SONET/SDH

What is SONET/SDH

- **SONET – Synchronous Optical NETwork (ANSI).**
  - ANSI started work on SONET in1985.
- **SDH – Synchronous Digital Hierarchy (ITU).**
  - The ITU began work in 1986 to achieve the same goal.
- **SONET and SDH define a set of physical layer standards for communications over optical fiber.**

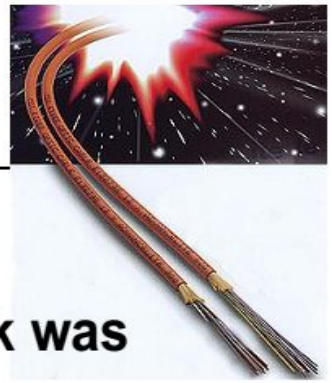
Source: Fundamentals of SONET/SDH: ***P. Michael Henderson***

What is SONET?

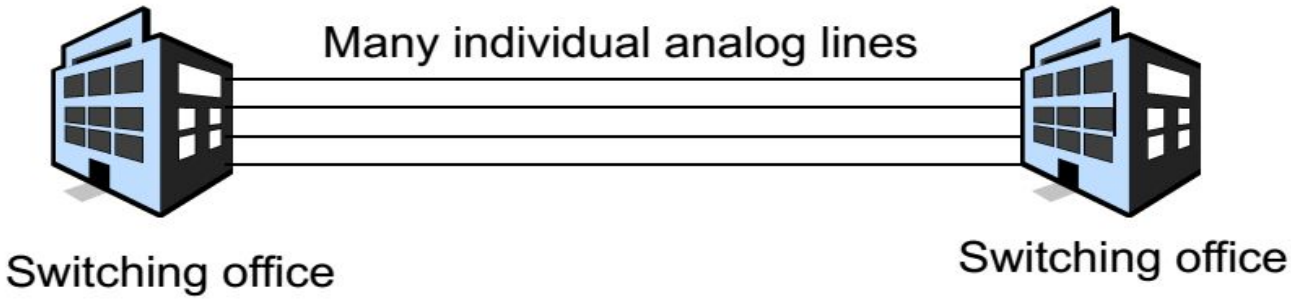
SONET = Synchronous Optical NETwork

- **Optical** = This is a standard for optical telecommunications. (Although some SONET rates can be transported over microwave radio.)
- **Synchronous** = All terminals in a SONET network are normally timed from the same clock source.

Why SONET/SDH?

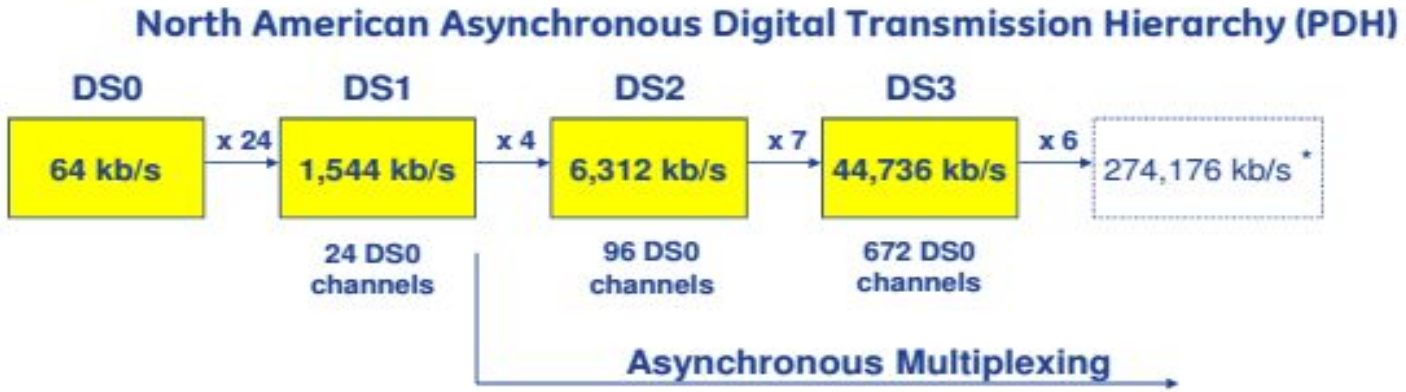


- **Originally, all communications in the telephone network was analog.**
- **Analog lines or analog microwave was used to connect to switching offices.**



What Preceded SONET?

- Prior to SONET, digital transmission systems were generally asynchronous, with each terminal running on its own clock.



- The bit rates produced by devices running at nominally the same rate could be slightly different (within specified range).

  DS1: 1544 kb/s ± 50 ppm (±77 bits/sec)
  DS3: 44,736 kb/s ± 20 ppm (± 895 bits/sec)

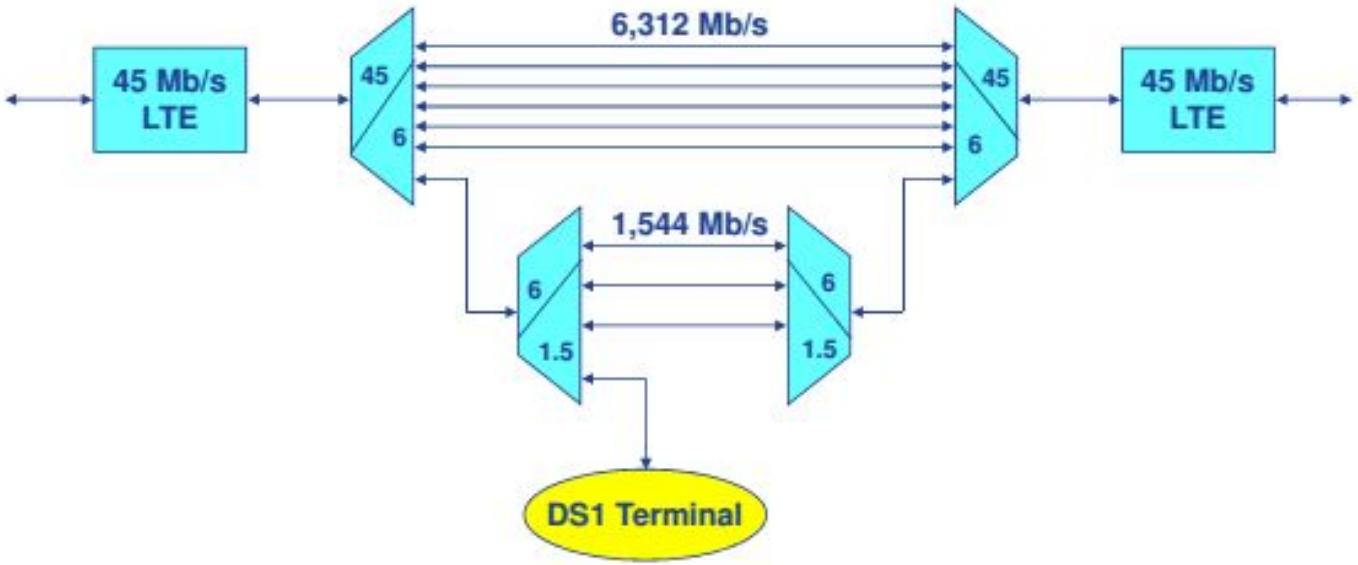
- PDH = Plesiochronous Digital Hierarchy (Plesiochronous = Almost Synchronous)

*Not Recognized by ITU-T

Asynchronous vs. Synchronous

Asynchronous Multiplexing	Synchronous Multiplexing
Bit stuffing. During multiplexing, extra bits are added to account for bit rate variations.	No need for bit stuffing.
No "visibility" of lower order signals in a higher-order multiplex signal.	Full "visibility" of lower order signals in a higher-order multiplex signal.
Lower-order signals cannot be accessed without demultiplexing.	Lower-order signals can be added/dropped without demultiplexing of the higher order signal.

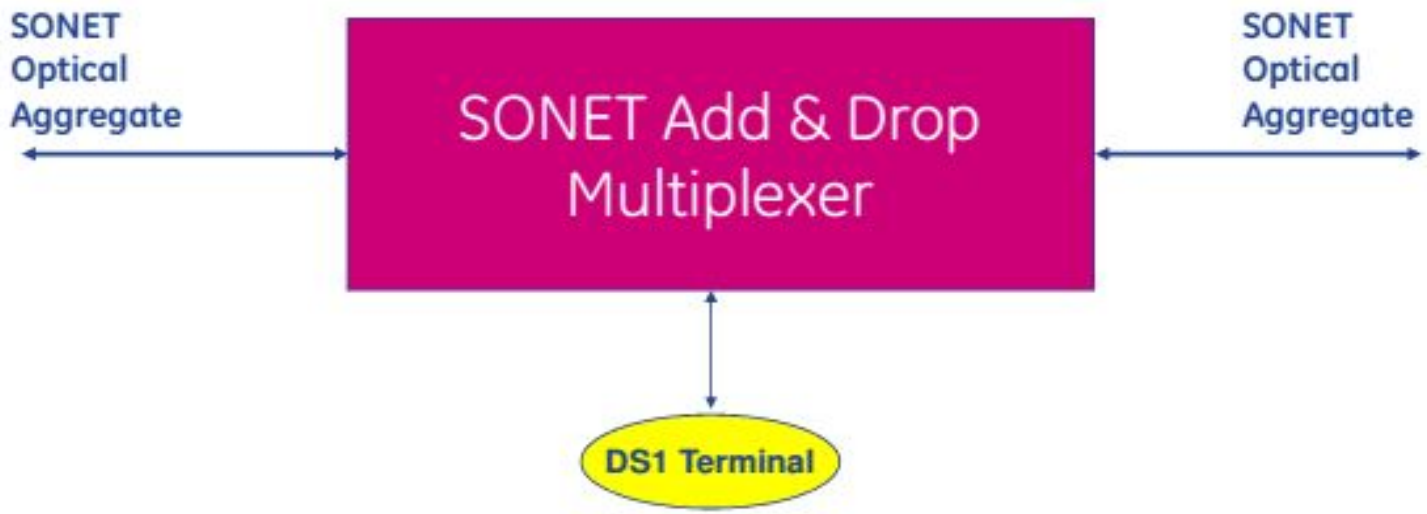
Asynchronous "Drop/Insert"



- Multi-stage multiplexing/demultiplexing
- Multiplex equipment connected back-to-back

LTE: Line Terminating Equipment

Synchronous "Drop/Insert"



- Single-stage multiplexing/demultiplexing
- Complete add/drop functionality provided in one box

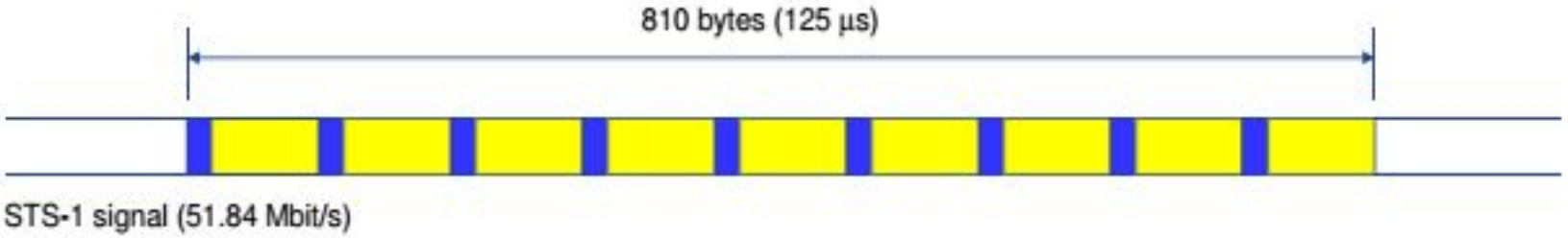
SONET Objectives

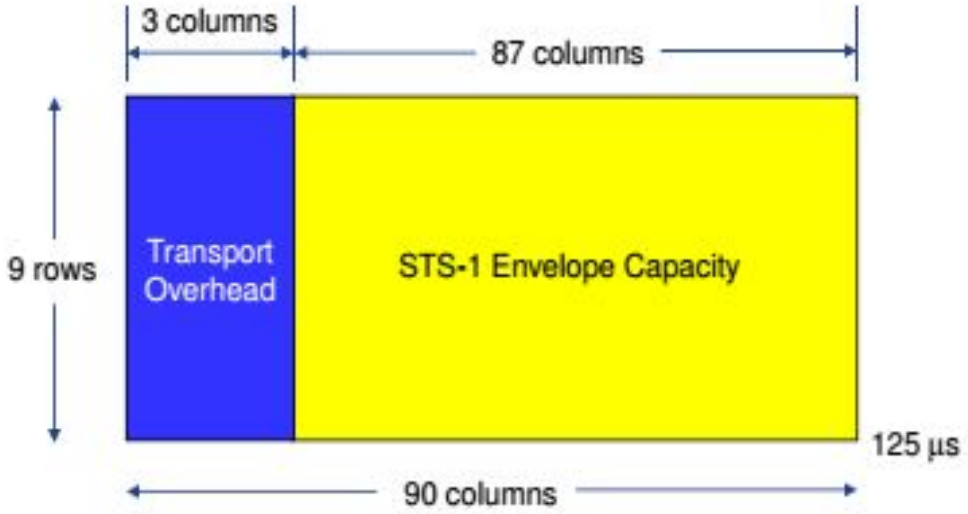
- Eliminate need for multi-stage multiplexing
- Provide optical interconnectivity in multi-vendor environment ("mid-span meet")
- Enhance Operations, Administration, and Maintenance (OAM)
  - Provide sufficient capacity for transmitting overhead information
  - Create basis for efficient Network Management System
- Come up with a universal multiplex signal structure applicable to all (even future) SONET rates
- Ensure scalability of bandwidth allocations to services
  - Position the network for transport of new services (ATM, IP, Video...)
- Ensure backward compatibility
  - Transparent for legacy PDH transport signals

SONET Signal Hierarchy

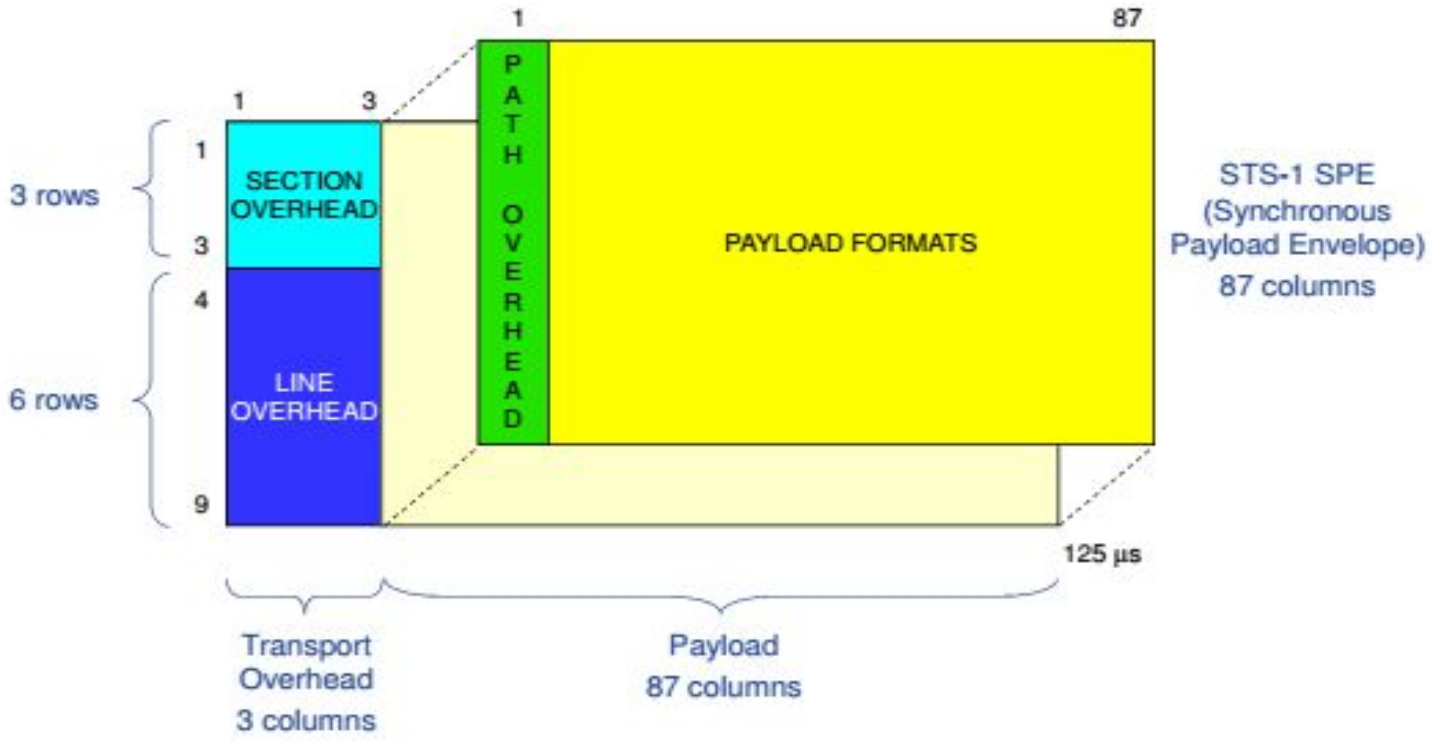
STS Level	OC Level	Bit Rate (Mbit/s)	# of DS1s	# of DS0s
STS-1	OC-1	51.84	28	672
STS-3	OC-3	155.52	84	2016
STS-12	OC-12	622.08	336	8064
STS-48	OC-48	2488.32	1344	32,256
STS-192	OC-192	9953.28	5376	129,024

STS-1 Frame Format

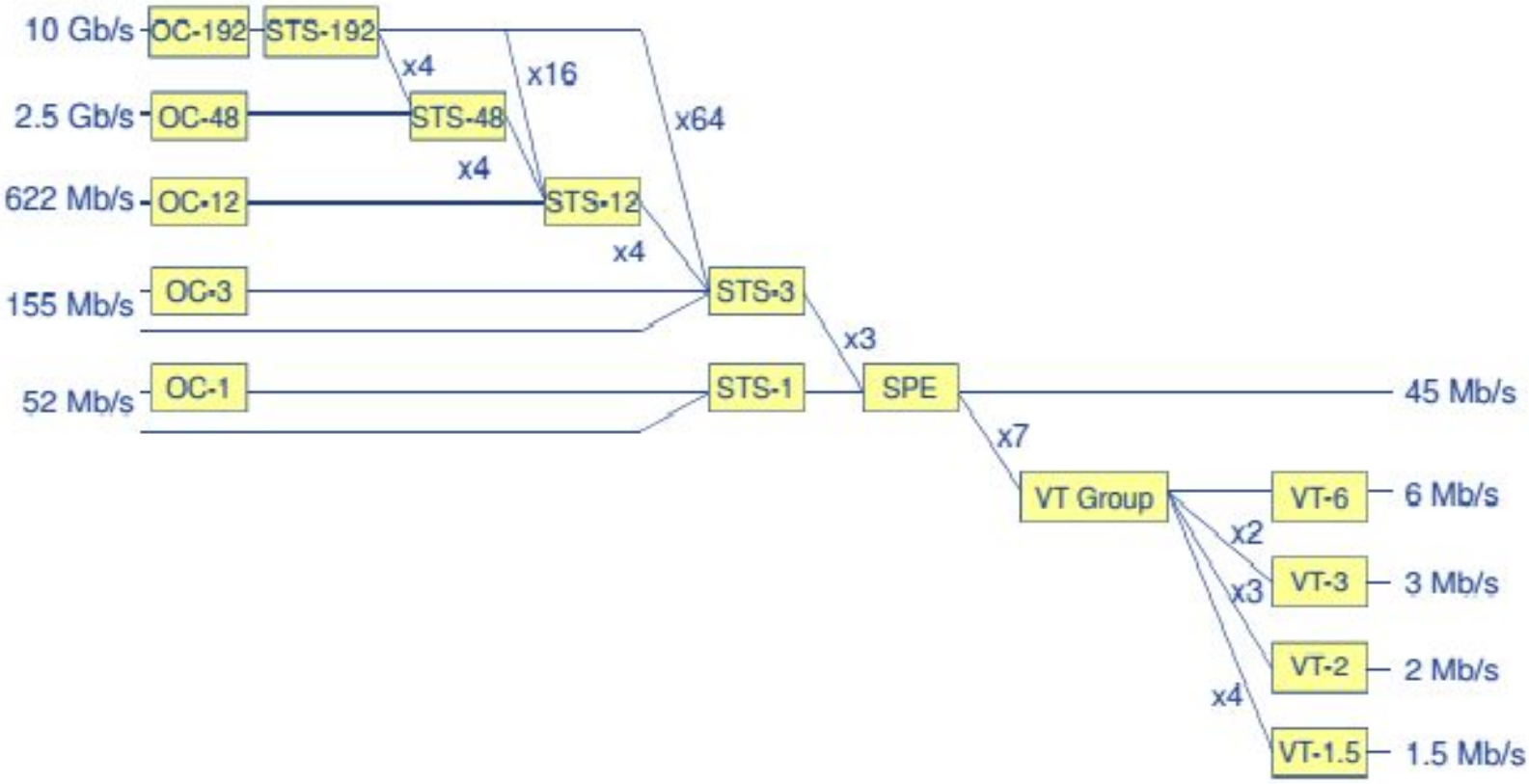


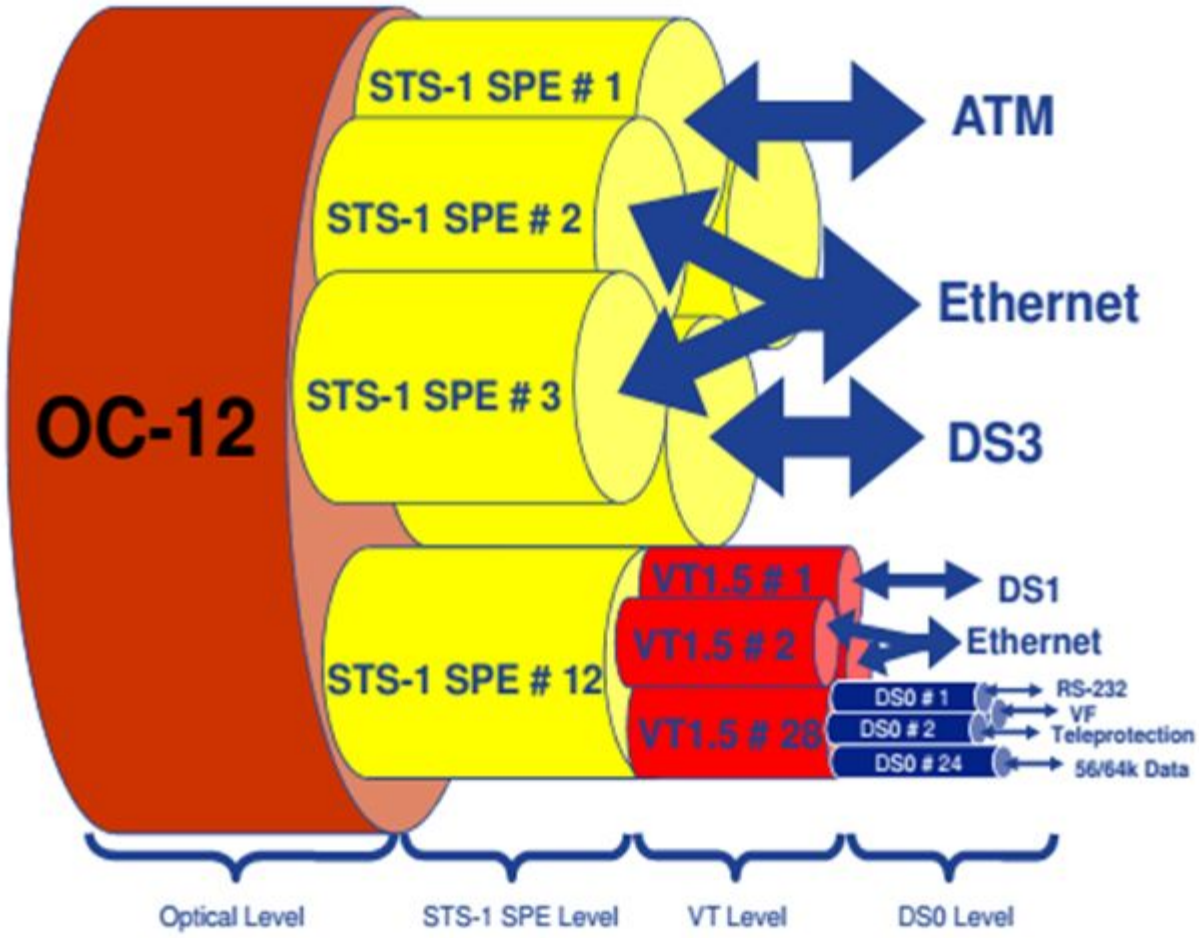


STS-1 Frame Format

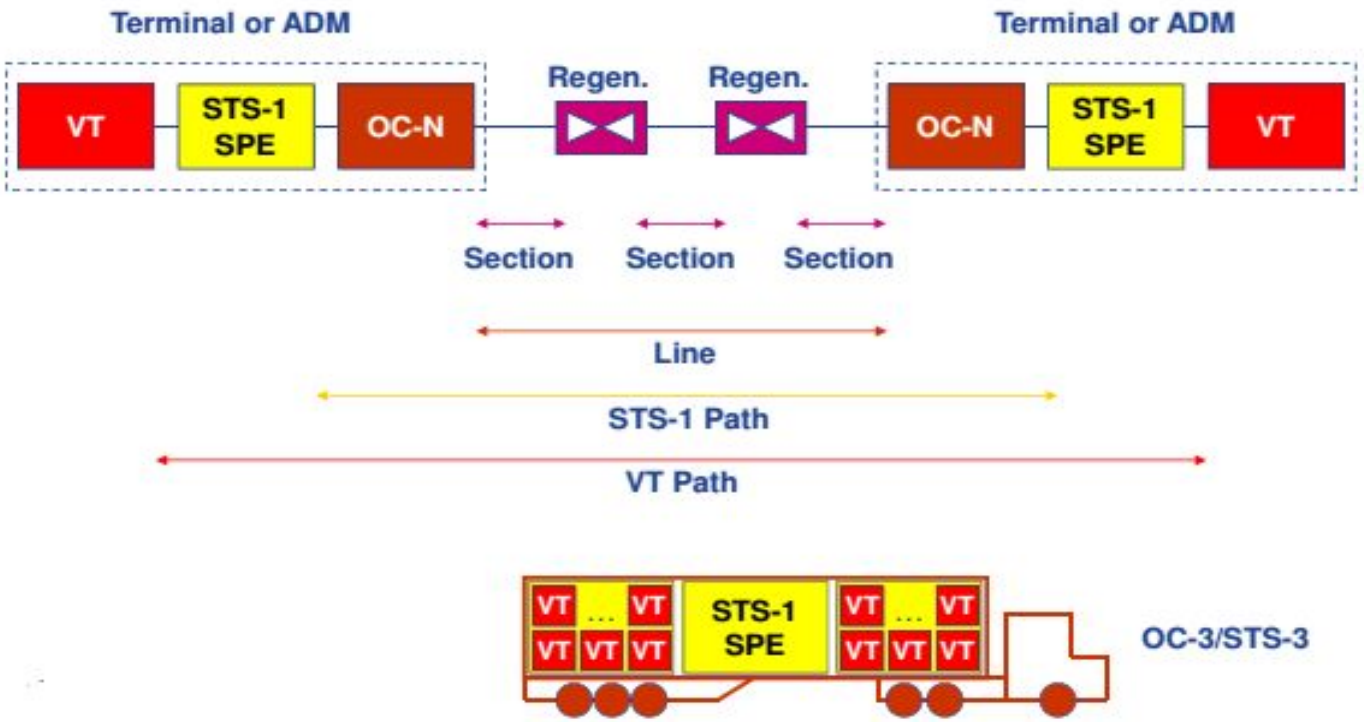


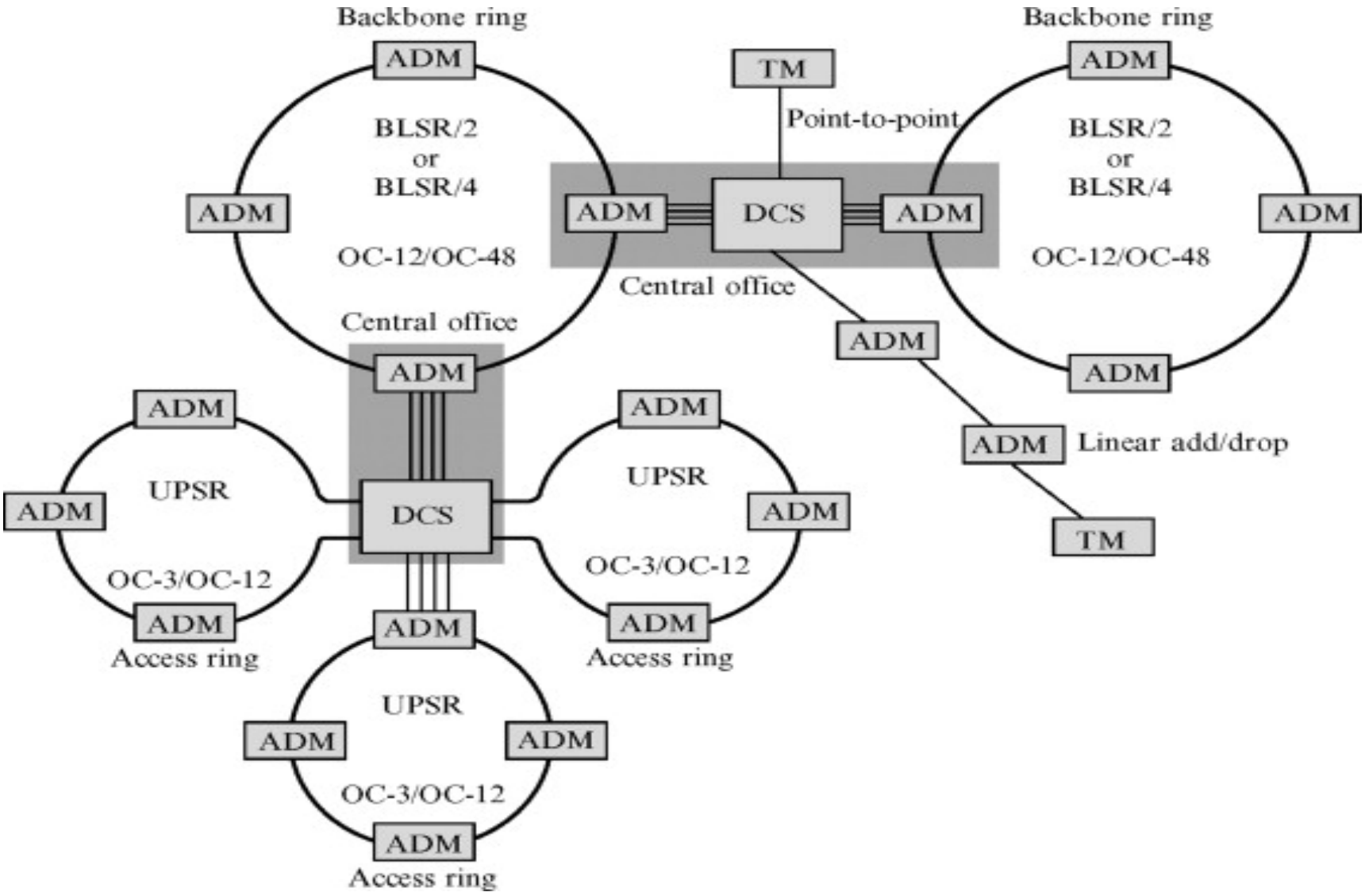
SONET Multiplexing Hierarchy

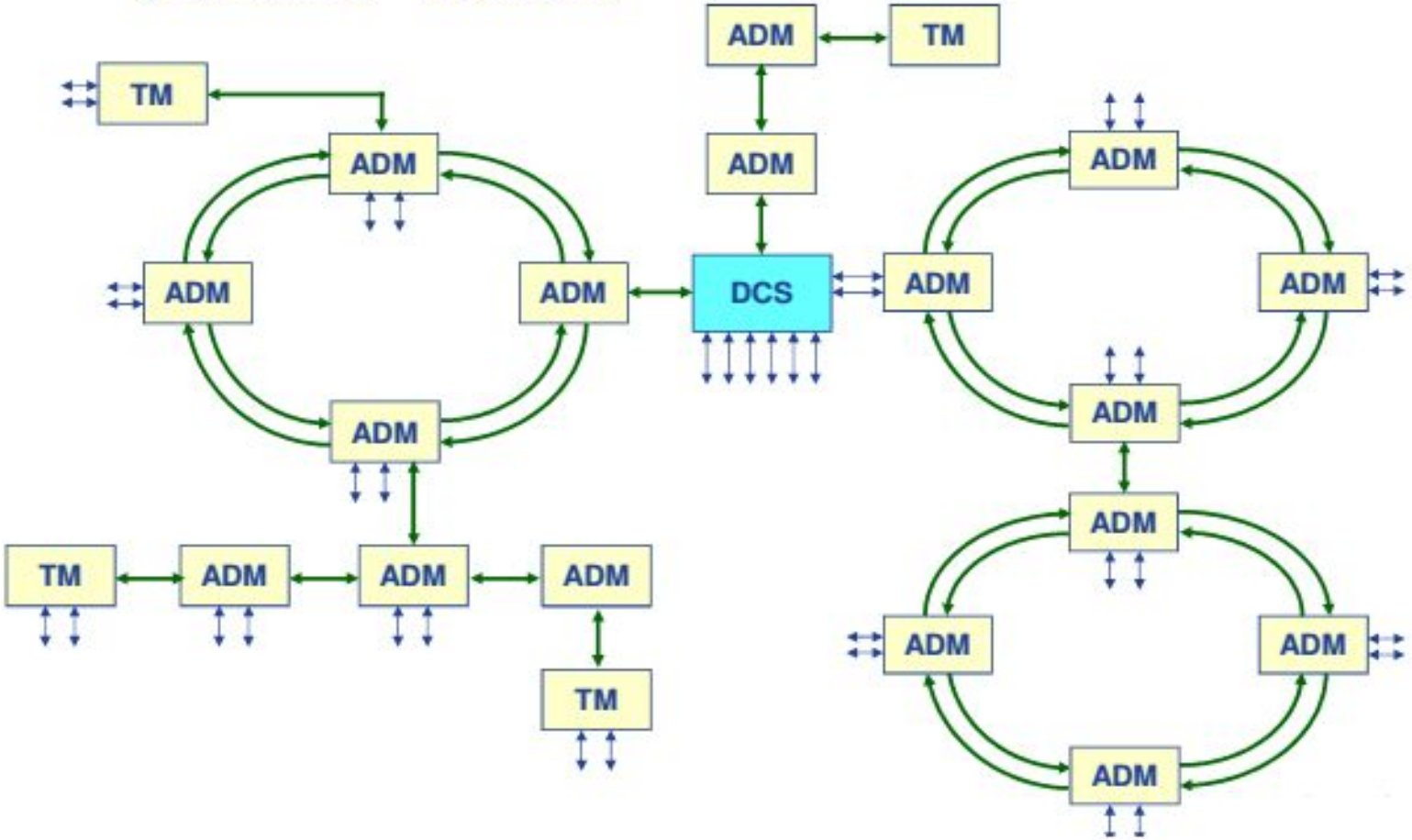



OC-12
STS-1 SPE # 1
STS-1 SPE # 2
STS-1 SPE # 3
STS-1 SPE # 12
ATM
Ethernet
DS3
VT1.5 # 1
VT1.5 # 2
VT1.5 # 28
DS1
Ethernet
DS0 # 1
DS0 # 2
DS0 # 24
RS-232
VF
Teleprotection
56/64k Data
Optical Level
STS-1 SPE Level
VT Level
DS0 Level

SONET Layers




Backbone ring
ADM
BLSR/2
or
BLSR/4
OC-12/OC-48
ADM
Central office
ADM
TM
Point-to-point
ADM
DCS
ADM
Central office
Backbone ring
ADM
BLSR/2
or
BLSR/4
OC-12/OC-48
ADM
ADM
ADM
Linear add/drop
TM
ADM
UPSR
ADM
DCS
OC-3/OC-12
ADM
Access ring
ADM
UPSR
ADM
OC-3/OC-12
ADM
Access ring
ADM
UPSR
ADM
ADM
OC-3/OC-12
ADM
Access ring

SONET Network Topologies

- "Combined" Network