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Data Communication CS601 Lecture No 34

Lecture Prepared By

Muhammad Abid Ali

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CS601 Lecture No 34 Topic 197 to 204

Synchronous Optical Network (SONET)

- **A wide area network (WAN) that is used as a transport network to carry loads from other WANs**
- **ITU–T standard called Synchronous Digital Hierarchy (SDH)**

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- **Architecture of a SONET system consists of signals, devices, and connections**

SONET Architecture

- **Signals**
  - ✓ Synchronous Transport Signals (STS)
  - ✓ Optical Carriers (OCs)
  - ✓ Synchronous Transport Module (STM)

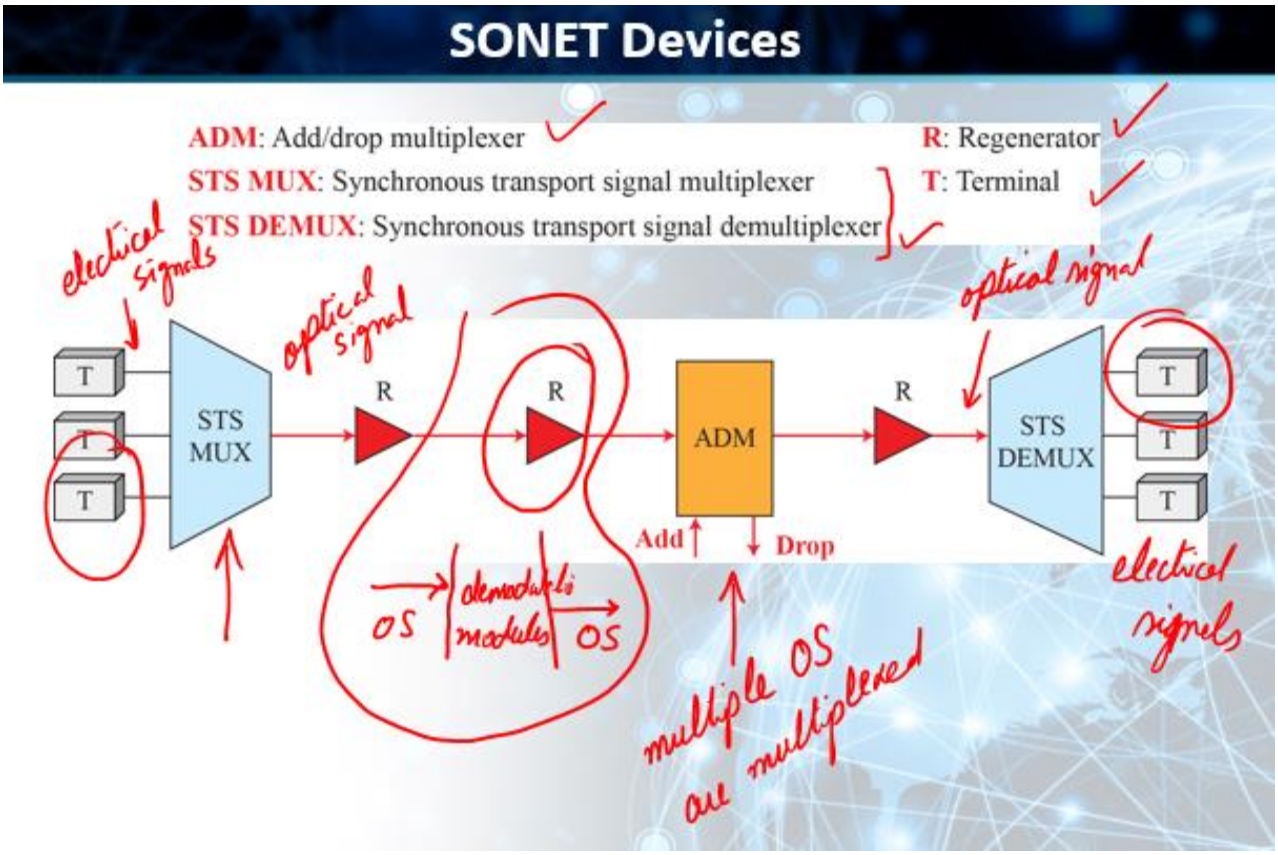
- **SONET Devices**
  - ✓ STS Mux/Demux
  - ✓ Regenerators
  - ✓ Add-Drop Multiplexer and Terminals

- **Connections**
  - ✓ Section
  - ✓ Line
  - ✓ Path

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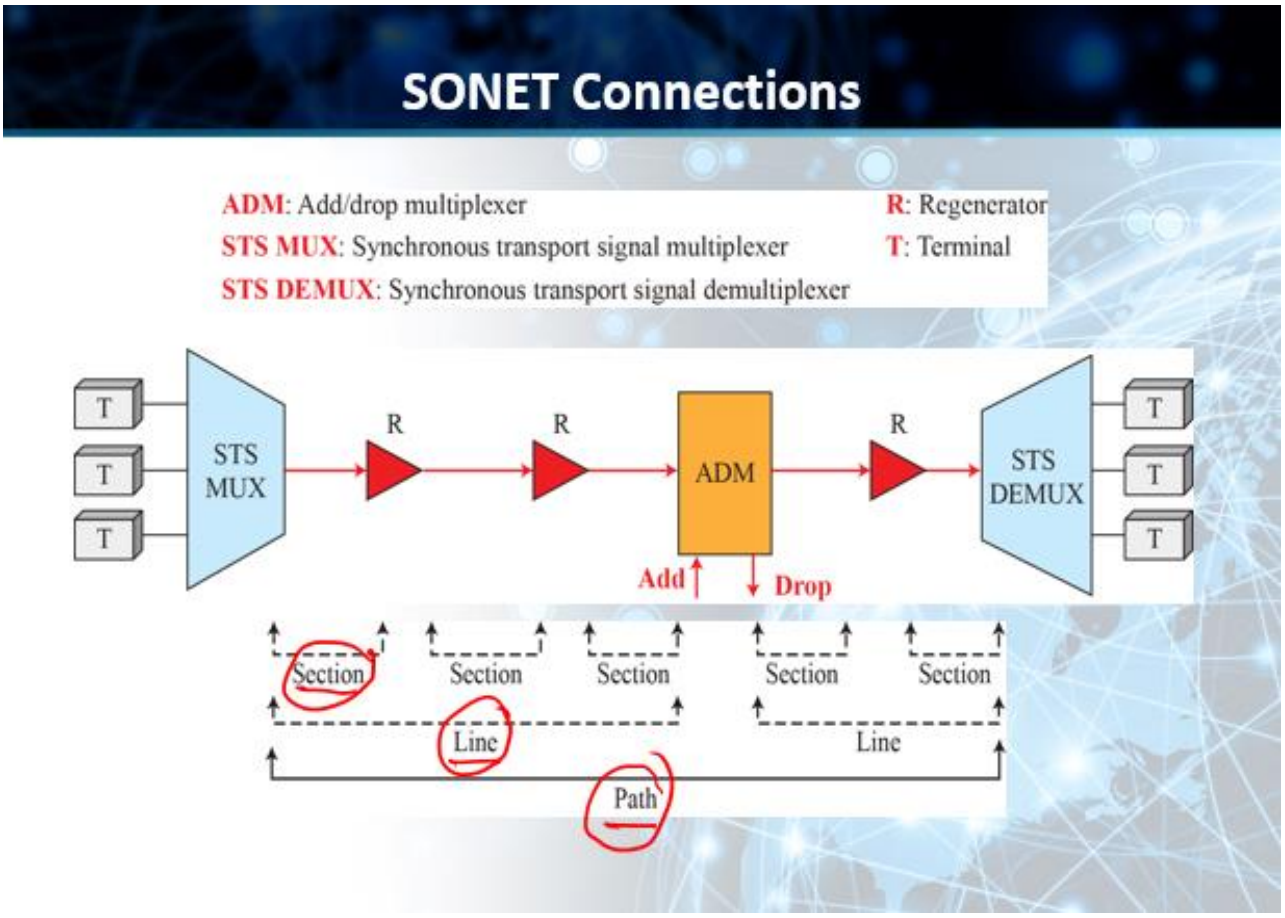
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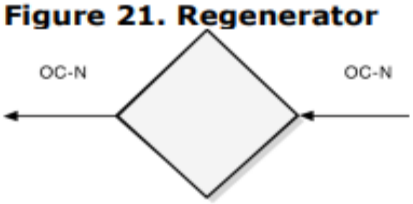
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Regenerator

A regenerator is needed when, due to the long distance between multiplexers, the signal level in the fiber becomes too low.

The regenerator clocks itself off of the received signal and replaces the section overhead bytes before retransmitting the signal. The line overhead, payload, and POH are not altered (see *Figure 21*).

Figure 21. Regenerator



SONET Layers

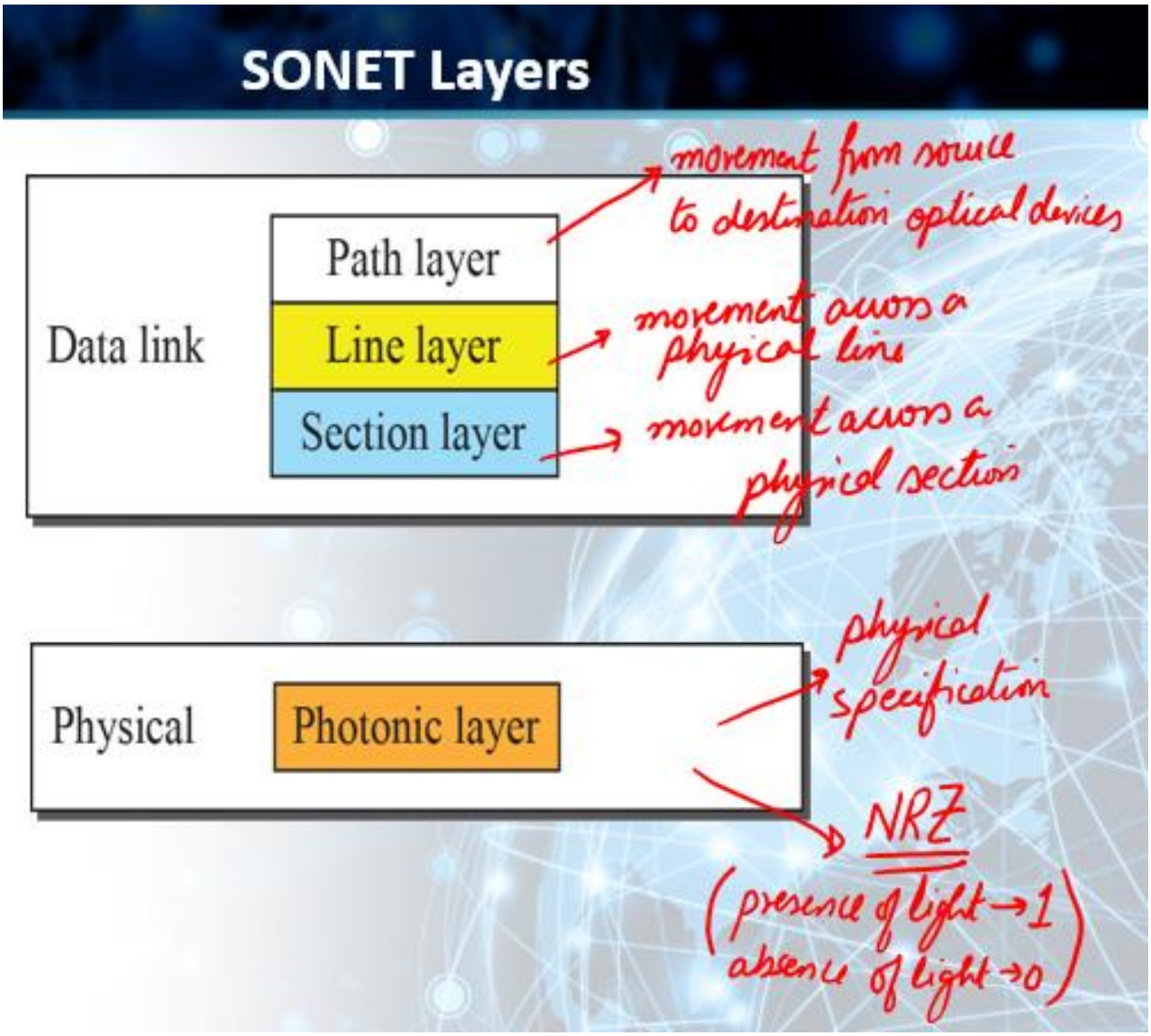
- **The SONET standard includes four functional layers:**
  - ✓ **The Path Layer**
  - ✓ **The Line Layer**
  - ✓ **The Section Layer**
  - ✓ **The Photonic Layer**

- **The layers correspond to both the physical and the data-link layers**

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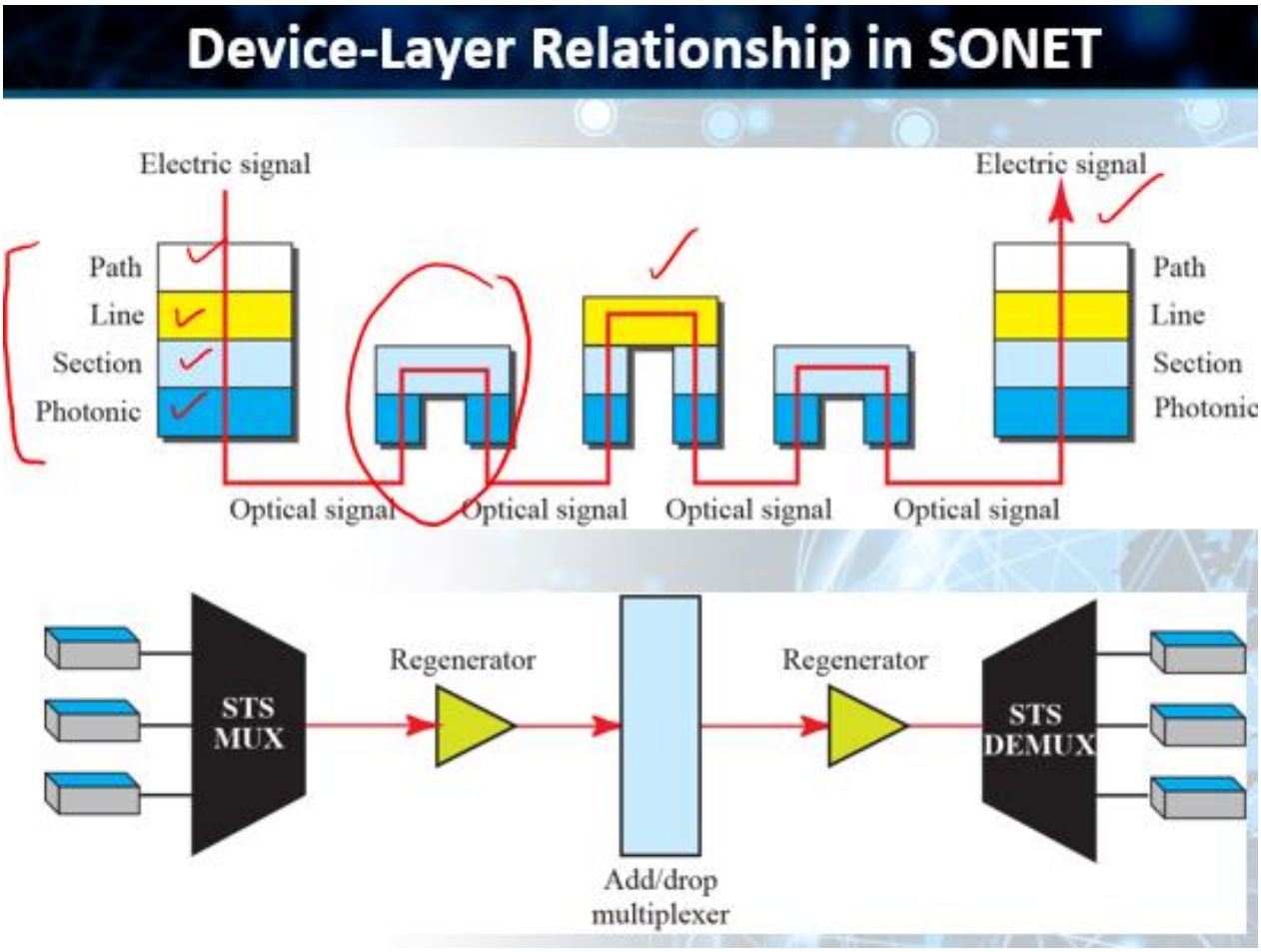
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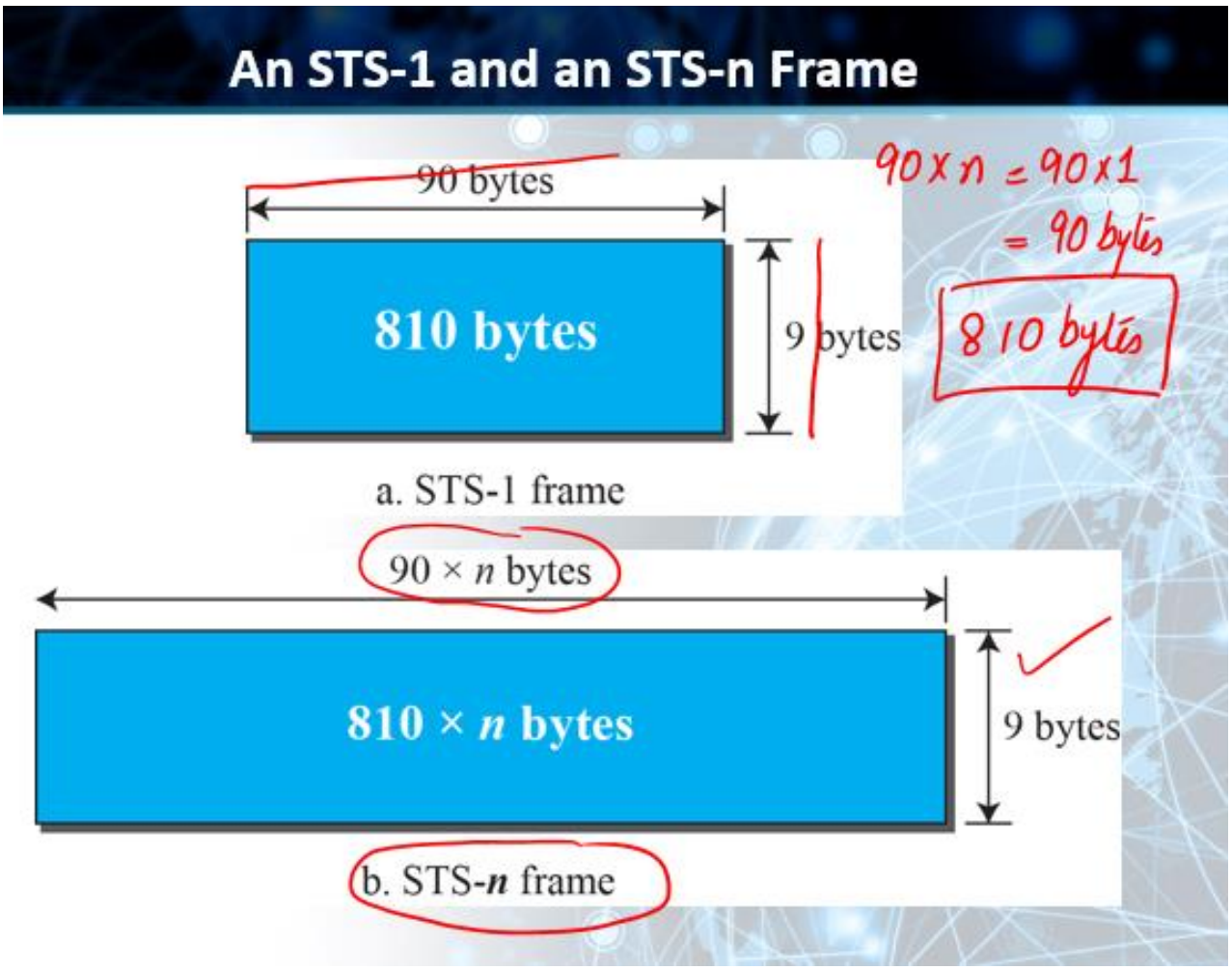
SONET Frames

- **Each synchronous transport signal STS-n is composed of 8000 frames**
- **Each frame is a two-dimensional matrix of bytes with 9 rows by 90×n columns**
- **STS-1 frame is 9 rows by 90 columns (810 bytes), and an STS-3 is 9 rows by 270 columns (2430 bytes)**

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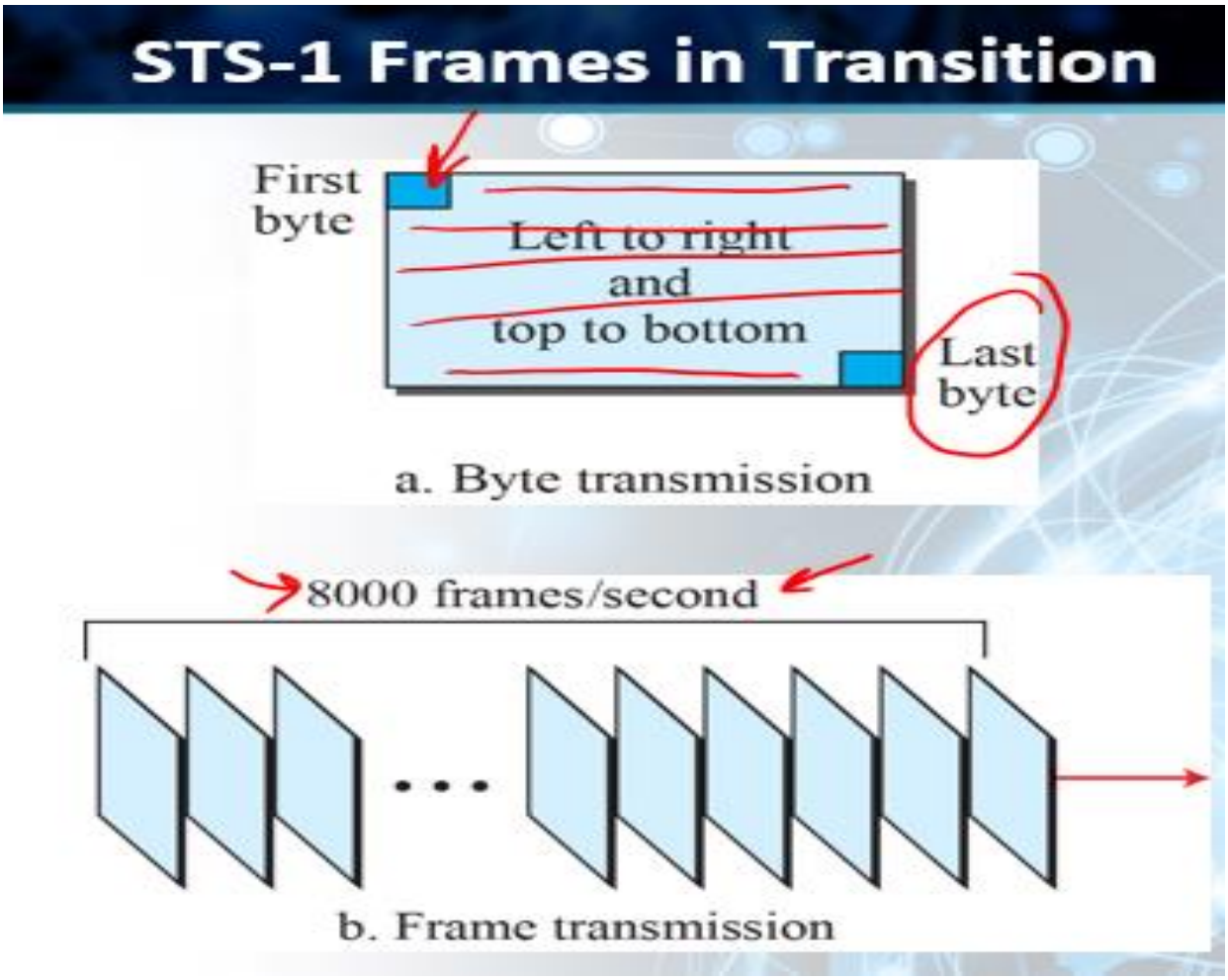
SONET Signal	Bit Rate (Mbps)
STS–1, OC–1	51.840
STS–3, OC–3	155.520
STS–12, OC–12	622.080
STS–48, OC–48	2,488.320

STS-1 Frames in Transition

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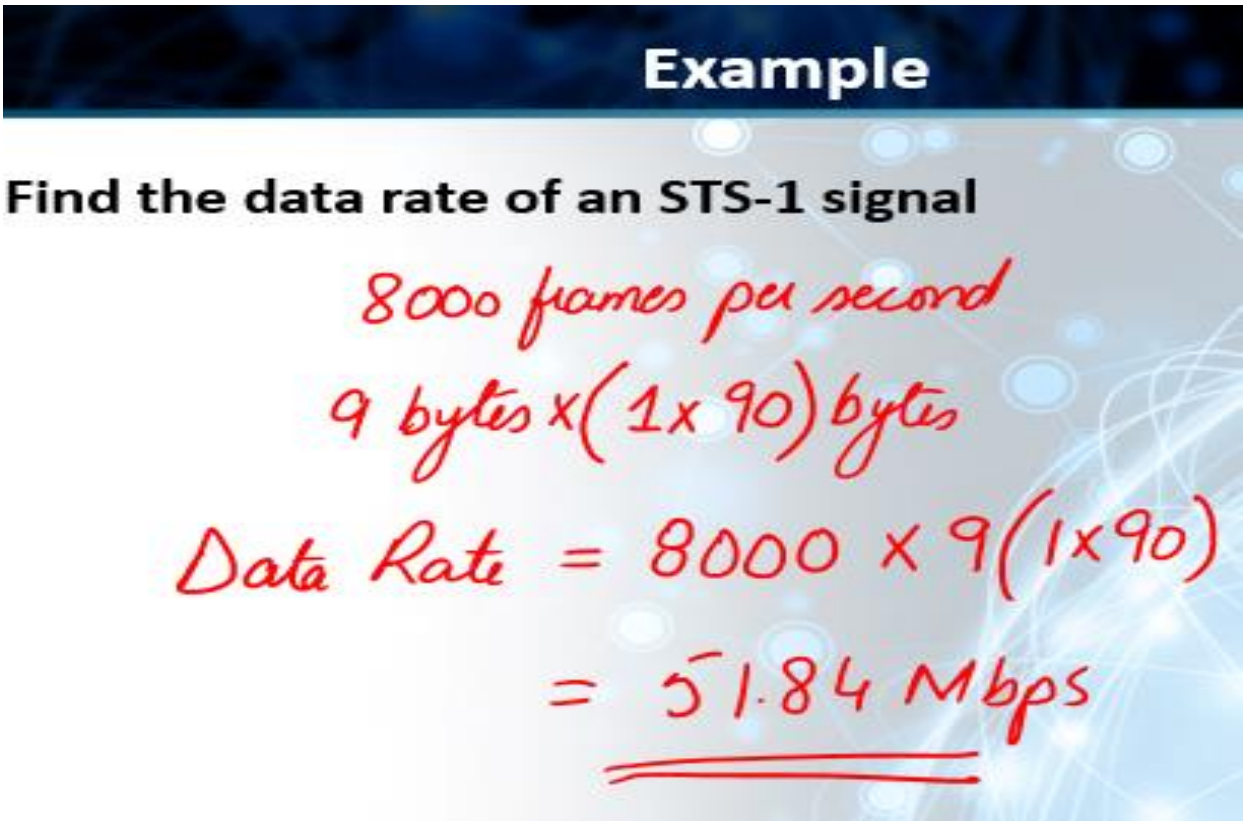
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STS–1 is a specific sequence of 810 bytes (6,480 bits), which includes various overhead bytes and an envelope capacity for transporting payloads. It can be depicted as a 90-column by 9-row structure. With a frame length of 125 µs (8,000 frames per second), STS–1 has a bit rate of **51.840 Mbps**.

(9) x (90 bytes/frame) x (8 bits/byte) x (8,000 frames/s) = 51,840,000 bps = 51.840 Mbps

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Example 17.1

Find the data rate of an STS-1 signal. SONET sends 8000 frames per second.

Solution

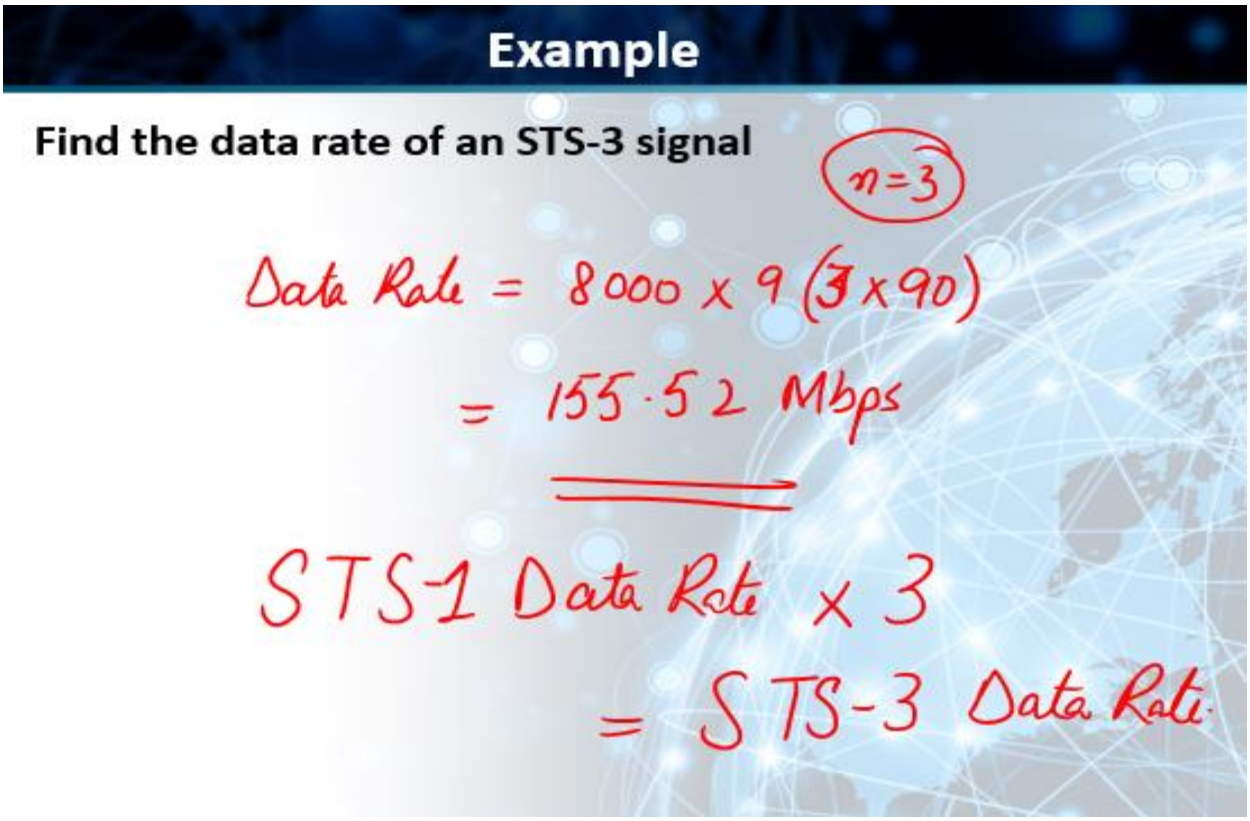
STS-1, like other STS signals, sends 8000 frames per second. Each STS-1 frame is made of 9 by (1 × 90) bytes. Each byte is made of 8 bits. The data rate is

$$\text{STS-1 data rate} = 8000 \times 9 \times (1 \times 90) \times 8 = 51.840 \text{ Mbps}$$

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Example 17.2

Find the data rate of an STS-3 signal.

Solution

STS-3, like other STS signals, sends 8000 frames per second. Each STS-3 frame is made of 9 by (3 × 90) bytes. Each byte is made of 8 bits. The data rate is

$$\text{STS-3 data rate} = 8000 \times 9 \times (3 \times 90) \times 8 = 155.52 \text{ Mbps}$$

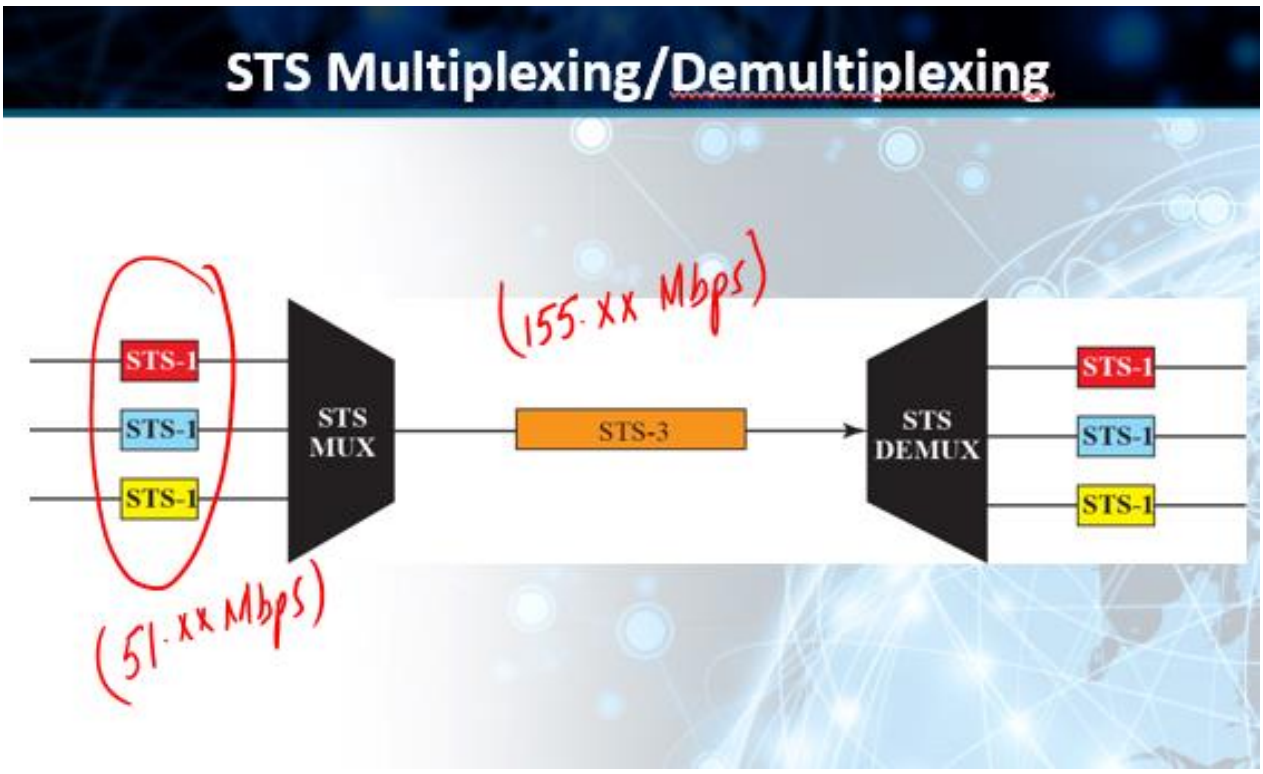
STS Multiplexing

- **In SONET, frames of lower rate can be synchronously time-division multiplexed into a higher-rate frame**
- **For example, three STS-1 signals (channels) can be combined into one STS-3 signal (channel), four STS-3s can be multiplexed into one STS-12, and so on**

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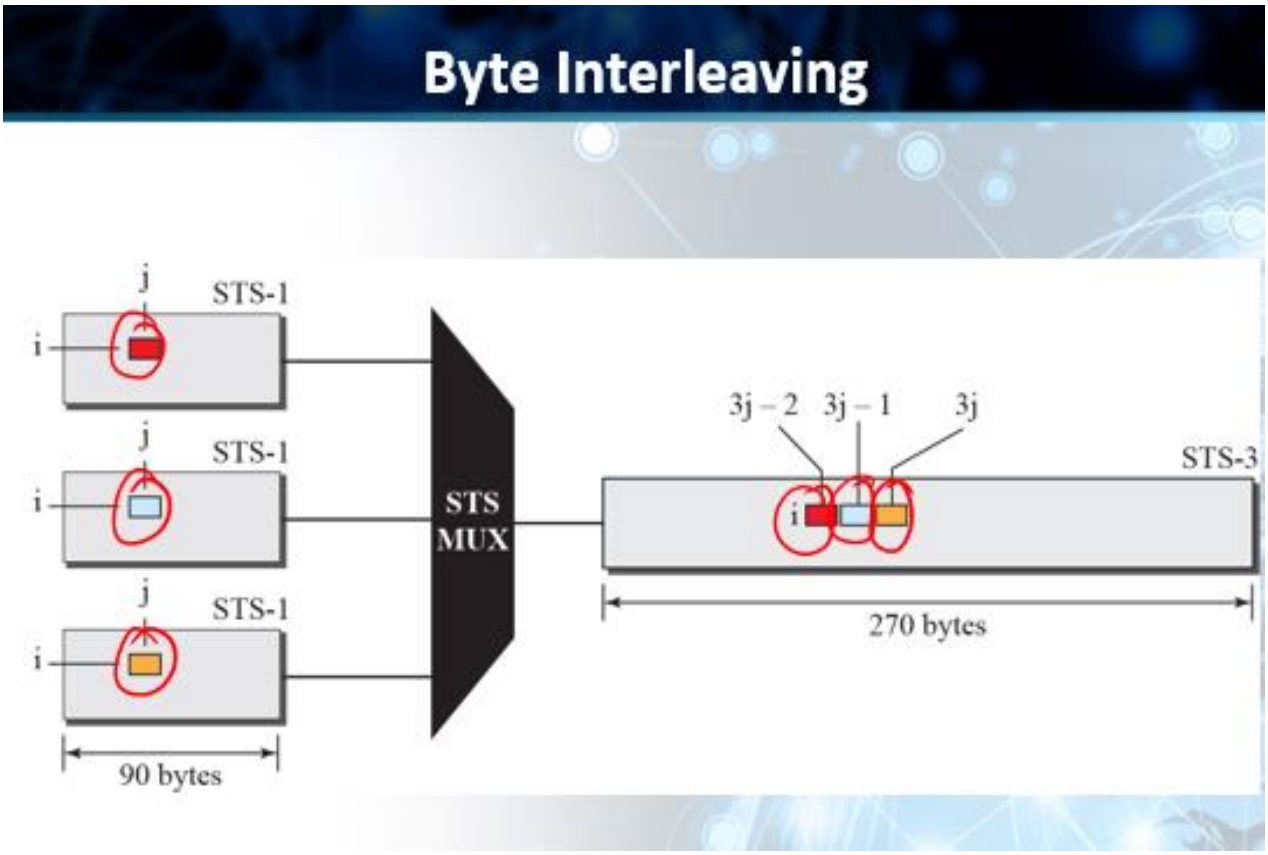
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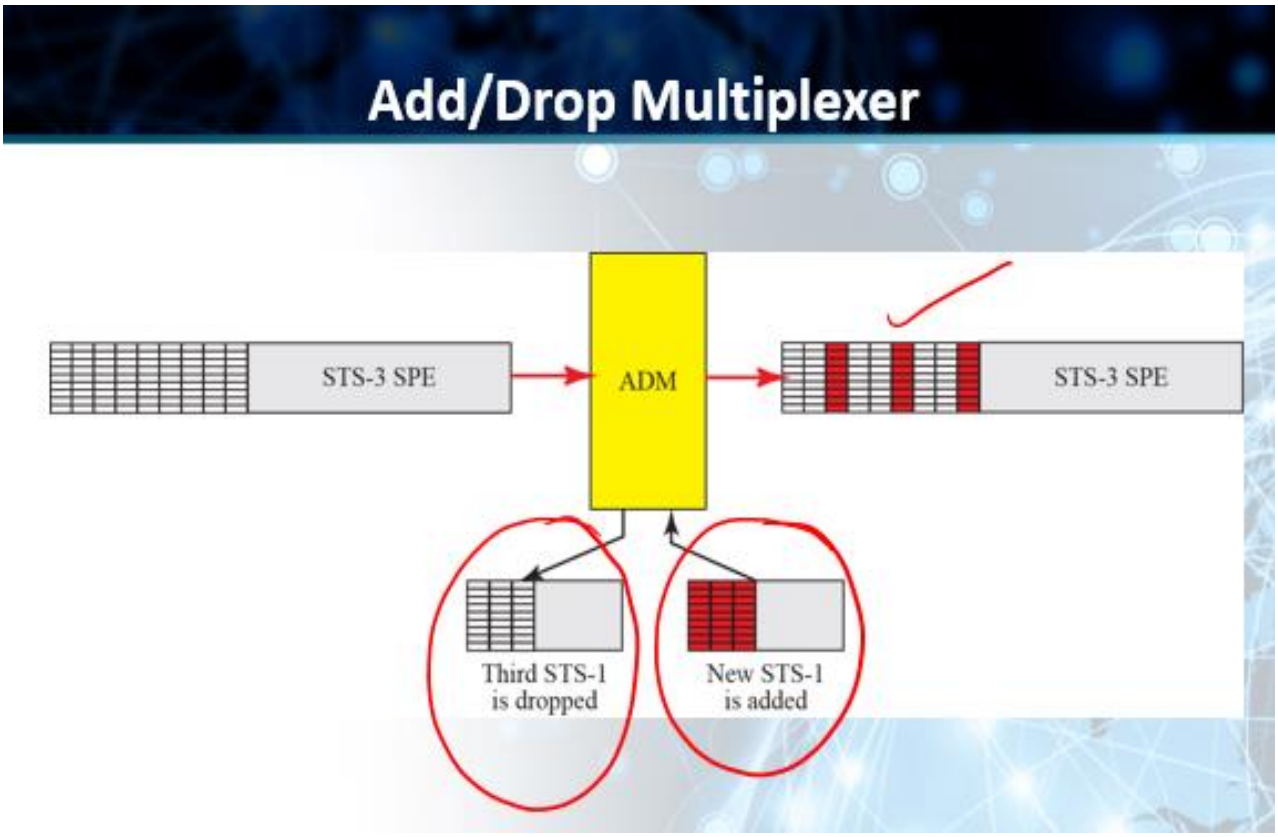
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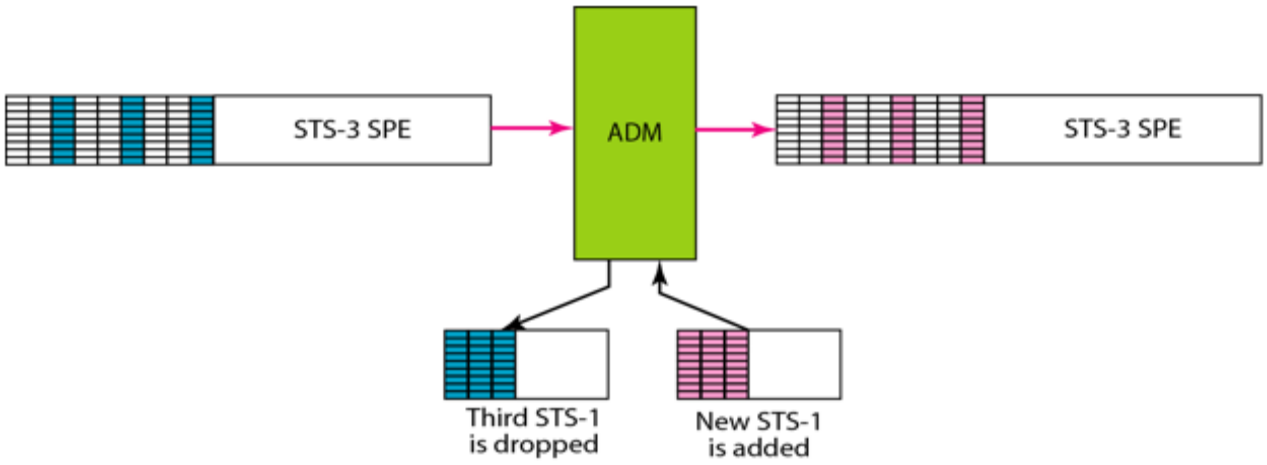


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Figure 17.16 *Dropping and adding STS-1 frames in an add/drop multiplexer*



Notice that ADM only operates a physical layer – it drops one STS-1 and adds a new one in its place.

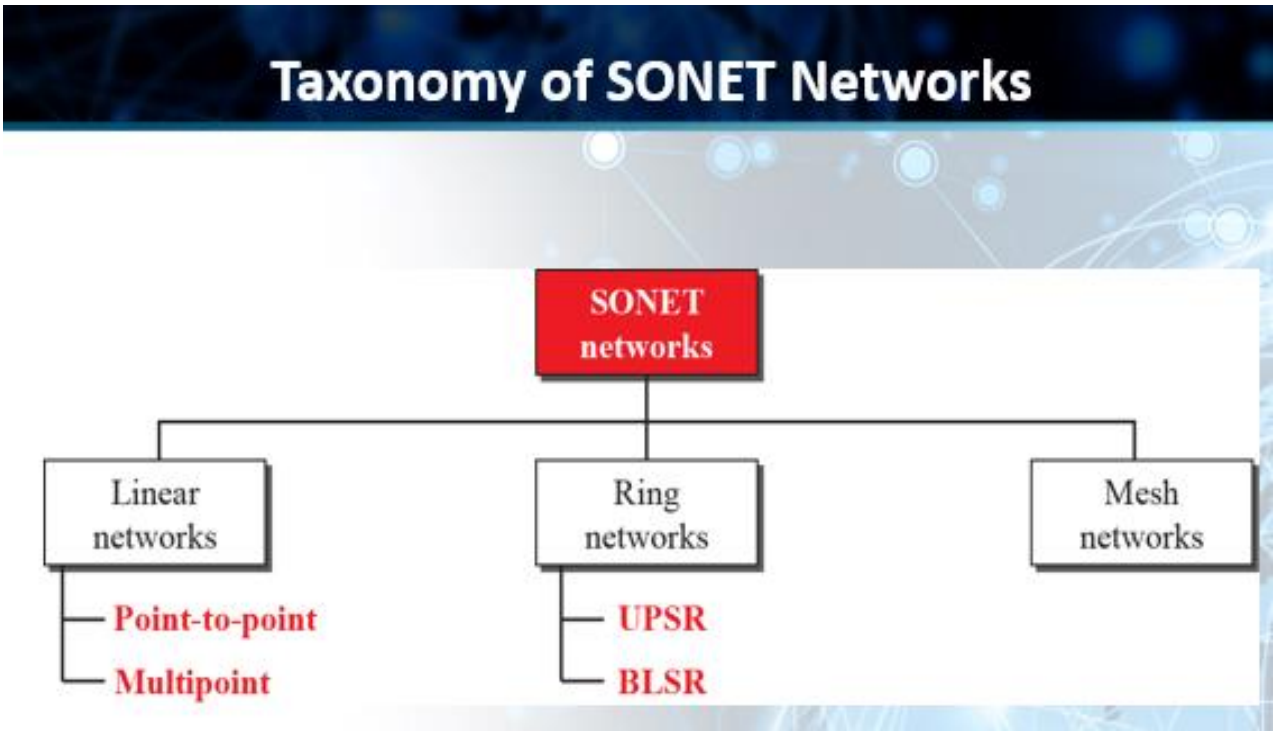
SONET Networks

- **SONET network can be used as a high-speed backbone carrying loads from other networks such as ATM or IP**
- **We can roughly divide SONET networks into three categories:**
  - ✓ **Linear Networks**
  - ✓ **Ring Networks**
  - ✓ **Mesh networks**

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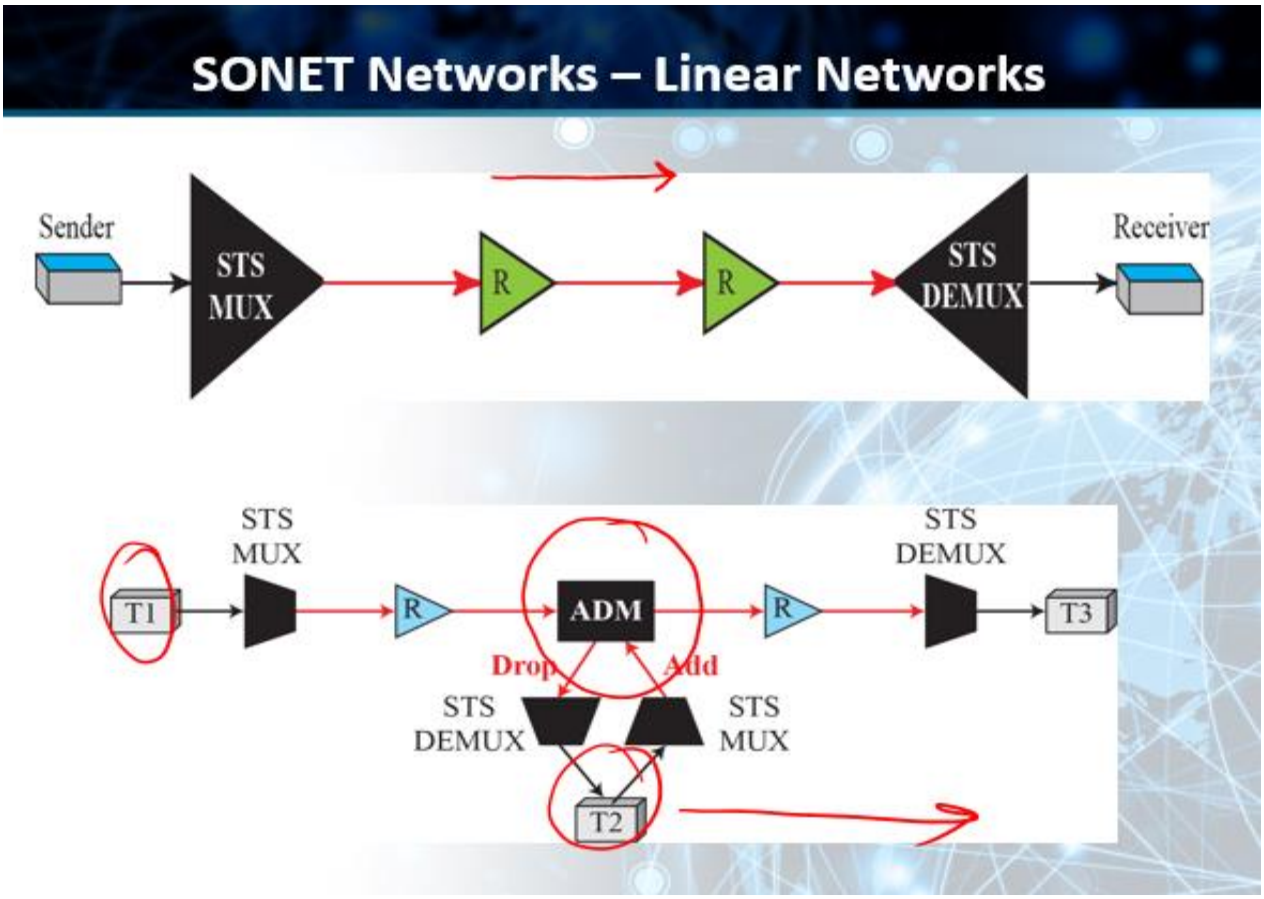
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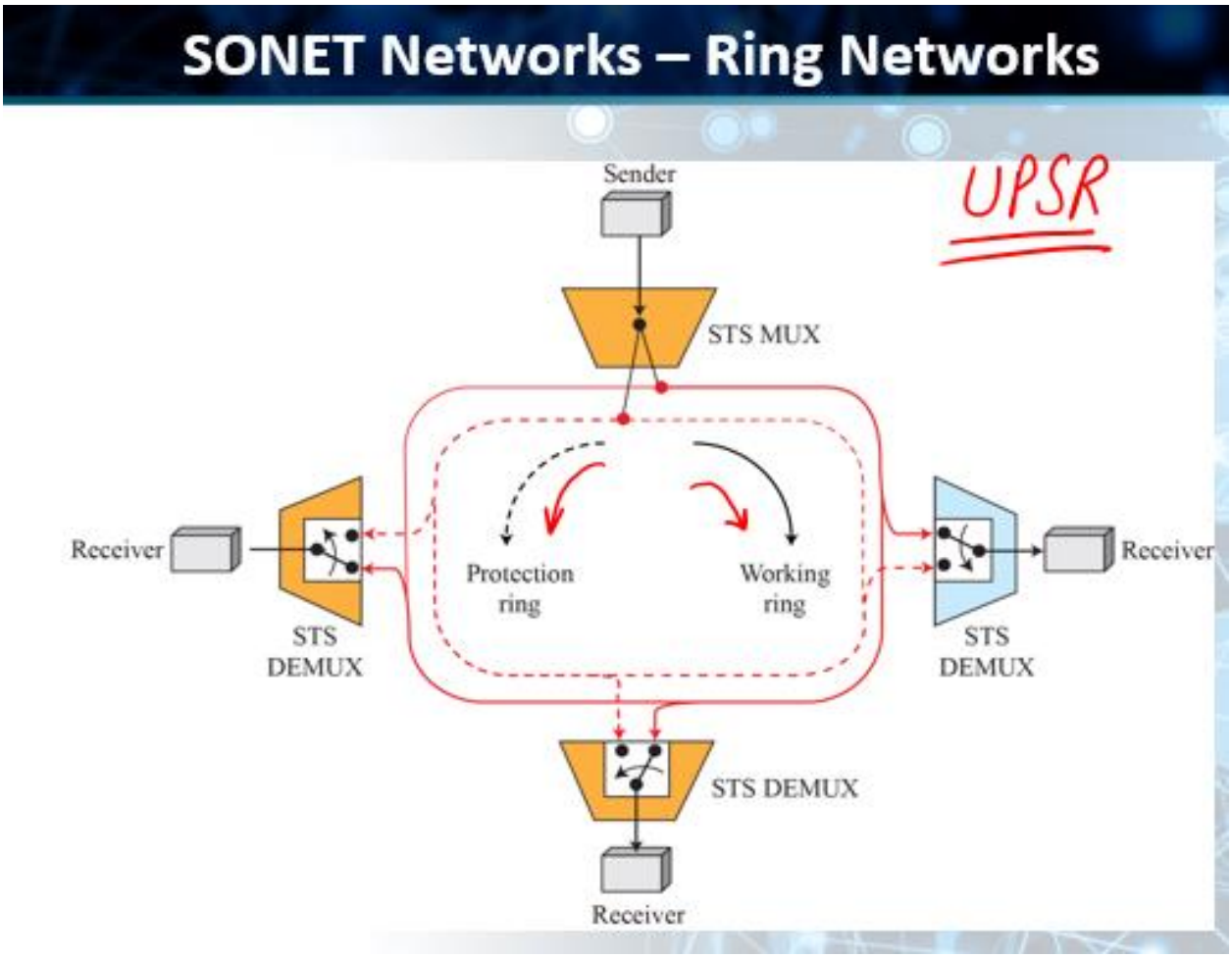
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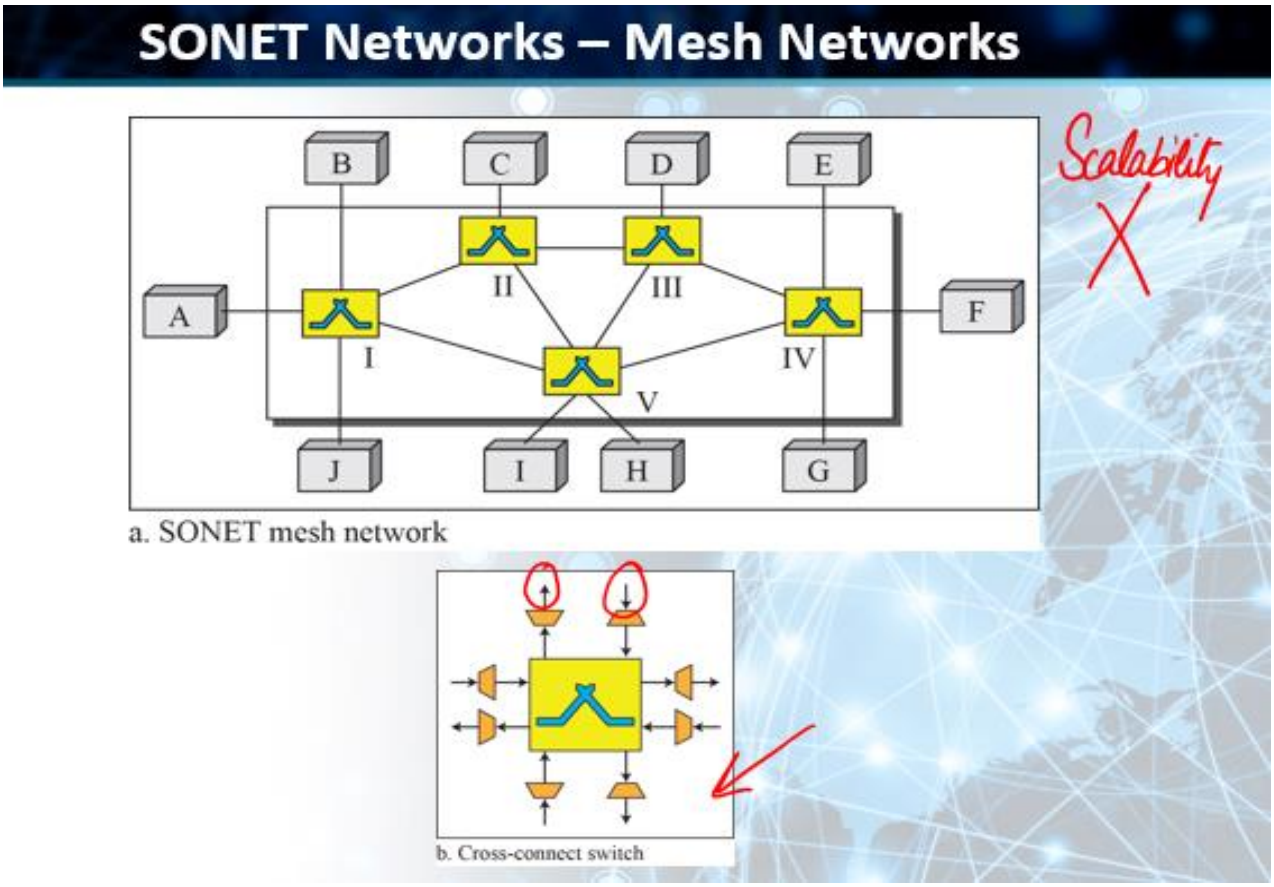
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ATM

- **Asynchronous Transfer Mode (ATM) is a switched wide area network based on the cell relay protocol designed by the ATM forum**
- **The combination of ATM and SONET will allow high-speed interconnection of networks**

Problems

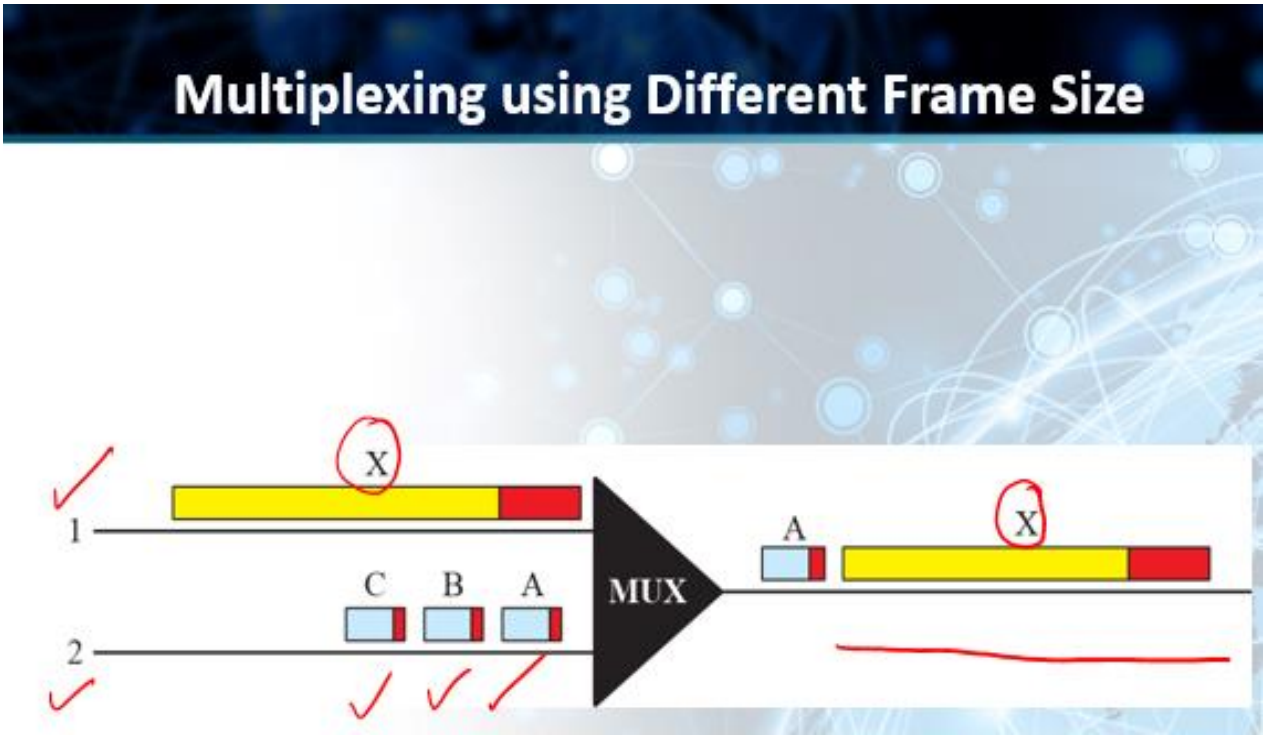
- **Some of the problems associated with existing systems are:**
  - ✓ **Frame Networks**
  - ✓ **Mixed Network Traffic**
- **Solution**

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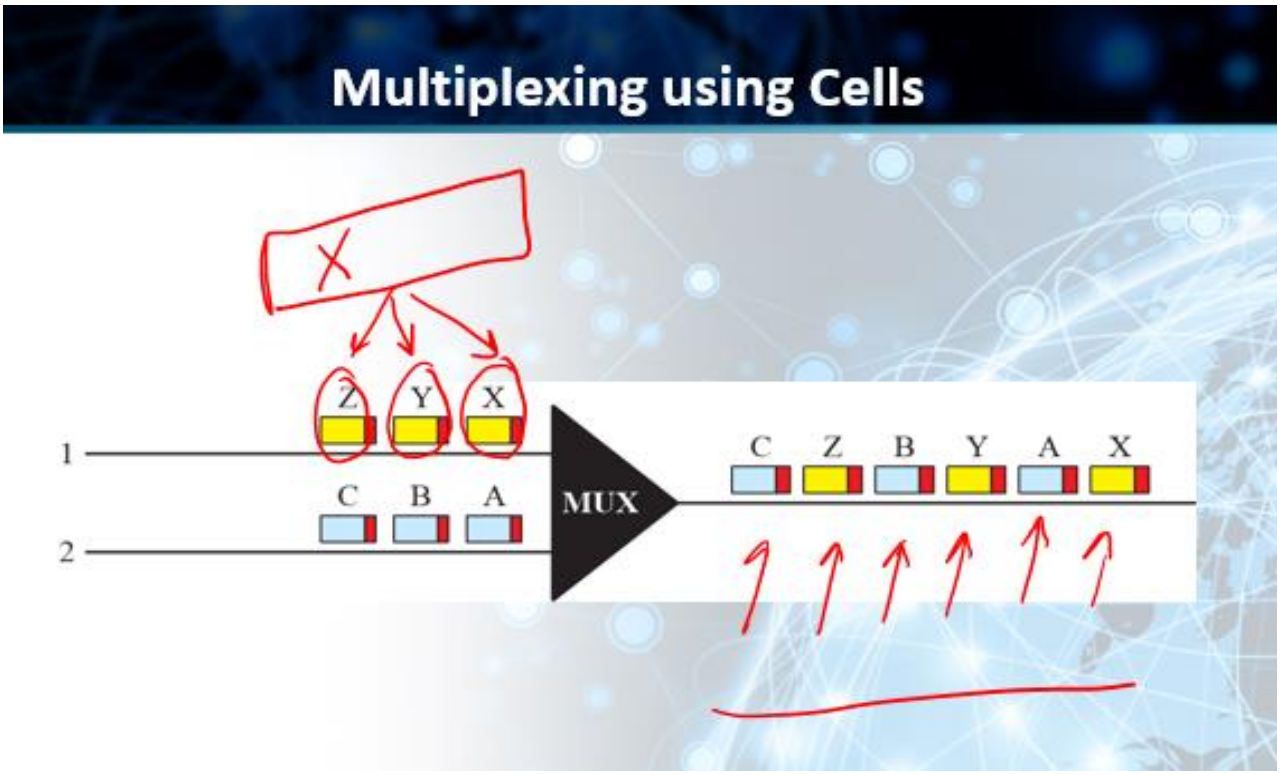
- ✓ **Cell Networks**
- ✓ **Asynchronous TDM**



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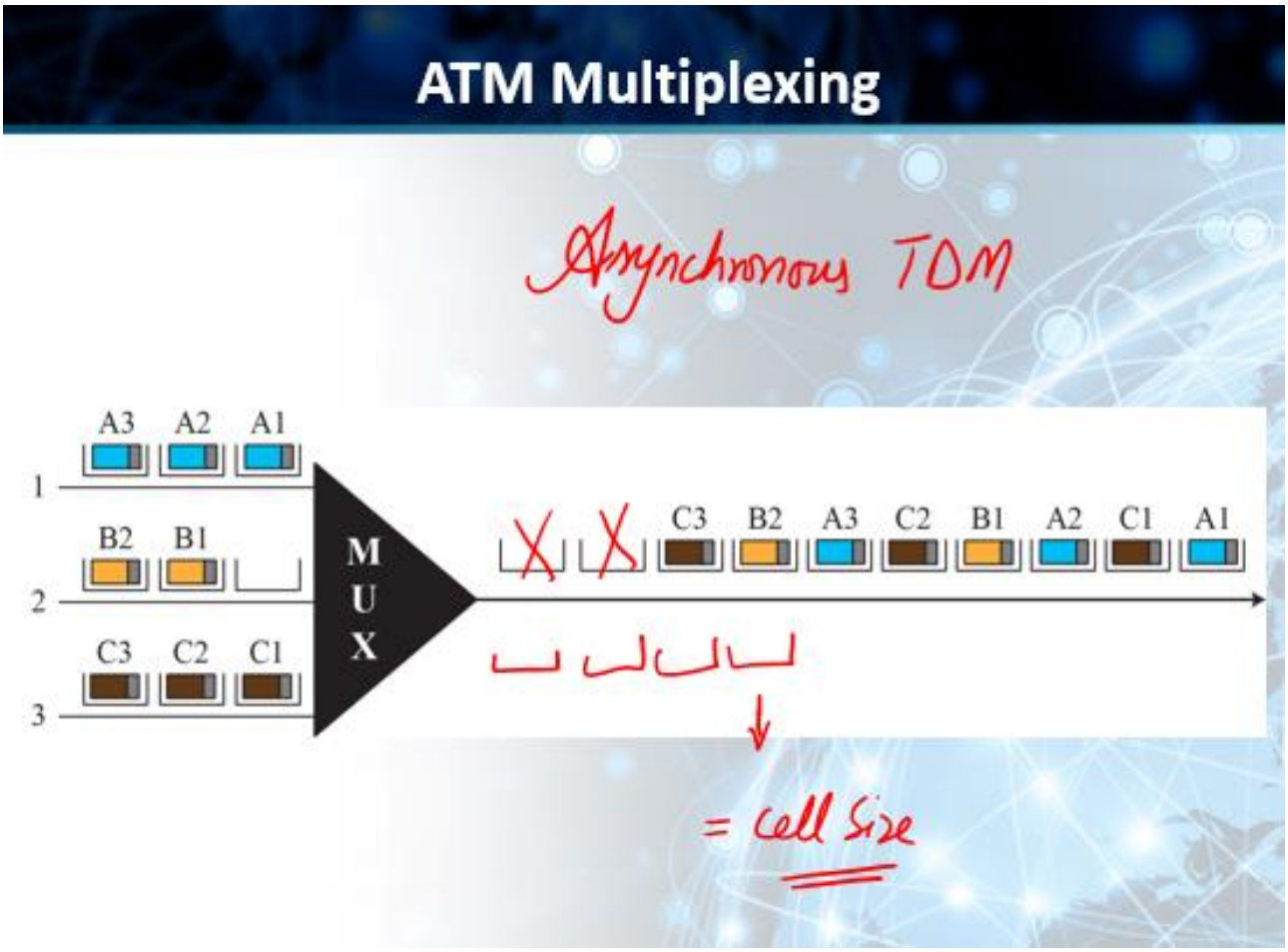
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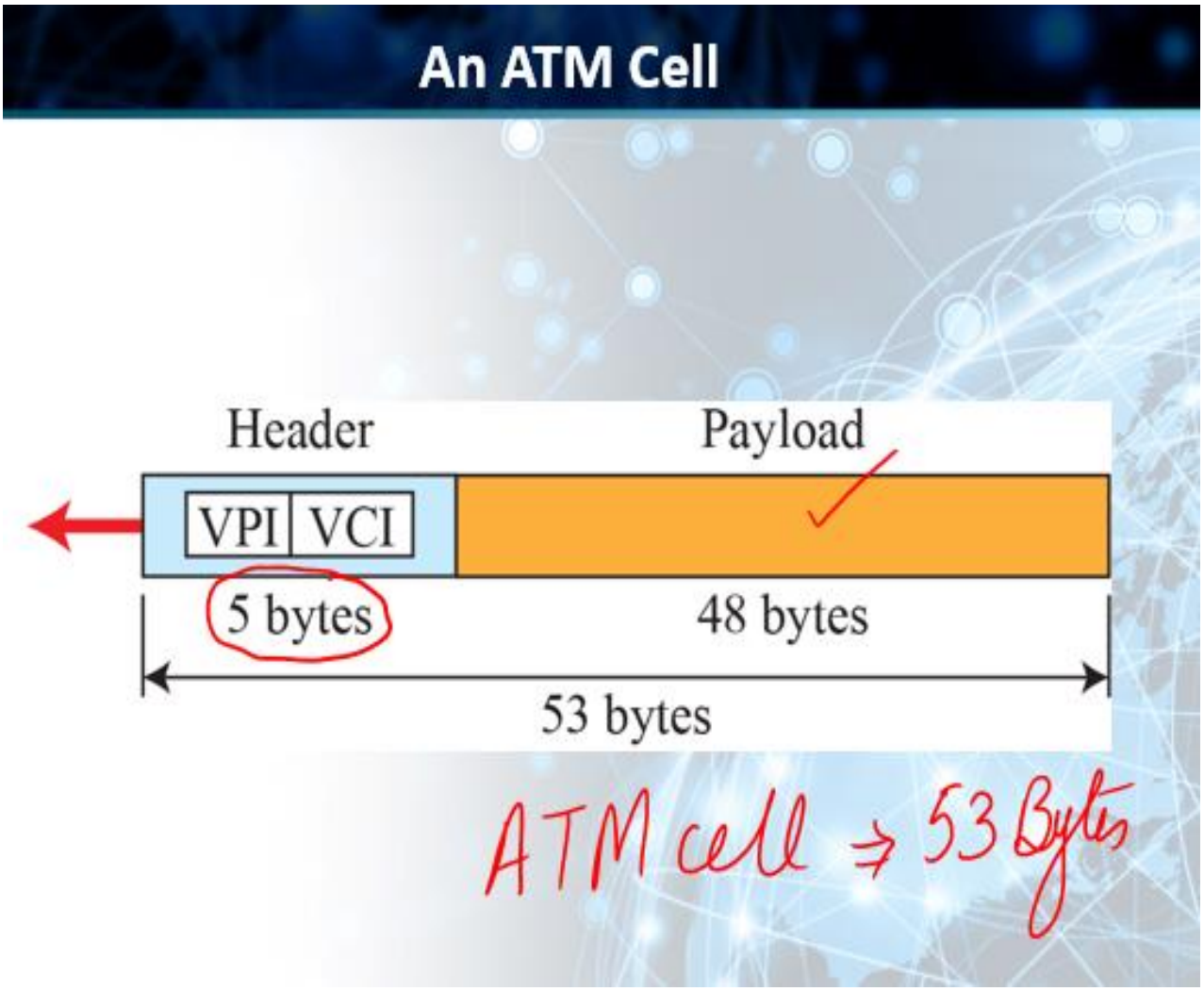
Architecture

- **ATM is a cell-switched network**
- **The user access devices, called the endpoints, are connected through a user-to-network interface (UNI) to the switches inside the network**
- **The switches are connected through network-to-network interfaces (NNIs)**

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