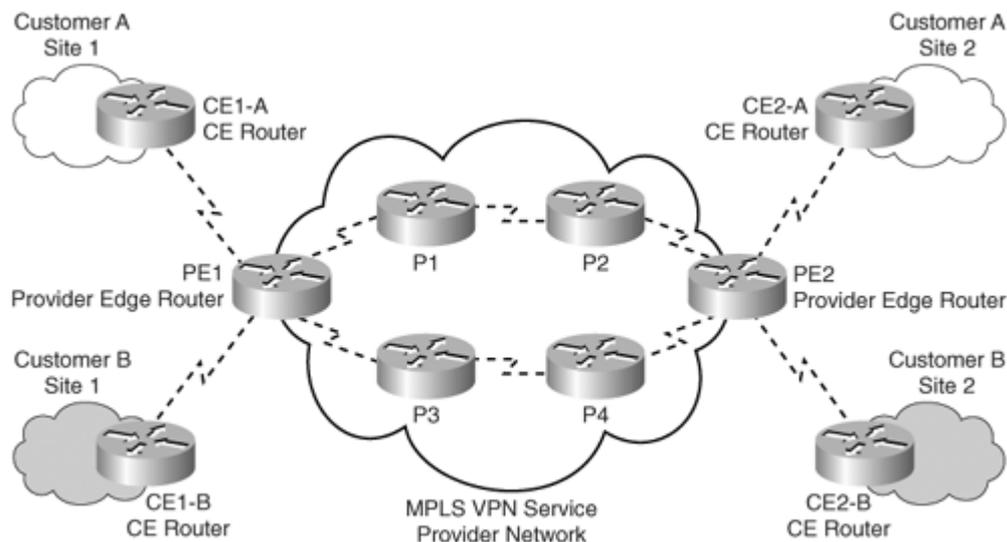
Controlled route distribution was another method of implementing the peer-to-peer model; routers in the core of the service provider's network contained network layer reachability information for all customers' networks. The PE routers (connecting customer network to provider network) in the provider network would contain only information pertaining to their connected customers. A *dedicated* PE router was required for each customer's site connecting to the provider network, and controlled route distribution would occur between P and PE routers in the SP backbone network. Only pertinent customer these routes would be propagated to PE routers that were connected to sites belonging to a specific customer. BGP with communities was usually used in the SP backbone because it offered the most versatile route-filtering tools. This implementation is often referred to as the *dedicated PE peer-to-peer model*. This implementation, however, did not prove to be a viable operating business model due to the higher equipment costs that were incurred by the provider to maintain dedicated edge routers for customer sites connecting into the provider backbone. A need arose for deploying efficient VPN architectures that could implement a scalable peer-to-peer model.

6.4 MPLS VPN ARCHITECTURE AND TERMINOLOGY

In the MPLS VPN architecture, the edge routers carry customer routing information, providing optimal routing for traffic belonging to the customer for inter-site traffic. The MPLS-based VPN model also accommodates customers using overlapping address spaces, unlike the traditional peer-to-peer model in which optimal routing of customer traffic required the provider to assign IP addresses to each of its customers (or the customer to implement NAT) to avoid overlapping address spaces. MPLS VPN is an implementation of the peer-to-peer model; the MPLS VPN backbone and customer sites exchange Layer 3 customer routing information, and data is forwarded between customer sites using the MPLS-enabled SP IP backbone.

The MPLS VPN domain, like the traditional VPN, consists of the customer network and the provider network. The MPLS VPN model is very similar to the dedicated PE router model in a peer-to-peer VPN implementation. However, instead of deploying a dedicated PE router per customer, customer traffic is isolated on the same PE router that provides connectivity into the service provider's network for multiple customers. The components of an MPLS VPN shown in Figure 3 are highlighted next.

Fig 3. MPLS VPN Network Architecture



The main components of MPLS VPN architecture are

- **Customer network**, which is usually a customer-controlled domain consisting of devices or routers spanning multiple sites belonging to the customer. In Figure 3, the customer network for Customer A consists of the routers CE1-A and CE2-A along with devices in the Customer A sites 1 and 2.
- **CE routers**, which are routers in the customer network that interface with the service provider network. In Figure 3, the CE routers for Customer A are CE1-A and CE2-A, and the CE routers for Customer B are CE1-B and CE2-B.
- **Provider network**, which is the provider-controlled domain consisting of provider edge and provider core routers that connect sites belonging to the customer on a shared infrastructure. The provider network controls the traffic

routing between sites belonging to a customer along with customer traffic isolation. In Figure 3, the provider network consists of the routers PE1, PE2, P1, P2, P3, and P4.

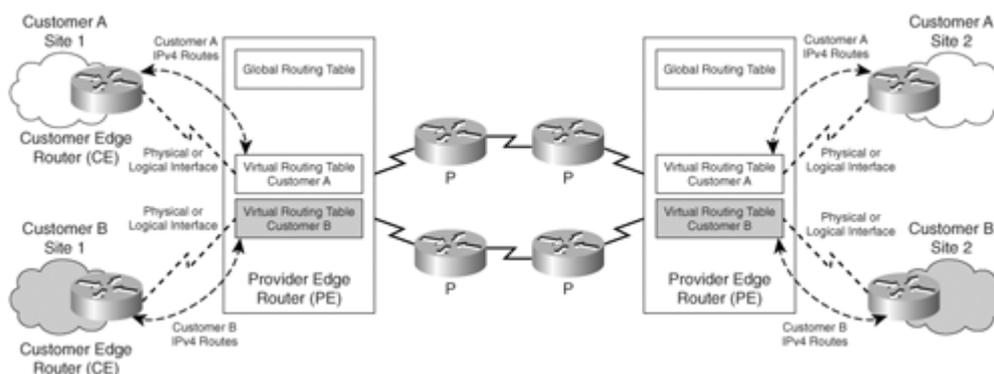
- **PE routers**, which are routers in the provider network that interface or connect to the customer edge routers in the customer network. PE1 and PE2 are the provider edge routers in the MPLS VPN domain for customers A and B in Figure 3.
- **P routers**, which are routers in the core of the provider network that interface with either other provider core routers or provider edge routers. Routers P1, P2, P3, and P4 are the provider routers in Figure 3.

6.5 MPLS VPN ROUTING MODEL

An MPLS VPN implementation is very similar to a dedicated router peer-to-peer model implementation. From a CE router's perspective, only IPv4 updates, as well as data, are forwarded to the PE router. The CE router does not need any specific configuration to enable it to be a part of a MPLS VPN domain. The only requirement on the CE router is a routing protocol (or a static/default route) that enables the router to exchange IPv4 routing information with the connected PE router.

In the MPLS VPN implementation, the PE router performs multiple functions. The PE router must first be capable of isolating customer traffic if more than one customer is connected to the PE router. Each customer, therefore, is assigned an independent routing table similar to a dedicated PE router in the initial peer-to-peer discussion. Routing across the SP backbone is performed using a routing process in the global routing table. P routers provide label switching between provider edge routers and are unaware of VPN routes. CE routers in the customer network are not aware of the P routers and, thus, the internal topology of the SP network is transparent to the customer. Figure 4 depicts the PE router's functionality.

Fig :4 . MPLS VPN Architecture



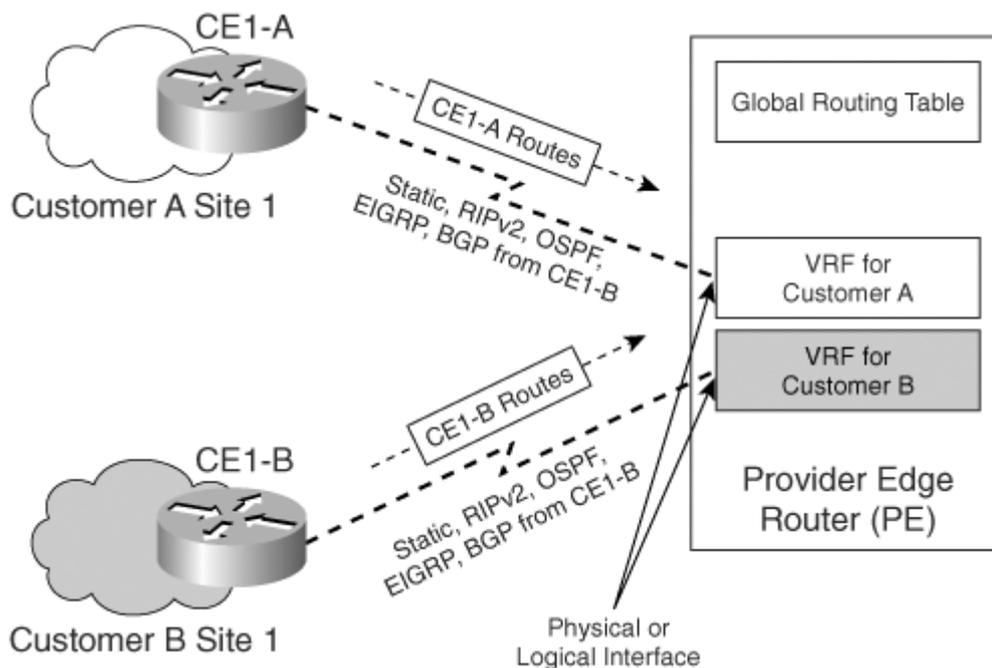
The P routers are only responsible for label switching of packets. They do not carry VPN routes and do not participate in MPLS VPN routing. The PE routers exchange IPv4 routes with connected CE routers using individual routing protocol contexts. To enable scaling the network to large number of customer VPNs, multiprotocol BGP is configured between PE routers to carry customer routes.

6.6 VRF: Virtual Routing and Forwarding Table

Customer isolation is achieved on the PE router by the use of virtual routing tables or instances, also called virtual routing and forwarding tables/instances (VRFs). In essence, it is similar to maintaining multiple dedicated routers for customers connecting into the provider network. The function of a VRF is similar to a global routing table, except that it contains all routes pertaining to a specific VPN versus the global routing table. The VRF also contains a VRF-specific CEF forwarding table analogous to the global CEF table and defines the connectivity requirements and protocols for each customer site on a single PE router. The VRF defines routing protocol contexts that are part of a specific VPN as well as the interfaces on the local PE router that are part of a specific VPN and, hence, use the VRF. The interface that is part of the VRF must support CEF switching. The number of interfaces that can be bound to a VRF is only limited by the number of interfaces on the router, and a single interface (logical or physical) can be associated with only one VRF.

The VRF contains an IP routing table analogous to the global IP routing table, a CEF table, list of interfaces that are part of the VRF, and a set of rules defining routing protocol exchange with attached CE routers (routing protocol contexts). In addition, the VRF also contains VPN identifiers as well as VPN membership information (RD and RT are covered in the next section). Figure 5 shows the function of a VRF on a PE router to implement customer routing isolation.

Fig :5 . VRF Implementation on PE Router



As shown in Figure 5, Cisco IOS supports a variety of routing protocols as well as individual routing processes (OSPF, EIGRP, etc.) per router. However, for some routing protocols, such as RIP and BGP, IOS supports only a single instance of the routing protocol. Therefore, to implement per VRF routing using these protocols that are completely isolated from other VRFs, which might use the same PE-CE routing protocols, the concept of routing context was developed.

Routing contexts were designed to support isolated copies of the same VPN PE-CE routing protocols. These routing contexts can be implemented as either separated processes, as in the case of OSPF, or as multiple instances of the same routing protocol (in BGP, RIP, etc.). If multiple instances of the same routing protocol are in use, each instance has its own set of parameters.

Cisco IOS currently supports either RIPv2 (multiple contexts), EIGRP (multiple contexts), OSPFv2 (multiple processes), and BGPv4 (multiple contexts) as routing protocols that can be used per VRF to exchange customer routing information between CE and PE.

Note that the VRF interfaces can be either logical or physical, but each interface can be assigned to only one VRF.

6.7 ROUTE DISTINGUISHER, ROUTE TARGETS, MP-BGP, AND ADDRESS FAMILIES

In the MPLS VPN routing model, the PE router provides isolation between customers using VRFs. However, this information needs to be carried between PE routers to enable data transfer between customer sites via the MPLS VPN backbone. The PE router must be capable of implementing processes that enable overlapping address spaces in connected customer networks. The PE router must also learn these routes from attached customer networks and propagate this information using the shared provider backbone. This is done by the association of a route distinguisher (RD) per virtual routing table on a PE router.

A *RD* is a 64-bit unique identifier that is prepended to the 32-bit customer prefix or route learned from a CE router, which makes it a unique 96-bit address that can be transported between the PE routers in the MPLS domain. Thus, a unique RD is configured per VRF on the PE router. The resulting address, which is 96-bits total (32-bit customer prefix + 64-bit unique identifier or RD), is called a *VPN version 4 (VPNv4) address*.

VPNv4 addresses are exchanged between PE routers in the provider network in addition to IPv4 (32-bit) addresses. The format of an RD is shown in Figure 6. As shown in Figure 6, RD can be of two formats. If the provider does not have a BGP AS number, the IP address format can be used, and, if the provider does have an AS number, the AS number format can be used. Figure 6 also shows the same IP prefix, 172.16.10.0/24, received from two different customers, is made unique by prepending different RD values, 1:100:1 and 1:101, prior to propagating the addresses as VPNv4 addresses on the PE router.

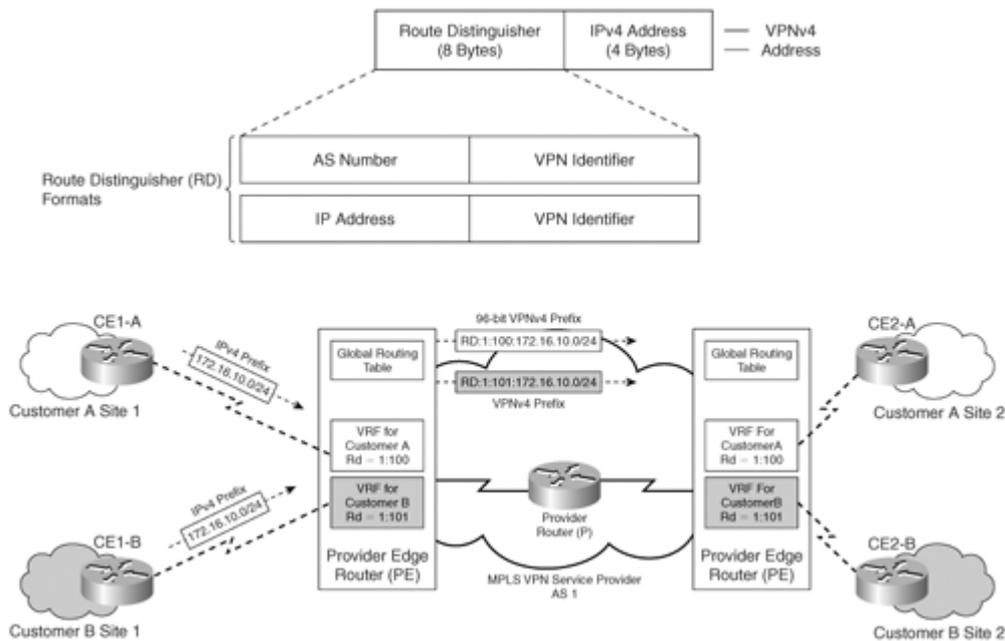


Fig.6. RD Operation in MPLS VPN

The protocol used for exchanging these VPNv4 routes between PE routers is *multiprotocol BGP* (MP-BGP). BGP capable of carrying VPNv4 (96-bit) prefixes in addition to other address families is called MP-BGP. The IGP requirement to implement iBGP (internal BGP) still holds in the case of an MPLS VPN implementation. Therefore, the PE router must run an IGP that provides NLRI information for iBGP if both PE routers are in the same AS. Cisco currently supports both OSPFv2 and ISIS in the MPLS provider network as the IGP. MP-BGP is also responsible for assignment of a VPN label. Packet forwarding in an MPLS VPN mandates that the router specified as the next hop in the incoming BGP update is the same router that assigns the VPN label. Scalability was a primary reason for the choice of BGP as the protocol to carry customer routing information. In addition, BGP enables the use of VPNv4 address in an MPLS VPN router environment that enables overlapping address ranges with multiple customers.

An MP-BGP session between PE routers in a single BGPAS is called an MP-iBGP session and follows rules as in the implementation of iBGP with regards to BGP attributes. If the VPN extends beyond a single AS, VPNv4 routes will be exchanged between AS at the AS boundaries using an MP-eBGP session.

Route targets (RTs) are additional identifiers used in the MPLS VPN domain in the deployment of MPLS VPN that identify the VPN membership of the routes learned from that particular site. RTs are implemented by the use of extended BGP communities in which the higher order 16 bits of the BGP extended community (64 total bits) are encoded with a value corresponding to the VPN membership of the specific site. When a VPN route learned from a CE router is injected into VPNv4 BGP, a list of VPN route target extended community attributes is associated with it. The *export route target* is used in identification of VPN membership and is associated to each VRF. This export route target is appended to a customer prefix when it is converted to a VPNv4 prefix by the PE router and propagated in MP-BGP updates.

The *import route target* is associated with each VRF and identifies the VPNv4 routes to be imported into the VRF for the specific customer. The format of a RT is the same as an RD value. The interaction of RT and RD values in the MPLS VPN domain as the update is converted to an MP-BGP update is shown in Figure 7.

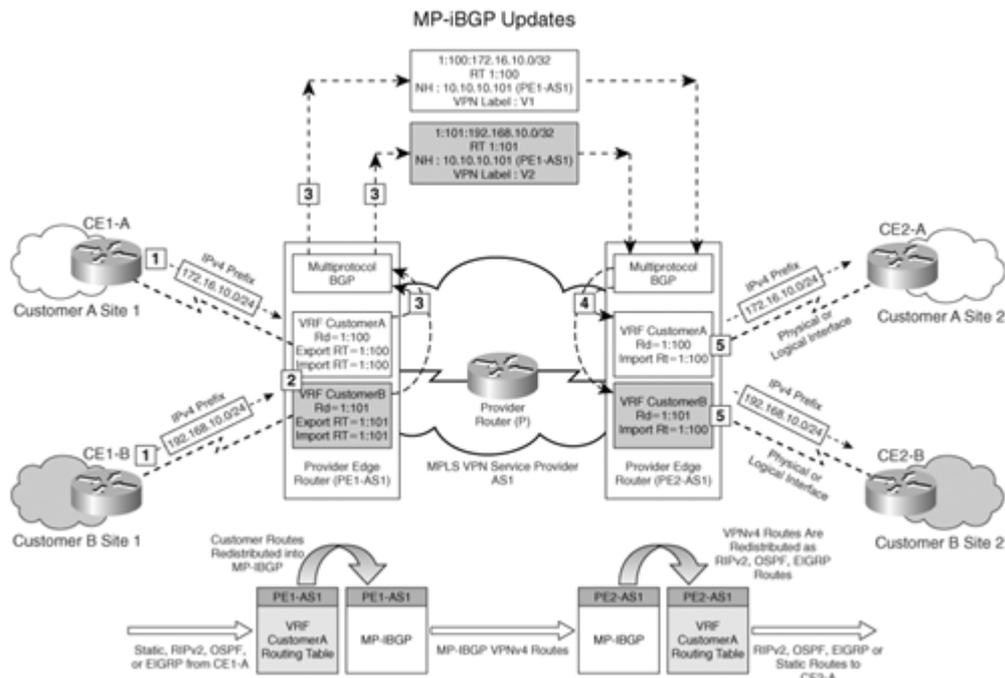


Fig:7 . RT and RD Operation in an MPLS VPN

When implementing complex VPN topologies, such as extranet VPN, Internet access VPNs, network management VPN, and so on, using MPLS VPN technology, the RT plays a pivotal role. A single prefix can be associated to more than one export route target when propagated across the MPLS VPN network. The RT can, as a result, be associated to sites that might be a member of more than one VPN.

The following processes occur during route propagation in an MPLS VPN, as shown in Figure 7:

1. The prefix 172.16.10.0/24 is received from CE1-A, which is part of VRF CustomerA on PE1-AS1.
2. PE1 associated an RD value of 1:100 and an export RT value of 1:100 as configured in the VRF definition on the PE1-AS1 router.
3. Routes learned from connected CE routers CE1-A are redistributed into the MP-BGP process on PE1-AS1 where the prefix 172.16.10.0/24 is prepended with the RD value of 1:100 and appended with the route target extended community value (export RT) of 1:100 prior to sending the VPNv4 prefix as part of the MP-iBGP update between PE routers.

The VPN label (3 bytes) is assigned for each prefix learned from the connected CE router's IGP process within a VRF by the PE router's MP-BGP process. MP-BGP running in the service provider MPLS domain thus carries the VPNv4 prefix (IPv4 prefix + prepended RD) in addition to the BGP route target extended community. Note that although the RT is a mandatory configuration in an MPLS VPN for all VRFs configured on a router, the RT values can be used to implement complex VPN topologies in which a single site can be a part of more than one VPN. In addition, RT values can also be used to perform selective route importing into a VRF when VPNv4 routes are learned in MP-iBGP updates. The VPN label is only understood by the egress PE (data plane) that is directly connected to the CE router advertising the prefix. Note that the next hops on PE routers must not be advertised in the BGP process but must be learned from the IGP for MPLS VPN implementation. The VPN label has been depicted by the entries V1 and V2 in Figure 7.

4. The MP-BGP update is received by the PE router PE2, and the route is stored in the appropriate VRF table for Customer A based on the VPN label.
5. The received MP-BGP routes are redistributed into the VRF PE-CE routing processes, and the route is propagated to CE2-A.

In addition, other BGP extended community attributes such as *site of origin (SoO)* can also be applied to the MP-iBGP update prior to propagation. The SoO attribute is used to identify the specific site from which the PE learns the route and is used in the identification and prevention of routing loops. The SoO extended community is a BGP extended community attribute used to identify routes that have originated from a site so that the re-advertisement of that prefix back to the source site can be prevented, thus preventing routing loops. The SoO extended community uniquely identifies the site from which a PE router has learned a route. SoO enables filtering of traffic based on the site from which it was originated. SoO filtering manages MPLS VPN traffic and prevents routing loops from occurring in complex and mixed network topologies in which the customer sites might possess connectivity across the MPLS VPN backbone as well as possess backdoor links between sites.

The implementation of a MPLS VPN in which all VPN sites belonging to a customer can speak to all other sites in the same customer domain is called a simple VPN implementation or *intranet VPN*. As mentioned earlier, RTs can be used to implement complex VPN topologies in which certain sites that are part of one customer's domain are also accessible by other customers' VPN sites. This implementation is called an *extranet VPN*. In addition, variants of extranet VPN, such as network management VPN as well as central services VPN and Internet access VPN, can also be deployed.

It is important to understand the concept of address families and their place in the operation of MP-BGP to enable the transport of VPNv4 routes with extended community attributes. Prior to RFC 2283, "Multiprotocol Extensions for BGP-4," BGP version 4 was capable of carrying routing information only pertaining to IPv4. RFC 2283 defines extensions to BGP-4 that enable BGP-4 to carry information for multiple network layer protocols. RFC 2283 states that to enable BGP-4 to support routing for multiple network layer protocols, the additions to BGP-4 must account for

the ability of a particular network layer protocol to be associated with a next hop as well as the NLRI (network layer reach ability information). The two new attributes that were added to BGP were Multiprotocol Reachable NLRI (MP_REACH_NLRI), and Multiprotocol Unreachable NLRI (MP_UNREACH_NLRI). MP_REACH_NLRI carries the set of reachable destinations together with the next-hop information to be used for forwarding to these destinations. MP_UNREACH_NLRI carries the set of unreachable destinations. Both of these attributes are optional and nontransitive. Therefore, a BGP speaker that does not support these multiprotocol capabilities will just ignore the information carried in these attributes and will not pass it to other BGP speakers.

An *address family* is a defined network layer protocol. An address family identifier (AFI) carries an identity of the network layer protocol associated with the network address in the multiprotocol attributes in BGP. (Address family identifiers for network layer protocols are defined in RFC 1700, "Assigned Numbers.")

The PE router, in essence, is an Edge LSR and performs all the functions of an Edge LSR. The PE router requires LDP for label assignment and distribution as well as forward labeled packets. In addition to the functions of an Edge LSR, the PE implements a routing protocol (or static routes) with connected CE routers per virtual routing table and requires MP-BGP to propagate prefixes learned from CE routers as VPNv4 prefixes in MP-iBGP updates to other PE routers along with the VPN label.

The P router's requirements are to run an IGP (either OSPF or ISIS) as well as have MPLS enabled to forward labeled packets (data plane) between PE routers. The IGP is used to provide, as well as propagate, NLRI to connected P and PE routers to implement an MP-iBGP session between PE routers (control plane).

6.8 CONCLUSION

MPLS VPN is a popular technique to build VPNs for customers over the MPLS provider network. The better understanding of MPLS – VPN facilitates the participants to better handle the O and M of MPLS network in real time scenario.

7. RADIO MODEM

7.1 LEARNING OBJECTIVES

After reading this chapter over Radio Modem, the trainees will come will to know about following important concepts

- What is Radio Modem?
- Various Features and Technical specifications of Radio Modem.
- Various Interfaces and Modulation used in Radio Modem
- Where Radio Modem is used for providing BSNL Services?
- How Radio Modem is suitable in Remote/Rural area?
- Advantages and Disadvantages of Radio Modem

7.2 INTRODUCTION:

BSNL is providing long distance connectivity to medium and large enterprise customers to establish their private networks facilitating their internal communications like office data, inter office information from various units spread across the country. As more and more enterprises are using IT and applications like ERP for their operations, the need for such private networks and virtual private networks has increased many fold.

BSNL has been providing such service to its customers across India, for urban, semi urban and rural locations. Customers look towards BSNL for their remote locations where only BSNL has the needed infrastructure. Such links have three parts- local lead at 'A' end , long distance media (on OFC), and local lead at 'B' end.

Conventionally, the need was for speed of 64 kbps, 128 kbps, up to 2 Mbps, and very rarely higher than 2 Mbps. Now the speed requirement has gone up for most customers, and this is posing a challenge on the local lead. Secondly, many factories etc are located in sub urban locations which are far away from the nearest exchange or BTS location of BSNL. Copper cable has severe speed and distance limitations. It is not possible to lay OFC except in special cases. Thirdly, all local leads working on copper are prone to faults resulting in loss of business to customers. This is inevitable and causing loss of face before many customers.

As a standard practice in the industry, radio connectivity is used in last mile for such cases and same has also happened in our market. BSNL has gone for such solution and many customers have been given such connectivity.

7.3 RADIOMODEMS:

Similar to our usual microwave systems, these links work on the wireless principle based on line of sight operation. It comprises of Transmitter-receiver on both sides with necessary interface for feeding in and taking out data of appropriate rate.

Since there is shortage of frequency spectrum as it is already being used by so many agencies, this system uses only those bands which are available or some free bands which do not need any permission.

The design of these systems is such that they are low cost and work on easily available infrastructure at these locations.

7.3.1 FEATURES OF RADIO MODEM USED IN BSNL:

The radio modems in BSNL are of RADWIN make and the broad features are as follows:

- Frequency band: 2 GHz (free band)
- Data transmission: Data is transmitted in the form of Ethernet on the system.
- Interface required for interconnection: Convertors are used to connect data into the system from user side. V35 to Ethernet convertors have been used in the systems deployed.
- Data speeds: it supports speeds up to 10 Mbps, however, it has been used for data rates upto 4 Mbps in our applications so far.

- Distance range: upto 10 kms, but extendable. It depends on line of site and option taken from vendor.

- **Antenna height:**
 - BSNL end: either exchange or BTS tower is used to give maximum height as per need. The needed height is decided by survey calculations. It also depends on the height of antenna at customer site. This varies from case to case.
 - Customer end: Antenna at customer end is fixed on roof top or any structure available. If height needed is more and no structure is available, a tripod type mast is erected for the antenna. It is available in lengths up to 20 meters. Normally the antenna height at customer end varies from 3m to 20m.

- In the systems commissioned so far, speed upto 4 Mbps is working over distances in the range of 10-12 km.

7.3.2 ADVANTAGES:

This solutions has not only solved the last mile problems but is also useful in many new ways

- Overcomes limitations of copper lead
- Offers attractive speeds upto several MBPS
- Gives a fantastic distance range beyond 20 km
- Reliability is far more than copper counterpart. Not affected by factors like road cuts, monsoons, man-made factors etc.

7.4 TECHNICAL SPECIFICATIONS OF RADIO MODEMS

(TEC GR no. GR/MOD-09/02 JAN 2005. The following guidelines have to be followed)

- i) **Hop distance:** It shall depend upon the TX power, RX sensitivity, size of the antenna and tower height. The typical range of operation as per the GR is about 40 km. however, the links may be planned up to 25 kms in 2.4 GHz band and upto 20 kms in 5.7 GHz band.
- ii) **Safe Separation between the links:** It shall depend on the frequency separation, azimuth angle of the links and antenna discrimination and can therefore be decided on link to link basis.
- iii) **Size of the antenna:** The maximum EIRP is 30 dBm. The links may be planned accordingly.
- iv) **Choice of frequency band:** This depends upon a) hop distance b) Intersystem Interference etc.
- v) **Input power supply:** The radio modem equipment is capable of working on 230 V AC.
- vi) **Cost of the Radio modem link:** Approximate cost of a radio modem link is about 1.5 lakhs.

7.4.1 FUNCTIONAL & TECHNICAL REQUIREMENTS OF RADIO MODEM EQUIPMENT:

A) Modem

1. Data Rates

The modem shall support one or more of the following data rates.

- 64Kbps
- 128Kbps
- 256Kbps
- 512Kbps
- 2048Kbps(E1)
- 2*2048Kbps(2xE1)
- 4*2048Kbps(4xE1)
- 8*2048Kbps(8xE1)

The pay load of 2048 Kbps can be voice, data or video signals and can carry any type of signaling as per the interworking requirements. The 2048 Kbps signals can be framed or unframed, synchronous or asynchronous.

2. Digital Line Interface:

The modem interface shall be either hardware configurable (e.g. DIP Switches) or software configurable (e.g. AT commands) to act as Data Communication Equipment (DCE) or Data Terminal Equipment (DTE) as per the requirements. The following digital interfaces shall be supported on Subscriber End Equipment (SEE) and Exchange End Equipment (EEE).

3. Digital Interfaces on Subscriber End Equipment (SEE):

The Subscriber End Equipment (SEE) shall be equipped with one or more of with the following physical interfaces with the indicated electrical characteristics:-

- a) V.35 / V.36 ISO – 2593 physical connector (34 pin, female type) with provision for holding the corresponding cable using standard screw-type arrangement. The electrical characteristic of interface shall be as per the requirements under ITU – T Recommendation V.35/V.36. The pin-allocation for various signals is as given in Table 6.
- b) V.11 ISO – 4902 physical connector (37 pin, female type) with provision for holding the corresponding cable using standard screw-type arrangement. The electrical characteristic of interface shall be as per the requirements under ITU –T Recommendation V.11. The pin-allocation for various signals shall be as given in Table 7.
- c) V.36/V.35/V.II ISO – 2110 physical connector (25 pin, female type) with provision for holding corresponding cable using standard screw-type arrangement. The electrical characteristic of interface shall be as per the requirements under ITU- T Recommendation V.36 / V.35 or V.II signals on the ISO 2110 is as given in Table 8 columns (1&2) for V.36/V.35 and (3&4) for V.11.
- d) G.703 Co-directional interface at 64 Kbps with ISO-2110 connector (Female type) and with pin allocation as given in Table 8 column (5).
- e) G.703 physical interface with ISO 2110 connector (female type) with 120 Ohm balanced for 2048 Kbps. The electrical characteristics of interface shall be as per para 6 of ITU-T Recommendation G.703 and pin allocation as given in Table 8 (column 5).

4. Digital Interfaces on Exchange End Equipment (EEE):

The Exchange End Equipment (EEE) shall be equipped with one or more of the following physical interfaces with the indicated electrical characteristics:-

- V.II ISO-4902 connector (37 pin, female type) with provision for holding corresponding cable using standard screw-type arrangement. The electrical characteristic of interface shall be as per the requirements under ITU- T Recommendation V.II. The pin-allocation for various signals is as given in Table 7.
- V.36/V.35 ISO-2110 connector (25 pin, female type) with provision for holding the corresponding cable using standard screw-type arrangement. The electrical characteristic of interface shall be as per the requirements under ITU- T Recommendation V.36 / V.35. The pin allocation for various signals is as given in Table 8 column (1&2).
- G.703 Co-directional interface at 64 Kbps with ISO-2110 connector (Female type) and with pin allocation as given in Table 8 column (5).

- G.703 physical interface with 120 Ohm balanced for 2048 Kbps. The electrical characteristics of interface shall be as per para 6 of ITU- T. Recommendation G.703. The modem can be connected to the PSTN on digital line which could be ISDN PRI (30B+D) or E1 trunk line.
- In case the modem is to be connected over ISDN PRI, then the ISDN UNI requirements shall be as per the TEC Standard No. SD/ISN-01/03. OCT 2003.
- In case the modem is to be connected over E1 trunk line the physical characteristics of the trunk line shall be as per the clause 1.2.10.2 of TEC Generic Requirements (GR) No. GR/LLT-01/05.MAR 2003. The signaling shall be as per clause 1.2.11 of the same TEC GR.
- The modem shall support SS7 signaling as per the TEC Generic Requirements GR No. GR/LLT-01/05. MAR 2003.
 1. Conversion of different types of physical interfaces to other physical types through external cables is not permitted.
 2. The combination of interfaces given in clause 2.1.2.1 and 2.1.2.2 can be simultaneously available or they may be achieved through separate plug in modules.

B) Radio:**1. MODULATION**

The radio modems shall conform to one of the following modulation:

- a. Frequency Hopping Spread Spectrum (FHSS)
- b. Direct Sequence Spread Spectrum (DSSS)

A) FREQUENCY HOPPING SPREAD SPECTRUM (FHSS) MODULATION:

Frequency Hopping Spread Spectrum (FHSS) modulation is a form of modulation in which transmitter signal occupies a number of frequency in time, each for some period of time, referred to as dwell time.

FHSS modulation shall make use of at least 75 well defined, non-overlapping channels of hopping positions separated by the channel bandwidth as measured at 20 dB below peak power. The maximum 20 dB bandwidth of hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 seconds period. While the radio modem is operating (transmitting and/or receiving) each channel of the hopping sequence shall be occupied at least once during a period not exceeding four times the product of the dwell time per hop and the number of channels.

For the hybrid system the frequency hopping operation with the direct sequence operation turned off shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system

receivers shall have shift frequencies in synchronization with the transmitted signals.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

B) DIRECT SEQUENCE SPREAD SPECTRUM (DSSS) AND OTHER FORMS OF MODULATION:

Direct Sequence Spread Spectrum (DSSS) modulation is a form of modulation in which both data to be transmitted and known code sequence are combined used to directly modulate a carrier.

For the purposes of this document, other forms of spread spectrum modulation which do not satisfy the constraints of the requirements given in sub clause 2.2.1.1, shall be considered equivalent to DSSS modulation. Systems using the other forms of modulation shall be tested according to the requirements for DSSS modulation. The minimum 6 dB bandwidth shall be at least 500 kHz.

C) TRANSMITTER PARAMETER LIMITS:

(i) Effective radiated power: For frequency hopping systems and for all direct sequence systems, the maximum peak output power shall not exceed 1 watt effective isotropic radiated power (e.i.r.p).

(ii) Peak power density: For direct sequence systems, the peak power spectral density shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. For the hybrid system the power density requirement shall comply for the direct sequence operation with the frequency hopping turned off.

(iii) Processing Gain

The processing gain (the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on) of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio after filtering to the information bandwidth from the spreading / despreading function. Hybrid systems that employ a combination of both direct sequence and frequency hopping modulation techniques shall achieve a processing gain of at least 17 dB from the combined techniques.

D) FREQUENCY RANGE

The frequency range of the radio modem is determined by the lowest and highest frequencies occupied by the power envelope.

FH is the highest frequency of the power envelope: it is the frequency furthest above the frequency of maximum power where the output power drops below the level equivalent to -80dBm/Hz e.i.r.p spectral power density (-30 dBm if measured in a 100 kHz bandwidth).

FL is the lowest frequency of the power envelops: it is the frequency furthest below the frequency of maximum power where the output power drops below the level equivalent to -80dBm/Hz e.i.r.p spectral power density (-30 dBm if measured in a 100 kHz bandwidth).

The frequency range of the radio modem shall lie within one of the following band: i) 2400 MHz to 2483.5 MHz (FL>2400 MHz and FH < 2483.5 MHz)

ii) 5725 MHz to 5825 MHz (FL>5725 MHz and FH < 5825 MHz)

Field Strength

The field strength of emissions from the radio modem operated within these frequency bands shall comply with the following:

E) Table 1: Field strength of emissions

Fundamental Frequency	Field Strength fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
2400 – 2483.5 MHz	50	500
5725 – 5825 MHz	50	500

Field strength limits are specified at a distance of 3 meters. Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental.

F) SPURIOUS EMISSIONS:

Spurious emissions are emissions outside the frequency range (s) of the radio modem as defined in sub clause 2.2.2.4.

The level of spurious emissions shall be measured as:

Either

- (i) Its power in a specified load (conducted spurious emissions); and
- (ii) Its effective radiated power when radiated by the cabinet or Structure of the radio modem (cabinet radiation);

Or

- (i) Its effective radiated power when radiated by cabinet and antenna.
- (ii) The spurious emissions of the receiver shall not exceed the values in tables 2 and 3 in the indicated bands.

Table 2: Narrowband spurious emissions limits for receivers

Frequency Range	Limit
30 MHz – 1000 MHz	-57 dBm

Above 1 GHz – 12.75 GHz	- 47 dBm
-------------------------	----------

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage.

Wideband emission shall not exceed the values given in table 3

Table 3: Wideband spurious emissions limits for receivers

Frequency Range	Limit
30 MHz – 1000 MHz	-107 dBm/Hz
Above 1 GHz – 12.75GHz	- 97 dBm/Hz

G) TIME DIVISION DUPLEXING INTERFERENCE:

When a large number of radio modems are used at one location in a hubbed mode, they shall not cause near end mutual interference. The radio modems using Time Division Duplexing (TDD) technique shall have a provision of burst synchronization, a system by which all radio modems in that hub transmit bursts of data at same time, to enable a large number of radios to co-exist at one location.

Provision of Stand By: The modem, operating at data rate of 2048 Kbps (E1) and above, shall operate with 1 + 1 configuration with automatic switchover of transmitter and receiver whenever transmitter or receiver power goes down below threshold due to failure of any module in trans or receive path.

Order wire facility: For data rates 2048 Kbps and above, one of the following order wires along with a handset shall be provided :-

One omnibus order wire.

One express order wire with selective calling facility

Potential free contact for extensions of buzzer calling facility to a centralized place is desirable.

Antenna and Cables: The details of type and size of antenna required along with interconnecting cable between radio modem and antenna and miscellaneous items required for the complete setup of radio link at both end to meet the requirements for the user's specified link distance, path profile, frequency of operation and data rate, shall be supplied by the supplier.

H) POWERSUPPLY

The modem shall operate on AC power supply of 230 V + 10% to -15% and frequency 50 Hz +- 2 Hz.a.

Alarms and Diagnostics

D) ALARM INDICATIONS

There shall be indication on front panel on LED / LCD display for the following alarms.

- Transmit power failure
- Receive power below threshold
- Radio sync loss
- Power up
- DTE input loss

J) DIAGNOSTICS

For data rates 2048Kbps (E1) and above there shall be, in built or as attachment which is to be considered as part of modem, provision for

- Local loop back test
- Remote loop back test
- Loop back to remove end
- Receive power level determination
- Receive power signal quality determination
- Quasi random sequence generator
- Data output failure
- System log capability for alarms and test results
- Local & remote monitoring

7.5 SAFETY REQUIREMENTS

The operating personnel should be protected against shock hazards as per IS8437 {1993} “Guide on the effects of current passing through the human body” {equivalent to IEC publication 479-1 {1894}}.

The radio modem shall conform to IS 13252 (1992) “Safety of information technology equipment including electrical business equipment” {equivalent to IEC Publication 950 (1986)} and IEC 215 {1987} “Safety requirements of radio transmitting equipment’s” {for Radio Equipment’s only}.

The radio modem should follow proper construction practice to minimize unintended radiations due to leakage from any gap or monitoring points. All unused if/rf ports and monitoring points should be terminated. The power flux density shall not exceed 1mW/cm² at a distance of 2.5cms.

7.6. CONCLUSION

The Radio Modem is a device used for providing Wireless connectivity to customers for BSNL private line services like Data Circuits and other services. The Radio Modem works on similar to Microwave transmission system with line of sight principal. It uses free Band available which don’t need any permission. It is most suitable in Remote/Rural area where connectivity through cable is very difficult. It can provide services to Private customers with several speed options and distance upto 20kms.

8. CONCEPT OF ONE NETWORK

8.1 LEARNING OBJECTIVES:

- Learn the concept and requirement of One Network
- Learn the activities involved in one network concept
- Implementation of one network program
- Learn about the network and partner team management

8.2 INTRODUCTION TO ONE NETWORK

The activities related to network management and customer management are being done currently at the exchange / equipment location level. Customer service management is generally done through indoor staff station at main exchange locations and outdoor takes care of last mile activities. The commercial activities related to partner (cluster, FTTH) management are being done in decentralized manner.

With the change in technology and management methodologies, it is very much desired that 24/7 network management is done through a centralized location for first level monitoring and corrective action required for the operational excellence. Wherever physical presence of staff is required for change of network card etc., there should be common staff at site to manage technical equipment, power plan, electrical infrastructure, etc.

One network program was started by BSNL on 16-12-2020

One network is Centralized NOC (Network operations center) for CFA (Consumer Fixed Assets)

8.3 ACTIVITIES IN ONE NETWORK

Following Activities are proposed for centralized network/customer/partner management.

(A) Network Management

- FTTH /OLT Management.
- OMCR- BTS Monitoring
- OF Route Patroller Monitoring
- NIBNetwork Elements Management (BNG/RPR/OCLAN/MNGPAN /Facebook Cache Server/Google Cache Server) Monitoring and Management
 - Monitoring and Management, Escalation of faults to maintenance in-charge
 - Monitoring of Leased circuits (MLLN & Non-MLLN both), Monitoring of Wi-Fi Hotspots, intimation regarding faulty nodes to field maintenance teams
 - Monitoring of BBNL OLTs
 - Testing of OLTs of TIPS from BNG
 - PING Test, Profile check, handling customer speed issues



Restructuring of CFA network - Partner Management activities

A common Toll Free Number is created by Bangalore Telecom District for partner management activities as **18005991001**

Fig 8.2 Common Toll Free Number for partner management

- A telephonic PIN (T-Pin) shall be issued to all partners so that call from the partners can be routed to the respective BA P-CSG.
- For this every BA will have its own 3-digit PIN and its corresponding destination number/ line hunting group.

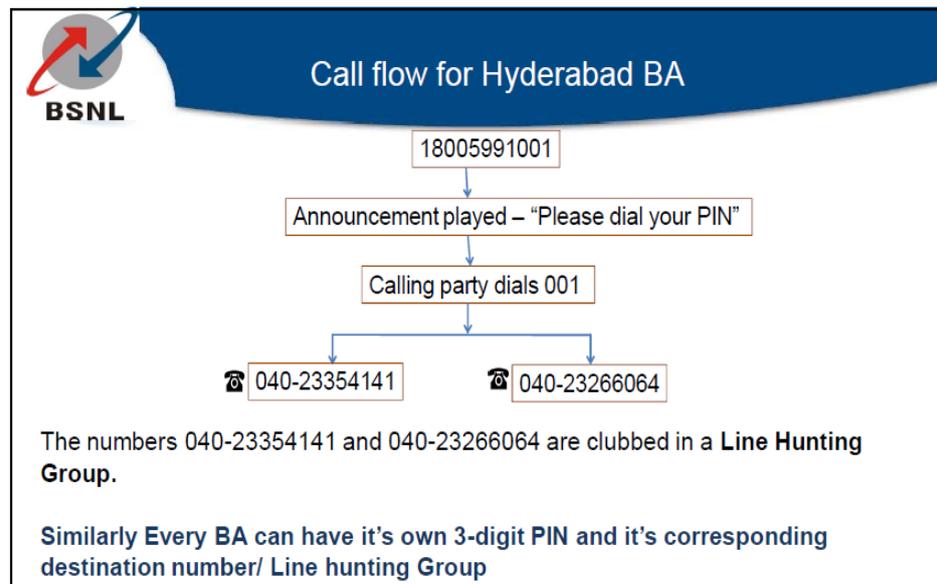


Fig 8.3: Call flow for BA

8.3.1 FTTHMANAGEMENT (BSNL OLT/TIP OLT/BBNL OLT)

- FTTH OLT Management (EMS)
- FTTH Soft Switch Management (Voice Creation)
- FTTH Lead Management.
- FTTH Fault Management.
- FTTH CAF Approval.
- CDR activities with respect to FTTH.
- FTTH TIP support.
-

8.3.2OMCR ACTIVITIES

- BTS Monitoring (2G/3G/4G) and Reporting
- TRE/Combiner HW Reset
- Partial Fault Monitoring
- Attending calls from field persons
- BTS External Alarm Monitoring

8.3.3OFC ROUTE PATROLLER MONITORING

- Patroller Monitoring and Reports.
- Updation of data for Patrollers and New OF route in Patroller Monitoring System.

8.4MORE ACTIVITIES PROPOSED IN ONE NETWORK

- Transmission system monitoring and management
- NGN-LMGs/DSLAMs/OLTs/Exchange Monitoring and management
- NOFN – OLT/ONT monitoring and management
- PRI & SIP Monitoring and Management
- LEASED CIRCUIT & MLLN Monitoring and Management (DXC/V-MUX/Circuits)
- CDR/FMS SYSTEM management (Central Router/Exchange Router/MLLN Circuits)
- Wi-Fi Hotspots- monitoring & Management
- High Bandwidth Circuit Monitoring & management
- MPLS Monitoring (Edge Router/Core Router/Super Core Router/Circuits)

8.5 NETWORK MANAGEMENT BA TEAM

BA Team wise size required for centralized NOC activities and partner support group is to be prepared in following format

(A) Network Management Team Details

Name	Designation	Monitoring on network elements (FTTH/OLT/BNG etc.)	Mobile No.	E-mail ID

(B) Partner Management Team Details

Name	Designation	CLUSTER FTTH	Mobile No.	E-mail ID

8.6 ONE NETWORK BA TEAM CASE STUDY OF MAHARASHTRA CIRCLE

Sl. No.	Name of circle	Name of BA	BA Type	Members in the centralized NOC team for network management	Members in the CGPS for the cluster/FTTH partner
1	MH	Ahmednagar	Category-B	12	6
2	MH	Amaravati	Category-C	8	4
3	MH	Aurangabad	Category-C	8	4
4	MH	Chandrapur	Category-C	8	4
5	MH	Goa	Category-C	8	4
6	MH	Jalgaon	Category-C	8	4
7	MH	Kalyan	Category-B	12	6
8	MH	Kolhapur	Category-B	12	6
9	MH	Nagpur	Category-C	8	4
10	MH	Nanded	Category-C	8	4
11	MH	Nashik	Category-C	8	4
12	MH	Pune	Category-A	16	8
13	MH	Satara	Category-C	8	4
14	MH	Solapur	Category-C	8	4

8.7 CONCLUSION

As the name suggest one network program is a drive to monitor all the network components at a centralize location with 24x7 watch on the entire level and provide first level of escalation. With the growing number of subscribers and network elements to cater to such huge subscriber base, it is necessary to monitor the entire network for seamless services round the clock. One Network program is an initiative towards the NOC based approach.

9. BROADBAND NOC

9.1 LEARNING OBJECTIVE:

The objectives of this chapter is

- To understand the concept of broad band NOC and its architecture used in BSNL.
- To understand the concept of NIB project, NMS, EMS, OSS and QOS.

9.2 INTRODUCTION

BSNL has planned to setup NIB-II to provide world class infrastructure to offer various value added services to a broader customer base county-wide that will help to accelerate the Internet revolution in India. Moreover the NIB-II will create a platform, which enables e-governance, e-banking, e-learning, etc. with the key point of Service Level Agreements & Guarantee in tune with Global standards and customer expectations.

NIB-II has been grouped into following three major projects.

- **Project 1:** - MPLS based IP Network infrastructure covering 71 cities along with associated NMS, PMS, Firewall and Caching platforms.
- **Project 2.1:** Access Gateway platform using Dialup comprising of narrow band RAS and DSL equipment.
- **Project 2.2:** Access Gateway platform comprising of Broadband RAS and DSL equipment.
- **Project 3:** Messaging and Storage platform and Provisioning, Billing and Customer care and Enterprise management system.

The network shall seamlessly integrate with the already existing network infrastructure comprising of the TCP/IP based NIB-I and MPLS VPN network. The NIB-II project comprises of Technology solutions from different product manufacturers with the provision for future expansion.

9.3 PROJECT

[Messaging and Storage Service Platform, Provisioning, Billing & Customer care, Enterprise Management System (EMS) and Security System.]

The Core messaging system shall be the heart of NIB-II that will enable BSNL to add users across varied value added services. This shall envisage design and up gradation of the current messaging system to grow from the existing infrastructure in NIB-I supporting 650,000 users to support the increasing user base. The messaging systems and associated Storage will be implemented in phases, in accordance with phased induction of Access equipment.

The system shall be an integrated provisioning, billing, customer care and accounting platform and shall support billing for the complete range of IP based services mentioned and meet next-generation requirements as well.

The salient aspects of the projects are summarized as follows:

- (i) Setting up proven, robust, scalable Messaging Solution with best in class security components.
- (ii) Roll out across the country supported by 5 messaging & associated storage systems at Delhi, Mumbai, Bangalore, Chennai and Kolkata.
- (iii) Designed with High Availability architecture with no single point of failure.

Components of the Solution:

The proposed solution shall consist of the following components with the items of functionality listed below:

- (i) Messaging
 - a) DNS, AAA
 - b) MMP
 - c) LDAP (Consumer, Replicator Hub, Primary and Secondary)
 - d) SMTP IN & OUT
 - e) Messaging Servers
 - f) Address Book Servers, etc.
- (ii) Storage
 - a) SAN Switch & SAN Storage
 - b) Tape Library
 - c) Staging Servers, etc.

Storage platform

Various Applications servers placed at the 5 Messaging Storage locations like LDAP, AAA, EMS, Messaging, UMS & Billing etc. would require Data storage capacities for storing User's mailboxes, Billing data etc. Such huge storage requirements need to be met with the Fast, Reliable & Scalable storage devices that would be deployed as "End to End High Performance Switched Architecture Fiber Channel SAN (Storage Area Networks) providing No Single Point of Failure".

Such storage device should be compatible with all the Servers of major companies such as HP, IBM, SUN, Dell etc. so that choice of Application Servers Platform remains independent of the storage device.

System Dimensioning:

The user base will be serviced through 5 Messaging and associated Storage systems that will be set up in the 5 cities. Each of the cities will be connected through the IP Backbone. Since the proposed user base is envisaged to increase in a phased manner, the associated messaging system is also proposed to be upgraded in phases correspondingly.

The system should be designed to support:

- On-line services such as Internet, pay-per-view TV and video on demand or a combination of all or some of the above.
- Periodic charges, such as telephone line and cable TV rental.
- One-time costs, such as connection fees.

- Events, such as telephone calls, data service usage, pay-per-view TV selections, home shopping purchases, utility metered usage – such as electricity supply (live site example)
 - Financial services ASP services.
 - Telephony services.
 - Enterprise Backup Systems.

The billing system shall be capable of

- Providing electronic versions of bills to customers over the Internet.
- Creation/modification of service.
- Processing Service requests in real time and non-real time and accounting in real time.
- Producing flexible billing depending upon the use of service.

Security Systems

These include the following.

- Load Balancers
- Firewall Appliances
- Intrusion Detection System
- Antivirus system, etc.

9.4 NETWORK OPERATION CENTER (NOC)

The NOC shall provide facility for centralized Network Management and end-to-end Provisioning of multiple services, giving a single view of the entire network services being delivered countywide. The servers for the NOC shall be connected through a Gigabit Ethernet link from Core router with three zones of firewall within the Centre.

The network shall be centrally managed from Network Operation Centre (NOC) located at two sites, one of them being master and the other the disaster recovery site. The main NOC is at Bangalore with Disaster Recovery is at Pune. Interface to the NMS back-office facility shall be provided along with Firewall security in the Data Centre. All customer databases shall reside centrally at NOC.

The NMS of NIB-II project 1 is the comprehensive NMS for entire NIB-II including NIB-I, MPLS VPN, Project 2.1, Project 2.2, which will support entire F (Fault), C (Configuration), A (Accounting including Access/Inventory), P (Performance) and S (Security functionality). The conceptual view of EMS, NMS OSS/BSS for NIB-II is given in figure 4 and the connectivity Architecture of NOC at Bangalore is shown in figure.

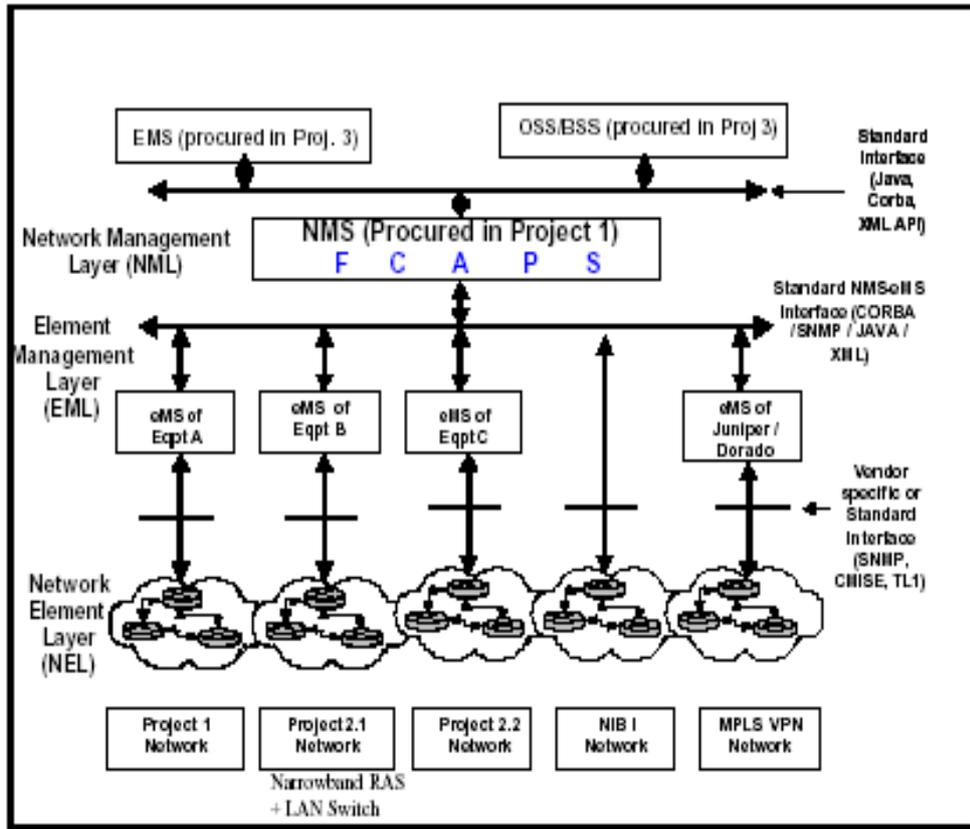


Figure 9.1: Conceptual view of eMS, NMS, EMS OSS/BSS for NIB-II

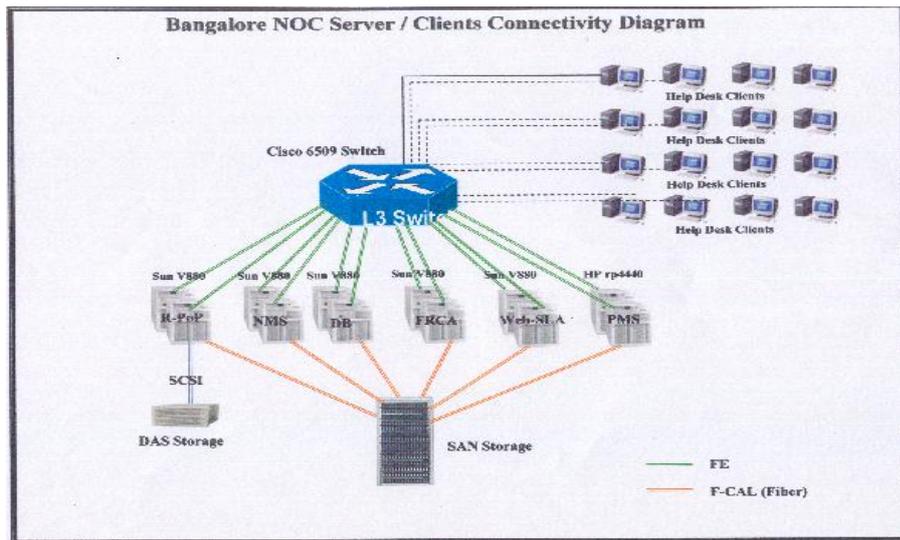


Figure 9.2: Bangalore NOC Connectivity Architecture.

9.5 SERVICE LEVEL AGREEMENT (SLA):

It shall be possible to support SLA i.e. the level of service that the customer can expect together with any penalties to be levied by the service provider for failure to deliver. It should be possible to provide at least 4 classes of services. The SLA parameters shall include measurements of service delivery, availability, latency,

throughput and restoration time etc. It should be possible to generate management reports providing information on customer node configuration and charges, faults and achievement against the SLAs. It shall be possible to deliver network management reports via a secure Website.

Implementation of OSS, Messaging, Storage, Billing, EMS & Security Solutions

9.5.1 MESSAGING

- Messaging Solution of NIB-II will provide the SMTP, POP3, IMAP4, WEBMAIL, WAPMAIL and Notifications services as a Class Of Service to all the customers of NIB-II and NIB-I
- Will support for Country wide roaming for dial up and message store access through any data center.
- The Messaging Server will support Wireless messaging and Directory services to WAP enabled phones and laptop users
- Message store will be content aware to support different types of services to be created by BSNL ranging from text email to multi-media messaging service
- Will provide Family Mailbox where the head of the family can manage options for Family members. Options will include setting of allowed and block senders and recipients and control of Anti-SPAM settings.
- Messaging solution shall provide flexible control of message aging to define the conditions under which messages are automatically erased
- Web mail interface will support multimedia message types for voice and fax mail, providing unified messaging interface in future
- Message Transfer Agent (MTA) will be designed to handle peak loads without service degradation or message loss
- MTAs will be designed to handle large message queues. There will be capability available to analyze and manage large message queues generated due to unreachability of message store (internal) and mail exchangers of other ISPs (external) or SPAM

9.5.2 WEB HOSTING

- Web space (Data Storage) on servers based on UNIX and Microsoft for hosting HTML pages with browser
- Ftp access for uploading and downloading pages as per the plan. Restriction on simultaneous ftp sessions
- FrontPage etc. access for Web-publishing
- Multiple Email Ids per domain with flexible email quota, as per the plan
- Web Interface for centralized administration by user and administrators for services, usage reports, invoice and other reports
- It will provide access to customers for analyzing the Web-site performance through analysis tools

Interface for online registration of domain name

9.5.3 WEB COLLOCATION

- Necessary Security measures will be implemented both from customer and BSNL's perspective
- Billing for this will be done on the basis of usage

- One of the service differentiator will be bandwidth on which the server is collocated.

9.5.4 SECURITY SOLUTION

- Anti-Virus solution: It will provide a mechanism to detect unknown virus. The solution will protect any Gateway and SMTP traffic from virus
- Notification: For mails containing repeated complaints regarding abuse from the same IP address, mail will be sent automatically to the technical contact of the assignee of that IP address
- Network Intrusion detection System: The NIDS will detect unauthorized internal/external intrusion attempts into the data centers of NIB-II and will enable to apply appropriate policies on the firewall so as to prevent such attacks in real time. Suitable alarms will also be sent to the Security Control Console.
- Anti Control System: It is provided for Database servers, Messaging Stores, Web-Hosting Servers and NIDS.
- Self-protection: Must be able to prevent hackers with root/administrator access from circumventing or shutting down the security engine.
- Resource protection: Must allow controlling of access to all system resources including data files, devices, processes/services and audit files.
- Rights delegation: Must provide the ability to designate specific users as administrators, auditors and password managers etc with appropriate rights.
- Program Controls: Must provide protection against Back Doors and Trojan Horses.

9.6 ENTERPRISE MANAGEMENT SYSTEM

- Objective of EMS is to provide a snap-shot graphical view of the health of NIB-II IT infrastructure as a whole including networking equipment, servers and services (business and process view)
- Reporting system will be able to generate customized reports such as event-level, performance -level and service-level reports grouped by specific data fields such as time period, location, customer, series type, device type etc
- Security Management will display alarm and events specified by the criteria such as alarm type, vendor, service, location, source of attack, type of attack and impacted services
- Event Management will capture all the events that are being generated across the complete IT infrastructure, correlates them and initiate corrective actions automatically, as defined
- System& Application Management will measure the availability and performance of heterogeneous host systems on a 24x7x365 basis and initiate preventive and corrective actions automatically
- System& Application Management will monitor and manage multiple attributes (such as status, memory usage, size and resident size, process time, threads, response time, average throughput and CPU utilization etc) of a running process and problems and perform restart when processes go down. It will generate reports on QOS and capacity planning
- Database Management will be able to manage tables including database, table space, buffer pool, processes and session summaries. It will be able to look at

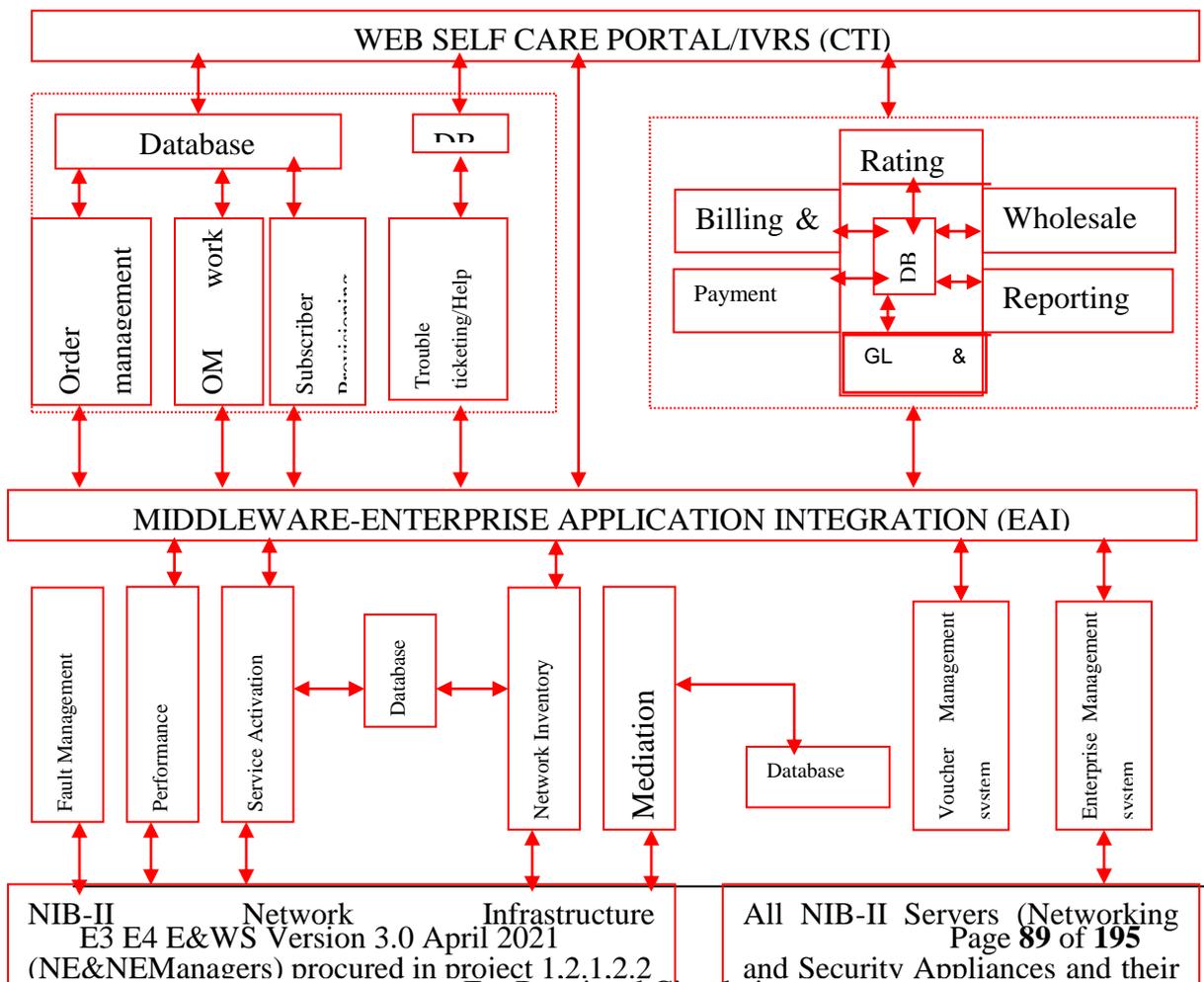
thresholds of objects like free space, process page faults, transaction rates and average wait time

- Service Management will be able to measure Availability /response time of applications (Basic services, Email services, Web services, Mission critical applications). It will be possible to specify SLA for the applications and monitor them.
- EMS will have tool to monitor SLA .It will provide alerts for SLA violations and violation trends, for proactively correcting service level problems.
- Asset Management will store hardware and software inventory information of all the servers and desktops& creating, tracking and maintaining records for the assets and components.

9.7 OBJECTIVE OF OPERATION SUPPORT SYSTEM (OSS)

- OSS will allow BSNL to carryout automation of majority of the processes needed in service definition & provisioning, service activation, authentication, authorization and accounting, mediation, rating, billing and invoicing etc. including service assurance and customer care
- OSS shall provide an integrated view of all customers and services across the network for Customer life cycle management
This includes a customizable web-based GUI client tools for configuration and setup

OSS ARCHITECTURE



Web Portal

- Web Portal will be the gateway for customer and CSR based on their authorizations for accessing various system, services etc
- Portal will have an integration, with NMS, EMS and OSS for providing services to the BSNL's customer service representatives (direct, indirect, helpdesk, supervisor) and account managers
- Portal services Ranging from business, process, network, customer specific maps/views, trouble-ticketing, pre-sales query, post-sales order-booking, order tracking, trouble –shooting etc
- Portal will integrate with components like Service Provisioning, Order Management, Billing, Customer Care, EMS and Messaging etc. to provide a unified view of the network and services to the customers and CSRs for all the front office functions and some back office functions
- Order status and history provide both subscribers and the customer service representatives with sufficient data to fully manage and monitor the service selection and delivery process
- It will be possible to provide a user friendly interface for customers to plan and schedule their bandwidth for Band width on Demand services

Services provided by portal to the customers

- Customer registration services for both pre-paid and post-paid customer
- Self-registration for getting information about products and services
- Self-registration for availing services such as post-paid dialup service based on telephone number authentication
- Shopping cart for procuring services
- Access to services such as messaging, web-hosting, storage and content-services etc. This will include on demand services like video on demand and online gaming etc
- Booking an order for services. Allow the user to submit, and track service requests online at any time
- View current bill status in real time including billed, unbilled and pre-billed services, payment-details and other related information
- Reporting a problem by opening a fault docket and tracking its solution
- View the status of related network and services subscribed
- View the status of SLA compliance, SLA resolution and rebates applied through integration with billing and NMS

9.8 ORDER MANAGEMENT**OM will have**

- Customer Interface Management
- Order Entry and Validation
- Workflow Management

Customer Interface Management & Order Entry and Validation:

- Order will be entered through Web-portal by CSR or Customer directly

- CSR will accept the order after completion of signed order form by the customer. He will scan it and attach it with the online order form
- All orders will be checked against the feasibility from the RMS For all committed orders, check will be made for customers credit worthiness/default and the billing system will generate a unique ID for the customer
- It will be possible to query the status of order, service, billing etc. on the basis of unique ID
- OM will track the order status
- OM will inform the billing system of successful provisioning or else it will roll back all the steps
- Record all the transactions between OM and customer
- Record the details of the services provisioned for the customer
- Purge customer data from RDBMS and LDAP databases based on pre-defined and configurable policies when the customer surrenders service

Work Flow Management:

Work Flow Management will automate the process that controls and monitors the execution of an order according to the customer requirements. This involves the steps of qualification, reservation, configuration and verification of a service fulfillment instance.

Work Flow Management will integrate OM and provisioning Management systems (PMS) being procured under project-1, project –2.2 and Whole-sale Dial Application being procured under project-2.1

Subscriber Provisioning Management System (SPMS)

SPMS will cover the provisioning of following services under project 2.1 and project 3 through configurations in files. Subscriber Provisioning will be fully flexible to support all the requirements of services

- Dial up Internet Access with different variants
- Messaging with different Variants
- Web Hosting
- Web Collocation
- Domain Hosting
- Broadband Internet Access with Content delivery through SSSC.

Mediation

Billing mediation will be responsible for collecting usage and other charging data from the various network nodes, normalize the data into a consistent format and distribute it to other applications and billing system for processing this information

- System will collect different parameters from different sources to provide Cflow and Netflow based collection and mediation for usage based billing of different services including MPLS-VPN, Web-hosting, Message-Hosting etc

Parameters are

- Bandwidth
- Volume
- Time of day/ day of week/ month (Peak/off peak)

- Application (WWW, Email (POP3/IMAP4), Video, E-commerce etc)
- Destination
- Type of Service (Gold, Silver, Bronze/best efforts) etc

DATABASE

- Latest Oracle RDBMS will be used with all applications
- RDBMS will work in fail over mode over geographical locations
- RDBMS will work in a distributed mode across multiple servers
- RDBMS will work in a cluster mode
- Provisioning will be made for data replication to or from databases of project 1,2.1 and 2.2

9.9 HELP DESK AND TROUBLE TICKETING

- Whenever a customer reports a problem, a unique trouble ticket-ID will be generated by the system. This will be intimated to the customer, so that he can track the status on the basis of this ID
- It will be possible for customers to submit and check the status of reported problems through web interface
- System will automatically track, log and escalate user interactions and requests
- CSRs will be able to view, change the status of the calls, reassign/ transfer the trouble tickets to others CSRs or technical specialist through the web interface
- Will be able to generate various customized Service Level Reports e.g. Open Call Reports, closed Call Reports, problem area/ Location Specific Reports
- Will have the capability for accepting queries through various sources including Telephone, email or Web interface
- System will check for tickets status and escalation and notify the management or next level of support staff based on predefined Service Level Agreement (SLA) which will include criteria like Service application, Severity and customer etc
- It will have bulletin board to allow CSRs, Managers and Customers to post and review messages about critical issues
- It will be possible to track the time spent on specific case
- It will be possible to generate work orders for field staff or technicians for fault repair
- Trouble ticketing system will interface with SLA and performance management systems to account for the period of network or service unavailability
- Trouble ticketing system will be able to extract all incidents, resolution progress reports and all affected services via its interface with the inventory system

- The trouble tickets will be attached to a work-flow where ever there are multiple steps required for resolution
- It will be possible to include information about the equipment, circuit built up details etc in the trouble ticket automatically after obtaining the same from inventory
- Will integrate with web-portal for report trouble ticket status
- System will allow CSR to check the network fault status as part of problem investigation

Billing

- Billing engine will cater to all the billing requirements of BSNL include Retail Billing (Prepaid and Postpaid), Wholesale and third party billing, Inter connect and content billing, Dealers and Agents Commissions etc
- Billing system will support the preparation of detailed bill, Differential tariff, Cross product discounting, Sponsored/split billing. Bundled accounting, Hot billing/On-demand billing, Hierarchy/ Corporate billing, Discounts & Promotions, Taxes, Notification system, Dealers and Agent commissions, Content Billing
- Billing system will allow customers the option of receiving complete event details along with their invoice or view them online through the Web portal. Provision will also be available for the customer to print the event-details from the Web portal in a printable format
- Content Billing
- System will provide BSNL subscribers to access services provided by external content providers and be able to handle the revenue sharing with the content provider within the single billing platform
- System will allow content providers who do not have their own customer care and billing system to use the billing system of BSNL

Authentication, Authorization and Accounting

- Irrespective of mode of access (such as Dial-up Internet access, outsourced remote access, managed VPNs, Broadband etc), it will manage the Authentication of all users/customers- both locally and via proxy RADIUS- and deliver the appropriate level of service to each customer
- It will enable defining access schemes by time-of days, days-of-week, call type (PSTN, ISDN and DSL etc.), calling number and called number etc
- It will be capable of authenticating through CLI, DNIS, Voucher number, pin code etc
- Radius server will be able to handle at least 10,000 concurrent sessions per second
- It will integrate with billing server for providing real time pre-paid balance management and session management across multiple sessions of multiple services of a user.

9.10 CONCLUSION

The NOC concept is very important for O & M workflow, the proper understanding of features and functioning of NOC requires for uninterrupted services of the network .The guidelines for maintenance of NOC and define the responsibilities of various node in charges to ensure uninterrupted service and customer satisfaction.

10. MPLS VPN

10.1 LEARNING OBJECTIVES

After the completion of the module, the trainee will know about

- Circuit Switching.
- Packet Switching.
- Label Switching.
- Evolution of the MPLS.
- Functions and features of MPLS.
- Function and features of VPN.

10.2 INTRODUCTION

Switching is the process by which, two circuits are interconnected for exchanging information. Information is in the form of either analog or digital. In electro mechanical era, information was in the form of analog. Presently, information is in the form of digital. In order to interconnect the circuits, supporting the digitized information, suitable digital switches are designed. Digital Switches are classified as

- Circuit switch
- Packet switch

Apart from the above models of switching, **Multi-Protocol Label Switching** model is configured in Packet Switch Area.

10.3 CIRCUIT SWITCHES

Circuit switch mainly supports the switching the voice paths. Digital spectrum is divided into equal parts (64 kbps). Circuit switch uses these 64 kbps path for voice switching. Voice samples of a particular conversation should reach the destination sequentially through the 64 kbps digital path by maintaining maximum permissible delay of 125 us, to avoid the loss of intelligence. In order to satisfy the above conditions, switched path should be permanent until the end of the conversation. Hence, the routing becomes connection oriented. No other user also can intrude in that path. Also the switched paths can be categorized according to the type of services and class of services.

Example:-

Emergency Services Routes

CLASS OF SERVICES Special Services Routes

- Normal users (non priority users)

TYPE OF SERVICES

- Prioritized users.

10.4 PACKET SWITCHES

Instead of dividing the digital spectrum, entire message is divided into packets, addressed and numbered. Packet switch sends the addressed and numbered packets one by one to

the destination, in different routes, by using the entire spectrum available in last week. For an example, if the packet size is 2 mb, then the packet switch uses the 2 mbps digital spectrum for the period of one second. At destination, packets are arriving randomly at different time. Even the first packet may arrive lastly. Receiver has to wait until all the packets are received. Then packets are arranged sequentially and then converted as message. Since the packets are routed through different routes, this routing becomes connection loss. Routing and no dedicated path is used between source and destination. Packet switches are presently used in ISP Network.

10.4.1 COMPARISON OF CIRCUIT AND PACKET SWITCHES

CIRCUIT SWITCH	PACKET SWITCH
Since this switch follows connection oriented routing (dedicated path), there will be no loss of intelligence.	Since this switch uses connection loss routing, loss of packets may be possible
Latency can be kept within the limit	Latency cannot be maintained
Class of services can be defined	Class of services cannot be defined.
Type of users can be defined	Type of users could not be defined.
Security is high during the transaction, since the switched path could not be intruded.	Security is meager. Intrusion is possible during transaction. Eg. Receiving many advertisements during downloads.
Part of the address of the destination (Rout code, Exchange code, etc.) is analyzed.	Entire address (IP address) is analyzed for selecting best match.

Hence, the limitations of the packet network are summarized as follows:

- Creation and processing of routing table is tedious.
- Class of services (Priorities) as in circuit switch is not implemented presently.
- Type of services (category) as in manual board is not available in the present IP network.
- Loss of packet, because of the random routing of packets.
- Delayed processing at receiving end, since packets are not reaching the destination sequentially.
- Security problem.

10.5 LABEL SWITCHING

Above limitations can be overcome by using following techniques in the present IP network.

- Connectionless IP routing is converted into connection oriented routing by overlaying Network Layer function with Data link layer Function.
- IP address is converted as Labels (Rout codes in circuit switch), according to the class and type of services like categories and Priorities in circuit switches.
- Intermediate Routers uses the Labels only (Rout Codes in Circuit Switch) for further routing of destined IP packet with appropriate Label.

The above techniques are used in Multi Protocol Label switching. Hence, MPLS is the implementation of circuit switch model in the Packet switch area. MPLS frame uses the various Data Link frames like ATM, Frame Relay PPP/Ethernet etc. Since MPLS uses label switching and supports the multiple protocols, it is called Multi Protocol Label Switching.

COMPONENTS OF MPLS IP NETWORK

- Customer Edge, which works at IP level.
- Provider Edge is the entry point of MPLS Domain. It is called “Label Edge Router”
- Provider Routers are working as transit switches in between LERs. These are known as “Label Switching Routers”.
- Label switched path is the data path between two routers, through which packets are traveling.

10.6 MPLS Architecture

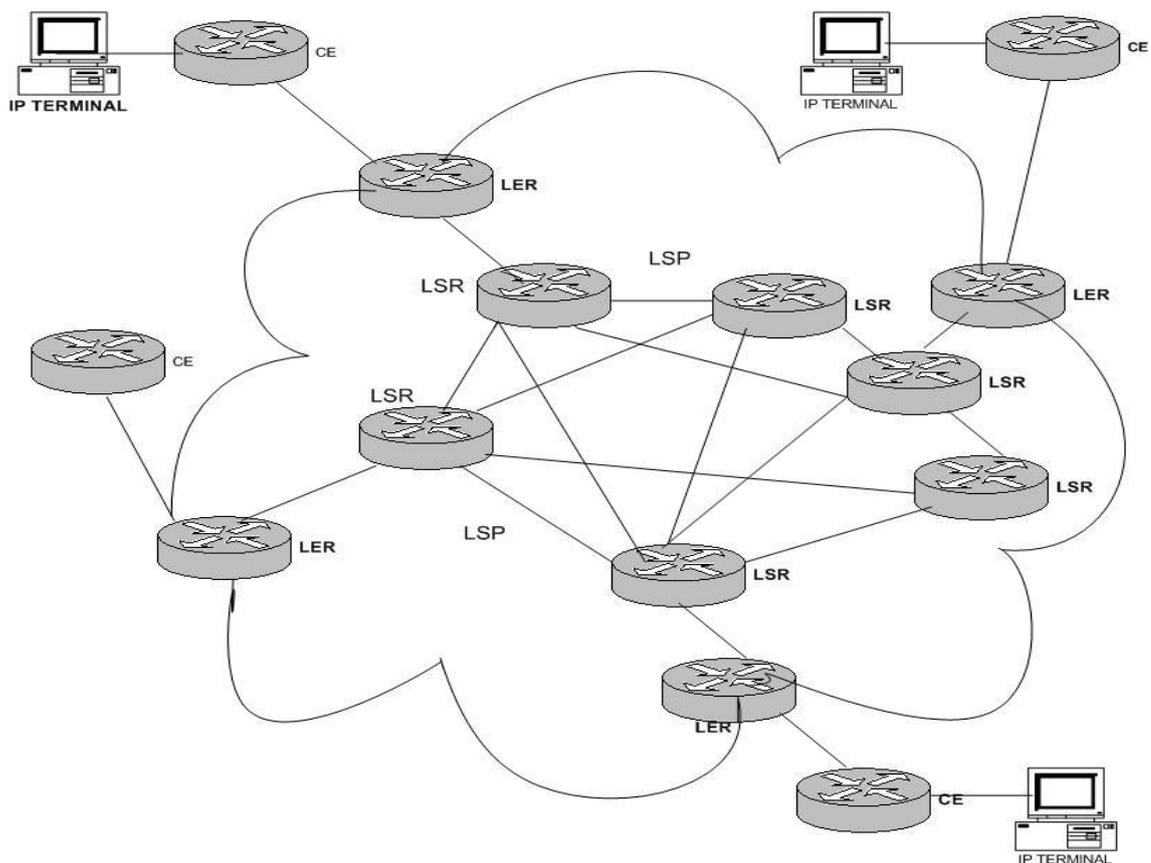


Figure 1:

Customer Edge

It structures the customer message into IP Packets and sends to the entry node of MPLS domain. While receiving the IP Packets from the egress node of the MPLS domain, CE sends packets to Network layer of its own, after removing the IP address.

Label Edge Router

Label Edge Routers are working as the gateways of MPLS Domain. Ingress LER, it receives the IP Packet from CE, assigns the appropriate Label. After wrapping label, it sends labeled packet towards the next hop through the Label Switched Path, which is assigned for the specific Forward Equivalence Class. Assigning the Label is known as Label Binding. LER also acts as the egress Router. It receives the labeled IP Packets from the previous transit router, pops up the label (removes the label) and routes the IP packets towards the destined CE. LER receives the multiplexed input from CE, and extends the switched output towards the transit routers.

Label Switching Router

Label Switched Routers are basically working as transit switches in MPLS cloud. It receives Labeled IP packets through the appropriate LSP. It analyses the Label bound over the packet, consults the forwarding information table (LIB) and routes the packet through the appropriately mapped outgoing LSP. When the LSR is routing the packets from incoming LSP to outgoing LSP, it strips out the Incoming Label and assigns a new label to same packet to ensure the security from the intruders. This process is known as Label Swapping or Label Changing. MPLS Network architecture is as shown in the diagram. Lines, shown between CE and LER carry the IP Packets bi-directionally.

10.6.1 LABEL SWITCHED PATHS

Within an MPLS domain, a path is set up for a given packet to travel based on an FEC. The LSP is set up prior to data transmission. Lines, shown in the MPLS domain, are the Label Switched Paths that carry labeled IP Packets between the routers. There are two types of Label Switched Path. One is Static LSP and the other is Signaled LSP.

- **Static LSPs**

Static LSPs are configured manually on each LSR in the LSP. No signaling protocol is used. To establish a static LSP, you configure the ingress LER, transit LSRs, and egress LER, manually specifying the labels to be applied at each hop.

- **Signalled LSPs**

Signalled LSPs are configured only at the ingress LER. When the LSP is enabled, RSVP signaling messages travel to each LSR in the LSP, reserving resources and causing labels to be dynamically associated with interfaces. When a packet is assigned to a signaled LSP, it follows a pre-established path from the LSP's ingress LER to its egress LER.

10.6.2 HOW MPLS WORKS?

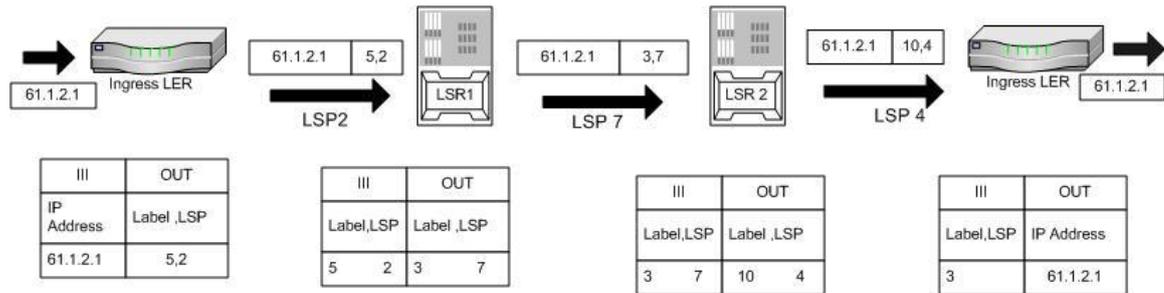


Figure 2:

LER receives destined IP packet 61.2.1.1 from the Customer Edge and selects the correct label (5) from its LIB. It binds the selected label (5) according to the FEC over the IP packet and sends it through the pre programmed LSP (2) towards the LSR 1. On receipt of labeled IP Packet, LSR1 analyses label only and it will ignore the IP address. It will consult its LIB for further routing. As the result it removes the incoming label (5), winds the newly assigned label (3) over the IP Packet and sends it towards the LSR2 over the assigned LSP (7). LSR2 consults its LIB and transmits the IP Packet after swapping the incoming Label (3) with outgoing Label (10) towards the egress LER over the pre assigned LSP (4). Egress LER stripes the label (10), goes through the destined IP address (61.1.2.1) and hands over it to the correct CE.

10.6.3 FORWARD EQUIVALENCE CLASS

Forward equivalence class (FEC) is a representation of a group of packets that share the same requirements for their transport. All packets in such a group are provided the same treatment en route to the destination. As opposed to conventional IP forwarding, in MPLS, the assignment of a particular packet to a particular FEC is done just once, as the packet enters the network Forward Equivalence Class is created in the LER based on

- Class of service requirement.
- Quality of Service requirement.
- Prefixes of the IP addresses.

Based on Class of service requirement: IP packets from different users are categorized on the basis of class of services they are entitled and allotted with one Forward Equivalence Class number .For an example, One FEC represents all the VOIP packets received from different users and MPLS Domain a treats them equally.

Based on Quality of Service requirement: Some online services like video conferencing requires constant and high-speed data transmission. If delay exceeds, there could be a loss of intelligence. Such IP packets could not be made to wait in the queue. Such services deserve the separate FEC.

Based on the prefixes of the IP addresses: FEC is assigned on the basis of the prefixes of the IP address of the destination.

Label

A label in MPLS is used as the routing code like STD code in circuit switch. It identifies the path a packet should traverse in the MPLS domain. Label is encapsulated in a Data Link Layer 2 header. So, new layer is formed in between Network Layer and Data Link Layer in OSI Layer concept. The name of the new layer is MPLS SHIM Layer. Function of this layer is to bind the MPLS Label over the IP packet received from the customer edge. Label contains the information about next hop address. Value of the label is having local significance. So same label number can be reused in some other area.

10.6.4 GENERIC MPLS LABEL FORMAT

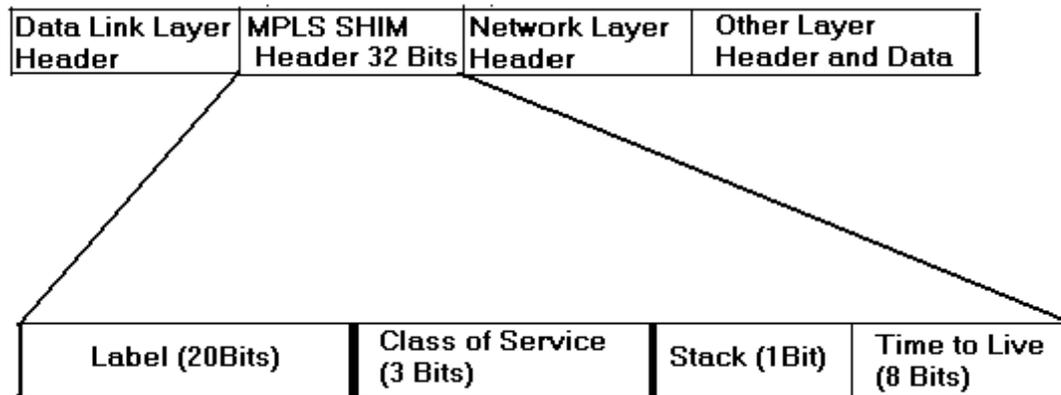


Figure 3:

MPLS layer works between Network layer and Data Link Layer as shown in the Diagram. Label binding and popping is done by the ingress and egress LERs respectively while LSR does the Label Swapping.

- VPI/VPC of ATM, DLCI of Frame Relay are used as Labels, while they are supported by MPLS.
- MPLS also supports the PPP. Shim Layer is created in between L3 header and L2 header in all LERs for the insertion of label to the IP packets received from Customer Edge.

ATM's header as Data Link Layer

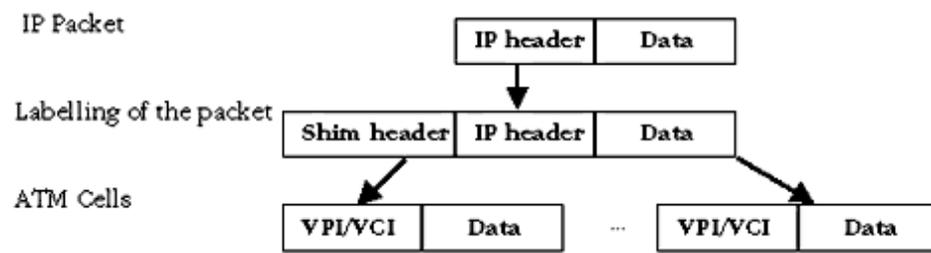
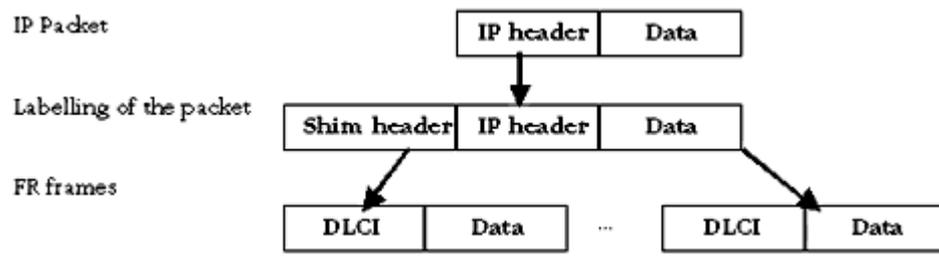
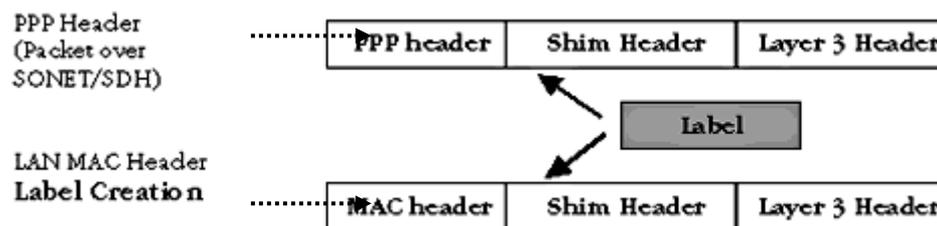


Figure:4

Frame Relay header as Data Link Layer

**Figure:5**

10.6.5 Point-to-Point (PPP)/Ethernet as the Data Link layer

**Figure:6**

10.6.6 LABEL BINDINGS

Once a packet has been classified as a new or existing FEC, a label is assigned to the packet. The label values are derived from the underlying data link layer.

ATM, Frame Relay, Point-to-Point Protocol/ Ethernet, and MPLS are having following common characteristics:

- Connection oriented protocols.
- Associated with the frame level functioning.
- Transfer the IP packets between the adjacent nodes only.

These are the obvious reasons for MPLS supporting these protocols. So data link layers (such as frame relay or ATM), Layer-2 identifiers, such as data link connection identifiers (DLCIs) in the case of frame-relay networks or virtual path identifiers (VPIs)/virtual channel identifiers (VCIs) in case of ATM networks, can be used directly as labels. The packets are then forwarded based on their label value.

Labels are bound to an FEC as a result of some event or policy that indicates a need for such binding. These events can be either data-driven bindings or control-driven bindings. The latter is preferable because of its advanced scaling properties that can be used in MPLS. Policy of label binding is based on

- Destination unicast routing
- Traffic engineering
- Multicast
- Virtual private network (VPN)

- Quality of Service.

10.6.7 LABEL MERGING

The incoming streams of traffic from different interfaces can be merged together and switched using a common label if they are traversing the network toward the same final destination. Label merging is the replacement of multiple incoming labels for a particular FEC with a single outgoing label.

Label Stack

In MPLS architecture different labeled IP packets bound to a common destination can be assigned with a common label. Thereafter that common label can be used up to the destination as shown in the diagram.

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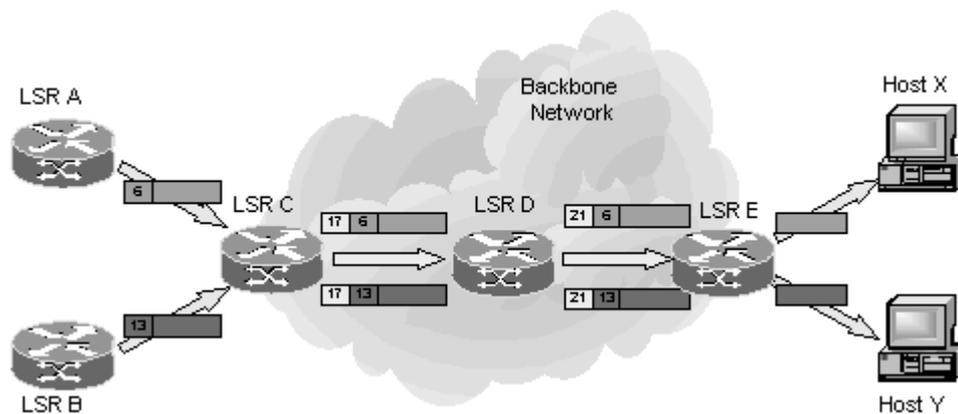


Figure:7

It achieved by stacking the label at LSR based on the instant of arrival packets through the incoming LSPs. It is organized as a last-in, first-out stack. We refer to this as a "label stack". Last label has 1 in the stack field, while others filled with 0 in the stack field.

10.7 DIFFERENT TYPES OF PROTOCOLS USED IN MPLS NETWORKS

- **Open Short Path first (OSPF)** is the routing protocol, that multicasts the change in routing table of a host to all other hosts with in the boundary of Network. In MPLS Network, this protocol is used as **Label Distribution Protocol** between peers. This protocol is one among the Interior Gateway Protocols (IGP)
- **Border Gateway Protocol** is also one among the routing protocol, which provides loop-free inter domain routing between autonomous systems. An autonomous system is a set of routers that operate under the same

administration. Here MPLS Domain becomes autonomous system. BGP is often run among the VPN networks and MPLS Network.

- **Protocol-independent multicast (PIM)**, which is used for multicast states label mapping.
- **Resource Reservation Protocol** is not the routing protocol and works in conjunction with other routing protocols to keep the Quality of Service with in the MPLS cloud. It uses exchanging of labels pertaining to the services require time management (on line services like Video Conferencing, IP Telephony etc. RSVP provides the creation of Tunnels in MPLS Domain.

Label Creation

Label is created during the following events:-

- The construction of MPLS architecture.
- The creation of new LER and LSR.
- Introduction of new user with distinguished service like VPN etc.

There are several methods used in label creation:

- **Topology-based method**—uses normal processing of routing protocols (such as OSPF and BGP)
- **Request-based method**—uses processing of request-based control traffic (such as RSVP)
- **Traffic-based method**—uses the reception of a packet to trigger the assignment and distribution of a label using label request and label assign mechanism for routing the unlabeled IP packet is received.

10.7.1 LABEL INFORMATION BASE

Label Information Base is Software database crated in both LER and LSR. It contains the mapping information of Incoming label & LSP with outgoing Label & LSP. This database is created during the installation of the router and subsequently updated automatically when the new LSR and LER is added by using Label Distribution Protocol.

Label Information Base contains the following components: -

- FEC-to-label bindings.
- Forward Information Base.

FEC-TO-LABEL BINDINGS

This table contains the mapping information for binding the label over the IP Packet based on the FEC. This table resides in LIB of LER.

10.7.2 FORWARD INFORMATION BASE

FIB contains the following components of information.

- Next Hop Label Forwarding Entry (NHLEF)

- Incoming Label Map (ILM)
- FEC to NHLFE Map (FTN)

Next Hop Label Forwarding Entry(NHLFE)

Entry is used for routing IP packet towards the next hop. Also it defines how the IP packet is to be treated. Hence, this entry contains the following information: -

- Next hop address
- Interface number (LSP) in between the routers.
- Label binding (LER) /swapping (LSR) information, for binding/changing the label.
- Layer 2-encapsulation information.
- Label encoding procedure.
- Packet processing information.

NHLEF is created in all LERs and LSRs. More than one NHLFE may be created in LER and LSR, depending upon the number of next hop LSRs connected with it.

Incoming Label Map (ILM)

When an labeled IP packet is received from the previous LSP or LER, the LSP analyses the information available in the label. Then it will consult the ILM data base and decides the NHLFE to which it should be handed over to decide the next hop to which the IP packet is to be sent after changing the label. Thus ILM information is used to map the Incoming IP packet with the NHLFE. Since LSR uses ILM, LSRs store ILM information in their FIBs.

Forward Equivalence Class to NHLFE Map

When the destined IP Packet is received from the Customer Edge, LER assigned the appropriate Label according to the FEC. Then it looks into the FEC to NHLFE Map (FTN) entry to rout the labeled IP Packet further. So LERs contains the FTN information.

10.7.3 LABEL DISTRIBUTION IN MPLS DOMAIN

MPLS architecture does not mandate a single method of signaling for label distribution. It uses

- **LDP**—maps unicast IP destinations into labels. It provides hop-by-hop or dynamic label distribution, using IGP (OSF). The resulting labeled paths, called label switch paths or LSPs, forward label traffic across an MPLS backbone to particular destinations. It uses the request based label distribution also. LDP uses the following events, for distributing labels
- **Discovery messages** – announce and maintain the presence of new router in the network.
- **Session messages** – establish maintain and terminate sessions between LDP peers to exchange messages.
- **Advertisement messages**-- eate or change or delete mapping for FECs.
- **Notification messages** – provides signaling error information.

- **RSVP**—used for traffic engineering and resource reservation. When the new VPN /Video Conferencing/IP telephony user is created this protocol supports the distribution distinguished Labels with in the MPLS domain, resulting with the Traffic Engineered Tunnels which carry the distinguished user’s traffic.
- **Protocol-independent multicast (PIM)**—used for multicast states label mapping. Some users may want to broadcast their messages to different users, this protocol supports the distribution of multicast labels. As a result multiple of LSPs are formed between single users to multi-user during the broadcast period only.
- **BGP**— VPN functions out side of the MPLS network. But it uses the MPLS domain. Hence distinguished label is to be used when VPN- IP packet enters in the MPLS domain. This protocol supports the distribution of such Labels.

Request method of label distribution: - When new destined IP packet arrives at any one of the LER in MPLS domain, that ingress LER sends Label request to all other LERs in the MPLS cloud, specifying the new IP address. The related egress LER to which the new destined IP address is connected, responds the request and sends the Label for that new IP user towards requesting ingress LER in the same route in which label request is made, but in opposite direction. In between, LSRs will update their LIBs and forward appropriate Labels towards ingress LER. Finally ingress LER will update its LIB. Thereafter that LER will use that label while forwarding packets destined to that Peer Egress router.

10.7.4 SIGNALING MECHANISMS

- **Label request**—Using this mechanism, an LSR requests a label from its downstream neighbor so that it can bind to a specific FEC. This mechanism can be employed down the chain of LSRs up until the egress LER (i.e., the point at which the destined packet exits the MPLS domain).
- **Label mapping**—In response to a label request, a downstream LSR will send a label to the upstream initiator using the label mapping mechanism.

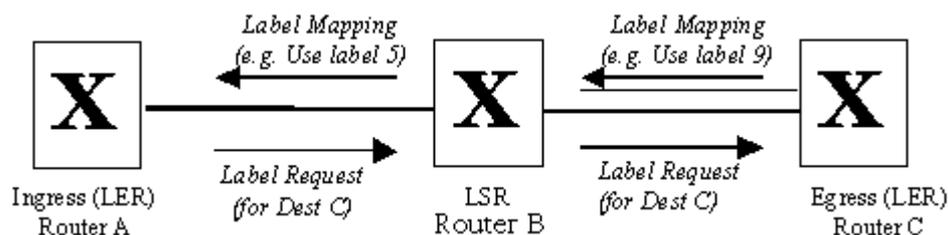


Figure:8

10.7.5 ROUTING IN THE MPLS CLOUD

- **Hop-by-hop routing**—Each LSR independently selects the next hop for a given FEC. This methodology is similar to that currently used in IP networks. The LSR uses any available routing protocols, such as OSPF, ATM private network-to-network interface (PNNI), etc.

- **Explicit routing**—Explicit routing is similar to source routing, that contains all the rout information. It uses the RSVP-TE signaling protocol. The ingress LSR (i.e., the LSR where the data flow to the network first starts) specifies the list of nodes through which the Traffic Engineered LSP traverses. The path specified could be no optimal, as well. Along the path, the resources may be reserved to ensure QoS to the data traffic. This eases traffic engineering throughout the network, and differentiated services can be provided using flows based on policies or network management methods. It uses the signaled LSP.
- **Constraint-Based routing**--to maintain the QOS, while routing the IP packets in the MPLS network characteristics of the Path and Link to be selected.

Path involves much number of Links between the ingress and egress peers. Less loaded path with minimum hops should be selected, while selecting the path.

Link involves the selection of next Hop and associated LSP. QOS dictates as follows.

- Bandwidth of the LSP.
- Permissible maximum delay. Whether the IP Packet should stand in the Queue or it should be given priority.

CB- routing mechanism takes care of all the above. It uses the source routing concept. These labels not only contain information based on the routing table entry (i.e., destination, bandwidth, delay, and other metrics), but also refer to the IP header field (source IP address), Layer 4 socket number information, and differentiated service. Once this classification is complete and mapped, different packets are assigned to corresponding Labeled Switch Paths (LSPs), where Label Switch Routers (LSRs) place outgoing labels on the packets.

10.8 TRAFFIC ENGINEERING IN MPLS

Traffic engineering is essential to optimize utilization of network. Network resources should not be wasted. At the same time QOS is to be maintained for the users. In MPLS Layer3 is overlaid with connection oriented switching function of Layer2. By using this property, we can define Traffic Engineered dedicated paths for different category of IP packets to maintain the QOS. Thus MPLS network is converted into homogeneous to handle the heterogeneous type of traffic these dedicated paths are known as Traffic Engineered Tunnels. MPLS uses the above concept. MPLS Tunnels are created by using CR- Based Explicit Routing. Different type of TE Tunnels is created based on the QOS of different users.

Sample MPLS Traffic Engineering Tunnel Configuration

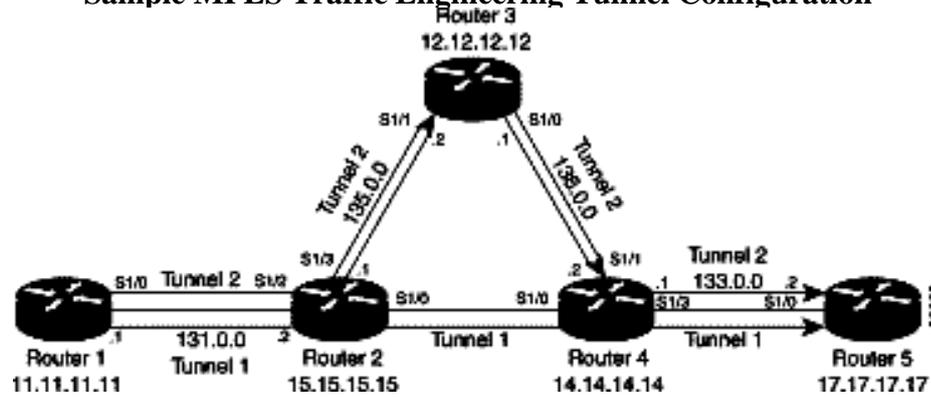


Figure:9

Inferences

- LE Routers and LS Routers are not analyzing the entire IP address to select best matching. Only they analyze the Label and LSP details that reduce the delay in routing the data packets. Construction of Routing Table becomes simple. It looks like circuit switch analyses the Rout Code only for routing the call.
- LSPs and Labels are selected for routing according to the Forward Equivalence Class of that IP Packet (category and priority) which is followed in the Circuit Switch by the LSRs.
- Since it is a connection oriented transmission protocol, loss of Packet is avoided.
- Security is ensured, because of Label Swapping.

MPLS supports the following services efficiently with full integrity

- Virtual Private Network
- Intranet
- Voice over Internet Protocol.
- Extranet.

10.9 VIRTUAL PRIVATE NETWORK

Function and features of VPN.

Branches of Corporate giants are normally distributed geographically over the entire nation at least. Since it is the competitive world, they may require their own private, secured, faster and economical data network between Corporate Office and all branch offices. Construction of their data network is not economical and unwise, because it involves provision of individual paths in between their offices to ensure the safety and authentication. Virtual Private Network comes as the solution of the above problem. Virtual Private Network is Private Data Network, carved out from the Public Data Network. In this concept only switched paths(virtual paths) are assigned

between the hosts. VPN can be constructed by using conventional IP network. But the users have to encounter with the defects in present IP backbone as discussed earlier. Since MPLS adopts the connection oriented routing, VPN can be overlaid on MPLS architecture, by constructing Tunnels. Other users according to their FECs can share tunnels.

In case of Circuit Switch area, PBX is used for local distribution of calls, by using the Junctions lines from the Exchange. In Telephone Exchange, only one number is assigned as Primary Directory Number. The subscriber is expected to dial only Primary Directory Number to get connected with any one of the Extension Telephones. The same concept is adopted in the Virtual private Network. VP Networks are created in the cloud of

IP network.

Each VPN sight is provided with one router at the edge, that acts as the gateway with the service provider network. It is known as "customer Edge". Router, that accommodates the CE is known as "Provider Edge". There are two types of VPN model basically.

- Overlay VPN Model.
- Peer VPN Model.

Overlay VPN Model, which supports direct IP routing between CEs, by using Service Provider Backbone. CE is connected with "Provider Edge" that acts as the gateway of IP backbone. CE is connected with PE by using from L1toL3.VPN logic (L3 functions) resides in the customer Edge. CE performs routing between its coordinated CEs (Hub), before it gets connected with the Provider Edge. Hence it is also known as "CE-based VPN". Architecture of this type is as shown in the figure.

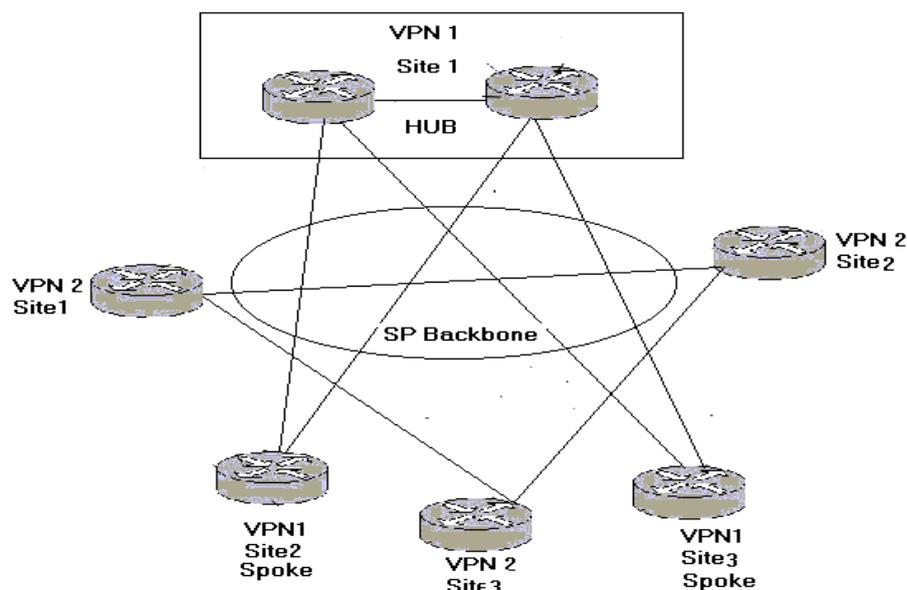


Figure:10

In this case Provider Edge performs Layer 2 Services only, since Customer Edge performs Layer3 functions. PE and P network is used to only provide the routing and forwarding that supports the tunnel endpoints on between CE devices.

Peer VPN Model, in which CE is not having any routing resources for having direct routing with other CEs. It has direct routing adjacency within the HUB. Outside of the Hub it depends upon the Provider Edge. Here Provider Edge performs Layer3 function. It works as shown in the diagram.

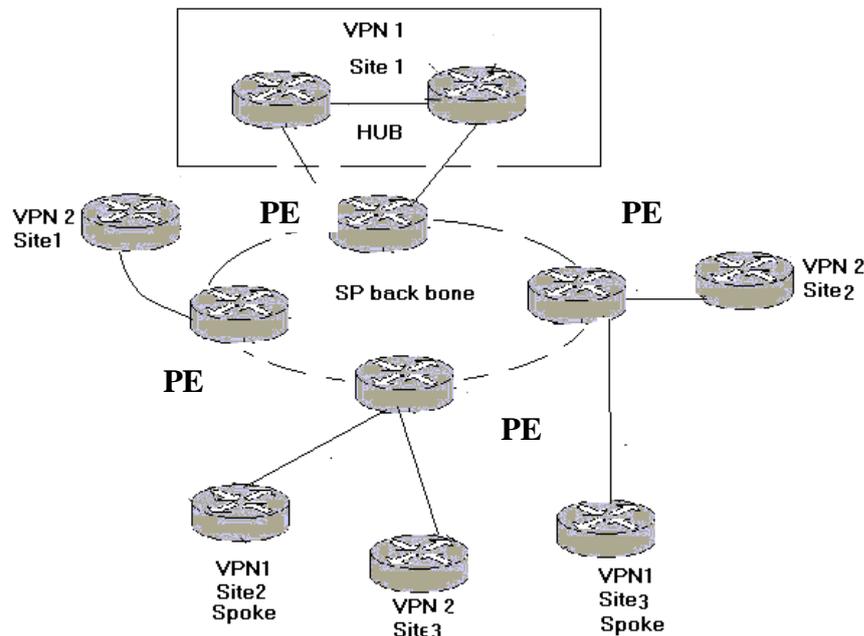


Figure:11

If the a corporate customer wants Layer3 VPN, Service Provider has to configure the IP addresses of the all Branch Offices and Corporate Office. Serving Customer Edge will be configured and maintained by the Service Provider. Every VPN user is allotted with unique VPN address or tag or header, which is represented by **8 bytes**. While transmitting the IP packet from one of the VPN member, Customer edge adds VPN header with designated IP address and sends to LER of service provider. LER affixes appropriate Label according to the FEC and sends those packets through the designated LSP (Tunnel) by LER. At last the packet will reach the egress LER that will send that VPN IP packet to C.E after removing the label. Then the C.E checks the VPN tag and routes the IP Packet to the destined terminal. VPN works as shown in the figure.

Customer Edge supports more than one IP Terminals. Path between CE can be a shared one. VPN Forwarding information(VFI) is available with the PE(LER)

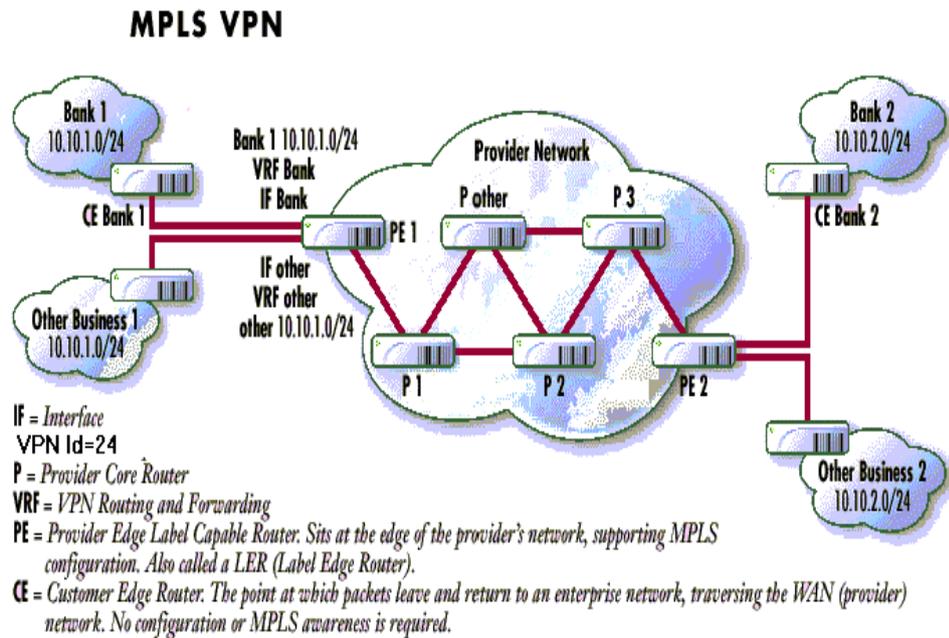


Figure 12:

In such a way, a corporate can create his private data network by using public MPLS network.

10.10 CONCLUSION

MPLS VPN is a popular technique to build VPNs for customers over the MPLS provider network. The better understanding of MPLS – VPN facilitates the participants to better handle the O and M of MPLS network in real time scenario.

11. ENTERPRISE SERVICE

11.1 LEARNING OBJECTIVES

After the completion of the module, the trainee will know about different Enterprise Services such as

- Voice
- Data
- Broadband etc with their key features

11.2 INTRODUCTION

There is a growing need of connecting various branches of an Enterprise, which might be located across the globe. Lease line & Internet bandwidth has become a must for networking multisite business. Today's business owner wants to focus more on its core competencies rather than trying to implement such things of their own. Such a networking solution often requires not just bandwidth, but hardware components, security solution and maintenance also.

11.3 KEY FEATURES

- a) Complete Reliable Services from One Interface Organization.
- b) Supply of not only Bandwidth but also Leased line Modems / Routers etc. i.e. Complete Telecom Solutions.
- c) Secured Network.
- d) Proactive Monitoring of the customers Network.
- e) Guaranteed SLA.

BSNL offering verities of Enterprise solutions as discussed below:

11.4 ENTERPRISE VOICE/MOBILITY SERVICE

11.4.1 EPABX

BSNL permits telephone subscribers to use their own PABX/EPABX connected to the BSNL network under certain commercial/technical conditions :

- a) The type of Subscriber owned EPABX should be approved by BSNL
- b) External extensions outside subscriber's premises will be permitted only on the specific approval of the concerned authority and charged as per departmental tariff. In cases where external extensions from subscriber owned EPABX are provided within the premises of the subscribers using their own cables and wires without crossing any public road, no charge will be levied.
- c) Subscriber is free to use the existing internal wiring of the internal extensions left at the premises after the closure of the EPABX.

d) External extensions from subscriber owned PABX may be provided by the department and charged. Underground cables and lines may continue to be maintained by the department since the same may be required for provision of various telecom services the subscriber may require.

e) In cases where BSNL feels that the existing cables/overhead wires are not be used/likely to be used by the company the same can be made over to the user after recovering the depreciated value of assets.

f) Where subscribers themselves provide and maintain external extensions from the EPABX, applicable license fee would be charged if the extensions are crossing a public road.

g) Cases where PBX/PABX facilities are surrendered before the expiry of the guarantee period will be regulated as per Company rules.

11.4.2 CENTREX

It is central office based communication service, which integrates all your multi located telephone lines (Existing and New) into a single highly functional communication group with more distinctive features without any additional equipment (like EPABX) at your premises. Highly cost effective, Free Intra Centrex calls, No worry to select innovative (PBXs) equipment, No risk of obsolescence of technology, No requirement of power supply, No need to waste valuable floor space, No annual maintenance charges, totally flexible are some of the salient features of Centrex facility.

The following conditions are prescribed for the provision of Centrex facility:

- a) The registration amount, initial deposit, monthly rental, installation charges, etc for DELs under Centrex shall be same as normal DEL.
- b) All intra Centrex calls shall be free.
- c) The free monthly call shall be allowed on the DELs covered under the Centrex.
- d) There is no upper limit on the number of members in the Centrex group.
- e) The option of consolidated billing, payment and discount, under the "**Corporate Account Holders scheme**" where applicable, may be provided to the groups or organizations covered under the Centrex. However, the condition of combined billing for all the DELs covered therein shall be mandatory. In other words, wherever technically feasible to generate single/consolidated billing/payment the Centrex feature shall be offered, otherwise it will not be provided. However, existing Centrex groups may continue even without consolidated billing/payment.
- f) The DELs belonging to public services like, call centers, enquiry numbers, ISP Dial in numbers, paging service numbers, etc., besides franchises, PCO holders shall not be part of the Centrex group.

11.4.3 TOLL FREE SERVICE

This service is an ideal business promotion tool for business communities who want their customer to call them free of cost. Totally customer oriented organizations can provide information about their products, allow customers to place orders or even register their complaints/suggestions and offer assistance to customers without the user getting charges. Other features are:

- a) This service can be taken on any existing telephone line without requiring any additional line.
- b) Any user of BSNL telephone network can call FPH/TLF number free of charge.
- c) All charges are to pay by the FPH/TLF holder (who has taken this service & receive the call).
- d) The service subscriber is allotted a FPH service number (Eleven digits). For same FPH service number, the subscriber can have many destination numbers.
- e) Any subscriber who is willing to become a free phone subscriber outside the cities where the IN switches are installed, the call charges will be as per the national STD tariff.
- f) The charges indicated here are FPH service charges and they do not include the normal charges levied for basic telephony service.
- g) Billing for the same is separately issued to subscriber on monthly basis, which does not include landline rent & charges on which the TLF/FPH services is taken.
- h) Access Code is 1800233 (For new IN platform).
- i) Total digit for service is 1800-233-ABCD (For new IN platform)
- j) Vanity numbers are available for selection of ABCD on charge basis.

11.4.4 ISDN

ISDN Has emerged as a powerful tool worldwide for provisioning of different services like voice, data and image transmission over the telephone line through the telephone network. ISDN is being viewed as the logical extension of the digitalization of telecommunication network and most developed countries are in different stages of implementing ISDN.

11.4.4.1 Connectivity

The ISDN subscriber will have full connectivity, nationally, to other analog telephone subscribers. At present ISDN services are available to and from India for the following countries:-

Australia, Austria Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Israel, Japan, Malaysia, Netherland, Norway, Phillipines, Singapore, Switzerland, Thailand, U.A.E, U.S.A

11.4.4.2 Services Offered By ISDN

- a) Normal Telephone & Fax (G3)
- b) Digital Telephone -with a facility to identify the calling subscriber number and other facilities.
- c) G4 Fax
- d) Data Transmission at 64 Kbps with ISDN controller card
- e) Video Conferencing at 128 Kbps
- f) Video Conferencing at 384 Kbps (Possible with 3 ISDN lines)
- g) ATM (Asynchronous Transfer Mode) or PVC (Permanent Virtual Circuit)

11.4.4.3 Variety of supplementary Services supported by ISDN

- a) Calling Line Identification Presentation (CLIP)
- b) Calling Line Identification Restriction (CLIR)
- c) Multiple Subscriber Number (MSN)
- d) Terminal Portability (TP)
- e) Call Hold (CH)
- f) Call Waiting (CW)
- g) User to User Signaling (UUSI)

11.4.4.4 Types of Accesses

There are two types of "accesses" (connections) for ISDN.

11.4.4.5 Basic Rate Access (BRA): 2B+D

- a) 2 Channels of 64 Kbps for Speech And Data.
- b) 1 Channel of 16 Kbps for Signalling

11.4.4.6 Primary Rate Access (PRA): 30 B+D

- a) 30 Channels of 64 Kbps for speech and data.
- b) 1 Channel of 64 Kbps for signalling.

11.4.4.7 3G MOBILE SERVICE

BSNL 3G voice service also come under the category of Enterprise Voice service

11.5 ENTERPRISE DATA SERVICES**11.5.1 MPLS Based VPN Services**

Keeping pace with the technological trend to provide latest and varied value added services to its customers, BSNL harnesses IP Infrastructure based on MPLS Technology to offer world class IP VPN services. MPLS is an acronym for "Multi Protocol Label Switching".

MPLS VPN is a technology that allows a Service Provider like BSNL to have complete control over parameters that are critical to offering its customers service guarantees with regard to bandwidth throughputs, latencies and availability. The technology enables secure Virtual Private Networks (VPN) to be built and allows scalability that will make it possible for BSNL to offer assured growth to its customers without having to make significant investments. BSNL would now be geared to provide Bandwidth on demand, Video Conferencing, Voice Over IP (VoIP) and a host of other value added services that could revolutionize the way a corporate businessworks.

MPLS based VPNs reduce customer networking complexity, costs and totally do away with the requirement of in-house technical work force. Rather than setting up and managing individual point-to-point circuits between each office using pair of Leased Lines, MPLS VPN customers need to provide only one connection from their office router to a service provider edge router.

BSNL has tied up with various Networking solution providers to provide end-to-end solution to its valued customers, including Customer End (CE) routers and other networking components.

11.5.1.1 What advantages does MPLS VPN have over other Technologies:

BSNL's primary objectives in setting up the BGP/MPLS VPN network are:

- a) Provide a diversified range of services (Layer 2, Layer 3 and Dial up VPNs) to meet the requirements of the entire spectrum of customers from Small and Medium to Large business enterprises and financial institutions.
- b) Make the service very simple for customers to use even if they lack experience in IP routing.
- c) Make the service very scalable and flexible to facilitate large-scale deployment.
- d) Provide a reliable and amenable service, offering SLA to customers
- e) Capable of meeting a wide range of customer requirements, including security, quality of Service (QOS) and any-to-any connectivity.
- f) Capable of offering fully managed services to customers.
- g) Allow BSNL to introduce additional services such as bandwidth on demand etc over the same network.

11.5.2 INTERNET LEASED LINE

- a) ILL is an always on Internet connection based on leased line access (i.e. dedicated access). Leased lines provide the last mile access from the user premises to BSNL equipment.
- b) Required by heavy users like educational institutes, big cyber café, small and medium corporate house who need to constantly remain online with Internet.
- c) Permanent Internet connection as compared to the temporary connectivity through dialup access.
- d) Far superior quality as compared to dialup, thanks to digital signaling, less noise, fewer exchanges etc.
- e) A scalable access method - Bandwidths starting from 64 Kbps to 2 Mbps to 8 Mbps, 10/100Mbps Ethernet connectivity, 34/45/155 Mbps and beyond can be deployed.
- f) Since the access is "always on", it is possible to associate a pool of permanent IP addresses with a particular leased line. Using IP addresses provided by BSNL, it becomes possible to deploy a variety of services such as mail, FTP, WWW, DNS, and proxy, to name the most common requirements of organizations. In other words, leased lines enable hosting of services of all types, and provide a platform for enterprise intranets and extranets, apart from what we may term as "entry level" services such as messaging, which still account for over 70 percent of all Internet access.
- g) Leased Internet bandwidths up to 2Mbps are provided using modems on copper pair, however, large bandwidths are provided using OFC in the last mile.

11.5.3 VPN OVER BROADBAND

Presently, BSNL is providing VPNoBB for General EB customers as well as e-Governance projects for bandwidth 256 kbps to 24 Mbps

11.5.3.1 V-SAT Network

The network consists of a Hub located at Bangalore and VSATs located throughout the country. The VSAT communicates to the HUB through Express AM1 Satellite. All VSATs are connected in STAR topology and VSAT to VSAT communication is through the HUB at Bangalore. For more information on the service kindly read the FAQ. Ku band VSAT network of BSNL is capable of providing high speed data transfer up to 2Mbps (presently 512 Kbps) and voice communication service covering the entire country.

Tariff

- a) BSNL offers competitive and affordable Tariff.
- b) The Tariff is offered based on customer applications.

CUSTOMER CARE

- a) Reliability of Network 99% and above.
- b) 24x7 Help Desk and Technical support.
- c) Zone wise customer support centers for quick Fault clearance.
- d) Billing information can be accessed through Web Self care.
- e) Complaints can be booked either through internet, Toll free Phone Number.

11.5.4 LEASED LINE

To transmit data between computer and electronic information devices, BSNL provides data communication services to its subscribers. It offers a choice of high, medium and low speed leased data circuits as well as dial-up lines. Bandwidth is available on demand in most of the cities. Managed leased Line Network (MLLN) offers flexibility of providing circuits with speeds of n x 64 Kbps up to 2 Mbps. Useful for internet leased lines and international principle Leased Lines (IPLCs).

For dedicated point to point speech, private wire, tele-printer and data circuits are given on lease basis. Leased circuits are provided to subscribers for internal communication between their offices/factories at various sites within a city/town or different cities/town on point to point basis, or on a network basis interconnecting the various sites.

11.5.4.1 Managed Leased Line Service(MLLN)

The MLLN is a Managed Leased Line Network system which is proposed to provide Leased line connectivity. The State-of-the-art technology equipment MLLN is designed mainly for having effective control, monitor on the leased line so that the down time is very much minimized.

Speech Circuits (Hot Line or Private Wire)

Local or Long distance circuits within two locations in a city or between two different cities provided for the same applicant. The Terminating equipment at both ends is telephone without dialing facility. Both way signaling and speech is possible.

Data Circuits

Local or Long distance data circuits at different speeds viz. nx64 kbps and 2 mbps.
Data Circuits are of different types:

a) Point to Point Data Circuits - Local and Long Distance

b) Private Data Network - More than one Local or Long Distance leased circuits converging on a location such that data from one leased circuit can be transferred automatically to another leased circuit for the same subscriber.

c) Closed User Group - Leased circuits can be used by more than one legal entity if they form closed user group. The following categories of user groups constitute closed user groups for the purpose of licensing Private Telecom Networks.

11.5.5 IDC SERVICE

BSNL IDC is a service brand name for the data center services provided by Bharat Sanchar Nigam Limited, A leading telecom service provider in India. BSNL IDC is a state-of-the-art data center located at six major locations across India who maintains most fault tolerant networks. Internet Data Center services comprises IT operations which is provided with the expertise well recognized worldwide.

11.5.5.1 Managed Co-location Services

Co-location refers to co-locating your server or hardware at a Service Provider's Data Center and willing to pay only the rental charges for Bandwidth, racks space and climate control.

11.5.5.1.1 Features

- a) Customers have flexibility to even choose the SLAs most suited to their business environment
 - Tier III uptime certified Datacentres, 99.982% uptime guaranteed SLA
 - Custom-designed racks and space
 - Scalability on Demand anytime
- b) High levels of security (ISO 27001 & SAS 70 Certified Datacentres)
- c) 24x7 physical security – Security guards, CCTV surveillance and biometric access control
- d) Flexible pricing customized to customer's convenience.

11.5.5.2 Managed Hosting Services

It is a type of hosting in which the Customer leases an entire/ or part of server dedicated/ or shared with anyone. This is more efficient, client oriented and flexible. Here Customers are having full control over the servers and has choice of operating system, system configuration etc. Customers have to pay according to their requirement about system configurations. It can provide less overhead and a larger Return on Investment (ROI).

11.5.5.2.1 Features

- a) Convenience: Stop worrying about the fundamental problems of buying and maintaining hardware, giving you the convenience of focusing on your business instead diverting your mind towards management of infrastructure management.
- b) Control: Have control over the configuration, administration of your servers, choice of hardware etc.
- c) Scalability: Customer can increase resources such as memory or storage etc.
- d) Security: To protect your data security parameters can be tailored to Customer requirements. Customer can adopt multiple levels of security measures to safe and smooth operations.
- e) Faster deployment of services
- f) Vanishes threat of obsolescence
- g) Rapid response (e.g. in matters of configuration etc.)

11.5.5.3 Managed IT Services

It is a way of shifting day to day responsibilities of managing IT infrastructure in an efficient and more effective manner.

11.5.5.3.1 Features

- a) Clients can use our expertise in managing servers, storage, security, database, backup and DR, capacity planning, facilities management, service desk operations and remote infrastructure management.
- b) Any type of enrolment can be in an open and transparent way with a dedicated account manager providing a single point of contact and a personal commitment to successful outcomes.
- c) Our skill set covers network engineering, business information systems combined with broad IT project management capabilities to ensure that your technology and business goals are achieved.

11.5.6 ENTERPRISE BROADBAND

11.5.6.1 Wi-Fi

Wi-Fi Services have been introduced for providing high speed internet access at convenient public locations hereunder called as Hot Spots. Installation of Hot Spots is already under process at various cities/ locations.

Hot Spot Type-A is applicable for public utility services like Airports, Railway Stations, Universities and their campus etc initially for a period of 90 days from the date of its launch.

Hot Spot Type-B is applicable for personal type of services like Hotels, private owned institutes/ Colleges/ libraries/ Universities and their campuses etc. Prepaid schemes for Hot Spot B owners on commission basis is also available.

11.5.6.2 DSL BROADBAND

DSL is a wireline transmission technology that transmits data faster over traditional copper telephone lines already installed to homes and businesses. **DSL-**

based **broadband** provides transmission speeds ranging from several hundred Kbps to millions of bits per second

11.5.6.3 FTTH BROADBAND

Fiber to the home (**FTTH**) is the delivery of a communications signal over optical fiber from the operator's switching equipment all the way to a home or business, thereby replacing existing copper infrastructure such as telephone wires and coaxial cable.

11.5.6.4 VPN OVER FTTH

The VPNoverFTTH service for e-governance projects will be offered as on 'Add On' service on BSNL FTTH only to those customers who opt a BB plan of minimum Rs.700/- per month values. The customers will be able to access either VPN or Internet at a time.

11.6 MANAGED ENTERPRISE SERVICES

11.6.1 Manage Network Service

BSNL Managed Network Services is a fully managed Secured Data services, providing a truly one-stop and a complete experience that significantly reduces risks and complexities involved in implementing and maintaining a robust IP network. It brings together all of a business' communications needs in an integrated offering.

With the promise of an integrated platform with one-stop convenience and fully managed experience, BSNL Managed Network Services is an All-in-One comprehensive bundle of hardware, connectivity packages and managed services.

It is a solution that simply, affordably and reliably supports your business.

Comprehensive Service Package:

The "One-Stop" promise delivered by BSNL Managed Network Services is beyond technical integration of the best-in-breed network and hardware setup. It offers truly executable technical and business propositions for your business today:

- a) No CAPEX
- b) No risk of technical obsolescence
- c) Scalable according to changing business needs
- d) One helpdesk number to call for troubleshooting and fault resolution.
- e) Integrated customer report (Web Based) giving you a complete view of your network

11.6.2 Managed Global Audio Conferencing Service

BSNL has launched Global Audio conferencing Service in association with British Telecom (BT). It is an easy to use, reservation-less conferencing service aimed at Enterprise customers. The Enterprise customer has to subscribe the service by

filling a form as application. There are no charges for service subscription. Charges are only for the usage of the service.

11.6.3 Managed SaaS

BSNL Managed SaaS (Software as a Service) Business Mail Service has been launched with M/s Microsoft India Ltd.

11.7 OTHER ENTERPRISE SERVICES

11.7.1 Web Colocation

Web Co-location is an easy and cost effective solution to house a company's powerful infrastructure without losing the administrative control on the equipments.

11.7.1.1 Typical Applications

E-commerce, financial, B2B, email and other data storage and retrieval.

11.7.1.2 Facilities

- a) Air-Conditioned, dust free, fire-safe and secure space with racks (42 U) at the nodes for co-location.
- b) Necessary CAT5 cabling for connecting the server to the LAN.
- c) AC and DC power supply.
- d) One Sancharnet account of 100 hours to customer to enable administration of the server.
- e) BSNL provides one IP Address per site on request

11.7.2 Fleet Tracking

An innovative on-line tracking system powered by BSNL to manage fleets comprising of trucks, car carriers, trailers, tankers, containers or vehicles moving hazardous and specialty explosive chemicals etc. The eTracK vehicle tracking system uses vehicle-mounted, microprocessor-controlled device which sends periodic messages from the vehicle to a network command centre through SMS/GPRS. The received data is authenticated and forwarded to an application server which provides tracking information through an internet. Customers are provided a user name and password to access the fleet information on line. The user also has options to receive tracking information via e-mail, fax or SMS besides the facility of calling the customer support team on a toll-free telephone line.

11.7.2.1 Features

- a) No driver intervention
- b) Automatic Real time system.
- c) Vehicle information available 24 X 7
- d) Secured internet access anywhere in the world.
- e) Information through fax and emails
- f) Mobile Query SMS
- g) Widest Coverage on National highways through 20000+ BSNL towers spanning across 5000+ cities/town

- h) Transparency and Trust at your doorstep with MIS reports for better fleet management

11.7.3 Video Conferencing

'v-Sangoshti' BSNL Managed Public Room video Collaboration Service , is a unique service,making video conferencing facility accessible and simple to everybody across nation.Its ready to use infrastructure, along with rapid connectivity, ease of use and lower total cost of ownership.v-Sangoshti studios are 24x7 available video collaboration rooms that are connected to multiple such public rooms nationally and can be used by any Retail,SMB, Enterprise or any PSU/Government customers through reservation on demand basis on "pay as you go" model.These studios have the capability to connect to any private video enabled device across Public IP,MPLS, ISDN access having SLA with ease of use,higher uptime, proactive operator assistance and high definition video resolution to the users.It provides additional facilities of recording, live streaming, web casting and can connect to audio devices i.e landline/mobile on user demand.

11.7.4 Web Hosting

Web hosting is a service that allows users to post Web pages to the Internet. It allows users to publish their own information resources to any Internet user interested in accessing them. It is a business that provides the technologies and services needed for web sites to be viewed on the web.

11.7.4.1 Features

- a) Domain name hosting
- b) Web Publishing : HTML pages with Browser supported MIME pages
- c) Server side scripting: Perl, Java Servlets , JSP
- d) Web Server: Apache, Tomcat.
- e) Data base : MYSQL
- f) SMTP (Exim) and POP3 (apop3d) service for each domain
- g) Multiple e-mail ids per domain with flexible mail quota possible
- h) FTP access for uploading /downloading files
- i) Centralized authentication for SMTP, POP3,FTP and for administration
- j) Multiple Web Hosting Plans to choose
- k) Multi user Admin- Administration Console for the management of services & usage reports.
- l) Multi User – User Administration Console for limited management of services and usage reports. Data Transfer quota Exceeded Message Display.
- m) No hard limit on quota
- n) Round the clock Technical report support through Help Desk (1957)

11.7.5 Bulk Push SMS

BSNL Bulk SMS service provides a simple and user-friendly way for sending bulk as well as individual messages at affordable rates. This Service includes the facility to send both transactional and promotional SMSs. Transactional and Promotional SMS can be send by customers through our

webportal/API. Promotional SMS can be availed by the Customers having telemarketing registration .

11.7.6 GSPS(Global Satellite Phone Service)

BSNL's GSPS also called satellite phone service, provides voice communication and messaging from any part of the globe. However, presently, the services will be available within India only. It is a ubiquitous service, hence can be used from all part of the country including territorial water. It is being provided through world's most advanced satellite communications network working on Inmarsat I-4 F2 satellite located at 63.90 degree East. It is suitable for persons working in remote areas or disaster affected areas – defence, border security organizations, disaster management bodies, trekkers, fishermen, maritime applications.

11.8 CONCLUSION

In this session we learn about the different Enterprise Services (Voice, Data, Broadband etc) with their key features.

12. ENTERPRISE SOLUTION DESIGN

12.1 LEARNING OBJECTIVES

After the completion of the module, the trainee will be able to understand

- the Common requirement of Enterprises
- the common Solutions for Enterprises
- The Case Study

12.2 ENTERPRISE SOLUTION:

Communications is an inherent requirement of any enterprise. The scale, complexity and networking requirements for communication vary depending on the nature, size, acceptable delay and geographic spread of the enterprise. In general the communication solutions comprise of three elements:

- Hardware
- Software
- Telecom operator services such as Bandwidth, landline, mobile etc.

Integration of above three elements is also required. Job of enterprise solution designer is to develop a customized enterprise telecom (networking) solution which exceeds the competitor offerings in terms of various parameters such as price performance etc.

12.3 ENTERPRISE SOLUTION DESIGN

The design document is a high-level design report that describes how the supplier proposes to implement a technical solution to fulfill enterprise (customer) requirements. This design is customized to the specific integration and business process management. The document includes:

- Business and technical requirements regarding the proposed solution
- High-level design approach
- Solution design in terms of a BPM process flow
- Data flow diagram describing the technical solution
- List of discrete services/activities that are depicted in the flow
- Best practices guidelines describing implementation phases and tasks
- Effort estimate for the solution based on experiences with similar projects
- Deployment scenario for the solution in terms of hardware and software needed

12.4 ENTERPRISE REQUIREMENTS

To design an appropriate solution, the vendor has to understand various requirements of the enterprise. An indicative list of such requirements is given below:

- Short term and long term needs i.e. scalability
- CAPEX V/s OPEX models
- Service Level Agreements
- Telecom Expense Management
- 24X7 monitoring
- Long term service support
- Proprietary V/s generic hardware components
- Software components of the proposed solution [user friendliness, upgrades etc.]
- Plug & play type V/s High Tech skill for solution users
- Implementation time frame
- Smooth changeover from existing setup
- Disaster recovery and backup plans
- Number of sub contractors involved

12.4.1 CREATING BREAKTHROUGH SOLUTIONS FOR ENTERPRISE

Effective visions and business process designs result when:

- the solution has clearly defined **objectives** and **scope**
- the right **people** come together to form the team
- the solution team goes through a **learning process** together
- the team applies proven techniques for **creative** design
- The solution is analogous to a project and project management concepts hold good for solution design.

The overall process is show in the Figure below.

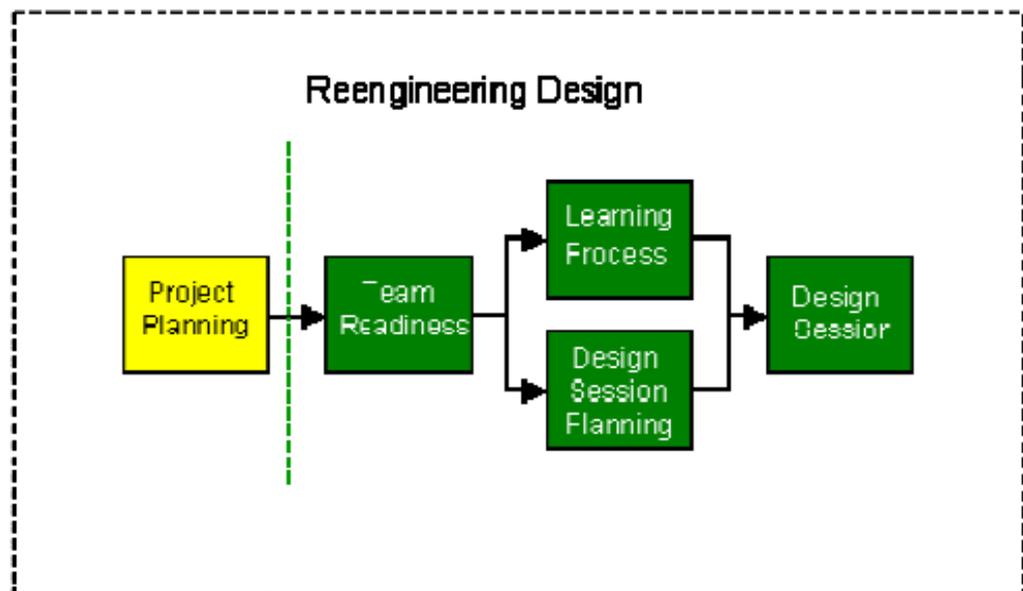


Figure:1

12.4.1.1 Getting ready: The solution objectives and scope are set during project planning. These are documented in the project plan and presented to key leaders involved in the business solution. Be sure to identify what is included in the scope of

the project, and what is not included in the scope of the project. Figures and graphics are an easy way to convey scope. Objectives need to be clear, communicated and agreed upon. Many projects fail to define the conditions of success - they set objectives (increase revenue) but fail to define what success looks like (increase revenue by 10% in 6 months).

12.4.1.2 Team Readiness: Team readiness is a key success factor for solution design. In many cases, telecom solution design involves experts from different domains such as wired, wireless and bandwidth. BSNL now has three verticals namely CFA, CM and Enterprise. While design is primarily handled by Enterprise wing yet they may need to rope in experts from other units.

Effective teams begin with a solid foundation in the following areas:

- business process reengineering
- benchmarking
- customer and employee data gathering
- process modeling
- business case development

12.4.1.3 The Learning Process: The learning process is often the source of true breakthroughs for solution teams and helps separate the team from the current realities and problems of day-today work. Many teams want to jump right in and design the new process based on the current knowledge of team members. Unless the customer has clearly articulated its requirements in terms of links, services, network diagrams etc., applying the principles of business process reengineering i.e. seeking new and innovative ways to produce dramatic improvements in business results is very important. Learning sources should include:

- Customers, Employees, Competitors, Non-competitors, Technology

Learning involves both internal data gathering from customers and employees, and external data gathering about technology and the practices of other companies.

Benchmarking is the process of learning these best practices and lessons-learned from other organizations. The result of benchmarking is new ideas and perspectives that help to develop the best solution.

12.5 SOLUTION DESIGN

Solution design is the creative process. The key steps are:

- Learning review, Idea generation, Concept selection, Design modeling, Business case development

The steps for the design session referred to in Figure 1 are shown in Figure 2 below.

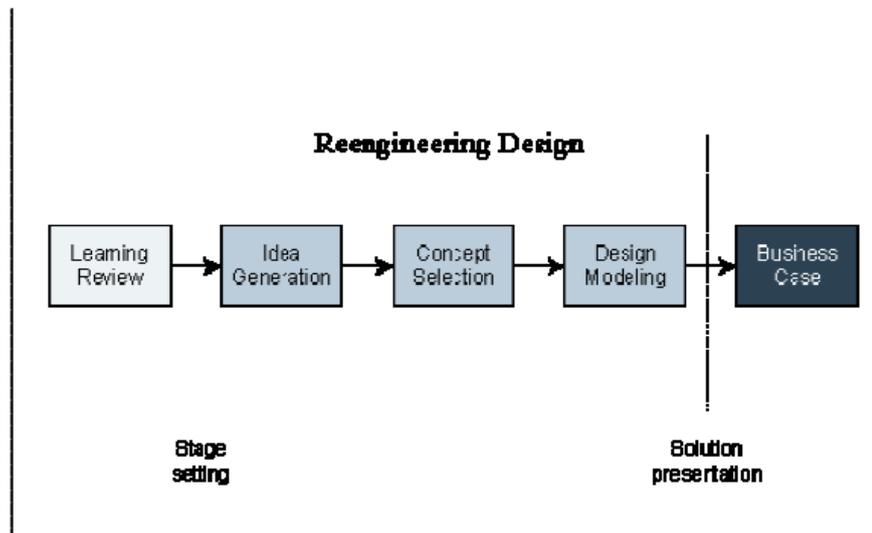


Figure 2

12.5.1 Summary of activities that must be completed before solution design begins

- The team selection and team readiness activities have been completed (including team building).
- The team has gathered data on best practices and performance levels of competitors and non-competitors through benchmarking.
- The team has gathered data from customers.
- The team has gathered data from employees.
- The team has researched new technologies that may enable new processes and capabilities.
- The team has shared information and learning between team members.
- The design session has been planned and all arrangements have been confirmed.
- The process for conducting the design session has been selected and skilled
- Facilitators are available to help the team through the process.

12.6. COMMON SOLUTIONS SOUGHT BY ENTERPRISES:

12.6.1 NETWORKING (BANDWIDTH INTENSIVE):

This type of solution may involve a design comprising of lease lines, MPLS links, MLLN links, VPNs, routers, firewalls, Managed services etc. In some cases, supplier may need to propose even the link speed, number of links, and other associated hardware after studying customer requirements.

12.6.2 UNIFIED COMMUNICATIONS (INTEGRATION INTENSIVE):

Unified communications (UC) is the integration of real-time communication services such as instant messaging (chat), presence information, Telephony (including IP telephony), video conferencing, call control and speech recognition with non-real-

time communication services such as unified messaging (integrated voicemail, e-mail, SMS and fax).

UC is not a single product, but a set of products that provides a consistent unified user interface and user experience across multiple devices and media types. UC also refers to a trend to offer Business process integration, i.e. to simplify and integrate all forms of communications in view to optimize business processes and reduce the response time, manage flows and eliminate device and media dependencies.

UC allows an individual to send a message on one medium and receive on another. It should be possible to easily transfer any activity or message to another medium. For example, one can receive a voice mail message and choose to access it through email or a cell phone. If the sender is online according to the presence information and currently accepts calls, the response can be sent immediately through text chat or video call. Otherwise, it may be sent as a non real-time message that can be accessed through a variety of media.

One of the main focuses of Unified Communications is to reduce communication response time, or in other words perceived speed, which often is essential in decision making and acting upon instructions. For example, an important action that takes two days to complete but is received a day late, takes three days to complete. Unified communications technology aims to reduce that delay as much as possible.

When considering the efforts of Unified Communications solutions providers, the overall goal is to no longer focus strictly on the telephony portion of daily communications. The unification of all communication devices inside a single platform provides the mobility, presence, and contact capabilities that extend beyond the phone to all devices a person may use or have at their disposal.

12.6.2.1 COMPONENTS OF UNIFIED COMMUNICATIONS

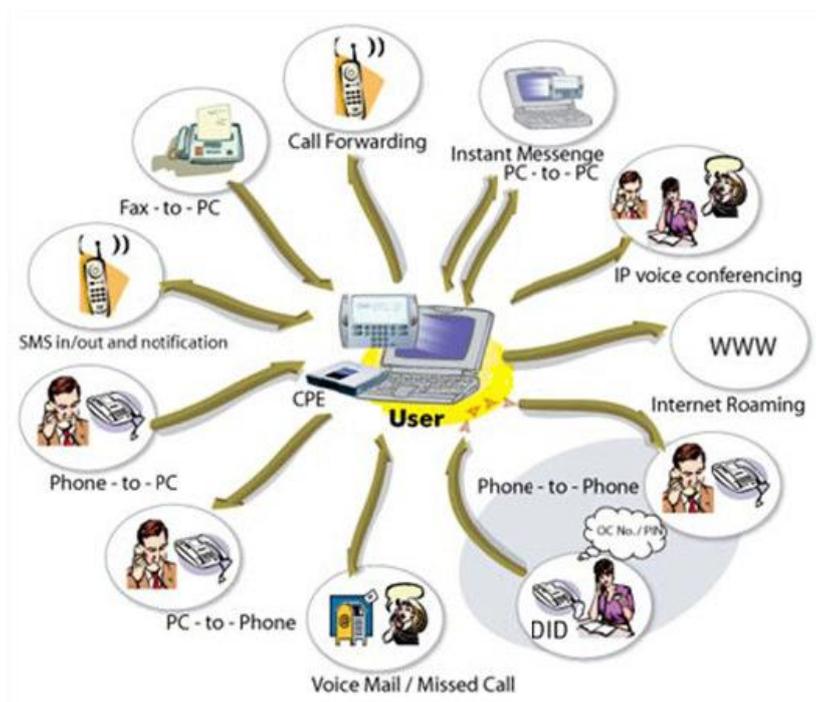


Figure:3**Examples: Bandwidth related Technical Solution Document****1. Introduction**

XYZ intends to procure domestic bandwidth for premier education and research institutions in different cities. XYZ has identified premier research and educational institutes at 15 locations where connectivity under this project is to be provided. XYZ intends to use point-to-point connectivity on fibre with interface Ethernet/ fast Ethernet / V.35, for the said project.

2. Deliverables:-

- The Tenderer has to provide point-to-point Leased Line Services to the institutions in 15 cities.
- The work involved is to set up communication links/bandwidths, provide equipment (hardware), operation, maintenance and monitoring of the network on 24x7x365 basis and provide online reports with traffic statistics.
- After the acceptance of the Leased Lines, they have to be kept operational for one year and thereafter to be renewed on yearly basis.
- Supply, installation and maintenance of equipments such as modems/converters.
- The service provider has to adhere to the Service Level Agreement specified in the tender.
- Redundant backbone of multiple STM-1 capacity to backhaul bandwidth from respective institutes to XYZ PoPs
- Network Management will be done from the NOC of BSNL.
- A web based monitoring tool, which will provide latency, packet drop and availability of subject capacity from carriers point and beyond.
- Duration-Three year, to be renewed on yearly basis.

12.7. BSNL CAPABILITIES

- BSNL has one of the world's best transmission networks spreading across every corner of the country. This network is capable of meeting not only the transmission requirements of BSNL but also public requirement.
- BSNL has a very strong Dense Wavelength Division Multiplexing (DWDM) backbone in the country, there are 16DWDM rings working in the BSNL network and each one is capable of 80gbps transport capability. Not only this, but the entire capacity is protected through SDH ring.
- BSNL deploys the various world standard technologies supplied by M/s Siemens, M/s FIBCOM, M/s Marcony, M/s ICOMM and M/s TEJAs etc. SDH equipments are thoroughly checked before its deployment in the field by the Quality assurance Circle of BSNL. BSNL has highly trained and capable manpower, which can install these equipments in a time bound manner.
- Apart from the networking capabilities, BSNL is also a National Long Distance (NLD) Operator having laid optical fiber over 6 Lakh Route Km.

- In addition to the Point-to-point lease lines, BSNL is also offering MPLS-VPN service, Internet Services, VSAT services, Broadband services, GSM/CDMA mobile and Basic telephony services.

12.8 CASE STUDY

BSNL is suitably placed to meet the requirement of customers like XYZ who are having huge bandwidth requirement.

1 .BSNL'S NETWORK:

BSNL has got a huge optical fibre Network across the length and breadth of the country. Almost all the District Head quarters are on STM ring based on DWDM technology as a carrier. The ring topology ensures uninterrupted flow of traffic. Any disorder in the ring & national network is detected at NMS which is regional as well as national. In cities also, BSNL has got extensive network of fibre on STM ring. Hence in local networks also, BSNL ensures uninterrupted services.

2. BSNL'S PROPOSAL:

XYZ plans to provide connectivity through 15 Points of Presence (PoPs) located at the premier education and research institutions in the country on Ethernet/Fast Ethernet/ V.35 interface. The Bandwidths required are of 2 Mbps, 8 Mbps and 34 Mbps. BSNL has already its point of presence at all the locations mentioned in the document except at Mumbai and Delhi, where BSNL is providing this service through MTNL. As stated earlier, the main channel connectivity between different cities, will be on a highly protected optical fiber SDH ring.

The output at different premises will be electrical signal, which will be connected to E1/multiple E1 to Ethernet/Fast Ethernet/ V.35 converter.

3. NETWORK MANAGEMENT SYSTEM

BSNL will take one E1 link from XYZ New Delhi premises to Kidwai Bhawan for Network monitoring and the Network will be monitored round the clock.

4. SPACE AND ELECTRICITY REQUIREMENT: XYZ - XYZ will provide a 10'x10' space at all the sites to install transmission systems. The space provided at above locations must have the following facilities.

- (i) Good earthing point
- (ii) UPS points
- (iii) Air conditioning
- (iv) Light Arrangements
- (v) Suitable entry point for taking OFC/ Copper cable to appropriate points at different locations.

The space provided and all the facilities mentioned above should not be more than 50 meters from the location of the routers

5. PROJECT IMPLEMENTATION AND MANAGEMENT- The project implementation will be carried out by a team comprising of personnel of BSNL and SI at the National Level.

6.. AMC DETAILS- BSNL is willing to offer an SLA of 99.5% uptime. However, it is requested that SLA be made at least as per link per quarter basis. However it is requested to impose Penalty based on single charge only instead of double charge. Penalty should also be restricted to maximum of 10% of Bandwidth rental for the period. Also it is requested to exempt Penalty in case of delay caused by natural disaster, riots, strikes & reasons beyond the control of BSNL.

7. Detailed Deviation statement is enclosed. This may please be read in conjunction with other Bid documents.

Example 2: In some cases purchasing enterprise may define its requirements explicitly in terms of servers, routers, link capacity, lease line, MPLS links, SLA, any software etc. There are cases where purchasing enterprise does not have such elaborate details. For example, New Bank PQR intends to setup a network of 216 branches across India with its Head office at Mumbai. There will be Six zonal offices. The branches served by these zonal offices are given in annexure. The average estimated transactions/day happening at individual branches are given in annexure. 100% disaster recovery is required between Head office and Zonal offices. 50%-degraded performance in branch offices is acceptable in case of link failures. SLA requirements are tabulated in annexure. The proposed network may be based on MPLS technology with scalability features. The timeline for national rollout is given in annexure.

Mobile phone requirement based Example: Assume that railways float a tender for mobile connections for engine and guard connectivity. They may ask for rail route coverage details along with call drop, TRAI QoS benchmark results. Some important aspects with reference to BSNL may be as given below:

S.No.	Features	Description	Remarks
1	Call Barring	Features like incoming or Outgoing call barring outside a group	Available but incoming barring from a number outside the group is not possible. Incoming barring will happen from all numbers.
2	Enhanced Multilevel Priority and Pre-emption services (EMLPP)	Allows at least 3 levels of priority with authority to higher priority subscriber to pre-empt the lower priority subscriber, the preemption is desired at switch as well as BTS level.	Available
3	Voice Group call services	Allows call to be established to small groups of subscribers.	This feature can be enabled using MVPN feature of IN and it can also be achieved using PTT subject to regulatory clearance.

4	Voice Broadcast services	Allows one-way broadcast communication to a group of subscribers	Can be achieved using PTT(Push to talk) subject to regulatory clearance.
5	Location based Addressing	Help drivers to dial single number to contact the nearest station master depending on the location of the train.	This feature can be implemented.
6	Emergency call	Intercepting on-going call to give important instructions.	This feature is presently not available. Not planned in Road map.

12.9 CONCLUSION

In this module we have discussed about the common requirements of the Enterprise business, the solutions to them and the case study as well.

13. EB CUSTOMER MANAGEMENT

13.1. LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- BSNL organizational structure for EB Customers..
- Roles and responsibilities of EB team members
- How to deal the customers etc

13.2 INTRODUCTION

What an Enterprise Customer generally looks for?

- Consultancy support for solution to new needs
- One stop shop
- Telecom Expense management
- Unified communication solution
- Faster roll out
- Scalability
- 24x7 monitoring & servicing
- Simplicity of deal
- Long term commitment
- Business continuity (Disaster Management)

13.3. ENTERPRISE CUSTOMER CLASSIFICATION:

13.3.1 DEFINITION AND GRADING OF ENTERPRISE CUSTOMERS

- a. If the organization is a business enterprise irrespective of whether it is in the private/public/government/co-operative sector, it must have a minimum annual turnover of Rs.10 Crore to qualify as Enterprise Customer.
- b. Any business enterprise having a turnover below the Rs. 10 Crore minimum will not be considered as Enterprise Customer irrespective of the extent of services the business is currently subscribing from BSNL or the revenue contributions it is making.

13.3.2 Grading of Enterprise Customer

i) **Platinum**

Enterprise Customers with an annual turnover of over Rs.500 Crore. For Telecom and IT sector customers, this limit may be reduced to Rs.100 Crore per annum.

Each Platinum Customer will be serviced by one designated National Account Manger (NAM). Penetration in the new Platinum Account is one of the important targets of Platinum Offices. At least 10 new Platinum Accounts are to be penetrated by each of the Platinum Offices. The Platinum Account is said to be penetrated if a

minimum business of Rs.40 lakhs per annum per account is generated from the customers

ii) Gold

Enterprise Customers with an Annual turnover of Rs.100 crore to Rs. 500 crore (barring those in IT and Telecom sector)

Gold Customers will be serviced by the designated Key Account Manger (KAM)

iii) Silver

All Enterprise Customers not falling into Platinum and Gold classes.

Customer classified as 'Silver' will be serviced by Channel Partners. Channel Partners are outside agencies appointed by BSNL to deal with the service needs of the customers.

13.3.3 Channel partners:

BSNL has decided to deal with Platinum & Gold customers directly. BSNL executives have been appropriately trained in enterprise sales.

For capturing silver customers, BSNL has started appointing Channel partners in all circles. These channel partners are given an exclusion list mentioning Platinum & Gold customers so that they don't waste their efforts on these customers. The job of channel partners is primarily for direct marketing & sales of BSNL services to silver customers. They get commission as per approved structure on various services. Purpose of such channel partner is to offer Total Telecom Solution to the silver clients as per need comprising of MPLS, lease lines, Web Hosting, VPN, Broadband, basic, Mobile, IN, bill collection etc.

Accounts are mapped to channel partners by geography and by their specializations. 100 to 300 accounts may be given to each channel partner. Channel partners are controlled at the circle level through channel managers. Technical expertise in basic products / bundles is essential.

General: Platinum and Gold customers will be identified centrally by the Enterprise Business Unit of BSNL Corporate Office. Silver Customers will be identified by each Telecom Circle in consultation with the SSAs. The coding of Enterprise Customers will be done by the units identifying them by applying the standard attribute set.

13.4. ORGANIZATIONAL STRUCTURE IN BSNL FOR ENTERPRISE CUSTOMER:

In order to leverage its widespread telecom network resources in India and to tap these business opportunities and to provide customized network solutions and services to its clients, BSNL decided in 2001 to set up BD cell in each circle and also at corporate office. GM & DGM posts were sanctioned to run these units.

In 2008, BD cell at corporate office was split thereby creating a new unit titled 'Enterprise Business' At circle level, earlier structure continued. In 2009, as part of massive restructuring under Project Shikhar, Director level post has been created for Enterprise & Whole Sale.

GM (Business Planning), GM (Enterprise Business), GM (ILD), GM (Lease circuit), GM (IT) and GM (Fin) report to Dir (E&WS) at BSNL HQ. A post of ED (core Network) has also been created and all project circles and maintenance regions have been brought under ED.

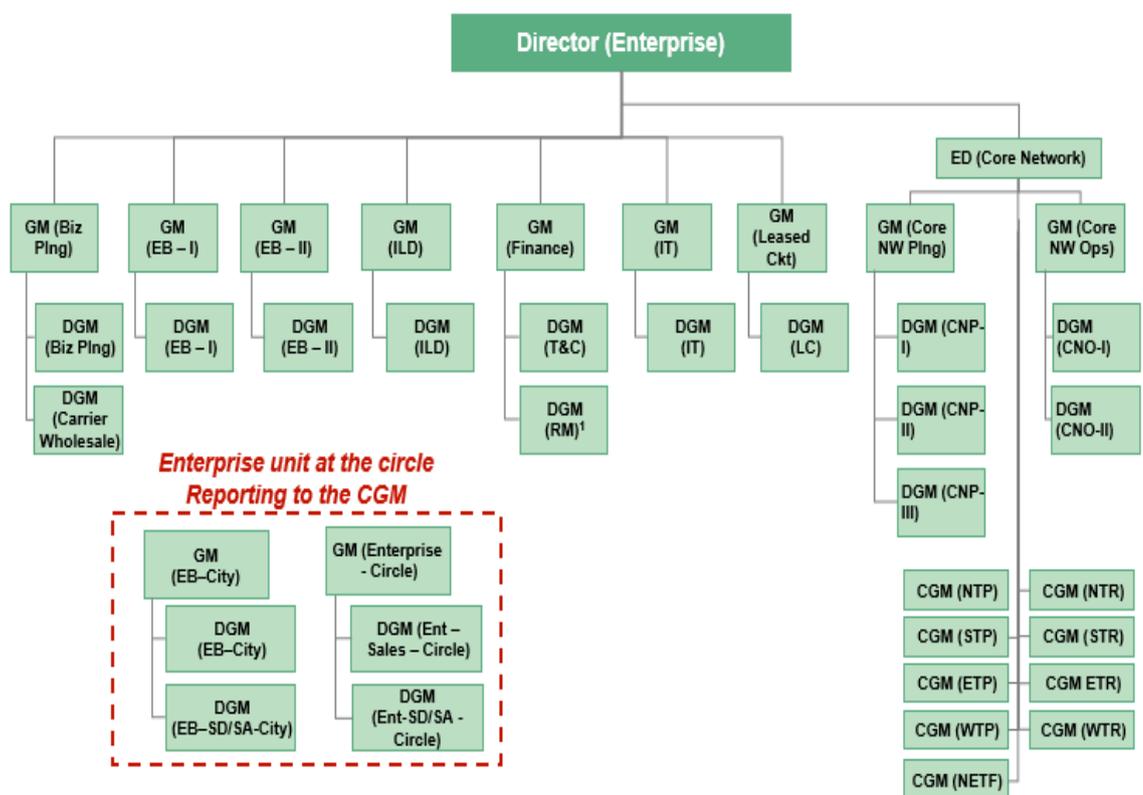
Also post of GM (EB-city) has been created in 4 big cities. All Circles now have GM (Enterprise) supported by DGM (Enterprise Sales) and DGM (Service Delivery/Service assurance).

Centralized National Account Managers (NAMs) organized by Industry Vertical. 5 to 10 Accounts are assigned to each NAM. They deal with Platinum Customer.

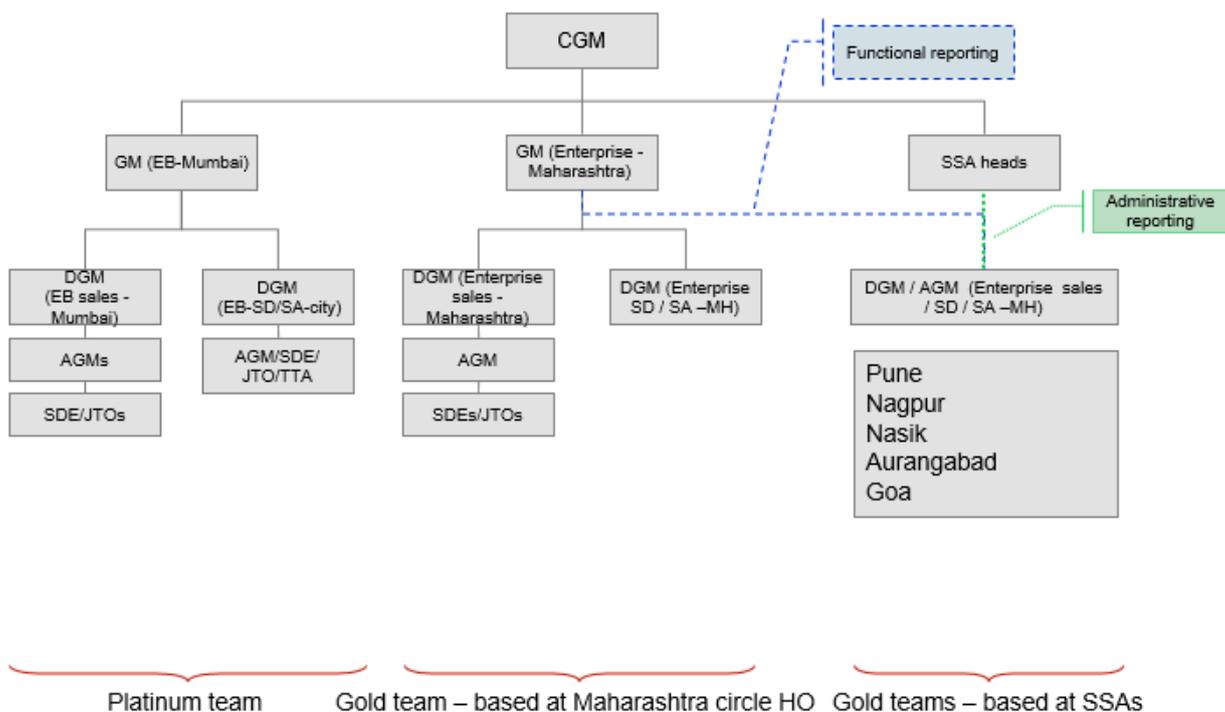
Circle based Key Account Mangers (KAMs). 25 to 75 accounts per KAM. They deal with Gold Customers.

Since the number of companies in Silver segment is very large, it is proposed that BSNL should use appropriate channel partners to ensure that sufficient attention is devoted to these accounts. Accounts are mapped to channel partners by geography and by their specializations.

1. At Corporate Level :



1. At Circle Level :



13.4.1 Summary of BSNL Organizational Structure:

The role of EB wing, which has been created at corporate as well as at circle level is to identify the specific needs of enterprise customer which can be a mix of Voice, Data and Managed Services solutions. To give proper focus to such customers based on their potential, such customers are categorized as Platinum, Gold and Silver.

Another important segment of enterprise customers is BFSI i.e. banking, financial services and Insurance sector companies. Main function of this wing is to achieve profitable and sustainable growth of enterprise business by creating sales policy & strategy for Platinum, Gold and Silver enterprise customers and monitoring performance for the same.

Promotion of Enterprise business to platinum customers through marketing activities such as advertisements and promotions based on focused market research is also its responsibility. This wing is supported by other related units such as leased circuit, Network operations, Core Network planning and field units of CFA, CM for execution of enterprise projects. A key difference from previous approach to enterprise sales is the creation of DGM (Service Delivery/Service Assurance) post at Circle level. Earlier this work was handled by DGM Enterprise sales thereby overloading the post with dual responsibility of bringing new business as well as handling project management for such business.

Concept of National Account Manager (NAM) and Key Account Manager (KAM) has also been introduced to provide focused attention to corporate customers. Reimbursement of travel/meal/sundry expenses is allowed to NAM/KAM depending on their role and quantum of work.

13.4.2 Roles and Responsibilities of Key Account Managers and National Account Managers:

- Account managers are pivotal to a BSNLs long term success BSNL is perceived to as good as its account managers
- Account managers personify BSNL for its key customers. They have an almost monopolistic relation with their customers and are responsible for interactions on all things pertaining to a product. E.g. sale, delivery, assurance, billing etc
- A successful account manager has deep personal relations with his client outside his office as well.
- Account managers have to balance requirements of customers with needs of their own company to ensure long term relations.
- Eventually, the customer buys products on the basis of their account managers

Account managers have a dual focus w.r.t. their customers.

A. Building new relationships

- Scouting and acquiring new customers for BSNL enterprise business

B. Maintaining existing relationships

- Expanding scope of business with current customers in enterprise.

13.4.3 Role of an account manager goes through five phases:

1. Understanding personal/ professional aspirations

- An account manager would define his/ her expectations from their position in BSNL.
- They would set long term/ short term goals

2. Pre work preparation

- The account manager would familiarise himself/ herself with the business of BSNL as well as the customer

3. Introductory meetings

- The account manager would set up scoping meetings with the customer to understand nature of opportunity

4. Solution refinement

- The account manager would create solutions for their clients needs and understand the profitability of the same in the long run

5. Reporting

- The account manager would keep BSNL updated on their progress

13.4.4 AMs should have clearly time commitments to effectively manage different roles.**➤ New Sales**

- Create sales opportunities by following leads for new customers
- Regularly follow up with existing customers to provide more products/ solutions whenever possible
- Map organizations of customers met with to understand current and future needs and other vendors supplying products

➤ Relation Ships:

- Call current clients and visit them at least once a month
- Ensure all clients are given updated product brochures from BSNL as and when issued
- Ensure all clients are aware of all BSNL enterprise related events

➤ Reporting:

- File timely reports on customers interacted with in order to allow proper review of business by BSNL
- Follow up with appropriate SD/ SA node to ensure speedy delivery of service to client
- Contact clients regularly to understand if product working satisfactorily.

13.5 Pre-work is required for all account managers before approaching customers:**BSNL Centric**

- Account managers should be well versed with BSNL products
- Account manager should have at least high level knowledge on BSNL network, reach, connectivity etc
- Account manager should know BSNL enterprise business, marquee customers, best selling products etc

Account Centric

- Account manager should try to assess which telecom provider is currently fulfilling customer's telecom needs (if it's a new customer).

13.6 Some perceptions, the account managers must create with their customers:

- Accessibility
- Keeps promises
- Respects my business
- Responsiveness
- Easy to do business with

- Easy to communicate with
- Understands criticality of situations
- Sincere and open

13.7 Key account fundamentals before approaching the firm Group/ Single Company

- Basic name and location
- Nature of business
- Shareholding
- Size of business
- Market share

13.8 Customers expectations from their initial meetings with NAM/KAM:

What is on the customer's mind?

How can you be prepared?

What is the business of BSNL?

Show them the introduction letter

Do they know about my business?

Be prepared with introductory templates for the client

What can they offer me?

Be ready with the corporate pitch

13.9 EB PORTAL

BSNL has introduced Online EB portal for the recording, processing, updating, reporting and monitoring of all the EB related activities.

The NAMs/KAMs are added in the portal and a separate user name and passwords are generated for them in the EB portal.

EB portal can be accessed through a separate link in the BSNL Intranet.

13.10. GENERAL INFORMATION

13.10.1 INTRODUCTION

The Enterprise Business Portal provides the Enterprise Business Team of BSNL with a end to end web based software solution that delivers a secure, scalable and reliable tool to enter, update, manage various Enterprise Business activities within BSNL and facilities to track and report the various activities of EB Team.

The Enterprise Portal is a replacement of the current Excel based Reporting where the current software is used enter the lead, Opportunity Data, generate Quotation, Service Orders and also keep track of the stages an opportunities are. The Enterprise Portal will utilize the user and unit id information stored in the database to limit the access to the information available for that user retaining the security and accessibility at various levels.

The Enterprise Portal consists of the following:

- Information Storage
- Reporting

13.10.2 INFORMATION STORAGE

- Stores information about users, units, leads, opportunities, companies in a database.
- Track changes to lead/opportunity and company information, who made the changes and when it was made.
- Updates opportunity data generated on weekly basis for generation of various reports, for example sales funnel report.
- Stores documents like contracts, MOU's and other information in database..
- Stores information on Companies and Users.

13.10.3 REPORTING

- Visually display out reports of information in spreadsheet (.xls) format and saved to a file or to be printed.

13.10.4 PROJECT REFERENCES

Provide a list of the references that were used in preparation of this document in order of importance to the end user.

13.10.5 AUTHORIZED USE PERMISSION

Any unauthorized use of this application without the consent of BSNL is prohibited. Any unauthorized usage of the system and making unauthorized copies of data, software, reports, and documents are also prohibited.

The Enterprise Portal is only to be use by an authorized user of Enterprise Business Team members.

The Enterprise Portal will utilize the HRMS and employee information stored in the database to map the user to a unit and also to keep track of various activities of the individual user including tasks, contacts and opportunity management activities.

13.10.6 HARDWARE REQUIREMENTS

The hardware requirements for the Enterprise Portal:

Computer/workstation/notebook:

Each member should have a computer available to use for this project. No particular funds have been allocated for any acquisition or rental of hardware resources

Internet hardware and active Internet connection: Each project member should have all the necessary hardware and an active connection to be able to access the project web site and the SVN repository. Also an Internet connection is required to connect to the Enterprise Portal.

13.11 CONCLUSION

This lesson gives emphasis on every aspect of maintaining relationship with EB customers. The customers of EB services are generally big customers with lots of expectation from BSNL Services. The EB Portal plays very important role to keep all the information of EB customers. These customers shall be entertained in proper and technical way to convince them for BSNL EB services. The EB Customer Management is very important and crucial activity in EB unit and everybody has to perform their roles and responsibilities to get best from customers.

14. EB SALES PROCESS, WORKFLOW IN EB FOR SALES/COMMERCIAL/SERVICE/BILLING

14.1 LEARNING OBJECTIVE:

This lesson provides the insight into the Sales Process, Buying and Selling cycles, Closing of Order, post-closing activities and reporting of the entire Sales process data into the EB portal.

14.2 THE SALES PROCESS

14.2.1 Pre –Sales Preparation:

- a) Success comes from preparation.
- b) Success in marketing comes from comprehensive preparation as it helps in understanding your prospect's needs, resolve their doubts and objections and Combat competition.
- c) Pre sales preparation helps in being: Organized, Confident, And Effective.

14.2.2 Components of pre-sales preparation:

- a) Knowledge of C-P-C
- b) Stands for company, Product and competition

14.2.3. Elements of Planning and Preparation:

The three critical components are

- a. Enhance your Knowledge on CPC
- b. FAB – Feature, Advantage, Benefit
- c. Self-presentation

14.3 FAB (FEATURE, ADVANTAGE, BENEFIT)

14.3.1 Understanding Features:

- a. Feature describe the characteristics of a product / Company / Plan

14.3.2. Understanding Advantages:

- a. Advantage refers to the general usage of a feature of any plan or product
- b. The best method of identifying the advantages is to identify all the features of a plan/

Product and how does it help the prospect?

14.3.3 Understanding Benefits:

- a. The second step in proposing a solution is to link the advantages of the product/plan to the stated needs of the prospect.
- b. The more benefits sales personnel states the greater the chances of success.

14.4 THE THREE STEPS OF PROPOSING A SOLUTION:

- I. Summarizing the buying criteria of the prospect

II .Associate or link the advantages of the product to the stated needs of the prospect.
In other words, state benefits for a solution

III. Summarize the benefits and ask for commitment.

14.5. CATEGORIES OF THE BENEFITS:

14.5.1 Reliability:

Most prospects are interested in dependability and consistency of a solution. A product /plan that promises and delivers ‘reliability’ is more likely to be successful in the present market

14.5.2 Easy Manageability:

A solution that is convenient for the prospect or is very simple to use will certainly appeal more to the prospects

14.5.3 Cost Effectiveness:

A cost effective solution gives value for money to the prospect

14.5.4 Adaptability:

An adaptable solution can easily adapt itself to any environment or situation

14.5.5 Time saving & Independence:

Many prospects would like to work in flexible time and avoid being dictated by somebody being one’s own boss.

14.6 THE BUYING CYCLE (REED-CYCLE):

14.6.1 Recognize the Need:

First an individual feels the need to buy a product / Service

14.6.2 Evaluate the options:

Then, he evaluates various offers in the market and short-lists the one that meet his needs most closely

14.6.3 Eliminate Doubts:

Having identified the brand that he would like to buy, he gets clarification on concerns regarding the product / service

14.6.4 Decide to Buy:

Finally, he decides to purchase the product/ service

14.7 .THE SELLING CYCLE (ODPEC-CYCLE):

14.7.1 Opening:

The stage the company representative is attending to the customer for the first time.

14.7.2 Developing the Sale:

This is the stage at which the company representative is supposed to determine whether or not the customer has recognized the need.

14.7.3 Proposing a solution:

A customer has various options to satisfy a need. At this stage the company representative should demonstrate to the customer that the offered product is the best solution to the customer's need as compared to the other options available.

14.7.4 Eliminating Doubts:

At this stage the company representative should clarify all the doubts of the customer so that the doubts should turn into strong beliefs to purchase the product. It is essential to uncover all the doubts as the client may not always express his doubts and then address these doubts.

14.7.5 Closing:

This is the stage where the customers make the payment and receive the delivery of the product according to the terms and conditions agreed upon.

14.8 CLOSE TECHNIQUES:**14.8.1: Close technique:**

Summarize in sets of three items- we will give you This, That and The Other, Use the classic business measurement trilogy-Cost, Quality and Time

14.8.2 Best time Close technique:

Invoke seasonal effects, such as its an introductory offer for limited period

14.8.3 No-hassle close technique:

Make completing the deal easy for them. Fill in all forms for them. Do all the paper work.

14.9 POST SALES FOLLOW UP:

The customer keeps evaluating the product even after taking the delivery and might develop negative feelings if he is unable to operate the product for any reason. He might come across unfavorable reports. It is important to manage the customers' post sales feelings by remaining in touch with the customer.

14.10 COMPILATION OF CUSTOMER MEETINGS DATA:

Information gathered is maintained in the prescribed templates, - Pre-Meeting and Post-Meeting Templates

Every AM should gather the information about the customers from secondary sources like Google.com, etc. A pre-meeting template indicating nature of business, listing, size of business market share and sister concern etc. of the Gold account should be prepared by AM before approaching the customer. After completing the pre-meeting template, AM should contact the customer.

An introductory letter and BSNL’s presentation may be given to customers in the first meeting.

After meeting with the customer, KAMs are supposed to fill post-meeting report and keep updated profile of the customer. The post-meeting template mainly consists of information about the customer like number of connections for landline/ Broadband / PRI/Mobile CUG, data circuits, current vendors, total telecom spent, billing details, key contact person, etc.

14.11 ORGANIZATION STRUCTURE

The Enterprise Business Unit at the circle level is structure as below:

Example taken from Karnataka Circle

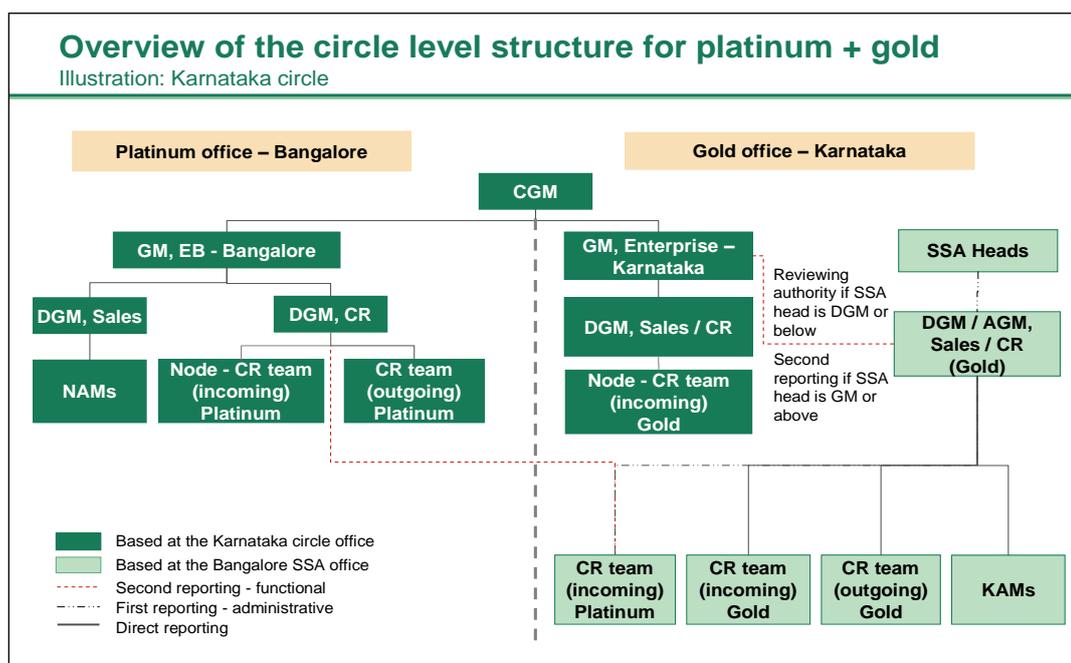


Figure:1

The Customer Relations Team is established for both Platinum and Gold teams within the circle office. Both teams report to the GM, EB – City, if they assist the Platinum sales team or GM, Enterprise – Circle, if they assist the Gold sales team. The Platinum Customer Relations Team consists of DGM, Customer Relations located in the Circle office. The DGM is assisted by two teams – incoming and outgoing team.

14.11.1 Platinum Customer Relations Team

The Platinum Customer Relations outgoing team is responsible for receiving all SD/SA requests from the sales team that require coordination with other circles (outside the home circle). The outgoing team is further divided into North/South/East/West zones. Each outgoing zonal team deals with circles lying within that zone. For example, Outgoing team of North zone deals with circles like UP East, UP West, Haryana, Himachal Pradesh etc. The outgoing team interfaces

with the National Account Managers (NAMs) located in the circle office and coordinates with the incoming Customer Relations team of other circles.

The Platinum Customer Relation incoming team is responsible for receiving all SD/SA requests from the sales team that require coordination with the home circle. As the Consumer Fixed Access Team which does the SD/SA activities is located at the field/SSA level, therefore the Platinum Customer Relation incoming team is also located at the SSA level. The SSAs in which this team is located are the SSAs in which Gold sales offices are working. In order to coordinate the incoming requests for SSAs in which this team is not placed, a nodal person is placed at the circle office under the DGM, Customer Relations. This nodal person acts as the nodal person for receiving all incoming SD/SA requests related to SSAs in which no incoming personnel is placed and pursues SD/SA requests in those SSAs.

14.11.2 Gold Customer Relations Team

The Gold Customer Relations outgoing team is responsible for receiving all SD/SA requests from the sales team that require coordination with other circles (outside the home circle). Since the Gold sales team (KAMs) is located in certain SSAs that are designated as Gold offices, therefore the outgoing team is also located in the same SSAs to complement and assist the sales team in those SSAs. The outgoing team is divided into North/South/East/West zones, similar to the structure used by the Platinum team.

The Gold Customer Relation incoming team is responsible for receiving all SD/SA requests from the sales team that require coordination with the home circle. As the Consumer Fixed Access Team which does the SD/SA activities is located at the field/SSA level, therefore the Gold Customer Relation incoming team is also located at the SSA level. The SSAs in which this team is located are the SSAs in which Gold sales offices are working. In order to coordinate the incoming requests for SSAs in which this team is not placed, a nodal person is placed at the circle office under the DGM, Enterprise. This nodal person acts as the nodal person for receiving all incoming SD/SA requests related to SSAs in which no incoming personnel is placed and pursues SD/SA requests in those SSAs.

In the circle office, there is only one DGM placed under the GM, Enterprise – Circle. This DGM has dual responsibility of coordinating for both Sales as well as Customer Relations. There is a standalone DGM/AGM placed in the SSA office who coordinates Sales and Customer Relations activity within that SSA. This DGM has a dual reporting. The DGM reports to the SSA Head as well as to the GM, Enterprise – Circle as the Circle office. The reporting to the GM, Enterprise is considered second reporting if the SSA Head in question is GM or above. The reporting is considered as previewing authority if the SSA Head is DGM or below.

The DGM/AGM, Enterprise at the SSA will be responsible for both Sales and Customer Relations activity in his/her SSA. The following personnel will report to him/her in the SSA:

Gold Customer Relations Team (Incoming)

Gold Customer Relations Team (Outgoing)

Platinum Customer Relations Team (Incoming)

Key Account Managers

The Platinum Customer Relations Team (incoming) reports to the DGM/AGM within the SSA for administrative purpose but its functional reporting lies with the DGM, Customer Relations at the circle office.

14.11.3 Roles and Responsibilities

The Customer Relations Team plays a critical role in expanding the Enterprise Business stream for BSNL.

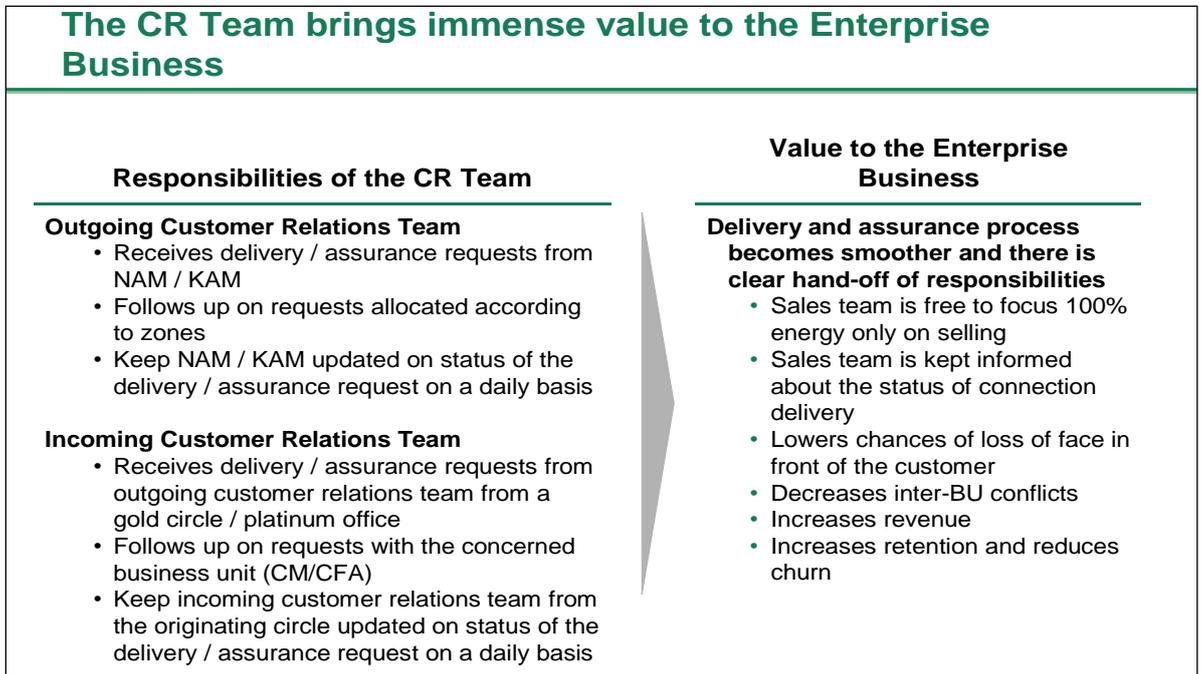


Figure:2

The roles and responsibilities of the Customer Relations Team encompass a number of activities which include: Receiving delivery/assurance requests from National Account Managers/Key Account Managers

Following up on requests allocated according to zones (Outgoing)

Following up on requests with the internal Consumer Mobility / Consumer Fixed Access business unit (Incoming)

Keeping Key Account Manager or National Account Manager updated on the status of the delivery /assurance request on a daily basis

It is expected that the National Account Managers or the Key Account Managers will spend all of their time in the field in order to generate new business or to retain the existing business. If an account manager is able to generate any new sales, the commissioning requests related to the new sales is directly passed on by the Account Manager (through the DGM, Sales and the DGM, Customer Relations) to the outgoing team (if the request pertains to an external circle) or to the incoming team (if the requests pertains to the domestic circle). The incoming team also follows up on

requests send by Enterprise teams located in other circles through their outgoing teams.

14.11.4 Review and Monitoring

In order to track the activities of the sales team and provide support to it, wherever necessary, a standard review format has been designed which tracks the sales activity, the size of the sales funnel and week by week status on all sales accounts allocated to an account manager for the Platinum/Gold Enterprise office within every circle/city. This sales review format captures the movement of a lead from the point of prospecting to the stage where a final order is booked on the specific lead. In order to ensure that the tracking is continued till the stage that an order is commissioned and revenue is booked in the ABF account for BSNL, it is suggested to follow a similar review and monitoring mechanism for the Customer Relations Team on weekly basis.

It is suggested that the Customer Relations Team is reviewed along with the sales team on a weekly basis where its activities on two primary areas of focus is tracked:

- Service Delivery
- Service Assurance

14.12 SERVICE DELIVERY AND SERVICE ASSURANCE:

As part of restructuring separate SD / SA wings are created headed by DGM / AGM level officers to look after the issues of provisioning and further continuing the services. Two structures are given for SD / SA activity as follows

SD / SA structure for enterprise
Gold / silver

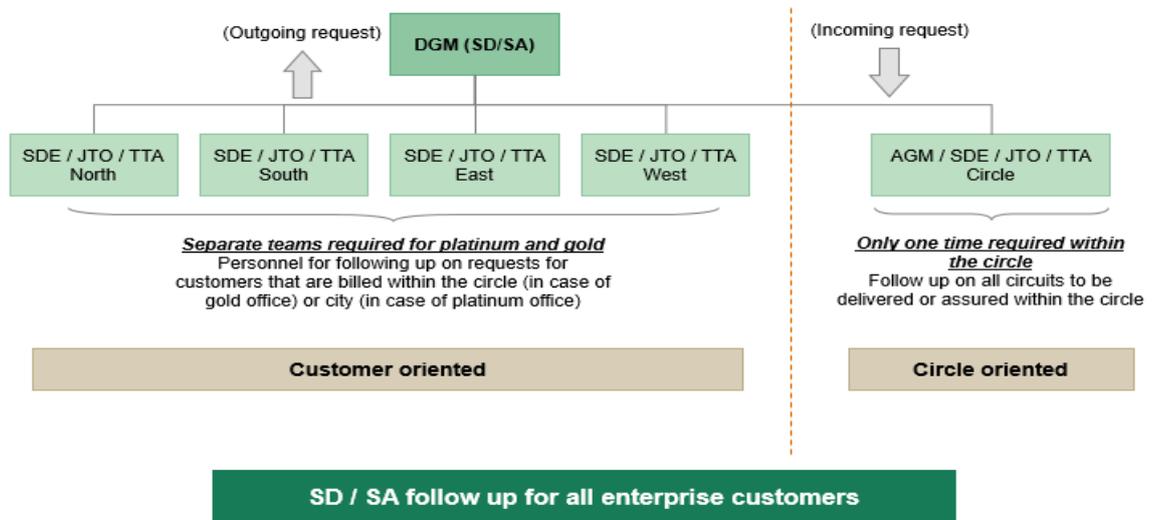


Figure.3

SD / SA structure for enterprise

Platinum

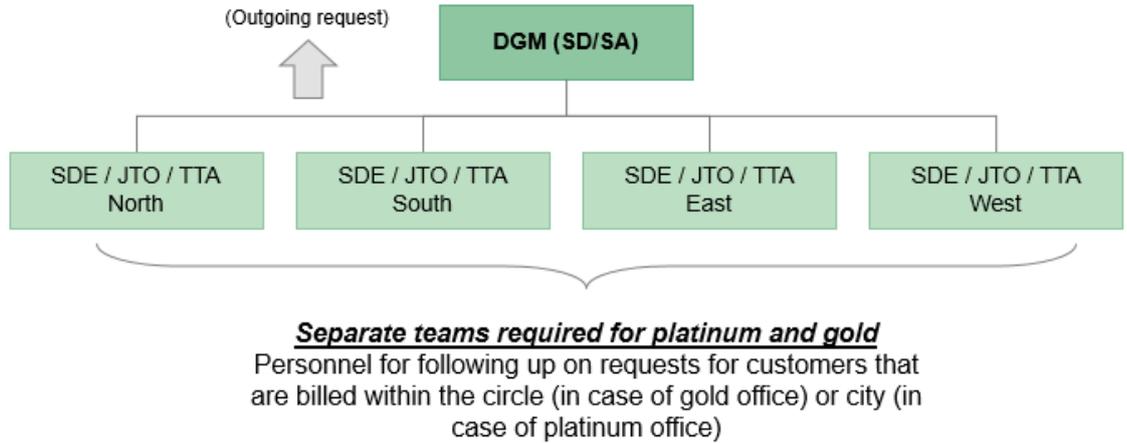


Figure.4

14.12.1 Customer Relations Team: Team Design and Roles and Responsibilities

This document explains the organization structure of the customer relations team and their roles and responsibilities. In addition to the same, the document also details the design of a review process for the Customer Relations

In order to track progress on Service Delivery, all leads that appear in Stage 4 of the sales funnel (Stage in which order is booked and money has been received from the customer) are analyzed one by one and commissioning status on the same is sourced from the Customer Relations Team.

In order to track progress on Service Assurance, a status chart is prepared of all Service Assurance requests received by the Account Manager till date and that have been passed on to the Customer Relations Team and status on the same is updated on a weekly basis.

The picture below explains the templates in further detail.

Service Delivery Status Report - Data

Coordination status with multiple circles on a single deal booked

S. No.	Name of the Customer	Customer Code	Name of the account manager	Date on which payment was received	Zone	Circle	Requirements (no. of circuits and bandwidth)				Status Update (with comments)					
							LL	MPLS	ILL	MNS	Work order released	Send to Indoor / Outdoor / OFC	Stream allocated	Last mile provisioned	Modems installed	Link tested
1	Central Bank of India		V.K. Dubey	12 / 10 / 2009	North	UP East				20 links - 64 kbps	all 20 on 1.11.2009	Pending - expected on 1.1.2010	Pending - expected on 15.1.2010	Pending - expected on 15.1.2010		
2	Central Bank of India		V.K. Dubey	12 / 10 / 2009	North	UP West				10 links - 64 kbps	all 10 on 2.11.2009	Pending - No update	Pending - No update	Pending - No update		
3	Central Bank of India		V.K. Dubey	12 / 10 / 2009	South	AP				1 links - 64 kbps	Completed on 2.11.2009	Pending - No update	Pending - No update	Pending - No update		
4	Kingfisher Airlines		R.R. Mahajan	1 / 11 / 2009	Home	MH				40 links - 2 Mb	all 40 on 2.11.2009	Pending - No update	Pending - No update	Pending - No update		

Home circle signified as Home zone

Figure 5

Service Assurance Status Report - Data

S. No.	Name of the Customer	Customer Code	Name of the account manager	Date on which complaint was received	Zone	Circle	Requirements (no. of circuits and bandwidth)				Status Update (with comments)										
							LL	MPLS	ILL	MNS	Docket booked	Last m/le checked	Last mile fault corrected	Stream checked	Stream fault corrected	GPE Fault checked	GPE Fault corrected	Cable break down corrected	Testing	Close the docket and confirm closure	
1	Dewan Housing Finance Limited		V.K. Dubey	1.11.09	North	UP East				1 link - 64 kbps	Yes on 12.11.09	No	No	No	No	No	No	No	No	No	No

Figure 6

The templates above capture the review and monitoring on data circuits (both service delivery and assurance) on a weekly basis. Similar templates should be developed by the circle teams on Voice products (landline, PRI, Broadband and mobility) to monitor delivery and assurance status on the same.

14.13 CONCLUSION

This lesson gives the various steps to be followed in selling the EB products to the customers. The sequence of EB sales process and workflow gives emphasis on important things while dealing with EB Customers. The organization structure of EB unit helps to understand the hierarchy in providing the necessary services the customers and solution for their communication needs. The role and responsibilities of each and every one is very important for getting good business in EB. The chapter also describes the services delivery and service assurance aspect to maintain good image of BSNL in the eyes of EB customers.

15. LEASED LINE SERVICES FOR EB CUSTOMER

15.1 LEARNING OBJECTIVES

After reading this unit, you should be able to understand:

- Options for different leased lines
- Managed Leased Line Services (MLLN) and
- Different services through leased circuits

15.2 INTRODUCTION

To transmit data between computer and electronic information devices, BSNL provides data communication services to its subscribers. It offers a choice of high, medium and low speed leased data circuits as well as dial-up lines. Bandwidth is available on demand in most of the cities. Managed leased Line Network (MLLN) offers flexibility of providing circuits with speeds of n x 64 Kbps up to 2 Mbps. Useful for internet leased lines and international principle Leased Lines (IPLCs).

For dedicated point to point speech, private wire, tele-printer and data circuits are given on lease basis. Leased circuits are provided to subscribers for internal communication between their offices/factories at various sites within a city/town or different cities/town on point to point basis, or on a network basis interconnecting the various sites.

15.3 WHAT IS LEASED LINE CIRCUIT?

- Typically referred as a point to point or dedicated connection. It is a pre-established WAN communication path from CPE (Customer premise Equipment) through service providers equipment to the CPE of remote site (may be within the city, intercity, out of country & also to the internet lease line). It allows DTE network to communicate at any time without set up procedure before transmitting data.
- Leased lines provides a scalable access method, important particularly for organizations with large user groups, including corporate, banks and financial institutions, educational and R&D organizations, government, military etc. Starting typically with 64 Kbps, it is possible to deploy a scalable architecture, with multiples of E1 (2 MBPS) pipes, providing the necessary bandwidth. In fact, leased access becomes a must for large organizations in most situations.

DIFFERENT TYPES OF LEASED LINE CIRCUITS.

- Private Wires
- Point to point speech Circuit (Hotlines).
- Leased Tele-printer Circuits.
- P2P leased circuits (MLLN / Conventional)
- Leased Data Circuits (Packet Switching)
- Leased X.28 Data Circuit (9.6 kbps)

- Leased X.25 Data Circuit (64 kbps,9.6kbps)
- Leased Frame-Relay (64 kbps)

4.8kbps,9.6 kbps Asynchronous Low speed, 64 kbps,128 kbps,256 kbps,512 kbps,1Mbps, 2Mbps,8Mbps, 34Mbps,140Mbps synchronous high speed

Typical Setup of Lease Circuit Between two customers

- It is a dedicated wired connectivity between two locations of the customer.
- Link is built on transmission N/W back bone.
Point to point leased circuits are being provided with following two technologies in the access network.

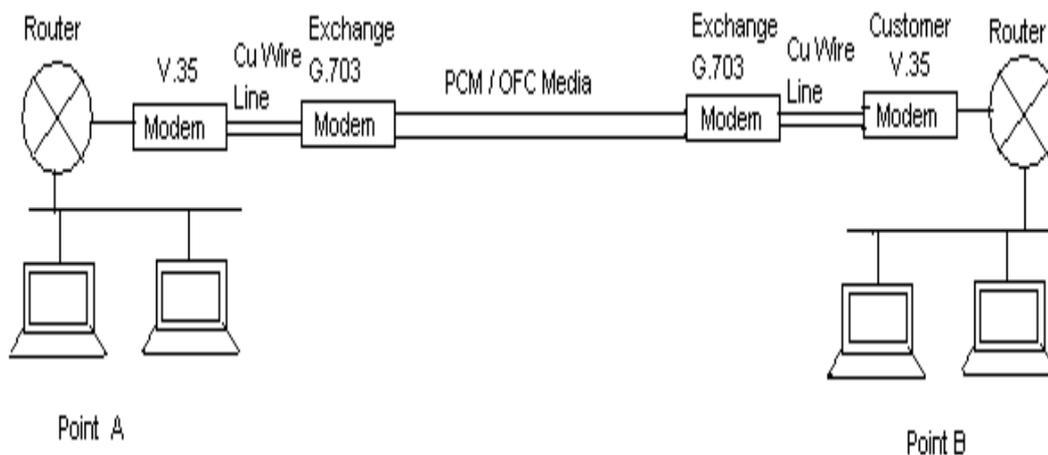


Figure:1 Point to Point Leased Line Circuit

15.4 SERVICES OFFERED THROUGH LEASED LINE

Speech Circuits (Hot lines or Private Wire): Between two locations in one city/ different cities for the same applicant. The terminating equipment at both ends is telephone without dialing facility.

Data Circuits: To transmit data between computers or any other type of electronic information devices.

- Local (within city) and long distance (intercity) data circuits at low, medium and high speeds, i.e., from 64 Kbps to nx64 Kbps to 2 Mbps to STM-1 (155 Mbps) and beyond.
- Dedicated path between two points
- Private Data Network – More than one local or long distance leased circuits converging on a location such that data from one leased circuit can be transferred automatically to another leased circuit for the same subscriber.
- Mainly used by banks, other financial institutions, corporate, government, etc to build their own private data network interconnection various offices and their computer systems.

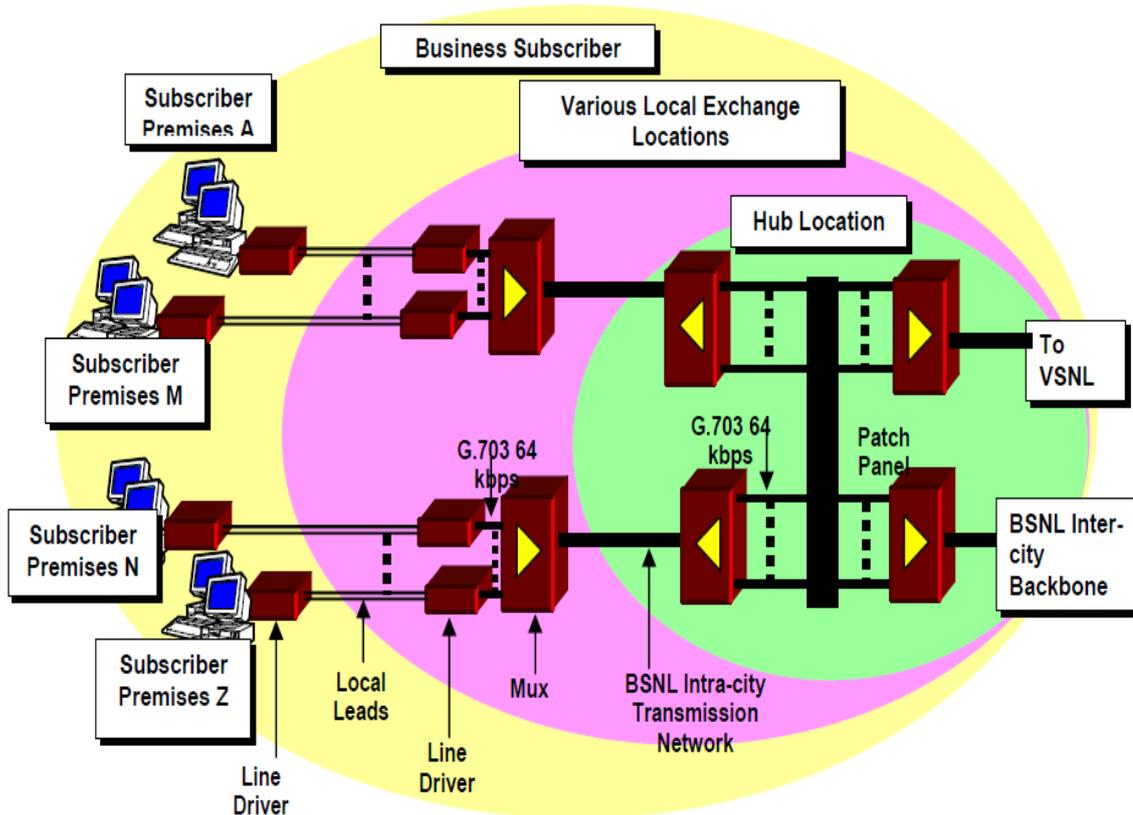


Figure:2 Typical Leased Line Network Set-up

ADVANTAGES

It provides permanent, reliable, high-speed connectivity as compared to the temporary connectivity of dial up access. The quality of the connection is far superior to what is normally available through dialup, because of the digital signaling, less noise, fewer exchanges etc.

DISADVANTAGES

Leased bandwidth prices are quite high, compared to dialup bandwidth of comparable size. Entry level annual port prices are also high at present, so that this access method is only feasible beyond a fairly high threshold level. Permanent connectivity to the Net exposes the organization to a variety of threats including hacking, malicious code including active vandals, viruses, Trojan Horses, macros, denial of service attacks etc.

15.5. TYPES OF LEASED LINE NETWORKS

WIRE-LINE LEASE LINE SERVICES

Before year 2000, limited development in computing technology, limited options available with the operators were being offered to customers. Leased line of discreet capacity of 64Kbps, 2Mbps etc. were only made available to the customers due to non-availability of options for providing leased line of intermediate capacity. The subscriber therefore always suffer either by

subscribing option with less than the capacity of their requirement or by paying more for subscribing lease line capacity more than their requirement. However, as more and more business introduces computer and its networking for increasing efficiency and ease of operations, demand for such networks increases. This increasing demand of lease line networks in conjunction with the development in computing technology forced the operators to set up a service platform which can provide a reliable, flexible, transparent and secure solution. BSNL launched following solution to meet the requirement of its customers.

MLLN solution uses existing **MANAGED LEASED LINE NETWORK (MLLN)** copper access network. It provides subscriber flexible option of choosing lease line capacity in multiple of 64Kbps from 64Kbps to 2Mbps unlike earlier solution. Customer can build a highly secured and reliable network for sharing information between various entities connected through this networking solution.

The network is built up with three elements viz, Digital Cross Connect (DXC), Virtual Multiplexer (VMUX) and Network Terminating Unit (NTU). DXC is at highest level in network element hierarchy and can modularly expanded with the customer demand from 64P to 960P capacity. VMUX provide network connectivity to the customer with NTU at the subscriber premises. The versatile NTU is configurable through software for increasing or decreasing lease line capacity in multiple of 64Kbps and having various interface options for connectivity with subscriber networking equipment. The NTU accepts G703, V.35 and Ethernet inputs. It relieves customers of expenditure required to be incurred for purchase of equipment required of interface conversion. The physical leased lines and all these elements can be provisioned and monitored through a elaborated, highly secured disaster resistance monitoring, provisioning and fault control system at Bangalore with hot standby at Pune. Hot standby system ensures up and running services to the customer in the extreme disaster conditions. It has elaborated performance monitoring and fault identification system. This system also provides easy and flexible service provisioning. Controlled access to this system can be made available to the customer for on line monitoring of networking services provided. Customers can also allow to flexibly change lease line capacity in time domain as per his requirement. The system has rich report generation option by keeping continuous log of network and connected equipments. The system thus enables transparent execution of Service Level Agreement (SLA) of the order 99.999 (five nine).

15.5.3 MULTI-PROTOCOL LABEL SWITCHING– VIRTUAL PRIVATE NETWORK (MPLS – VPN)

Application in convergence scenario generating IP based packet traffic from Voice, Data and Video applications. Efficient and secured IP based packet network therefore required to carry such traffic to the different entities in a business spread across wide geographical area. Sales related services demands access to information required by moving sales representatives too anywhere and at any time. BSNL to cater such demand in secure but flexible environment created nationwide highly efficient traffic and quality sensitive network based on MPLS technology. A core network of highly efficient, high speed MPLS 110 routers is established with

large no edge routers capable of accepting packetized data from almost all type of standard interfaces.

MPLS based VPN can be built up by the customer with different interface equipment at customer premises. This network can carry customer's traffic in highly secured mode with different QoS option. The lease line network is capable of providing lease line of virtually of any capacity which an application demands in present scenario. Point to multipoint connectivity can be provided to the customers to reduce number of physical lease line required in conventional lease line network solution. Connectivity while on move, particularly to sales representatives and customers can also be provided through secure mode.

Offices and entities in far flung, difficult and isolated areas are also required to be connected in a business. Quick connectivity in congested city needs a system very different from present conventional wire-line based lease line solution. Further, new business models are also being evolved which demands connectivity, transfer of information for business strategies and decisions. Wireless networking solution is the only possible option to cater such demands.

15.5.4.1 VAST SATELLITE BASED LEASE LINE (KU BAND) NETWORK

BSNL has established a wireless Ku-Band VSAT network with Hub earth station at Bangalore. Lease line of different bandwidth capacity from 64 Kbps to 2 Mbps can be provided to the customers. It needs installation of small terminal without door unit having dish antenna of 0.75 M to 1.8M size and modem like Indoor unit. The subscriber unit can be installed at any far flung, difficult or isolated place. Highly congested areas where wire-line solution is not possible can also be provided connectivity with this option.

15.5.4.2 VSAT SERVICES NETWORK

The network consists of a Hub located at Bangalore and VSATs located throughout the country. The VSAT communicates to the HUB through Express AM1 Satellite. All VSATs are connected in STAR topology and VSAT to VSAT communication is through the HUB at Bangalore. Ku band VSAT network of BSNL is capable of providing high speed data transfer up to 2Mbps (presently 512 Kbps) and voice communication service covering the entire country.

Key Features

- IP based VSAT Broad Band service
- Maximum Trans/Receive Data up to 2Mbps with 10/100 Mbps Base-T Ethernet Interface.
- Voice Telephony with add on ATA (Analog Telephone Adaptor)
- Power consumption is about 300W (AC input power supply)
- Compact Indoor Unit (IDU) occupies very little space.
- Supports all IP v4 protocols
- Shared and customized Bandwidth for customer's requirements.

- VPNs can be created with VSAT Network, MLLN nodes, MPLS nodes of BSNL.
- Supports Video Conferencing, Built in GRE Tunneling, Transparent to IP Sec protocols.

The Outdoor Unit consists of antenna (1.2m, 1.8m) and Block Up Convertor (BUC), Block down Convertor and feeder assembly. The IDU is connected to VSAT Antenna through RG-6 cable of maximum 30m length.

The lease line networks in BSNL has been developed and groomed over a period of time catering demand of all type of customers. These networks has been integrated together to leverage the advantage of making available both wire-line and wire-less solution to the customers as per their needs and benefit.

15.6 MLLN FEATURES:

1. MLLN is an integrated, fully managed, multi service digital network platform through which service provider can offer a wide range of service at an optimal cost to business subscriber.
2. Using NMS, MLLN can provide high speed Leased Line with improved QoS, high availability & reliability.
3. NMS supports service provisioning, Network optimization, planning & service monitoring.
4. System offers end to end circuit creation and modification, circuit loop testing & fault isolation, automatic rerouting of traffic in case of trunk failure, software programmability of NTU etc.
5. Banking, Financial institution, Stock market, paper industry, broadcasting & Internet service Provider main customers for MLLN.

15.6.1 Limitations of the present scenario (MLLN /P2P Leased Lines)

- Bandwidth on Demand – *Not possible(Dynamic Bandwidth allocation not possible)*
- As the organization grows, number of links becomes more. Network becomes more complex and it becomes difficult to maintain the reliability.
- As the organization grows present networking solution becomes costly since we will have to invest on multiple links and Networking equipments.
- Security, Maintenance of Network Elements is customer's responsibility in present scenario.

Provisioning & Commissioning time is more.

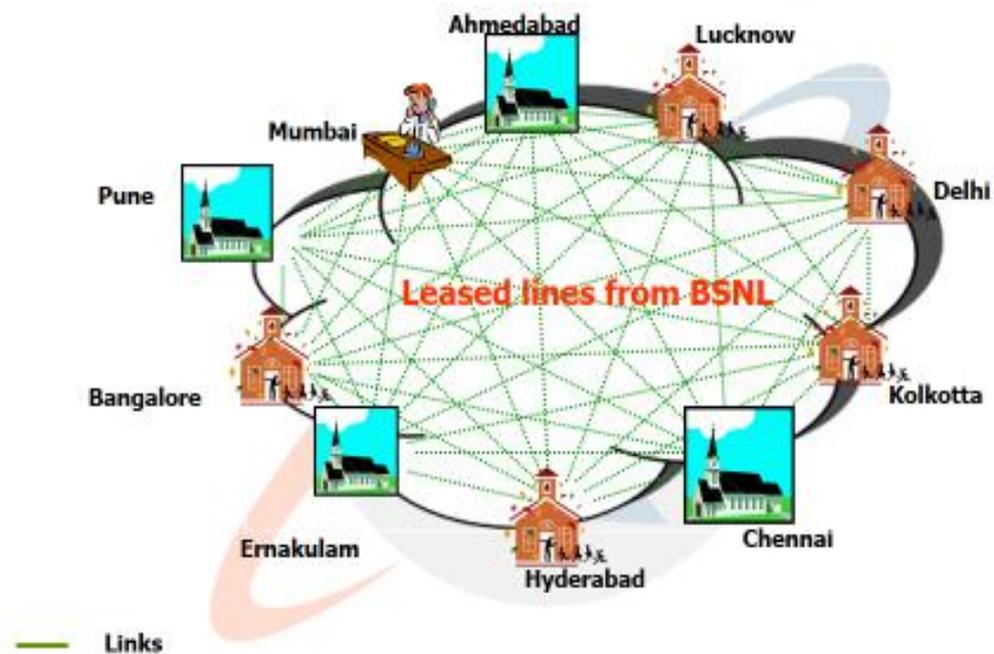


Fig:3 MLLN-or Point to Point Leased Line network

15.7. MPLS- VIRTUAL PRIVATE NETWORK (VPN)

- A network where customer sites are connected through the shared infrastructure of the provider, with the same access or security policies as a private network
- The term *virtual* indicates that the network is dynamic, with connections set up according to organizational needs
- It also means that the network is formed logically, regardless of the physical structure of the underlying network

Advantages of VPN

- Unlike physical links, VPNs do not maintain permanent links between end points. Connections are created and torn down according to requirements
- No wastage of bandwidth: when a connection is no longer required, it is torn down, releasing bandwidth and network resources for other uses.
- Much more economical than physical links in terms of telco tariffs
- Much more economical due to reduced equipment complexity, implying lesser investments in equipment and training

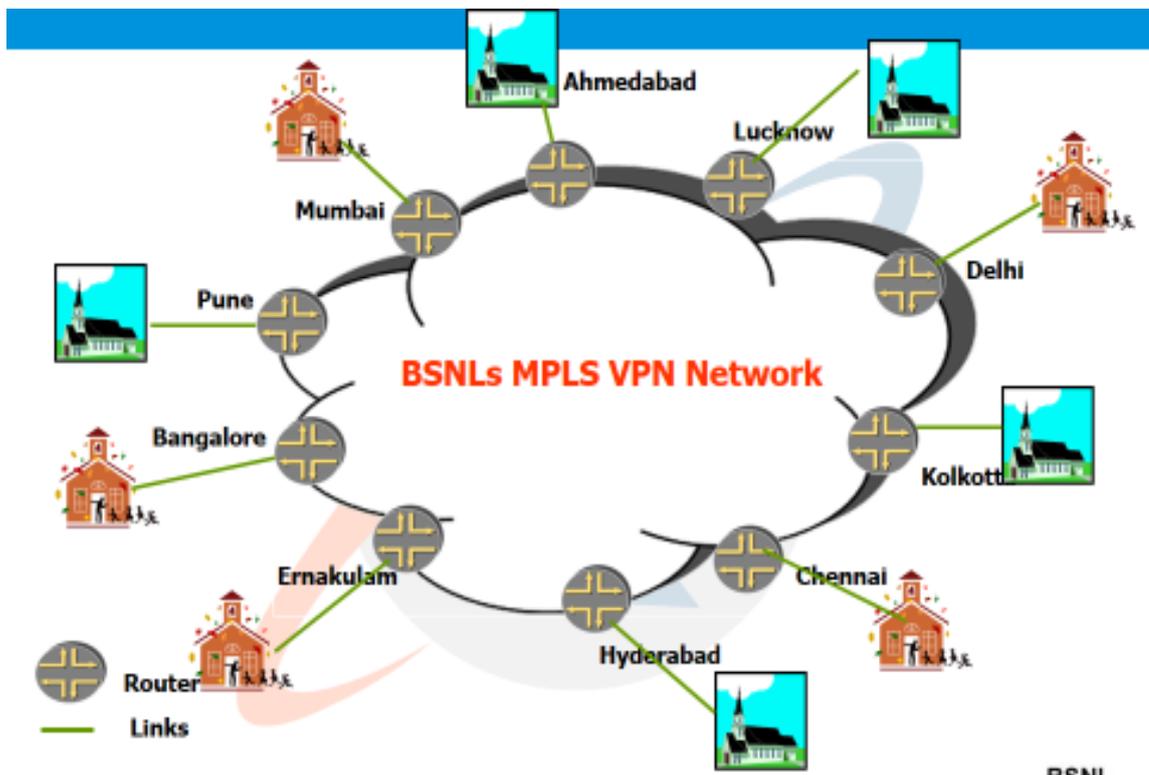


Fig:4 MPLS-VPN Leased Line network

15.8 INTERNET LEASED LINE (ILL) SERVICES

- ILL is an always on Internet connection based on leased line access (i.e. dedicated access). Leased lines provide the last mile access from the user premises to BSNL equipment.
- Required by heavy users like educational institutes, big cyber café, small and medium corporate house who need to constantly remain online with Internet.
- Permanent Internet connection as compared to the temporary connectivity throughdialup access.
- Far superior quality as compared to dialup, thanks to digital signaling, less noise, fewer exchanges etc.
- A scalable access method - Bandwidth speeds starting from 64 Kbps to 2/8/34/45/155 Mbps & 1/1.5/2 Gbps & beyond Ethernet connectivity can be deployed.
- Since the access is "always on", it is possible to associate a pool of permanent IP addresses with a particular leased line. Using IP addresses provided by BSNL, it becomes possible to deploy a variety of services such as mail, FTP, WWW, DNS, and proxy, to name the most common requirements of organizations. In other words, leased lines enable hosting of services of all types, and provide a platform for enterprise intranets and extranets, apart from what we may term as "entry level" services such as messaging, which still account for over 70 percent of all Internet access.
- Leased Internet bandwidths up to 2Mbps are provided using modems on copper pair, however, large bandwidths are provided using OFC in the last mile.

15.9 CONCLUSION

The Leased line circuits are the dedicated line for providing various services to the big customers like EB Customers. These are very popular and effective services for Data services. Most of the customers are using these Leased lines for their connectivity all over the world and for Internet purpose. BSNL is one of the leading service providers of Leased lines. Leased Lines on MPLS-VPN is now days with latest technology and eliminates all previous point to point networks problems. It is cheaper and most secured networks for private lines.

16. BULK SMS AND SMS MARKETING

16.1 LEARNING OBJECTIVE

After reading this chapter over SMS marketing and bulk SMS the trainees will come to know about following important concepts.

- Mobile Marketing
- SMS Marketing
- Bulk SMS
- Bulk SMS procedure in BSNL

16.2 MOBILE MARKETING

Mobile marketing is a multi-channel online marketing technique focused at reaching a specific audience on their smartphones, feature phones, tablets, or any other related devices through websites, E-mail, SMS and MMS, social media, or mobile applications. Mobile marketing can provide customers with time and location sensitive, personalized information that promotes goods, services, appointment reminders and ideas. In a more theoretical manner, academic Andreas Kaplan defines mobile marketing as "any marketing activity conducted through a ubiquitous network to which consumers are constantly connected using a personal mobile device".

16.3 SMS MARKETING:

Marketing through cellphones' SMS (Short Message Service) became increasingly popular in the early 2000s in Europe and some parts of Asia when businesses started to collect mobile phone numbers and send off wanted (or unwanted) content. On average, SMS messages have a 98% open rate, and are read within 3 minutes, making it highly effective at reaching recipients quickly.

Over the past few years SMS marketing has become a legitimate advertising channel in some parts of the world. This is because unlike email over the public internet, the carriers who police their own networks have set guidelines and best practices for the mobile media industry (including mobile advertising). The IAB (Interactive Advertising Bureau) and the Mobile Marketing Association (MMA), as well, have established guidelines and are evangelizing the use of the mobile channel for marketers. While this has been fruitful in developed regions such as North America, Western Europe and some other countries, mobile SPAM messages (SMS sent to mobile subscribers without a legitimate and explicit opt-in by the subscriber) remain an issue in many other parts of the world, partly due to the carriers selling their member databases to third parties. Who defined however, government's efforts of creating National Do Not Call Registry have helped cellphone users to stop SMS advertisements by sending a simple SMS or calling 1909.

Mobile marketing approaches through SMS has expanded rapidly in Europe and Asia as a new channel to reach the consumer. SMS initially received negative media coverage in many parts of Europe for being a new form of spam as some advertisers purchased lists and sent unsolicited content to consumer's phones; however, as guidelines are put in place by the mobile operators, SMS has become the

most popular branch of the Mobile Marketing industry with several 100 million advertising SMS sent out every month in Europe alone. This is thanks in part to SMS messages being hardware agnostic—they can be delivered to practically any mobile phone, smartphone or feature phone and accessed without a Wi-Fi or mobile data connection. This is important to note since there are over 5 billion unique mobile phone subscribers worldwide in 2017, which is about 66% of the world population.

SMS marketing has both inbound and outbound marketing strategies. Inbound marketing focuses on lead generation, and outbound marketing focuses on sending messages for sales, promotions, contests, donations, television program voting, appointment and event reminders.

In India, as per the TRAI guidelines, the companies who want to communicate with their customers will now have to register themselves with Telecom Operators for sending SMS. The Businesses and Bulk SMS Service Providers will be accountable to telecom operators who will be directly accountable to TRAI.

Understanding TRAI regulations for sending business SMS in India.

An independent authority of the telecommunications sector in India, TRAI is a regulation of broadcasting and cable TV services, also a recommendatory body for licensing in telecom and broadcasting. The Telecom Regulatory Authority of India also regulates bulk SMS and keeps updating senders from time to time on the rules for:

- Transactional SMS
- Promotional SMS
- DND Scrubbing
- Sending Time
- Termination Charges
- Sender Name
- Penalty and more

If you're sending any of these texts to your customers, you need to read ahead...

In India, there are 2 types of outbound SMS that a business can send –

16.3.1 TRANSACTIONAL SMS – FOR IMPORTANT UPDATES AND ALERTS.

With Transactional SMS one can send informative, generic, critical data or information. All SMS content needs to be transactional and should not contain any promotional content on this route.

“IM-DSTORE The refund of your order XYZ has been processed and will reflect in your account within 24 hours. Thank you for choosing us!”

Some characteristics of Transactional SMS:

Delivery Time	24×7
DND Number	Can be sent
Sender ID	Unique 6 alpha characters that represent your brand
SMS Gateway Route	4

16.3.2 PROMOTIONAL SMS – SEND MARKETING MESSAGES TO OPT-IN USERS.

Used to send promotional information on goods and services, with promotional messages one can promote brands, update information and provide offer details.

“DM-123456 The spring sale is on! Buy 1 get 1 valid only for till midnight.”

Some characteristics of Promotional SMS:

Delivery Time	10 AM -9 PM
DND Number	Cannot be sent
Sender ID	Pre-approved 6 digits
SMS Gateway Route	1

16.3.3 SO, WHAT IS A SENDER ID?

For Transactional SMS, the sender ID is in the format XY-ZZZZZZ having nine alphanumeric characters. You can choose the last six alphabetic characters that represent your brand name.

- First alpha character being code of Access provider
- The second alpha character being the code of service area
- The third alphanumeric character will be a dash (-)
- The last six alpha characters will be the identifier of the company or organization sending transactional SMS

For sending the Promotional messages, a company can use an alphanumeric identifier in the format XY-RZZZZZ, wherein:

- X stands for code allotted to Access provider
- Y stands for the service area
- R is any digit from 0 to 7
- ZZZZZ indicates 5 digit unique identification code allotted to the company by the Access Provider

16.4 INDIA PRE-REGISTERED SENDER ID PREFIXES

The following are the list of SMS prefixes used in India and their explanation:

Service Provider	Code
Aircel, Dishnet Wireless	D
Airtel	A
BSNL	B

Service Provider	Code
BPL Mobile/Loop Telecom	L
Datacom Solutions	C
HFCL Infotel	H
Idea Cellular	I
MTNL	M
Reliance Communications	R
Reliance Telecom	E
S tel	S
Shyam Telecom	Y
Spice Telecom	P
Swan Telecom	W
Tata Teleservices	T
Unitech	U
Vodafone	V

State Codes that signify the SMS Gateway Origin:

Service Circle	Code
Andhra Pradesh	A
Assam	S
Bihar	B
Delhi	D
Gujarat	G
Haryana	H
Himachal Pradesh	I

Service Circle	Code
Jammu & Kashmir	J
Karnataka	X
Kerala	L
Kolkata	K
Madhya Pradesh	Y
Maharashtra	Z
Mumbai	M
North East	N
Orissa	O
Punjab	P
Rajasthan	R
Tamil Nadu	T
UP-East	E
UP-West	W
West Bengal	V

So if the Sender ID is received as VD-NEXSMS, this will mean the carrier

delivering was Vodafone, and the region was Delhi.

16.5 TRAI REGULATIONS & RESTRICTIONS

Text messaging in India comes with a few regulations and restrictions. No matter whichever industry you are into you must comply with the guidelines before sending bulk SMS.

The primary rule to remember is that you can only send marketing messages to recipients who have opted-in to receive these messages.

Let's understand these rules in detail:

SENDING PROMOTIONAL MESSAGES FROM TRANSACTIONAL ROUTES

Now, this is something that marketers know isn't right but most of them still do – send marketing content from the transactional route.

All SMS content sent from the transactional route needs to be transactional and should not contain any promotional content. Doing so is an unethical practice, violates the TRAI regulations and can result in a heavy penalty.

Ask your users for their permission for sending **OPT-IN AND OPT-OUT** any updates and information regarding your services. Mention clearly in the message that if they want to opt out, they can, by texting your keyword followed by STOP to your shared short code or long number.

If the mobile numbers you send SMS to are your **OPT-IN PROMOTION** registered users and if you have an opt-in clause accepted by them then you may send them occasional promotional messages even if the user is on DND through transactional route.

Also, the validity of an opt-in is 180 days from the date subscriber sends in the opt-in START message. To stay opted-in, the subscriber will need to renew their preferences once every 6 months.

This is the type of message, voice **COMMERCIAL COMMUNICATION** or SMS transmitted for the purpose of informing, soliciting or promoting any commercial transaction in relation to products, investment or services.

UNSOLICITED COMMERCIAL COMMUNICATION (UCC) Any commercial communication

which a subscriber opts not to receive except:

1. Transactional message
2. A message transmitted on the directions of government or authorized agencies authorized

FULLY BLOCKED Subscribers who have registered with the national DND registry to not receive any marketing SMS belong to the fully blocked category.

Registered with the NDNC registry to not **PARTIALLY BLOCKED** receive marketing SMS, except from any one or more of the below categories belong to a partially blocked category.

Mobile subscribers can register with NDNC opting in to receive Promotional messages in one or more of the following categories:

1. Finance
2. Real Estate
3. Education
4. Health
5. Consumer goods and automobiles
6. Communication
7. Tourism and Leisure

NATIONAL DO NOT CALL (NDNC)

Over 23 crore mobile numbers are enlisted with the NCPR (National Customer Preference Register) earlier NDNC, to curb unsolicited commercial communication.

Telecom subscribers who do not wish to receive any promotional messages or calls can register to DND and the registration will be effective within 7 days of placing the request with the service provider.

If you are trying to send messages on any of these enlisted numbers,

First of all, it will be blocked

Secondly, you are violating the TRAI rule

BUT NOT ALL SMS WILL BE BLOCKED

The Do Not Call List can only stop sales messages. You may continue to receive:

1. Political SMS
2. Charitable SMS
3. Debt collection SMS
4. Informational SMS
5. Survey SMS
6. Personal SMS

Also, you may still get promotional texts from companies with whom you've recently done business; likewise, if you've given written permission to a company to text you.

CUSTOMERS CAN FILE A COMPLAINT AGAINST UNWANTED TEXTS

Despite being on the NDNC list, if you still receive marketing SMS it is considered illegal and TRAI encourages filing a complaint against companies following illegal practices.

In case of a DND complaint, the marketer would be required to produce the opt-in details for a user. Failing to do so can attract a penalty from INR 25,000 to INR 2, 75,000.

16.6 INDIA: NEW SMS FEATURES & RESTRICTIONS

Vonage supports Domestic and International enterprises SMS business to India.

To follow the regulations of Telecom Regulatory Authority of India (TRAI), domestic enterprises can submit A2P SMS through domestic connections to the end recipients only after successful registration of Distributed Ledger Technology (DLT).

Any enterprise, who fails to pre-register Distributed Ledger Technology (DLT), will become non-compliant and will not be able to send A2P SMS to the end recipient via domestic connections.

Please notice International Enterprises are not affected by this change. Timeline information of the DLT implementation:

***Phase-1: Lived on 1st June 2020. SenderID/Header Scrubbing.
Only DLT registered SenderIDs able to terminate sms on domestic routes.
Entity Registration and Header Registration was mandatory.***

***Phase-2: Lived on 19th Nov 2020. PEID/Entity Unique ID Scrubbing.
PE ID is mandatory to provide along with Header for successful sms termination.
Entities have to start registering their Content and Consent Templates on the DLT Portal on which they have got their entities registered.***

***Phase-3: Live on 8th March 2021. Template/Content Scrubbing. (TRAI extended scrubbing live 7 days from 10th Mar)
Only DLT registered Templates along with SenderID & PEID able to terminate sms on domestic routes.***

Similar to the Sender ID upload process, you need to upload these templates with any one operator DLT portals. Brand Name is mandatory to be included in content for template registration with effect from Oct 11 2020.

Complying with DLT and Vonage

As per TRAI new regulation, for SMS through domestic connections, all enterprise must register their **Principal Entity, its Headers, and Templates with Brand Name & provide consents** on any one of the DLT systems below.

<https://www.vilpower.in> - (Vodafone-Idea Ltd DLT URL)

<https://www.ucc-bsnl.co.in> - (BSNL DLT URL)

<https://dltconnect.airtel.in> - (Airtel DLT URL)

<https://trueconnect.jio.com/#/> - (Reliance JIO DLT URL)

- **PEID**- (Entity unique ID received from DLT after Entity registration Approved) :
- **Entity name** - (Company name under which registered on DLT) :
- **Sender Name** - (6 Alpha/Num Sender/Header which is registered in DLT and approved)
- **Registered on** - (The DLT platform information) :
- **Template file** - (as downloaded from DLT portal template section) and saved as csv format with entityID as file name. <entityid.csv>

Please notice Vonage is not responsible for domestic entities registering for DLT. Also we does not verify if domestic entities have provided their PED, template

ID and the sender ID correctly.

The carrier does, if a message error due to these fields not being provided or valid, this will be reflected in the Delivery Receipt web hook and SMPP DLR.

Vonage has added functionality within the Send SMS API endpoint, or via SMPP to allow domestic entities to comply with the DLT regulation, by providing both their PEID (unique entity ID), and the template ID for every SMS request made. The API properties used in this endpoint are to be matched exactly as listed below:

- 'entity-id' parameter needs to be the DLT approved PE ID (unique Entity ID)
- 'content-id' parameter needs to be the DLT approved Template ID
- 'from' parameter needs to be the DLT approved Sender ID (Header ID)

If you use SMPP to send SMS messages with Vonage, the following fields apply:

- 0x1470 needs to be the DLT approved PE ID (unique Entity ID)
- 0x1471 needs to be the DLT approved Template ID
- The Sender ID needs to be the DLT approved Sender ID (Header ID)

16.7 LIMITATION TO AVOID POTENTIAL SMS FLOODING

Local regulations specify limitations to the number of messages that can be sent to the same number:

- More than 6 messages to the same destination number within an hour with the same sender or text may be blocked
- Users may not be able to receive more than a total of 200 SMS per day across all incoming streams.

OTHER FEATURES/RESTRICTIONS ON DLT:

Unicode:

Unicode is supported.

Delivery Receipts:

Transactional/OTP Traffic: DLR is supported and its reliable delivery receipts.

Promotional Traffic: DLR is not supported. And / Or its unreliable Network DR.

DND/UCC registration/complaint on DLT platform: For any dnd request/complaint) query OTP from the concerned mobile number is mandatory hence it is requested to customers to do self login on <https://www.ucc-bsnl.co.in/customers/>

16.8 IN BSNL STEPS NEED TO TAKE FOR BULK SMS IF ANYONE APPROACHES TO ANY OF OUR STAFF:

1. Contact SSA/circle marketing team with details like text, Paid/free kind of (payment) promotional/Transactional type (req to fix CLI) etc for payment of broadcasting
2. If it is non-paid then Contact CC/SMSC team with details like text, approval letter of Concerned section GM/DGM, circular in which the given text is allowed for free broadcast, fixed CLI with customer consent, list of mobile numbers or area details where text to be broadcasted

3. If it is paid then Contact CC/SMSC team with details like text, approval letter of Concerned section GM/DGM, circular according to which payment taken, payment receipt, fixed CLI with customer consent.

16.9 CONCLUSION

Bulk SMS is one of the modern methods of marketing which reaches to the customers in very easy manner. In fact SMS penetration is maximum as it does not require internet / data pack.

17. DIGITAL MARKETING OF SERVICES AND PRODUCTS

17.1 LEARNING OBJECTIVE

After reading this unit, you should be able to understand:

- Digital Marketing.
- Ways and means of digital marketing
- Action, control and changes required to be implemented for digital marketing.

17.2 INTRODUCTION

This chapter provides a technical outline of the basics of online marketing. The outline includes an introduction to digital marketing and strategic planning and development. Our contribution offers theoretical and practical insights relative to this growing marketing area, with information on the main areas for which online marketing is particularly suited:

(1) the E-commerce section explores different business models and what techniques are used for their development;

(2) Web Search Marketing focuses on SEO and SEM, as well as in keyword selection for optimization;

(3) E-mail Marketing offers interesting content to develop a successful newsletter; and

(4) Social Media Marketing addresses planning and the most important tools used to maximize communication through social media.

In a nutshell, this chapter offers an overview of digital marketing and its strategies for an active and effective Web presence.

17.3 WHAT IS DIGITAL MARKETING?

The first approaches to digital marketing defined it as a projection of conventional marketing, its tools and strategies, on Internet. However, the particularities of the digital world and its appropriation for marketing have fostered the development of channels, formats and languages that have led to tools and strategies that are unthinkable offline.

Today, rather than a subtype of conventional marketing, digital marketing has become a new phenomenon that brings together customization and mass distribution to accomplish marketing goals. Technological convergence and the multiplication of devices have led to an opening up of the ways in which we thinking about marketing in Internet and have pushed the boundaries towards a new concept of digital marketing—user-centered, more measurable, ubiquitous and interactive.

The development digital marketing strategies offer much potential for brands and organisations. Some of them are as follows:

•**Branding.** Platforms and 2.0 services are a great opportunity to build a brand image on the Web due to their scope, presence and constant updates.

- **Completeness.** The possibilities to disseminate information through links offer consumers the chance to approach the organization in a wider and customized way.

- **Usability–functionality.** Web 2.0 offers simple and user-friendly platforms for all in order to improve user experience and allow for their activities.

- **Interactivity.** In the context in which organizations try to forge long-term relationships with their audiences, Internet offers the possibility of having a conversation and therefore of generating a positive experience with the brand. Such interactivity can be basic, as product assessment, or become an all-encompassing experience.

- **Visual communication.** In line with visual thinking, digital marketing offers marketers different image- and video-based tools. This is an attractive way of reaching audiences that can lead to greater engagement.

- **Relevant advertising.** Easy segmentation and customization of advertising in Internet maximize the output. Besides, free from the limitations of other media, this environment has allowed for more attractive advertising.

- **Community connections.** Internet is a unique opportunity to connect organizations with their audiences and users among themselves. This connectivity can improve their experience and enhance the relationship with the product, brand or organization.

- **Virality.** The essence of Internet as a Web of interconnected nodes makes exponential expansion of any content possible. Taking the model of WOM (word of mouth) communication, viral communication becomes more relevant due to connectivity, instant sharing on online platforms that enhance the dissemination of content.

- **Measuring output.** Online platforms rank first in the availability of follow-up options and the possibility to assess output.

In any case, to make the best of all these possibilities, organizations must ensure that their Internet presence or their presence on their different 2.0 channels follows a strategy with concrete goals, in line with their brand or organizational image. Being on the Web without proper planning can not only mean a lost opportunity in terms of resources and potential, but also it can indeed have a negative impact on the organization, as the audience, their needs and perceptions regarding the organization are unknown.

17.4 DIGITAL MARKETING PLAN

A digital marketing plan is a strategic document that takes the current situation of a particular organization to set some midterm goals and to determine the strategy and means to accomplish them.

The aims of a digital marketing plan include discussing organizations and their environment. Likewise, it needs to be a roadmap of how to manage the organization's marketing strategy, so that resources are properly allocated. The plans also helps control and evaluates output and tackle any potential deviation from the organizations expected outcomes. In this line, a marketing plan becomes a flexible document that must be adapted to the situation of the company and that must feed into the results obtained by each of the actions developed, especially in the digital arena.

The development of an online marketing plan is similar to a conventional one

in its structure, but it also includes some variations at an operational level. In fact, this means not only that some specific strategies and tools are to be developed, but also that the volatility of the digital media and its capacity for immediate measurement force organizations to develop a strategy that can be revised in the short term, as well as the iterative process between action and control.

An online marketing plan is a document in line with the company's strategic plan that sets goals of an activity in the digital environment, as well as the what, how, when, who and why (6 Ws) of Web presence.

There are different options regarding the structure of a marketing plan. We advocate for a four-phase structure as this is simple and clear to plan for any action's strategy (Fig. 1).

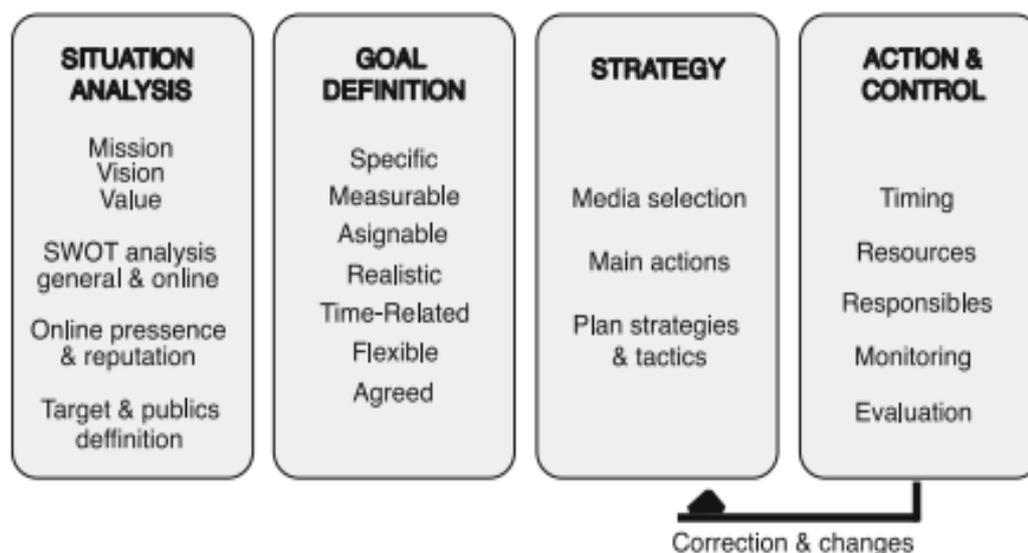


Fig. 1 Marketing plan.

17.4.1 Situational Analysis

One of the most relevant parts of any strategic document is the definition of the baseline situation of the organization and its environment. This analysis allows for the development of an action plan that is reality based and shall therefore minimize the risks in the development of a strategy.

The starting point of any situational analysis is to define the mission, vision and values of the organization.

17.4.2 Goal Setting

Setting goals is one of the key phases in any marketing plan. Goal setting offers an idea of where the organization is going and it enables adjustments to the marketing strategy.

Goal setting must follow SMART criteria

- **Specific:** simple and easy to understand.

- **Measurable:** they can be measured through any kind of quantitative or qualitative unit.
- **Assignable:** they can be assigned and implemented by a member of the company.
- **Realistic:** with accessible resources, goals can be achieved in a realistic framework.
- **Time-related:** they must have a time frame to achieve them.

17.4.3 Planning a Strategy

In order to accomplish the planned goals, a specific strategy must be defined. A strategy is the implemented scheme to achieve such goals. This strategy materializes in activities that are the ways planned to achieve such goals.

An online marketing strategy is based on the model of a marketing funnel, as a development of the AIDA model (Awareness, Interest, Desire and Action). The transformation of marketing in recent decades and the particularities of the digital world have allowed for a revision of this marketing model so that it captures the conversion strategy, as well as the loyalty strategy, key in the online world.

There are several proposals, apart from Awareness, Consideration, Preference and Action (an update of the AIDA model phases in the current context), two new states must be incorporated: loyalty and advocacy. Also, each phase means a higher level of commitment, and therefore, loyalty and advocacy are at the bottom of the model.

However, in the online world, loyalty and support for the brand can lead to change consumers into prescribers, thus increasing the scope of the organization's action, which could lead to an expansion of its consumer base.

Action and Control

In the process of setting up a strategy, a large number of actions are defined, and the possible theme areas for the development of content or keywords are listed (e.g. in the Social Media Plan). Likewise, the development of each strategy requires time planning to programmed implementation.

In this sense, an essential part of any digital marketing strategy is the scheduling of tasks and timing for each of them. In the case of marketing strategies based on a limited number of tools—or example a branding campaign where a Facebook profile and newsletter are exclusively used—the content of each of the actions (publication, sending the newsletter) can be briefly mentioned in the scheduled.

Likewise, for online marketing strategies linked to traditional marketing, offline actions have to be included in the schedule whenever they are interdependent on online tasks.

Scheduling means assigning tasks in the digital marketing strategy, with clear indication of who is responsible for each action. Therefore, all departments in the organization should have a copy of the marketing plan, especially those departments and professionals involved in its proper development.

17.5 SOCIAL MEDIA MARKETING

Social media is a great opportunity to establish significant relationships and

create ways of social interaction defined through dynamic exchanges between their members. Social media is booming in terms of the number and variety of platforms and users.

Thus, one can find audiovisual platforms such as YouTube, Vimeo and SoundCloud; image platforms such as Flickr, Picassa, Pinterest or Instagram; general social networks such as Facebook, Twitter, Google+ or specialized ones such as LinkedIn; news or bookmark aggregators such as Digg or Delicious; blogs; and wikis, etc., a vast digital arena where they become the new Web winners.

Although the notion of a social network is not new, it has reached new heights, thanks to Web penetration and connectivity. Social networks have developed through platforms that show different types of functions, but common features. These features aim at creating a community by connecting users, who can interact, discuss, and offer insights or knowledge. Technology in the case of these platforms also needs to be flexible and conducive to an exchange of information. This means that free web standards; and modular architectures that lead to complex but efficient applications are usually favored.

In essence, a social network manager is a service that allows individuals to create a public or semi-public profile within an enclosed system, to articulate a list of other users they share connections with, and to use that list of users, as well as other nodes in the system. The nature and nomenclature of such connections may vary from one site to the other.

Such platforms become content containers as they grant space and tools for a user who plays an increasingly more active role. In this sense, brands and organisations should be part of the social conversation and use the interactive channels to listen to their users, who share their perspectives, insights and knowledge, or generate value through content development.

17.6 SOCIAL MEDIA ADVERTISEMENT

Most social networks show business models based on advertising. If we take for granted that a social network manager is a massive database, with large amounts of qualitative data from its users, using them allows brands for micro segmentation of their advertising actions. Facebook is the King of segmentation. Its advertising platform, Facebook Ads, allows for a delimitation of the target audience of each ad depending on location, age, sex, languages and even interests and behaviours. Facebook is the social network with more data on its users. The basic data filled in by the user alone in the process of registration on Facebook includes name, e-mail, sex and age of the new user.

Facebook advertising formats are inserted either on the sidebar on the right-hand side of the platform itself or on the users own timeline (Web and mobile), as well as on the logout page. These adverts must to be identified as such, while their goal is to foster as much interaction with users as possible. They thus try to increase engagement, lead users to a website or special offers, get more likes on pages, app downloads... etc.

Twitter, on the other hand, has less information on users; therefore, its segmentation capacity is lower. However, through its advertisement platform, Twitter Ads, they have launched some highly efficient publicity formats. This is the case of Twitter cards, a format focusing on promoted tweets to generate tweet engagement,

website clicks or conversations, app installs or app engagements, followers or leads on Twitter, to name a few.

Other advertisement formats on Twitter are promoted accounts, which are placed on the profile recommendation section, or sponsored trending topics on the list of topics at a particular point in time.

17.6.1 E-mail Marketing

E-mail marketing is an online marketing technique that uses e-mail to send advertisements or commercial information. This is a communication tool used to attract new customers or make those that one already has loyal to the brand.

In such a volatile environment, e-mail has been one of the Web tools that have best adapted to change, both in content and in scope and penetration. Therefore, e-mail marketing becomes one of the main tools in a digital strategy.

The term “spam” refers to those messages we do not request and we do not want or with an unknown sender, usually sent through mass mailing. Although spam can be used on other platforms and devices, for example SMS on mobile phones, e-mail is the most important channel for this practice.

The line between commercial information sent by e-mail and spam is, in many cases, a fine one that experts in e-mail marketing must properly identify in order to avoid making mistakes in their work.

The most common form of e-mail marketing is the newsletter: a publication that is distributed with a specific periodicity on an interesting topic for all recipients, called subscribers.

The complexity level of a newsletter shall depend on its goals and content; they can be simple with mainly plain text as the predominant feature or be enriched with images, graphs, adverts and/or hyperlinks.

The objectives of e-mail marketing can be multiple and varied; however, all of them could be grouped around four main goals:

- **Diverting traffic to our website:** Be it the home page or any special section inside it.
- **Promoting a special action:** Either promotion of new services, special discounts, sales, download of applications, etc. When the goal is to increase traffic or some Web-based special promotion, specific websites are usually created. Such pages are called landing pages.
- **Cost savings:** E-mail marketing supports order management and information to the customer regarding the status of such orders, as well as the provision of customer support services at a lower cost than other communication channels.
- **Brand popularity and image:** Same as for other types of campaigns online, e-mail marketing is suited to generate popularity and brand image among consumers.

17.6.2 E-commerce

E-commerce means the development of transactions between companies and/or individuals on Internet, mainly for buying and selling products and services, using applications such as e-mail, instant messages, shopping carts or Web services, to name a few.

The progressive penetration of Internet and its possibilities have multiplied online trade relationships. This trend started in 1970 with the transfer of funds, with the arrival of the World Wide Web, and it became an opportunity for traditional companies and the beginning of businesses operating only online.

The boom of mobile devices, smartphones in particular, has opened the doors to mobile commerce (m-commerce), i.e. electronic commerce using a mobile device .

E-commerce is an increasingly wider and more diverse phenomenon; therefore, classifications are difficult. In any case, the most widely used classification of e-commerce is based on the nature of its transactions looking at the relationship between companies and/or between them and their final customers. In this line, we can speak of:

B2B: Business to business, these are already established companies that operate through Internet where consumers are not involved. Car manufacturers, for example, use online purchase platforms for their suppliers to place their orders.

B2C: Business to consumer, this is the most popular and widespread model on Internet, where a company sells its products (e.g. Zalando, Amazon, AliExpress) or services (Spotify) to the consumer through the Web.

B2E: Business to employee, this is a model of e-commerce that is derived from the previous one, where only the company and its employees take part. Microsoft, for example, uses it so that its workers can order office supplies, documents and company cards. This is a type of business that generates engagement by the staff through, for example, attractive offers that push their performance, which is the reason why big companies are so keen on this model.

G2C: Government to consumer, this is a variation of B2C for the public administration. This is a model of e-commerce that is gaining progressive weight in its implementation through the e-administration. A clear example is payment of taxes through Internet.

C2C: Consumer to consumer is common in sectors where end consumers relate to each other, away from companies, for their own transactions. This is a business model that is becoming stronger with crowd sourcing economies (e.g. BlaBlaCar or Uber) or online purchases and sales portals (eBay).

17.6.3 Web Positioning

Accessing information on Internet is done mainly through the World Wide Web, a vast digital arena that has experienced constant expansion since it was created in 1991 by Tim Berners-Lee. The current volume of websites is around 850 million (July 2015).

When Internet started, the number of websites was low enough to access all of them through their domain. As Internet expanded, it became clear that there is a need to create a system that allows for Web searches and enables access.

Until the end of the twentieth century, classification systems with embedded categories, known as directories, offered good results in an expanding community of Web users. The most widely known directory was Yahoo, still accessible on the website <https://business.yahoo.com/>.

However, a more intuitive and simple way to access the increasing volume of sites and Web pages was needed. That was when browsers first appeared.

A browser or search engine is a computer-based system that indexes websites

using some dedicated software. A search engine offers a list of the results depending on the search terms and connectors used by the user to access the desired content.

This simple process is currently the most important pathway to access online content, while it becomes the marketing base for browsers: SEO and SEM.

SEO stands for search engine optimization, and it refers to a set of techniques applied on a website structure, code, content and links—to improve positioning in the organic results of a concrete browser .

SEM stands for search engine marketing, and this refers to a publicity system of a browser offering users ads that are related to their search terms. Unlike SEO, SEM offers induced results (payment), even if they are presented to the Web surfer as the best result of their search (with the same look as for natural results).

17.7 CONCLUSION

In this context of intense digitalization of individuals and organizations and of the relationships between them, it is often the case that Internet presence is perceived as a must. Likewise, conversations on social platforms are open 24/7, so that a brand cannot just publish but have to follow the social conversation around their publications and even stimulate the participation of users to achieve higher engagement. All this needs resources that not all organizations have.

In this sense, it is not sufficient to be on the Web but to listen to it and follow it actively. In the current context, no company, regardless of its size, can live with its back to social platforms..

If they do not have enough resources to have an active presence adapted in the digital world, at least they need to have a strategy to monitor and know what is being said about their company on the Web.

Such action can be scaled up and adapted to any brand and organization that wants to have an active and effective online presence.

We have seen some techniques to attract users and the right audiences, to create attractive and interesting content so that customers remain loyal to organizations and brands. While we have also presented some concrete strategies and techniques to measure outcomes, organizations working in the digital environment must be careful not to get lost in the complex universe of tools and platforms. They must give and receive value, and their most important asset is in their real essence and audience, regardless of the channels used for this relationship.

18. PROJECT MANAGEMENT (OVERVIEW RELATED TO EB)

18.0 LEARNING OBJECTIVE:

This lesson provides insight into the Initiatives of BSNL for the special category of Enterprise Business customers, Roadmap and key growth areas of it. The lesson also provides an idea about what is the similarity between the typical Enterprise Business sales process and the world of project management. How concepts of project management are utilized in EB Sales processes.

18.1 ABOUT ENTERPRISE BUSINESS:

Aim of all business is to make more profit. To make profit two possibilities are selling high volume at less margin or low volume at high margin. Both approaches have its pros & cons. Companies usually adopt a mix of these approaches. To address both the retail market and the high volume Enterprise market BSNL has been structured into three business verticals namely, Consumer Mobility (CM), Consumer Fixed Access (CFA) both of which are focused on the retail market for wireless and wire-line telecom service products and Enterprise Business (EB) focused on generating high volume business by developing enterprise clients.

18.2 INTRODUCTION

India is currently the world's second-largest telecommunications market and has registered strong growth in the past decade and half. The Indian mobile economy is growing rapidly and is expected to contribute substantially to India's Gross Domestic Product (GDP).

The liberal and reformist policies of the Government of India have been instrumental along with strong consumer demand in the rapid growth in the Indian telecom sector. The government has enabled easy market access to telecom equipment and a fair and proactive regulatory framework that has ensured availability of telecom services to consumer at affordable prices. The deregulation of Foreign Direct Investment (FDI) norms has made the sector one of the fastest growing and a top five employment opportunity generator in the country.

18.3KEY GROWTH AREAS:

18.3.1 MANAGED NETWORK SERVICES

Data Centers and Managed Network Services(MNS) key growth areas
Experience Expertise and reliability valued by customers

18.3.2 DATA:

- MPLS VPN driving market growth
- Integrated “solutions” based selling is essential
- Trend towards customized product bundles for specific verticals(E.g. BFSI)
- Basic bandwidth to be commoditized
- Enterprise Mobility solutions (e.g. SFA)
- Reliability and competitive pricing is key

18.3.3 VOICE

- Mobile, Enterprise VoIP are growth drivers, fixed line voice is de-growing
- PRIs
- Mobile CUG
- Move towards Unified Communication Solutions, Managed voice and advanced voice services (e.g conferencing, Centrex etc.)
- Customers expect competitive pricing, & tailored plans tp help reduce their overall voice bill.

18.4 ASPIRATION OF BSNL FROM ENTERPRISE BUSINESS:

Growth in industrial and IT sectors in India during last few years has created new business opportunities in telecom sector.

- Enterprise customers are business customers with annual turnover of greater than Rs. 100 Crores
- The enterprise market is ~Rs 35,000 cr today, expected to grow to ~Rs. 60,000 cr in 5 years
- BSNL offers a wide range of products for this market Classified as voice, data and managed services
- Enterprise customers have moved from products to solutions
- BSNL will also have to move from products based selling to solutions based selling
- The enterprise market has three customer segments
- Each segment requires a distinct sales models
- Enterprise BU has been designed to house these models
- SD / SA structure for enterprise Gold / silver

18.4.1 BSNL’s Transformation towards Enterprise Segment:

From		To
Product Focused	→	Solutions focused
Soloed	→	<i>Converged</i>
Connectivity	→	<i>Services</i>
Legacy Products	→	<i>Next Generation Products</i>
“Customer Will Come”	→	<i>“Customer is King”</i>
XYZ Circle’s Customer	→	<i>BSNL’s Customer</i>



18.5. ENTERPRISE BUSINESS STRATEGY:

This sales initiative can happen from either party. Purchasers usually float request for proposal (RFP) or Expression of Interest (EoI) or Call for Tenders. Other possibility is the seller based on his own research and understanding suggesting a solution to a company for their unfulfilled need or a better solution than the existing in use.

- Goal is to help a client find value in offered solutions on a long-term basis ensuring win-win for the company & client.
- While marketing is for masses, BD specifically targets select clients where high revenue is expected either through sale of its own services or introduction of joint products/services.
- The emphasis is to make more money by selling solutions rather than just plain vanilla services.
- Enterprises have requirements for disparate telecom services on offer from the service provider many a time at geographically segregated locations to function not as individual services but as a total telecommunication solution that addresses his intra and inter business communication requirements. He does not want to invest time and effort on understanding the technical and managerial requirements of setting up Telecom solution after buying individual service components that are normally offered to the retail clients. He does also not want to invest in Telecom manpower to be part of his company. The strategy of the service provider is to study the communication requirements of the Enterprise and offer a total solution engineered and dimensioned as a mix of the individual wireless, wire-line telecom service products. If required the service provider should handle the management of the total network including the customer premises telecom equipment to ease the customers burden and allow him to focus on his core business activity.
- Enterprises could also be looking instead of total telecom solution for more of the same thing in bulk, e.g bulk requirement of landlines or mobile connections etc. They would be looking for single window handling of their requirements of provisioning, complaint handling and billing across units and geographical locations.
- Since it is usually a high volume business, purchaser expects volume discounts. Seller agrees to appropriate discounts depending on the contract value and the term.

Thumb rule is Higher the discount, longer is the contract period and more is the volume of business.

18.5.1 CERTIFICATION TO INTERNATIONAL STANDARDS:

Most enterprises requesting Telecom Services want to be assured that the vendor providing these services is capable and competent to provide these services and be able to sustain the QOS standards that have been promised. Towards this end

conditions are placed in the call for offers about previous experience of similar work, physical evidence of necessary infrastructure, financial clout and necessary licenses and permissions to provide the services. Further they also mandate that the organization is compliant to certify to relevant International/ National Quality standards. Some of this certification requirements are as listed below for the information.

ISO 9001:2008 Quality Management System,
ISO/IEC 20000-1:2005 Information Technology Service Management System
ISO 27001:2005 Information Security Management System.

18.6 OTHER TELECOM SERVICE PROVIDER AND ENTERPRISE BUSINESS:

It is very important to understand the Strength, Weakness, Opportunity and Threat with respect to other telecom service providers to carve out the fine strategy for BSNL

BSNL is operative throughout India and BSNL bucket of services is wide spread hence BSNL is facing competition from many TSPs at different level.

- Local level other Telecom Service Providers
 - There are many small TSPs operating at district level and provides competition to BSNL in serving Small to Medium Enterprise(SME) level by providing cost effective and customized services to SME.
 - Main services offered by such local Telecom operators are EPABX services, Broadband Internet, Internet Leased line, Point to point data services, Bulk SMS
 - They choose wired connectivity as well as wireless connectivity to provide such services.
 - Many times such firms are buying bulk bandwidth from a reputed ISP/MSP and resell the services into a niche area or niche customers.
- States level other Telecom Service Providers.
 - There are many medium sized TSPs operating at State level and provides competition to BSNL in serving Small to Medium Enterprise (SMEs) level by providing cost effective and customized services to SME.
 - Main services offered by such local Telecom operators are EPABX services, Broadband Internet, Internet Leased line, Point to point data services, Bulk SMS
 - They choose wired connectivity as well as wireless connectivity to provide such services.

- Many times such firms are buying bulk bandwidth from a reputed ISP/MSP and resell the services into a niche area or niche customers.
- National Level Other Telecom Service Providers
 - There are few bigger sized TSPs operating at National level and providing competition to BSNL in serving big size EB customers by providing fast and Reliable services at competitive rate with state of the art technology.
 - National level TSPs are providing wide range of services in all voice, data and video segments to EB customers.
 - It is always important for BSNL EB team to understand the competitive offering of such TSPs in order to project BSNL product and services to various EB customers.
 - Hence the SWOT analysis of such TSPs is given below so that BSNL representatives can able to craft the BSNL solution by looking in to such parameters while dealing with the competition.

18.7. PROJECT MANAGEMENT APPROACH IN EB SALES PROCESS:

18.7.1 HOW ENTERPRISE SALES WORKS?

In, Enterprise Business one business sells a set of products or services to another business. Typically, there is a group or department (i.e. rather than an individual) that uses the vendor's products and services. With some B2B companies, the entire company uses the product, such as office furniture, computers and productivity software, telecom services.

For larger or more complex products, the B2B product selection process is handled by a buying committee made up of the following:

- a business decision maker, such as the person who holds the budget
- a technical decision maker, such as the person who evaluates the capabilities of the prospective products or services
- influencers, such as individuals who provide input on the decision

Large purchases might involve the issuance of a request for proposals (RFP), in which the buyer invites prospective vendors to submit proposals detailing their products, terms and pricing.

Enterprise sales are very important for growth of any organization. Enterprise Business gives purchases which have a large average deal size. Because B2B purchases are thoroughly considered, customers tend to stay longer if they're satisfied with the product and service. Hence organization should keep in mind following factors of enterprise sales:

- **Decision maker**-In EB sales, there are more people involved in the decision. The committee involved includes decision makers and influencers.
- **Decision process** -The EB sales process might include a review of the vendor landscape, a series of vendor demonstrations, the creation of a vendor shortlist and then a final decision.
- **Marketing** - EB marketing seeks to reach companies, as well as specific roles or titles within those companies. B2B marketing covers a longer time horizon, focusing on a progression from awareness to consideration to selection.
- **Timeframe** - The timeframe for a B2B purchase is much longer and often involves weeks or months. Products that have high complexity and high costs can have a timeframe (also known as "average sales cycle") of two years or more

18.7.2 SIMILARITIES BETWEEN PROJECT MANAGEMENT AND EB SALES PROCESS

There is a striking similarity between the EB sales process and the world of project management. Not only do they share a lot of similarities from a process perspective, but there is also a lot in common between the attributes required to successfully manage a project and the sales evaluation process.

The discipline of project management and a typical sales process both rely on managing multiple tasks, the management of multiple stakeholders (both internal and external), as well as the concept of scope and budget.

Subsequently, great project managers and great sales people all must exhibit organization and attention to detail, and the ability to lead and build stakeholder confidence

18.7.3 MANAGING MULTIPLE STAKE HOLDERS

There are so many stakeholders needed to be satisfied in Enterprise sales not only externally but internally in organization also. A big part of effectively managing the EB sales is the ability to manage the different expectations and deliverables that each of those stakeholders requires

18.7.4 DEAL WITH MULTIPLE TASK AND DEAD LINE

All projects have deadlines, both for the project as a whole, as well as for milestone tasks throughout. All sales processes do too, even if there is not a firm deadline set by the prospect regarding completion of the evaluation process (as is the case in most RFP(request for proposals) scenarios). It's the job of the sales person to create a soft deadline in order to maintain momentum and create a sense of urgency.

In addition to the standard tasks that are built into the sales process, every buyer will come to the table with a unique set of needs requiring additional steps. From coordinating calls with various resources, customizing or getting information

ready to share, or even basic follow up work, there are many tasks to manage throughout the sales process.

Without tracking and managing these tasks in a highly organized fashion, and ensuring that deadlines and deliverables are met, the sales representative will lose control of the sales process. Lose control of the sales process and not only do you come across as unprofessional, but you also hand over more control to the buyer.

18.7.5 ORGANIZED SALES PEOPLE

The characteristics of a more complex EB sales process require that the individual(s) involved be highly organized. With multiple stakeholders, tasks, deadlines, and a large amount of opportunity critical information, being highly organized is vital. This is a foundational skill that both good project managers and sales representatives must possess in order to be effective

18.7.6 SCOPE & BUDGET

Scope and budget are critical components of every project; it's the project manager's job to manage both. It's also the job of sales representative to manage both of these during the evaluation process

For example basic need of telecom services in one office of a customer becomes need of telecom services on PAN India basis of that customer. The problem is that this increases budget and overall risk, and affects implementation timelines. It's the job of the sales person to mitigate scope creep as much as possible and properly manage the prospect's expectations around how increased scope will also impact the required investment and timelines

18.7.7 CONFIDENCE & ABILITY TO LEAD

Good project managers all have a certain level of confidence and subsequently an ability to lead their team to ensure deliverables and timelines are met, and overall project success is achieved. The best sales people possess these traits as well. When it comes to managing the sales process and stakeholders, sales people must steer the process and maintain momentum; this requires leadership ability.

Secondly, by conveying confidence a sales representative strengthens his ability to lead, and most importantly increases the confidence and trust that prospects have in him and his offering.

18.8 BENEFITS OF A PROJECT MANAGEMENT BASED APPROACH TO SALES

Taking a project management based approach to sales produces several benefits that will have a substantial impact on a sales leader's ability to maximize sales team effectiveness and efficiency.

Measurability: By rigorously tracking the progress of stages within the sales process sales leaders can more easily measure and track effectiveness and bottlenecks at each stage. This makes basic reporting easier as well.

Scalability: Clearly defined and repeatable processes are the most scalable ones. Using project templates to track tasks and stages within the sales process makes scalability more achievable.

Performance Improvement: Taking a project management based approach will absolutely improve the performance of sales representatives. They will become more organized, be able to more easily collaborate with prospects, and better maintain deal momentum

18.9 APPROACH IN BSNL FOR EB SALES

In order to leverage its widespread telecom network resources in India and to tap these business opportunities and to provide customized network solutions and services to its clients, BSNL has set up strong EB team under Dir (E&WS) at BSNL Corporate Office.

GM (Business Planning), GM (Enterprise Business), GM (ILD), GM (Lease circuit), GM (IT) and GM (Fin) report to Dir (E&WS) at BSNL HQ. A post of ED (core Network) has also been created and all project circles and maintenance regions have been brought under ED.

Also post of GM (EB-city) has been created in 4 big cities. All Circles now have GM (Enterprise) supported by DGM (Enterprise Sales) and DGM (Service Delivery/Service assurance

Centralized National Account Managers (NAMs) are appointed to deal with Platinum Customers and Circle based Key Account Managers (KAMs) are appointed to deal with Gold Customers.

Since the number of companies in Silver segment is very large, it is proposed that BSNL should use appropriate channel partners to ensure that sufficient attention is devoted to these accounts. Accounts are mapped to channel partners by geography and by their specializations.

The role of EB wing, which has been created at corporate as well as circle level is to identify the specific needs of enterprise customer which can be a mix of Voice, Data and Managed Services solutions. This wing is supported by other related units such as leased circuit, Network operations, Core Network planning and field units of CFA, CM for execution of enterprise projects

For monitoring all EB related activities a dedicated portal called EB Portal is used in BSNL.

18.10 EB PORTAL

The Enterprise Business Portal provides the Enterprise Business Team of BSNL with a end to end web based software solution that delivers a secure, scalable and reliable tool to enter, update, manage various Enterprise Business activities with in BSNL and facilities to track and report the various activities of EB Team.

The Enterprise Portal consists of the following:

- Information Storage
- Reporting

18.10.1 INFORMATION STORAGE

- Stores information about users, units, leads, opportunities, companies in a database.
- Track changes to lead/opportunity and company information, who made the changes and when it was made.
- Updates opportunity data generated on weekly basis for generation of various reports, for example sales funnel report.
- Stores documents like contracts, MOU's and other information in database..
- Stores information on Companies and Users.

18.10.2 REPORTING

Visually display out reports of information in spreadsheet (.xls) format and saved to a file or to be printed.

The Enterprise Portal is only to be use by an authorized user of Enterprise Business Team members.

18.11 CONCLUSION

The Enterprise Business has become important organ of BSNL services. Most of the big customers are getting good services from BSNL under EB category. The EB section is growing day by day and getting handsome revenue through these services due to in cooperation new customized services with latest technology and good percentage of SLA. Efficiency, effectiveness, and measurability are the backbone of a scalable revenue machine; a project management based approach to EB sales goes a long way in building that machine.

19. SERVICE LEVEL AGREEMENT

(DETAILED TERMS AND CONDITIONS, DURATIONS, QUALITY OF SERVICES, PENALTY PROVISIONS AND ARBITRATIONS).

19.1 LEARNING OBJECTIVES

After the completion of the module, the trainee will know about

- SLA.
- QoS
- Penalties and Arbitrations

19.2 INTRODUCTION

19.2.1 WHAT IS A SERVICE-LEVEL AGREEMENT (SLA)?

Service-Level Agreement or an SLA is a contract between a service provider and its customer. The customer can be either internal or external, depending on the organization and service arena. Through an SLA, a service provider states the terms that they can do the required work. An SLA helps service providers describe the scope of work and by doing so exempts them from any unwanted liability. For customers, an SLA gives them a clear idea about the work that can be done and any exclusion, which helps them compare the service provider with others and make an informed decision.

➤ GOALS & OBJECTIVES

The goal of this Agreement is to obtain mutual agreement between the Service Provider(s) and Customer(s).

The objectives of this Agreement are to:

- a. Provide a thorough understanding of service ownership and the roles and responsibilities.
- b. This Agreement represents a concise description of the services provided by the Service Provider.
- c. Match perceptions of expected service provision with actual service support & delivery.

19.2.2 WHAT DOES A SERVICE-LEVEL AGREEMENT CONSIST OF?

A basic Service-Level Agreement acts like a list, which usually defines what work can be done and what is excluded. Through this agreement, both parties are informed about the duties and scope of work that is to be done.

I. IMPLEMENTATION: In an SLA, this covers the scope of work. The service provider lists out the activities that are involved in the implementation of the services and the level of support offered by the service provider.

II. PERFORMANCE: An SLA consists of performance metrics that list outcomes and certain agreed- upon outputs that are expected from both the parties.

III. FINANCIAL REQUIREMENTS The SLA has to mention financial arrangements such as fee structures, adjustments, hikes, etc. Complete transparency is expected while listing out any variable factors.

IV. OPERATIONAL RESPONSIBILITIES The activities that fall on the service provider that is relevant to the operational requirements of the service.

➤ **Service Agreement**

The following are the responsibility of the Service Provider in the ongoing support of this Agreement.

SERVICE SCOPE

THE FOLLOWING SERVICES ARE COVERED BY THIS AGREEMENT;

1. (Name the services)
2. (Name the services)
3. (Name the services)

SERVICE PROVIDER REQUIREMENTS

Service Provider responsibilities and/or requirements in support of this Agreement include:

- Adhering to appropriate response times associated with service-related incidents.
- Advance notification to the Customer for all maintenance.

SERVICE ASSUMPTIONS

Assumptions related to in-scope services and/or components include:
Changes to services will be communicated and documented to all stakeholders.

Service Management For maintaining adequate customer-support levels, this Agreement lists the available scope of services provided by the Service Provider. This lists details regarding availability, monitoring, and other relevant factors.

SERVICE SUPPORT

Coverage parameters specific to the service(s) covered in this Agreement are as follows:

- a. Telephone support: ____ A.M. to ____ . Monday – Friday
Calls received out of office hours will be forwarded to a mobile phone and best efforts will be made to answer / action the call, however, there will be a backup answer phone service
- b. Email support: Monitored ____ to ____ Monday – Friday
- c. Emails received outside of office hours will be collected, however, no action can be guaranteed until the next working day

Onsite assistance guaranteed within 72 hours during the business week

SERVICE REQUESTS

In support of services outlined in this Agreement, the Service Provider will respond to service-related incidents and/or requests submitted by the Customer within the following time frames:

- a. 0-8 hours (during business hours) for issues classified as **High** priority.
- b. Within 48 hours for issues classified as **Medium** priority.
- c. Within 5 working days for issues classified as **Low** priority.

Remote assistance will be provided in-line with the above timescales dependent on the priority of the support request.

CUSTOMER REQUIREMENTS

CUSTOMER RESPONSIBILITIES AND/OR REQUIREMENTS IN SUPPORT OF THIS AGREEMENT INCLUDE:

- Payment for all support costs at the agreed interval

V. GOVERNANCE:

Questions like ‘Who does what? Why? Who answers for results? Who decides what?’ are answered in the agreement.

VI. ACCEPTANCE

IN WITNESS WHEREOF, by execution by the parties below, this Service-Level Agreement will form a part of the Contract.

[Supplier.Company]Signature

MM/DD/YYYY

[Supplier.FirstName] [Supplier.LastName]

[Client.Company]

Signature

MM/DD/YYYY

Approval

(By signing below, all Approvers agree to all terms and conditions outlined in this Agreement.)

<u>Approvers</u>	<u>Role</u>	<u>Signed</u>	<u>Approval Date</u>
	<u>Service Provider</u>		
	<u>Customer</u>		

VII. PERIODIC REVIEW

The terms stated in the Agreement shall be valid from the Effective Date. The revisions to this agreement shall be carried out every fiscal year, however, during the revision, the current Agreement shall be considered valid.

19.3. CALCULATION OF UPTIME OF CIRCUIT/SERVICE AVAILABILITY:

The Supplier shall at all times during term of this Agreement provide the Services to meet or exceed the Service Level Performance Measure for each Service Level Performance Criterion, as defined herein below. The Supplier acknowledges that any failure to meet a Service Level may have a material adverse impact on the business and operations of the Customer and that it shall entitle the Customer to the rights set out in this Agreement below, including the right to any Service Credits (as defined below).

The Supplier acknowledges and agrees that any Service Credit is a price adjustment reflecting the value of any lost service caused by failure to meet a Service Level. Both Parties agree that the Service Credits are a reasonable method of price adjustment to reflect poor performance.

Other than the Customer’s termination rights as set forth in the Contract, A Service Credit shall be the Customer’s exclusive financial remedy for a failure to meet a Service Level.

19.3.1 Calculation of Uptime

‘Uptime’ refers to the availability of bandwidth across various segments. Uptime for each link shall be calculated based on the formula:

$$100 \times \frac{[\{\text{Total Available time per Quarter}\} - \text{Downtime of a Link}]}{[\text{Total Available time per Quarter}]}$$

Uptime (in%) = -----
[Total Available time per Quarter]

- 1) Total Available time per month = (12 hrs * N days) - SLA Exclusion Time
- 2) N = Number of calendar days in a Quarter r"
- 3) Downtime of a link = Downtime of a particular link according to the Tier level
- 4) SLA Exclusion Time — as mentioned in section 8.6 including scheduled downtime

The uptime and downtime calculations will be measured for time between 08.00 Hrs. to 20.00 Hrs.

19.3.2 DETERMINATION OF DOWNTIME :

For the purpose of measurement, “downtime” or “fault duration” constitutes any period of time during which the Leased Circuit is unable to transfer data due to the reasons assignable to BSNL network.

- Downtime of a link shall be calculated based on the data collected by the monitoring tools (NMS) of the BSNUSWAN NMS.
- For non MLLN circuits, as the fault booking monitoring process will be manual, both state Government and BSNL have mutually agreed for manual booking of fault and monitoring mechanism.

Following principles apply for the calculation of the downtime: _

(a). Output port of the Terminal End Equipment’s at the SWAN PoPs or at the remote offices will be monitored by the SWAN NOC for the purpose of uptime I downtime of the link.

(b). In case of fault in the links, the SWAN NOC will book the fault with BSNL’s manpower present at NOC which will accept the fault and assign - a docket number.

©. A link shall be down when a “Ping” test to the remote router at the SWAN PoPs or remote offices fails due to the link failure or failure of the Terminal End Equipment supplied by the BSNL.

(d). Link failures when reported by the NMS tool shall be added together for each link every quarter to arrive at the down time for that particular link for the quarter. _ *

The SUBSCRIBER shall provide reliable and regulated NC Power Supply for working of the network termination unit (NTU)/ modem all the time. The SUBSCRIBER shall also keep the NTU/ modem powered on during 0800 Hrs to 2000 Hrs. if for any reason, NTU/modem is required to be switched off, the SUBSCRIBER shall intimate at the designated BSNL officers. The SUBSCRIBER will ensure availability of staff who are capable of dealing with the leased circuit equipment between 0800 Hrs to 2000 Hrs. The period in which

In addition to the above following shall be excluded from fault duration (SLA Exclusion time):

- Unavailability of circuit due to power failure at SUBSCRIBER end.
- Unavailability of circuit due to mishandling of BSNL equipment (NTU) or any cables attached to such equipment at SUBSCRIBER end. '
- Unavailability of circuit due to SUBSCRIBER modem/equipment network at either end of the circuit. . Period between 2000 Hrs and 0800 Hrs.
- Unavailability of circuit due to force majeure.
- Scheduled Downtime Scheduled downtime for link maintenance as agreed mutually between state and BSNL.

Further any downtime required for preventive maintenance and up-gradation shall be considered for scheduled downtime if informed three days prior to maintenance and approved by State

19.4. PERFORMANCE MONITORING

- The Supplier shall implement all measurement and monitoring tools and procedures necessary to measure, monitor and report on the Supplier's performance of the provision of the Services against the applicable Service Levels at a level of detail sufficient to verify compliance with the Service Levels.
- The Supplier shall immediately notify the Customer in writing if the level of performance of the Supplier of any element of the provision by it of the Services during the term of the Contract is likely to or fails to meet any Service Level Performance Measure.

19.4.1 PROCEDURE OF FAULT BOOKING.

- Subscriber shall book the fault with BSNL designated manpower deployed at SWAN NOC or on assigned number of IVRS, viz.. '-----'. (Date and time of booking of fault shall be taken as reference for the purpose of calculation of duration of non-availability of circuit.)
- If the circuit is a long distance circuit, the fault shall be booked at A end.
- SUBSCRIBER shall abide by the prescribed fault booking procedure of BSNL.
- Where the Subscriber is unable to find a BSNL representative, the fault can be booked on -----', which will work as alternate number in such emergency. For MLLN Circuits, Status fault report generated by BSNL MLLN network (to the extent provided by the system) shall be taken as reference in situations where there is ambiguity about the timing and nature of fault.
- For non MLLN circuits, as the fault booking monitoring process will be manual, both state Government and BSNL have to mutually agree for fault booking and monitoring mechanism procedure to be made separately.
- Normally a fault docket number shall be provided to the SUBSCRIBER from BSNL on booking of fault.
- Restoration of Faults, On receipt of complaint, BSNL shall make its best efforts to localize the fault and restore the same at the earliest.
- The SUBSCRIBER shall provide all necessary support for enabling testing of the circuit at any hour of the day. '
- In case the SUBSCRIBER is unable to provide necessary facilities to BSNL, BSNL will test the circuit on its own to the last point feasible and clear the fault docket after rectification of the fault. Circuit shall be presumed to be restored when BSNL has tested the circuit and cleared the fault docket after finding that the circuit is capable of working properly. The fault duration shall be accounted accordingly.
- It will be responsibility of BSNL to show proper working of circuit on end to end basis the rough use of test instruments by sending test data while at the same time keeping the bit error rate within limits. Once circuit is brought

to right condition through such tests and the data transfer by SUBSCRIBER equipment does not take place, it shall be the responsibility of the SUBSCRIBER.

- The BSNL should guarantee uptime during normal business hours as mentioned in the SLA on monthly basis. Department will impose penalty as given below for downtime at offices (spoke locations- PS/HO):
- Example for Uptime and Penalty on BSNL

Sr. No.	Uptime	Penalty in % of Rental value of Link
1	>=99.0%	0%
2	>=98.5% <99.0%	to 10%
3	>=97.5% <98.5%	to 20%
4	>=95.5% <97.5%	% to 25%
5	<95.5%	30%

Other Important Conditions in SLA

19.5. FORCE MAJEURE:

The conditions which may not be in the control of both parties like

- Natural Disaster : Any material effect on the natural elements, including lightning, fire, earthquake, cyclone, flood, storm, tornado, or typhoon;
- Explosion or chemical contamination (other than resulting from an act of war);
- Epidemic such as plague;
- Any event or circumstance of a nature analogous to any of the foregoing
- Other Events (Political Events) to the extent that they satisfy the foregoing requirements including:
- Act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, revolution, riot, insurrection, civil commotion, act of terrorism or sabotage;

- Strikes, work to rules, go-slows which are either widespread, nation-wide, or state-wide and are of political nature;
- Any event or circumstance of a nature analogous to any of the foregoing

19.6. PENALTY

(a). The penalty shall be calculated and deducted from the immediate due payment.

(b). Penalty will be calculated on a Quarterly basis and will be deducted from the next payment due to the Bidder.

©. All above mentioned penalties are exclusive to each other.

(d). If the total penalty reaches an amount equal to or more than 10% of the order value, the same shall invoke the Performance Bank Guarantee and seek an equivalent Performance Bank Guarantee and may also invite termination of contract.

Penalties shall not be levied on the BSNL in the following cases:

- The non-compliance to the SLA has been solely due to reasons beyond the control of the BSNL.
- There is a Force Majeure event affecting the SLA which is beyond the control of the BSNL.

19.7 DISPUTE RESOLUTION

a. In the event of any question, dispute or difference arising under this agreement or in connection there-with (except as to matter the decision of which is specifically provided under this agreement), the same shall be referred to sole arbitration

b. Every effort to resolve amicably by direct informal negotiations, any disagreement or disputes, arising between both parties under or in connection with the Contract.

c. In case of dispute or difference relating to any matter arising out of or connected with this contract, such dispute or difference shall be referred to the SMT (State Mission Team), SEC (State Empowered Committee) and SAC (State Apex Committee).

d. The venue of arbitration shall be as per decided by all three committees

19.8 WARRANTY

If, during the warranty period, any network infrastructure item at offices has any failure on three or more occasions, it shall be replaced by equivalent new network infrastructure item by the BSNL

19.9 PERIOD OF CONTRACT

As decided by agreement, the contract period shall be ----- years, after Go-Live of this Project. The contract period may be extended further at the mutually agreed terms & conditions.

19.10. PAYMENT TERMS

Payment will be made on successful and satisfactory completion of the Milestones decided by mutual agreement

19.11. EXIT CLAUSE : TERMINATION OF CONTRACT

Termination from either or party in agreement depends upon mutual agreement and conditions mentioned in SLA.

19.12. MODIFICATIONS: Any of the terms and provisions of this agreement, including all Exhibits hereto, can be waived, varied, amended, supplemented or otherwise modified in any respect only by written instrument executed by the parties

19.13. CONCLUSION:

Service Level Agreement or an SLA is a contract between a service provider and its customer. The contract between service provider and customer includes mutual understanding and technical specifications of services to be given. The conditions mentioned in SLA are bounded to both the parties and there should not breach of contract due to misunderstanding. SLA helps service providers describe the scope of work and by doing so exempts them from any unwanted liability. For customers, an SLA gives them a clear idea about the work that can be done and any exclusions, which helps them compare the service provider with others and make an informed decision.