**1. Write a short note on SONET network?**

* SONET/SDH is a standardized multiplexing protocol for optical communication.
* SONET uses synchronous transmission i.e. timing of all equipments is handled by a single clock.
* Different physical specifications and frame design of SONET are:
* Time division multiplexing (TDM) is used by SONET/SDH for optimum utilization of bandwidth

SONET has a four layered architecture model as shown in figure:

* Physical layer - It is also called as photonic layer as it provides photonic interface. It specifies the type of fiber used and characteristics of medium.
* Section layer - It supports physical integrity of network. It carries SONET frames between adjacent network equipment. It performs synchronization, channel multiplexing, etc.
* Line layer - It manages synchronous transport signal level n(STS-n) frame.
* Path layer - It carries information end-to-end across SONET network. It is responsible for data transport within network.

SONET structure - SONET transmission uses three basic devices. These are:

1. Syncrhonous Transport Signal (STE) multiplexer.
2. Regenerator.
3. Add/drop multiplexer.

They are explained in detail below:

1. STS multiplexer / Demux - It multiplexes multiple signals into STS and demultiplexes STS into different signals.
2. Regenerator - Regenerators receive optical signal and regenerates it. It replaces some overhead information with new information. It functions at data link layer.
3. Add/drop multiplexer - Add/drop multiplexer can add or remove signals to and from a path. The signal can be redirected without demultiplexing the entire signal. The figure shows interconnections of SONET devices.

Features of SONET:

1. Establishes a standard multiplexing format using any number of 51.84 Mbps signals as building blocks.
2. Establishes an optical signal standard for interconnecting equipment from different suppliers.
3. Establishes extensive operations, administration and maintenance capabilities as part of the standard.
4. Defines a synchronous multiplexing format for carrying lower-level digital signals.
5. Establishes a flexible architecture capable of accommodating future applications, such as B-ISDN with a variety of transmission rates.

SONET Applications:

1. High speed backbone networks.
2. Basic architecture for B-ISDN.
3. Basic architecture for ATM.
4. High speed optical network for data communication.

**2. Explain in brief DWDM.**

DWDM:

1. DWDM (Dense wavelength - division multiplexing) is a data transmission technology having very large capacity and efficiency.
2. Multiple data channels of optical signals are assigned different wavelengths, and are multiplexed onto one fiber.
3. DWDM system consists of transmitters, multiplexers, optical amplifier and demultiplexer. Figure shows a typical application of DWDM system.
4. DWDM uses single mode fiber to carry multiple light waves of different frequencies.
5. DWDM system uses Erbium - Doped Fiber Amplifiers (EDFA) for its long haul applications, and to overcome the effects of dispersion and attenuation channel spacing of 100 GHz is used.4

Hardware used in DWDM:

Major DWDM equipments are:

1. DWDM multiplexer/demultiplexer.
2. Optical add/drop multiplexer (OADM).
3. Optical cross connect (O X C).
4. Optical amplifier.
5. Regenerator.

**3. Explain Physical Layer of ATM.**

* Physical layer has same functions as that in OSI model. The physical layer is a point-to-point transfer mechanism at the top of real hardware. It can be a wire also.
* Physical layer adds its own information to each cell transmitted for link management purposes.
* Physical layer has four functions:
  + 1. To convert bits into cells.
    2. Transmission and reception of bits on the physical medium.
    3. Tracking of cell boundaries.
    4. Packaging of cell into frames.
* Physical layer involves the specifications of a transmission medium and a signal encoding scheme. The data rates specified at the physical layer include 155.2 Mbps and 622.08 Mbps. Other data rates, both higher and lower are possible.
* ATM layer common to all services that provide packet transfer capabilities. ATM adaptation layer that is service dependent.
* The ATM protocol reference model makes reference to three separate planes:
  1. User plane provides for user information transfer, alongwith associated control i.e. flow control and error control.
  2. Control plane performs call control and connection control functions.
  3. Management plane includes plane management, which performs management functions related to a system as a whole and provides co-ordination between all the planes.

**4. What is ATM?**

* ATM is a cell relay technique.
* ATM works on statistical multiplexing that uses features of both packet switching and circuit switching.
* The cells are considered as packets and relay as switching i.e. ATM uses packet switching technology.
* ATM networks are connection oriented i.e. it requires connection setup before cell transmission. Therefore it also follows circuit switching technology.

Need of ATM:

The following important features encourage the widespread uses of ATM for telecommunications.

1. High speed data rate.
2. Low error rate between switching centers.
3. Digitized video and speech.
4. Comparatively low operating cost.

Introducing faces of ATM:

The faces of ATM are as listed below:

1. ATM as an economical and integrated service.
2. ATM as an architecture and technology.
3. ATM as an interface and protocol.
4. ATM as a WAN transport service.

**5. Write a short note on ATM Adaptation Layer.**

* AAL provides the flexibility of a single communications process to carry multiple types of traffic such as data, voice, video and multimedia. ATM adaptation layer divides the information into smaller segments that are capable of being inserted into cells for transport between two end nodes.
* ATM adaptation layer is divided into two major parts. Upper part of the ATM adaptation layer is called the Convegence sublayer. Its job is to provide the interface to the application. The lower part of the AAl is called the Segmentation and Reassemble (SAR) sublayer. It can add headers and trailers to the data units given to it by the convergence sublayer to form cell payloads.
* AAL functions is one of four ways:

1. AAL - 1 (Constant Bit Rate Services)
2. AAL - 2 (Variable Bit Rate)
3. AAL - 3/4 (Connection Oriented)
4. AAL - 5 (Coding)

**Chapter 6**

**6. Write a short note on SAN (storage area network).**

* A Storage Area Network (SAN) is defined as a set of interconnected devices (for example, disks and tapes) and servers that are connected to a common communication and data transfer infrastructure such as fibre channel.
* A SAN is a network designed to transfer data from servers to targets, and it is alternative to a directly attached target architecture, or to a DAS architecture, where the storage is connected to the servers on general purpose networks.
* Multiple technology can be used when building a SAN; traditionally the dominant technology is fiber channel, but IP based solutions are also popular for specific applications.
* The concept of SAN is also independent from the devices that are attached to it. Can be disks, tapes, RAIDs, file servers, or other.
* The purpose of the SAN is to allow multiple servers access to a pool of storage in which any server can potentially access any storage unit.

Storage area network requirement:

1. Serial transmission for high speed and long distance.
2. Low transmission errors.
3. Low delay of transmitted data. Needs to make it feel like using a local disk.
4. The disk subsystem has around 1 ms - 10 ms latency itself.
5. The communication protocol should not use CPU.

SAN environment provides the following benefits

1. Centralization of storage into a single pool. This allows storage resources and server resources to grow independently, and allows storage to be dynamically assigned from the pool as and when it is required.
2. Common infrastructure for attaching storage allows a single common management model for configuration and deployment.
3. Storage devices are inherently shared by multiple systems. Ensuring data integrity guarantees and enforcing security policies for access rights to a given device is a core part of the infrastructure.
4. Data can be transferred directly from device to device without server intervention.
5. Because multiple servers have direct access to storage devices, SAN technology in particularly interesting as a way to build clusters where shared access to a data set is required.

**7. What is traffic engineering?**

* Traffic Engineering (TE) methods try to make network operations more effective and reliable while at the same time optimizing resource utilization.
* Many TE methods can be used at the same time. Most suitable TE method(s) depend on the network’s (e.g. random topology, regular topology, multilevel topology) and users properties (applications, demands).
* TE methods use resource reservation as they reserve bandwidth of network resources for the traffic along that route.
* TE reduced the overall cost of operations by more efficient use of bandwidth resources by preventing a situation where some parts of a service provider network are over-utilized (congested) while other parts are under-utilized.
* Traffic Engineering allows for one to spread the traffic and distribute it across the entire network infrastructure like magnetic fields between poles while also providing the redundancy required for high availability service.

**8. Explain IP over ATM.**

ATM networking is popular in these networks for numerous reasons:

1. It provides very high speed bandwidth capability
2. It provides a very scalable architecture
3. It is typically run over Synchronous Optical Networks (SONET), which in turn provide very reliable links for both short and long distance communications
4. It supports the simultaneous carriage of integrated services, that is voice, video, internet and gaming
5. Future development in both ATM and IP promises better support for QoS

**Chapter 5**

**9. What is Intra-domain Routing? What is Inter-domain Routing?**

* An internet is divided into autonomous systems. An autonomous system is a group of networks and routers under the authority of a single administration.
* Routing inside an autonomous system is referred to as intradomain routing.
* Routing between autonomous system is referred to as interdomain routing.
* Distance vector and link state routing is the example of intradomain routing protocols.
* Path vector is an example of interdomain routing protocol.
* Only one interdomain routing protocol handles routing between autonomous systems.

Comparison between Intra-domain Routing and Inter-domain Routing:

|  |  |
| --- | --- |
| Intra-domain routing | Inter-domain Routing |
| Routing within an AS | Routing between ASs |
| Ignores the Internet outside the autonomous system | Assumes that the Internet consists of a collection of interconnected ASs |
| Protocols for Intra-domain routing are also called Interior Gateway Protocols | Protocols for inter-domain routing are also called Exterior Gateway Protocols |
| Popular protocols are RIP and OSPF | Routing protocols are BGP |