Communications Technology

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Chapter 2

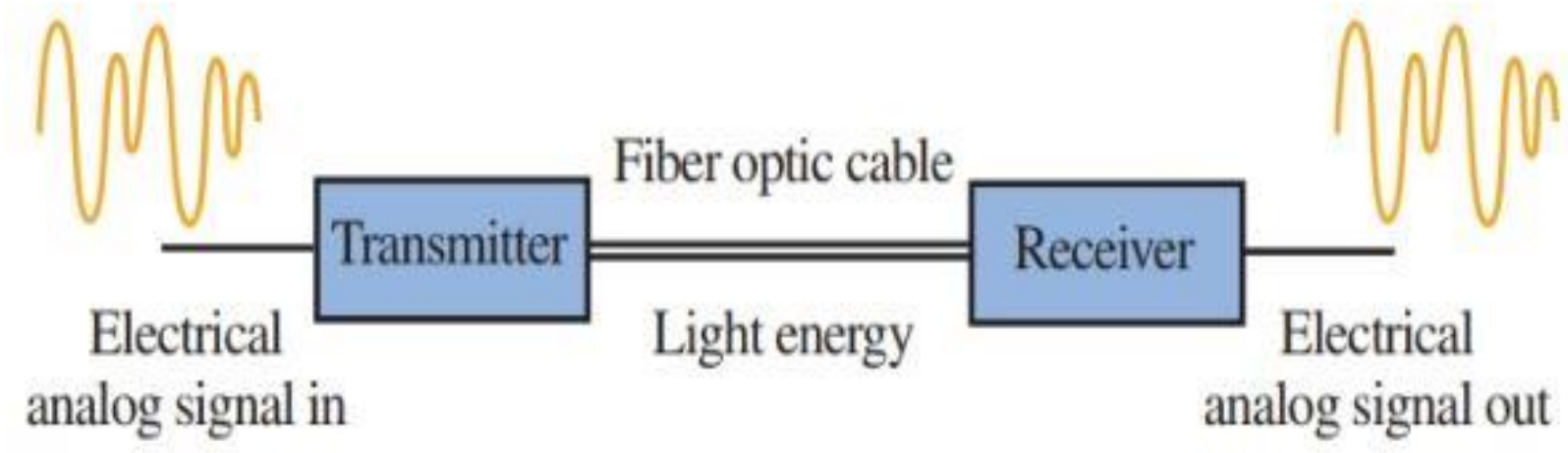
SONET Network

The high bandwidths of **fiber-optic cable** are suitable for today's high-data-rate technologies (such as video conferencing) and for carrying large numbers of lower-rate technologies at the same time. For this reason, the importance of fiber optics grows in conjunction with the development of technologies requiring high data rates or wide bandwidths for transmission.

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of infrared light through an optical fiber. The light is a form of carrier wave that is modulated to carry information. Fiber is preferred over electrical cabling when high bandwidth, long distance, or immunity to electromagnetic interference is required. This type of communication can transmit voice, video, and telemetry through local area networks or across long distances.

The process of **communicating using fiber-optics** involves the following basic steps:

1. creating the optical signal involving the use of a transmitter, usually from an electrical signal.
2. relaying the signal along the fiber, ensuring that the signal does not become too distorted or weak.
3. receiving the optical signal.
4. converting it into an electrical signal.


Fiber optic cable
Transmitter
Receiver
Electrical
analog signal in
Light energy
Electrical
analog signal out

Synchronous optical network (SONET) is a standard for optical telecommunications transport. It was formulated by the ECSA for ANSI, which sets industry standards in the United States for telecommunications and other industries. The comprehensive SONET/synchronous digital hierarchy (SDH) standard is expected to provide the transport infrastructure for worldwide telecommunications for at least the next two or three decades.

SONET/SDH is a synchronous network using synchronous TDM multiplexing. SONET system consists of :-

- Signals
- Devices
- Connections.

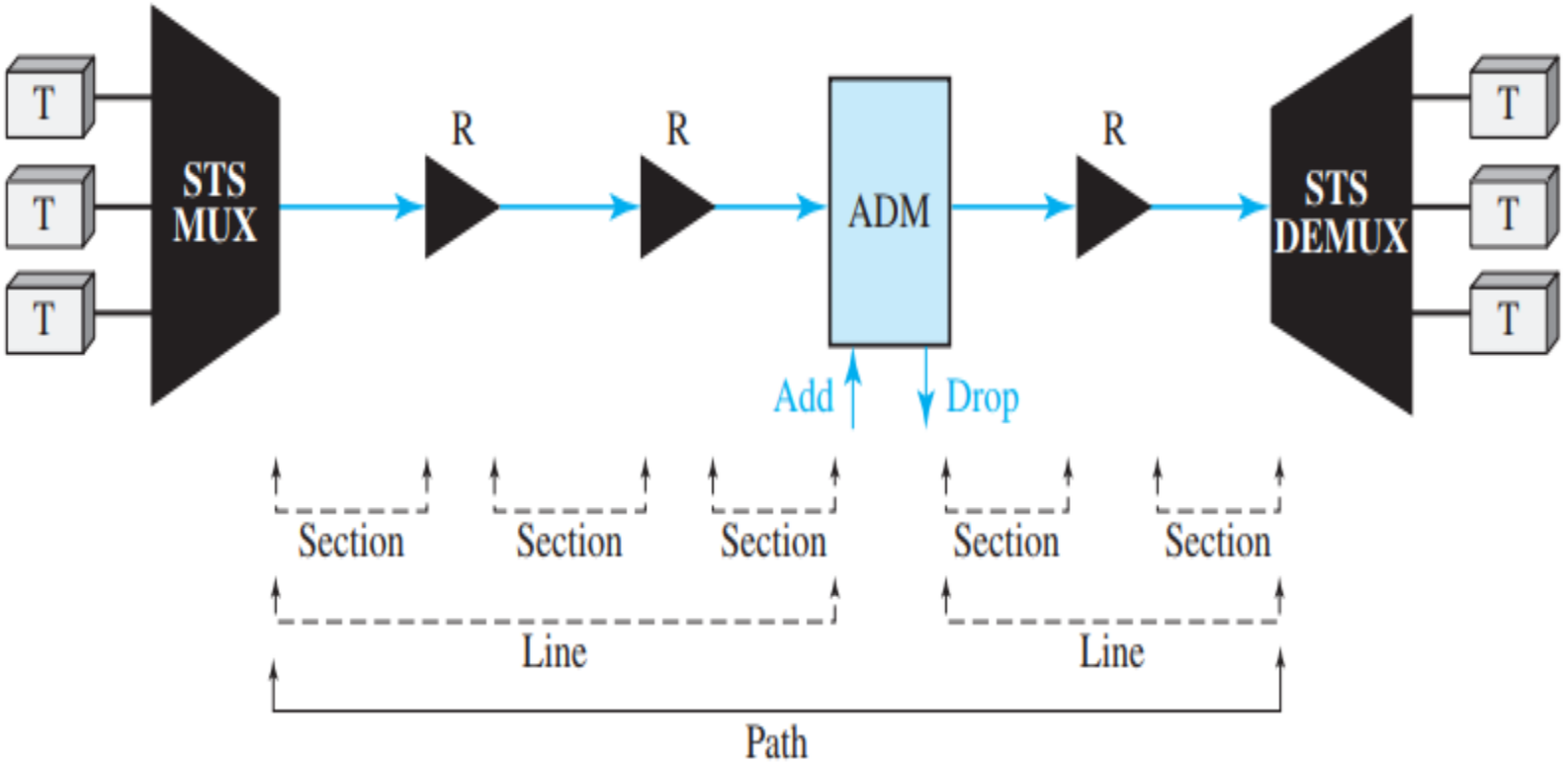
ADM: Add/drop multiplexer

STS MUX: Synchronous transport signal multiplexer

STS DEMUX: Synchronous transport signal demultiplexer

R: Regenerator

T: Terminal



SONET Signals

SONET defines a hierarchy of electrical signaling levels called **synchronous transport signals** (STSs). Each STS level (STS-l to STS-192) supports a certain data rate, specified in megabits per second. The corresponding optical signals are called optical carriers (OCs). SDH specifies a similar system called a **synchronous transport module** (STM).

STM is intended to be compatible with existing European hierarchies, such as E lines, and with STS levels. To this end, the lowest STM level, STM-l, is defined as 155.520 Mbps, which is exactly equal to STS-3. A glance through reveals some interesting points. First, the lowest level in this hierarchy has a data rate of 51.840 Mbps, which is greater than that of the DS-3 service (44.736 Mbps).

Table *SONETISDH rates*

STS	OC	*Rate (Mbps)*	*STM*
STS-1	OC-1	51.840	
STS-3	OC-3	155.520	STM-1
STS-9	OC-9	466.560	STM-3
STS-12	OC-12	622.080	STM-4
STS-18	OC-lS	933.120	STM-6
STS-24	OC-24	1244.160	STM-8
STS-36	OC-36	1866.230	STM-12
STS-48	OC-48	2488.320	STM-16
STS-96	OC-96	4976.640	STM-32
STS-I92	OC-I92	9953.280	STM-64

In fact, the STS-l is designed to accommodate data rates equivalent to those of the DS-3. The difference in capacity is provided to handle the overhead needs of the optical system. Second, the STS-3 rate is exactly three times the STS-l rate; and the STS-9 rate is exactly one-half the STS-18 rate. These relationships mean that 18 STS-l channels can be multiplexed into one STS-18, six STS-3 channels can be multiplexed into one STS-18, and so on.

SONET Devices

SONET transmission relies on **three basic devices**:

- STS multiplexers/demultiplexers.
- Regenerators
- Add/Drop multiplexers
- Terminals.

STS Multiplexer/Demultiplexer: STS multiplexers/demultiplexers mark the beginning points and endpoints of a SONET link. They provide the interface between an electrical tributary network and the optical network. An STS multiplexer multiplexes signals from multiple electrical sources and creates the corresponding OC signal. An STS demultiplexer demultiplexes an optical OC signal into corresponding electric signals.

Regenerator: Regenerators extend the length of the links. A regenerator is a repeater that takes a received optical signal (OC-n), demodulates it into the corresponding electric signal (STS-n), regenerates the electric signal, and finally modulates the electric signal into its correspondent *OC-n* signal. A SONET regenerator replaces some of the existing overhead information (header information) with new information.

Add/drop Multiplexer: Add/drop multiplexers allow insertion and extraction of signals. An add/drop multiplexer (ADM) can add STSs coming from different sources into a given path or can remove a desired signal from a path and redirect it without demultiplexing the entire signal. Instead of relying on timing and bit positions, add/drop multiplexers use header information such as addresses and pointers to identify individual streams.

A number of incoming electronic signals are fed into an STS multiplexer, where they are combined into a single optical signal. The optical signal is transmitted to a regenerator, where it is recreated without the noise it has picked up in transit. The regenerated signals from a number of sources are then fed into an add/drop multiplexer.

The add/drop multiplexer reorganizes these signals, if necessary, and sends them out as directed by information in the data frames. These remultiplexed signals are sent to another regenerator and from there to the receiving STS demultiplexer, where they are returned to a format usable by the receiving links.

Terminals: A terminal is a device that uses the services of a SONET network. For example, in the Internet, a terminal can be a router that needs to send packets to another router at the other side of a SONET network.

SONET Connections

The devices defined in the previous section are connected using :-

- Sections
- Lines
- paths.

Sections: A section is the optical link connecting two neighbor devices: multiplexer to multiplexer, multiplexer to regenerator, or regenerator to regenerator.

Lines: A line is the portion of the network between two multiplexers: STS multiplexer to add/ drop multiplexer, two add/drop multiplexers, or two STS multiplexers.

Paths: A path is the end-to-end portion of the network between two STS multiplexers. In a simple SONET of two STS multiplexers linked directly to each other, the section, line, and path are the same.