SONET/SDH Technology - OC-3 Analysis

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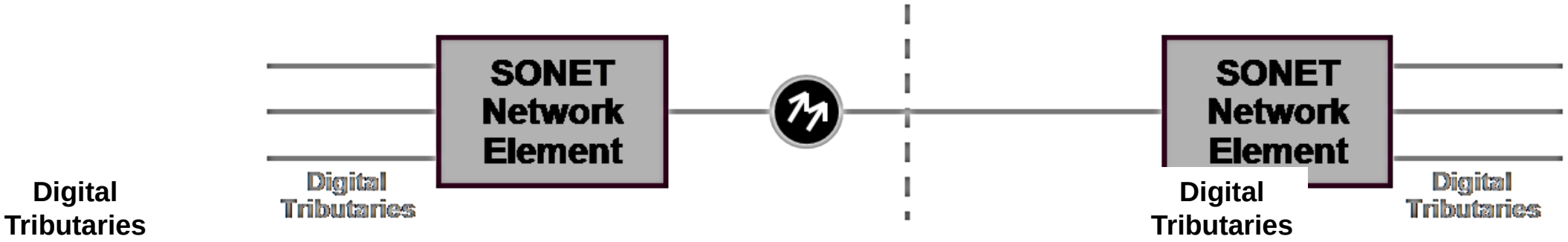
What is SONET / SDH ?

Synchronous Optical Network Standard



- Synchronous optical networking (SONET) and Synchronous Digital Hierarchy (SDH)
- Both SONET and SDH are standards for a synchronous, fiber-optic transport system
- SONET, is the North American standard (ANSI) and SDH is the similar standard used in the rest of the world (ITU)
- SONET defines interface standards at the physical layer of the OSI seven-layer model
- SONET/SDH's strength is in transporting delay sensitive voice and video, and also used for high speed data transport
- Supports several topologies, including point to point, a hub and spoke star configuration, and the ring topology

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SONET/SDH Supports

Applications

- Voice
- Digital Cable
- Broadband access
- Internet
- Interoffice trunking
- Private backbone networks
- MANs and WANs
- Cellular PCS cell-site transport

Technologies

- TE-carriers
- ATM transport
- Packet over SONET
- Frame Relay access

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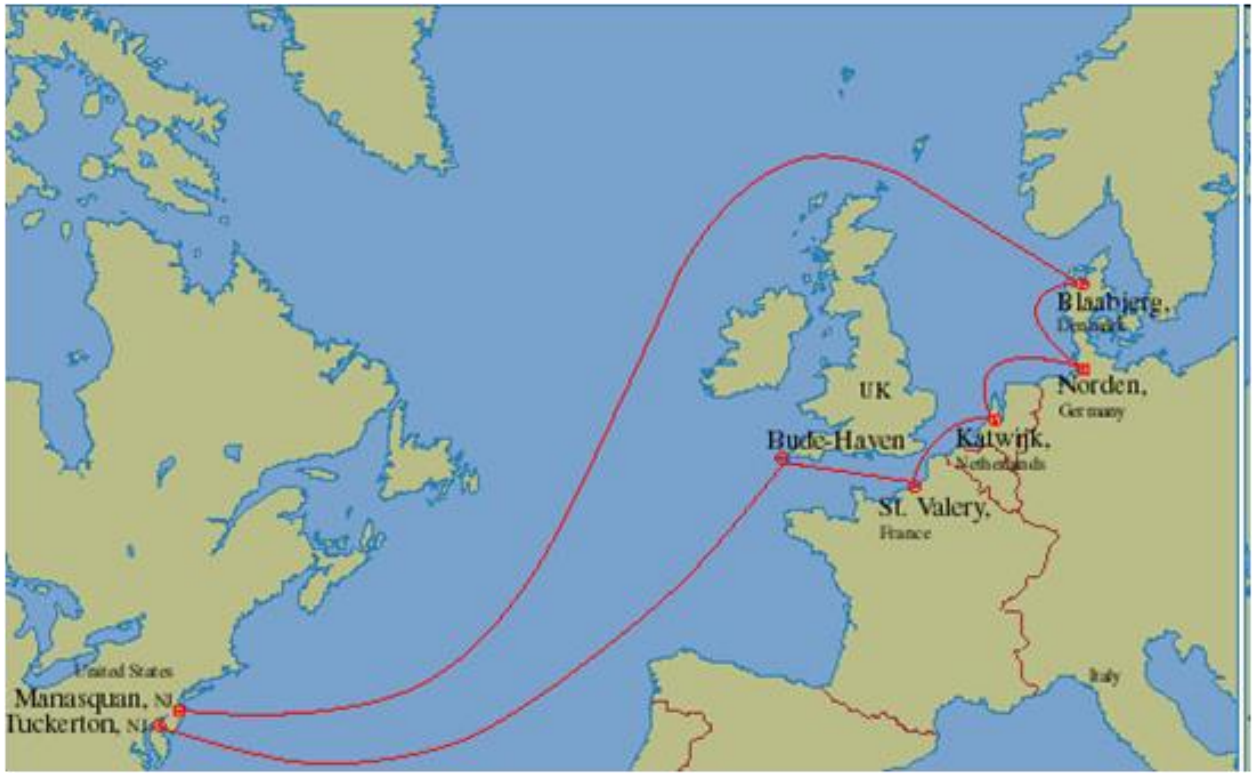
Benefits of SONET/SDH

- Need for a digital transmission system faster and more sophisticated than T1/E1 systems
- Standardization
- High Speed
- Reliability
- Operations, Administration, Maintenance & Provisioning (OAM & P)
- Quality of Service (QoS)
- Flexibility
- Scalability

SONET / SDH Today

- SONET/SDH technology in 95% of Service Provider high-speed, worldwide networks
- AT&T, MCI Worldcom, Qwest, SBC, Sprint, US West, etc
- Multiple, global equipment makers
- Alcatel, Cisco, Fujitsu, Lucent, Marconi, Nortel, Tellabs, etc
- Performance continues to increase
- OC-48 widely deployed; OC-192/768 emerging
- OC-3072 in the works

TAT-14 Cable System



- This transatlantic cable system is in full service, connecting the United States to the United Kingdom, France, The Netherlands, Germany, and Denmark
- This configuration provides a capability of transporting 4,096 STM-1's or approximately 9,700,000 circuits across the ocean

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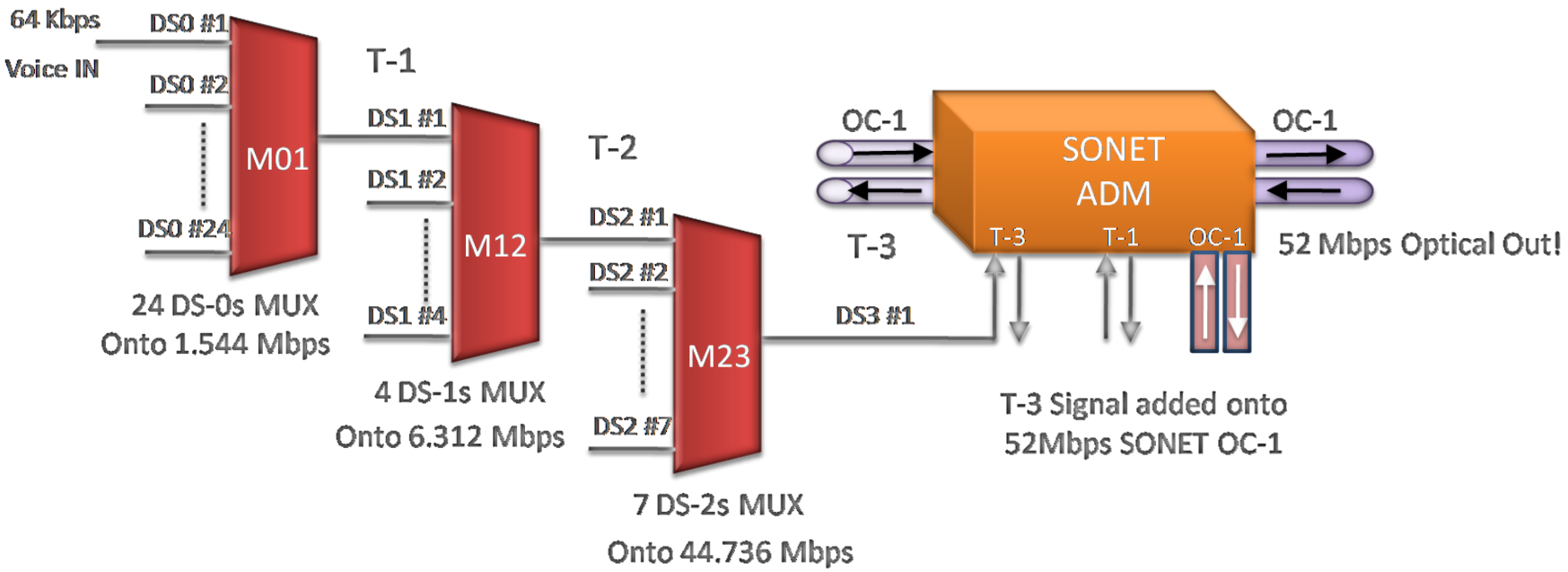
Pulse Code Modulation of Voice

- PCM involves sampling a 4 khz voice channel at twice the frequency, i.e. 8000 samples per second (Nyquist's Rule)
- Each sample is encoded into 8 bits
- Therefore need 64 kbps (8*8000) for each voice channel!
- This base level for the digital hierarchy is called DS0
- How does your DS-0 voice channel get onto a SONET signal?

From Voice to SONET



- SONET starts off where TE carriers leave off!
- Sequentially increasing Time Division
- DS-0voice=>DS-1=>DS-2=>DS-3=>SONET OC-1

What are STS-1 and OC-1 line rates?

- Basic foundation of SONET consists of groups of DS-0 signals (64Kbits/sec) that are multiplexed to create a 51.84Mbit/sec signal, which is the base signal of SONET and is referred to as STS-1(Synchronous Transport Signal - 1)
- STS-1 is an Electrical Signal rate that corresponds to the Optical Carrier line rate of OC-1
- T1: 1.544 Mbps
- STS-1=51.84Mbps
- OC-1=51.84Mbps

SONET /SDH Line Rates

Electrical	Optical (SONET)	Line Rates	SDH Equivalent
STS-1	OC-1	51.84 Mbps	____
STS-3	OC-3	155.52 Mbps	STM-1
STS-9	OC-9	466.56 Mbps	____
STS-12	OC-12	622.08 Mbps	STM-4
STS-18	OC-18	933.12 Mbps	____
STS-24	OC-24	1.2 Gbps	____
STS-36	OC-36	1.9 Gbps	____
STS-48	OC-48	2.5 Gbps	STM-16
STS-96	OC-96	5 Gbps	____
STS-192	OC-192	10 Gbps	STM-64
STS-768	OC-768	40 Gbps	____
STS-3072	OC-3072	160 Gbps	____

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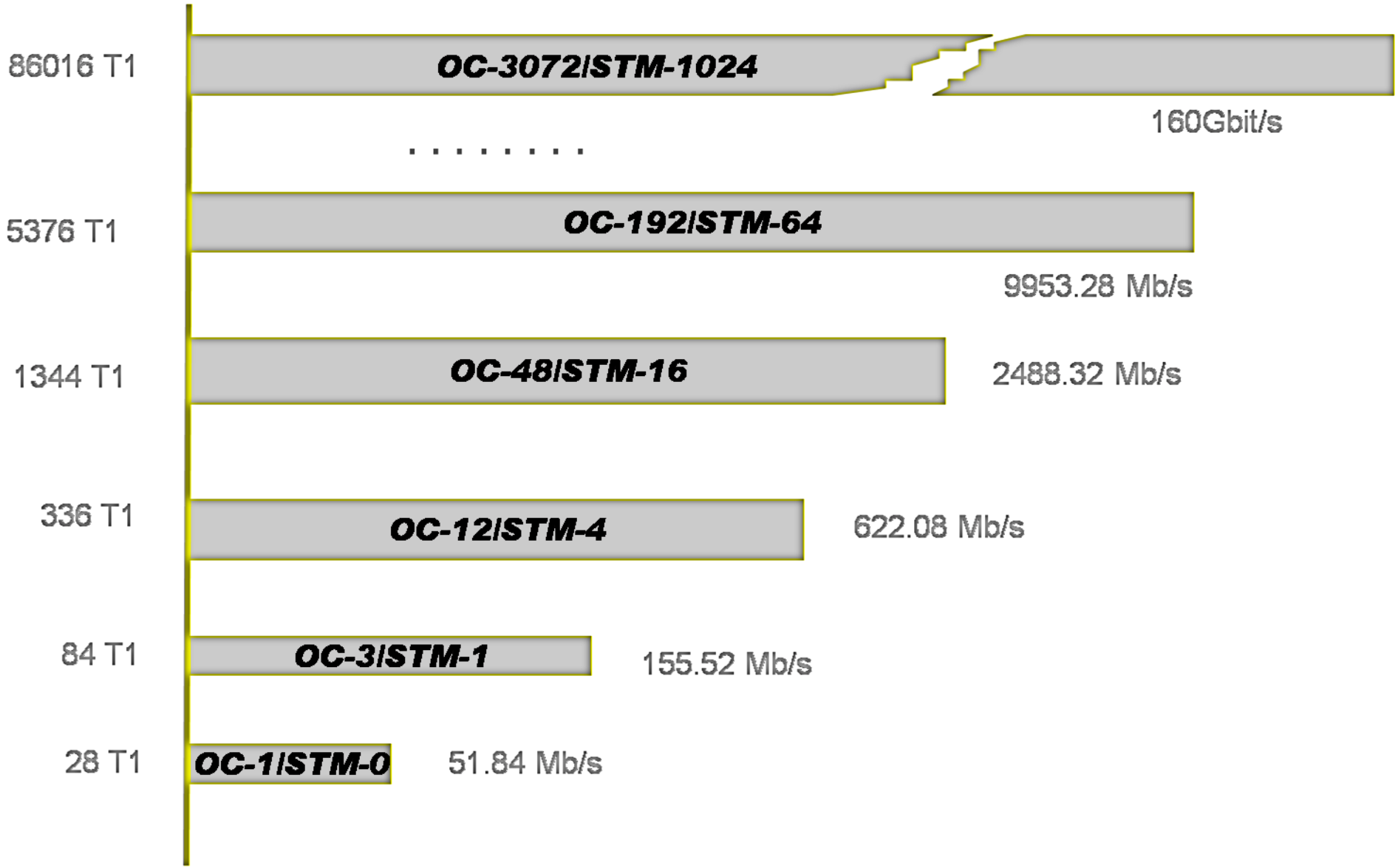

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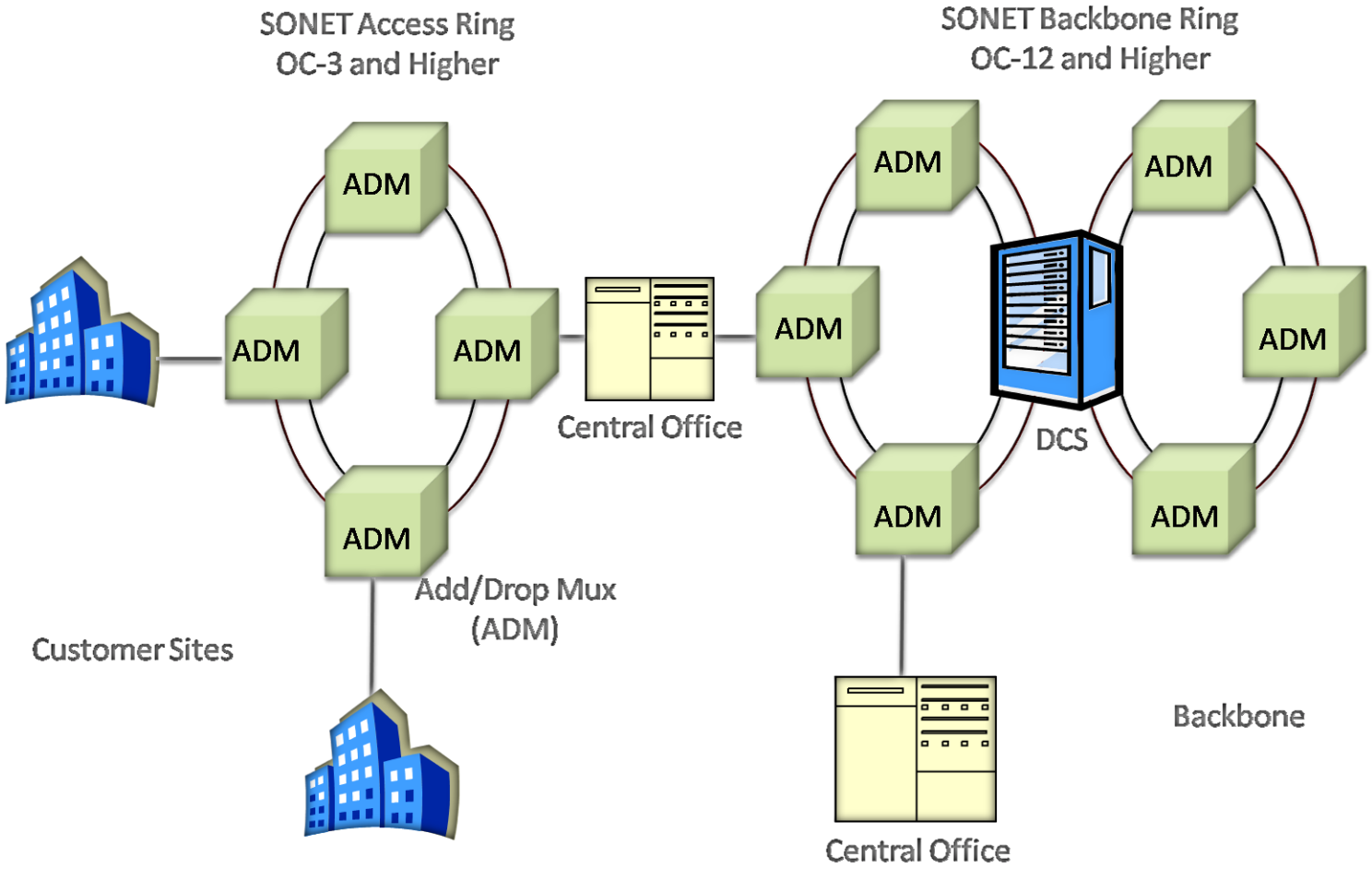
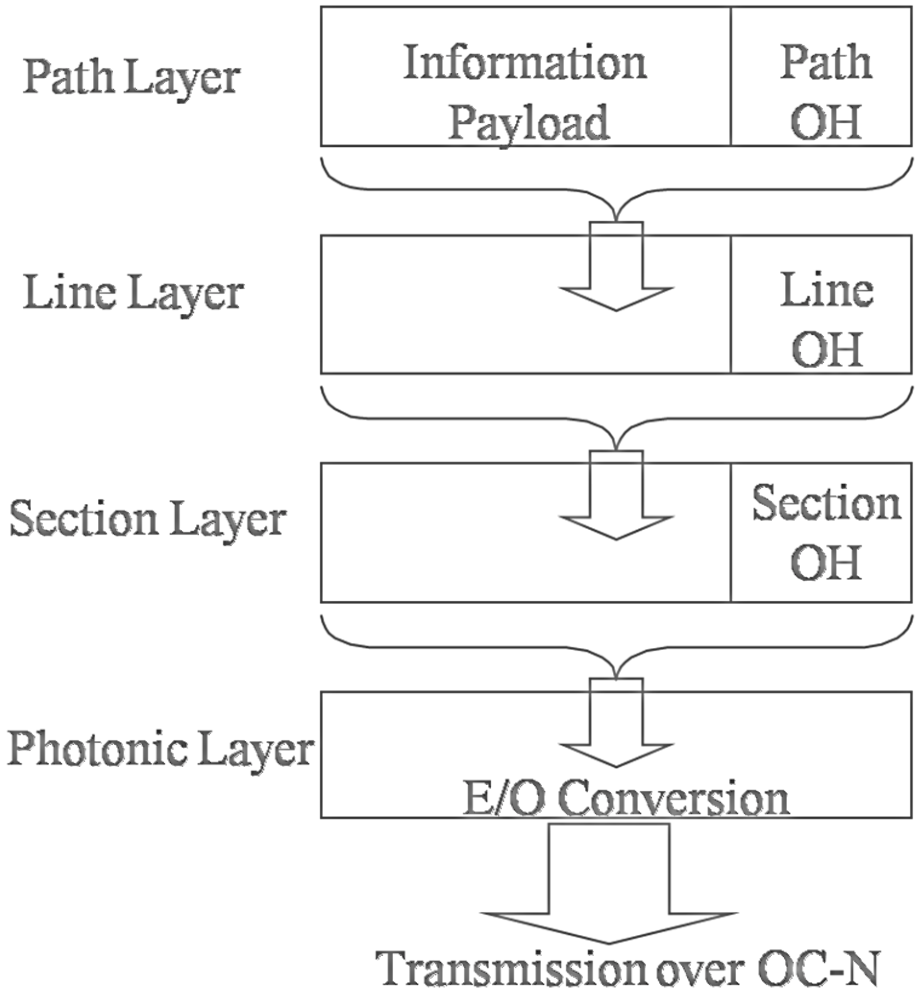
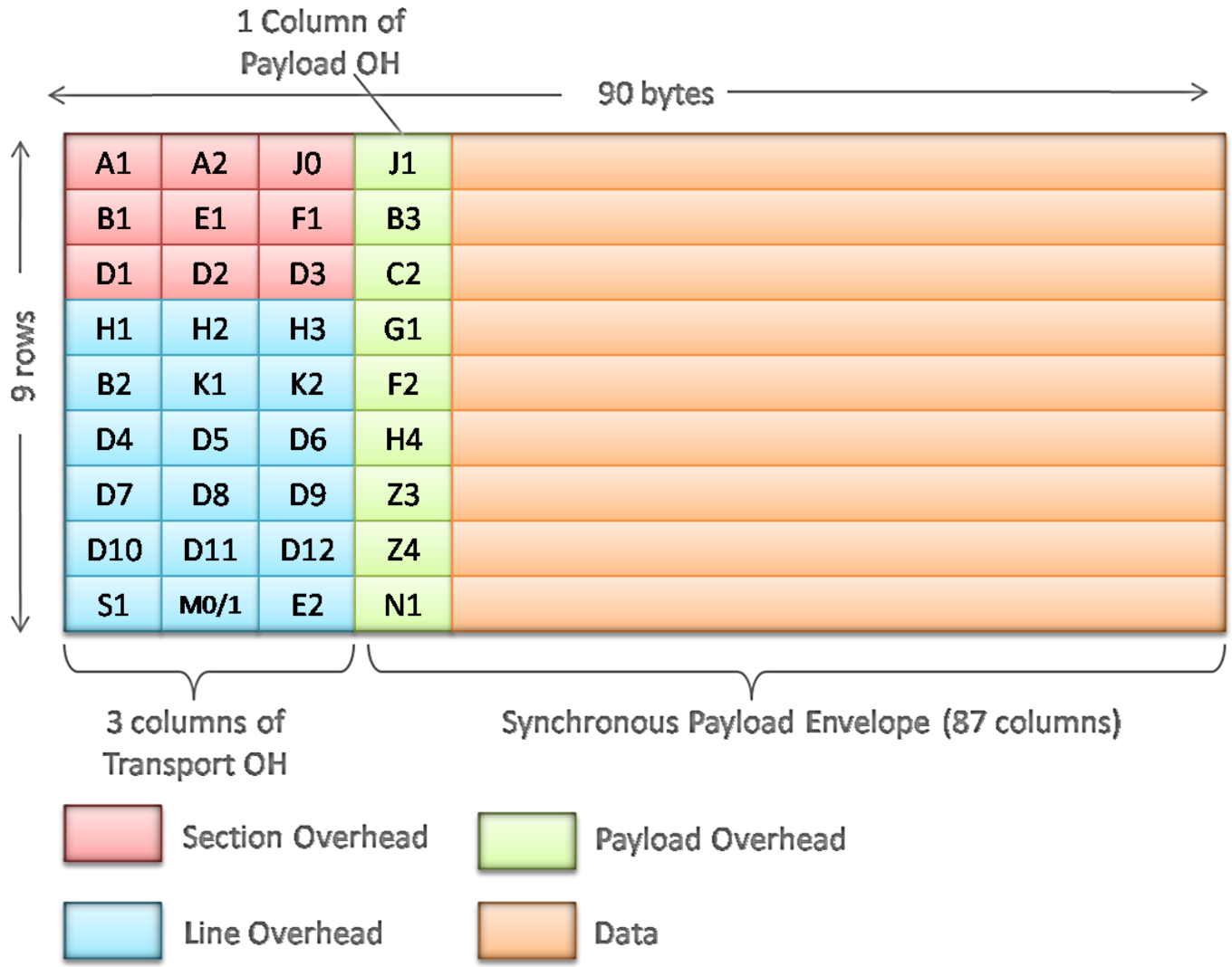
Network Elements



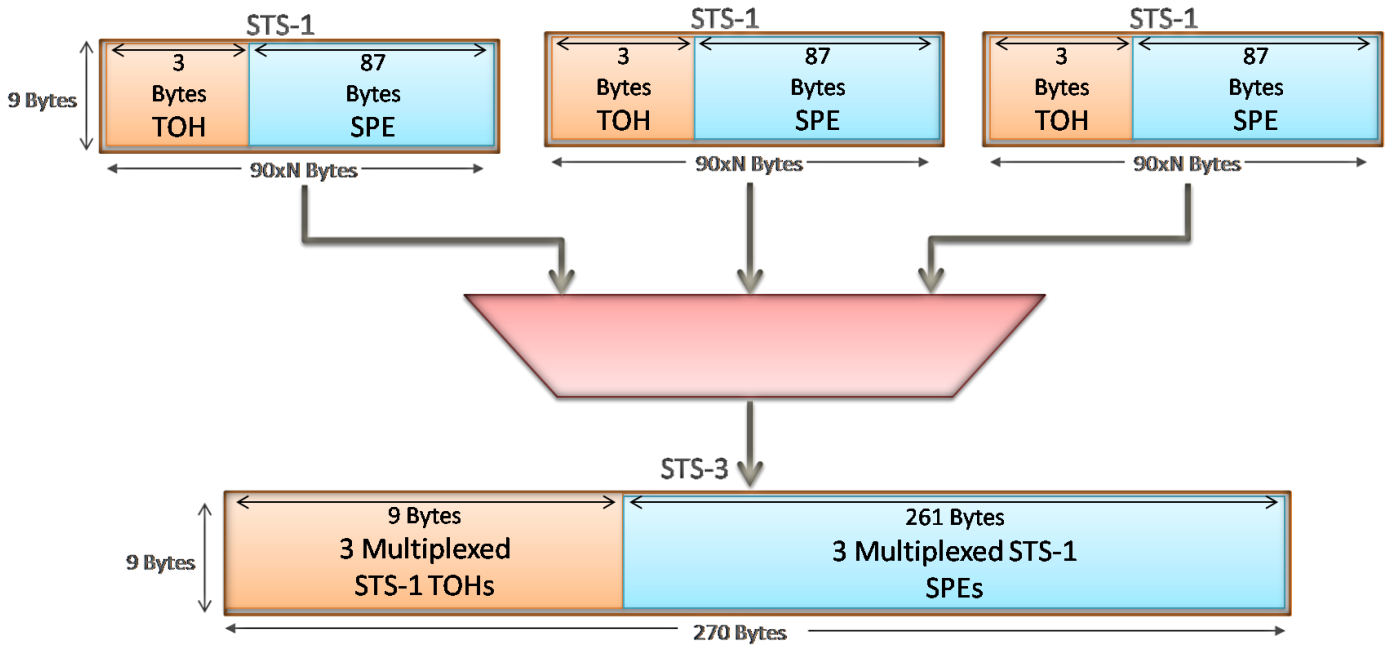
SONET Protocol Stack



SONET Basaic Frame Structure



STS-N Frame Format

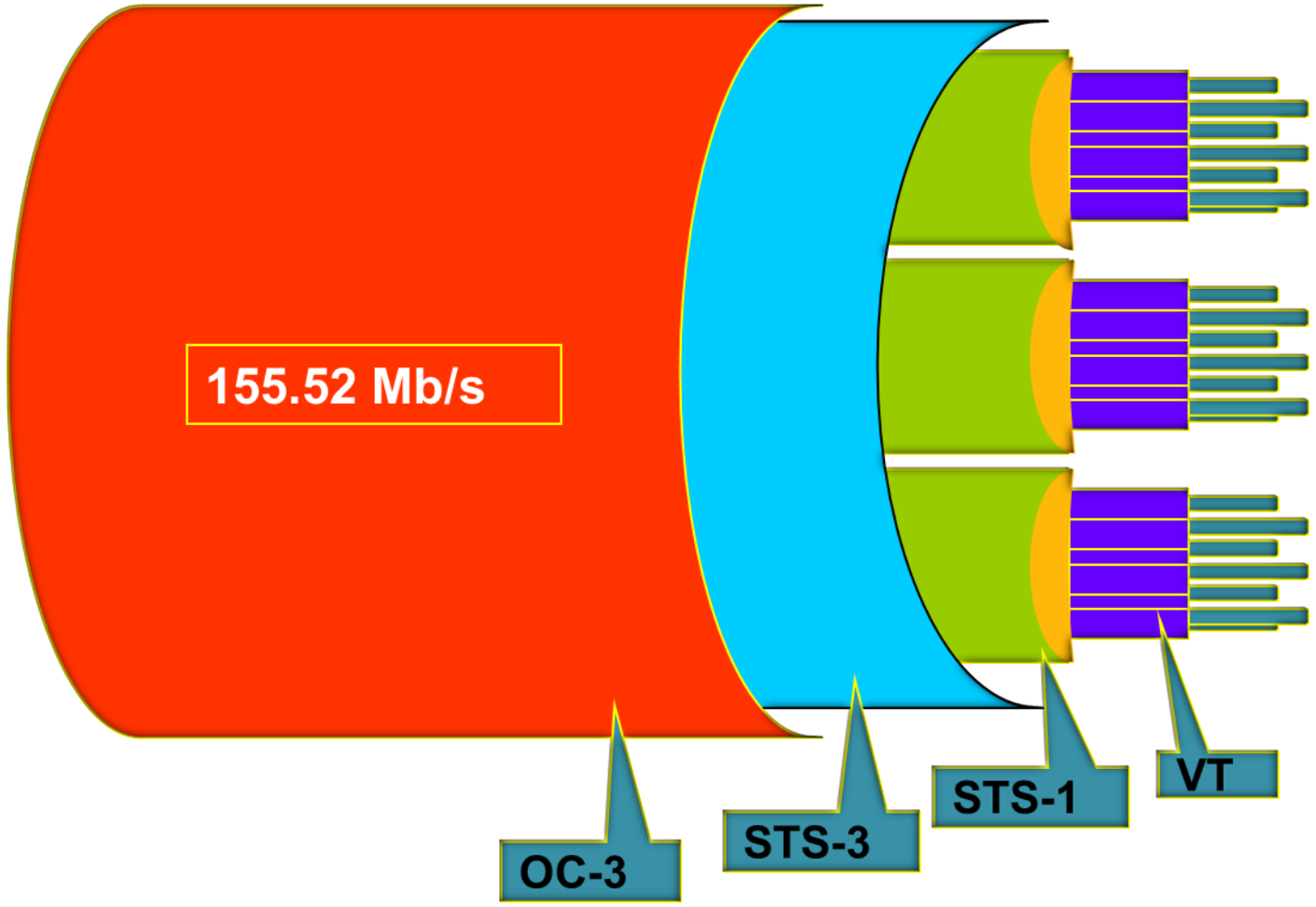


- STS-N frames are formed by byte-interleaving lower rate STS modules
  - 3 STS-1 are muxed to create an STS-3 (156 Mbps)
  - Have 3 sets of TOHs and 3 SPEs

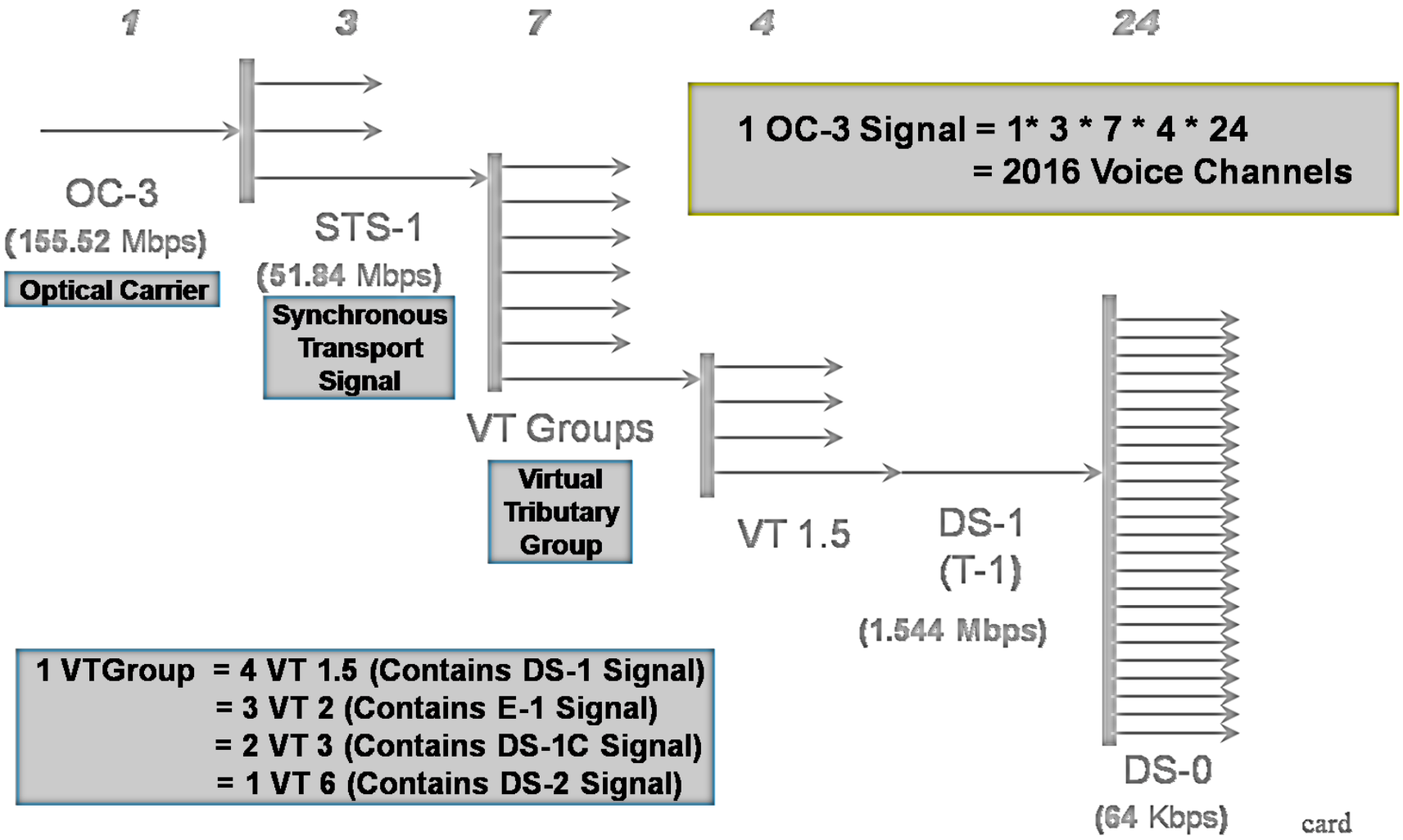
What is OC-3 ?

- OC-3 is a network line with transmission speeds of up to 155.52 Mbit/s (payload: 148.608 Mbit/s; overhead: 6.912 Mbit/s, including path overhead) using fiber optics
- OC networks break data into packets. These packets can include serial data, video data, IP data, or telephone data

Channelized OC-3 - Signal Components



TE Carrier to OC-3 Mapping



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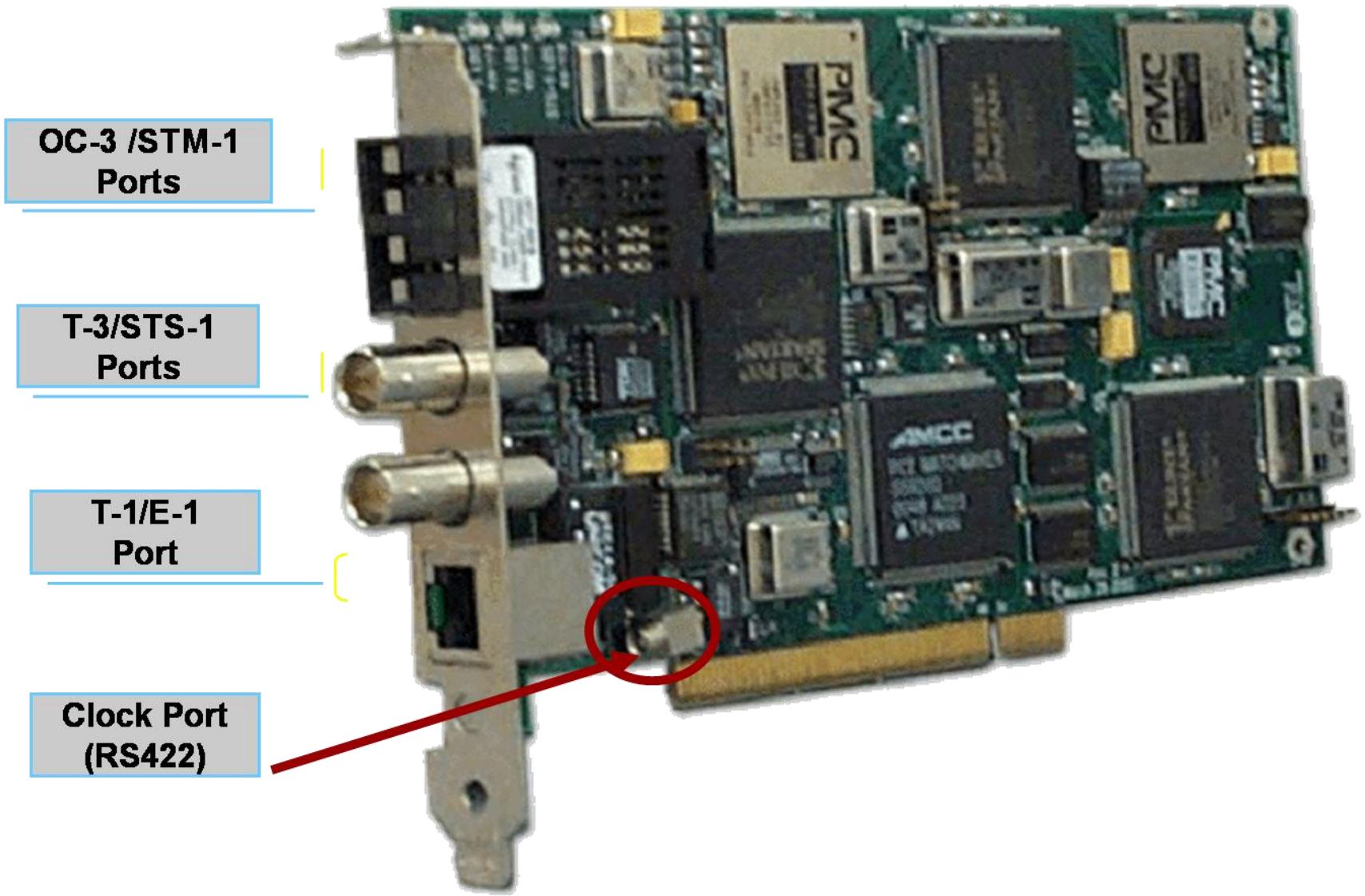
Factors affecting SONET/SDH

- Increase in Data Communications traffic
  - Data traffic is 2 times voice traffic
- Too many equipment w/ variety of traffic
  - ADM, DCS, Ethernet switch, ATM switch, IP switch/router, DWDM transport terminal
- Carriers want to address the above issues while keeping the benefits of SONET
  - Standardization, Reliability, Flexibility, QoS, and Manageability, Scalability

Future of SONET/SDH

- Faster speeds on legacy SONET equipment
  - OC-768 coming to market; OC-3072 in the works
- Proliferation to the Edge, MAN and WAN
- Multi-Service Provisioning Platforms (MSPP)
  - MSPPs are SONET/SDH equipment geared for data transport
  - Combines various functionality into one chassis

GL's OC-3 Board



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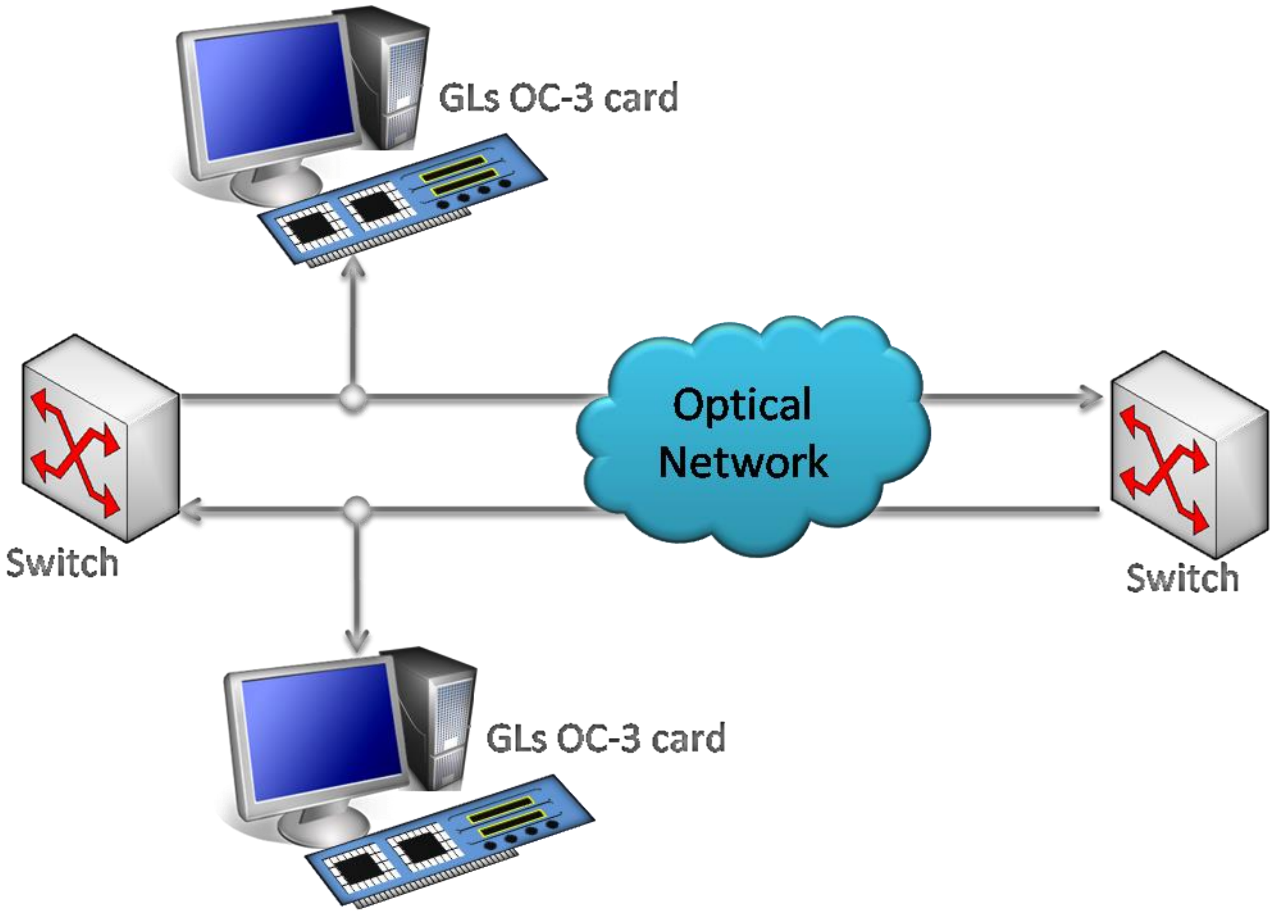
Non-Intrusive Monitoring

Monitor, both East bound and West bound signals



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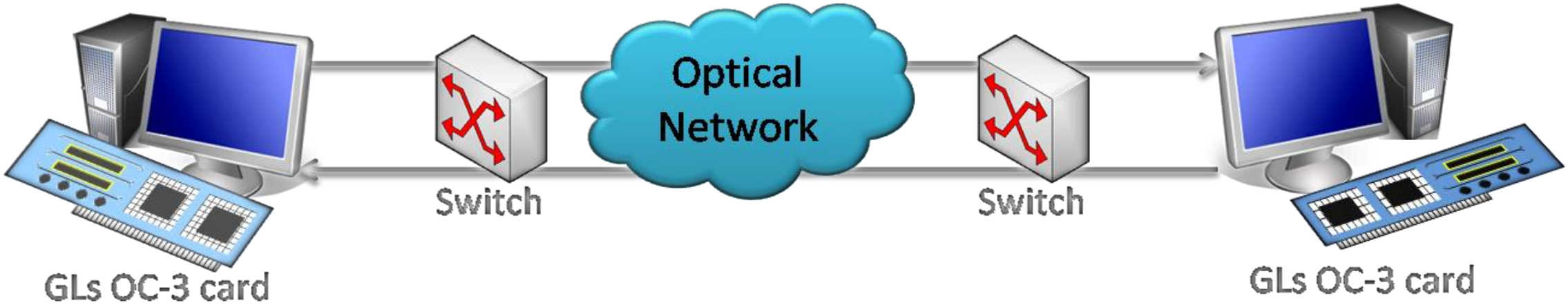
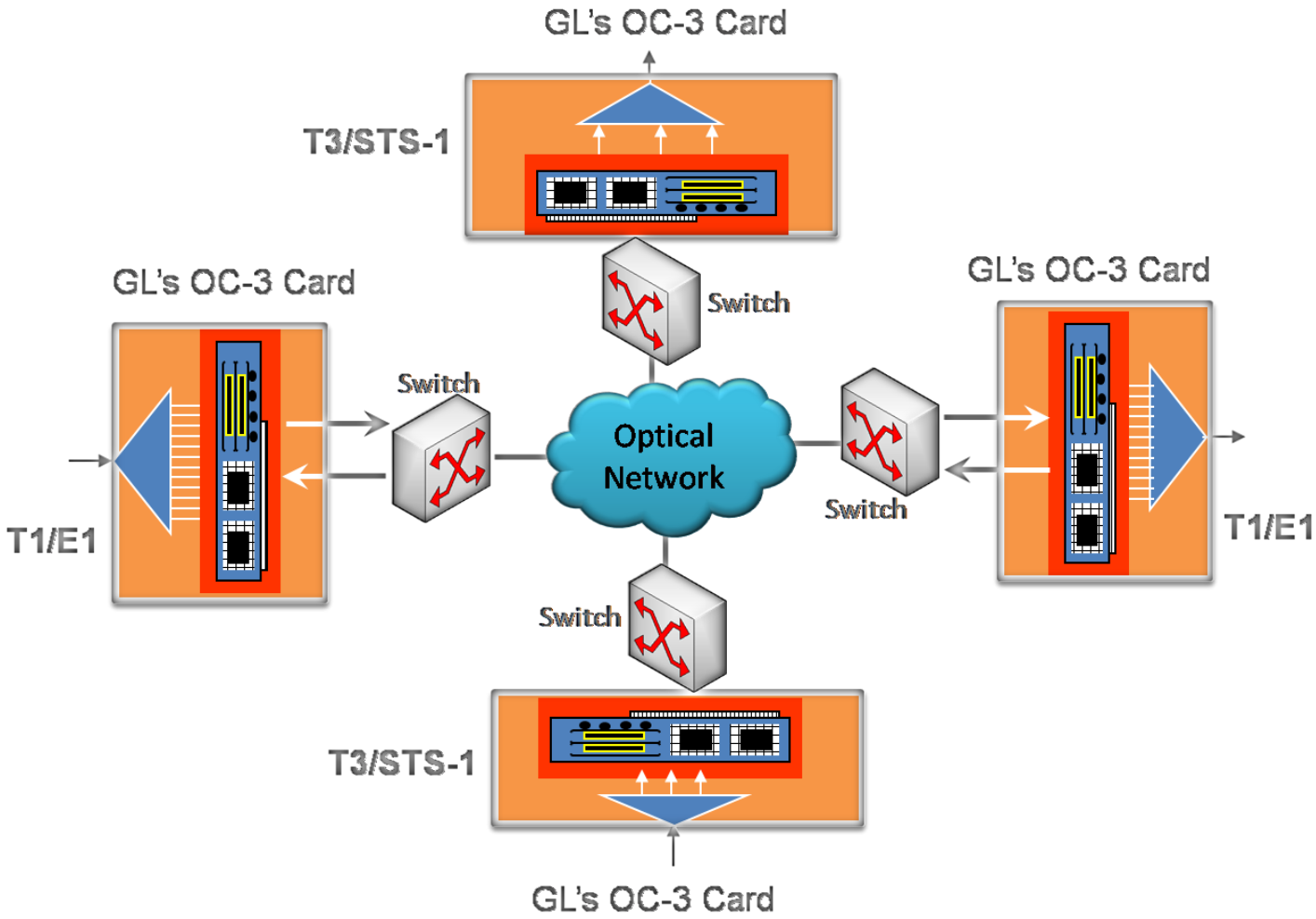
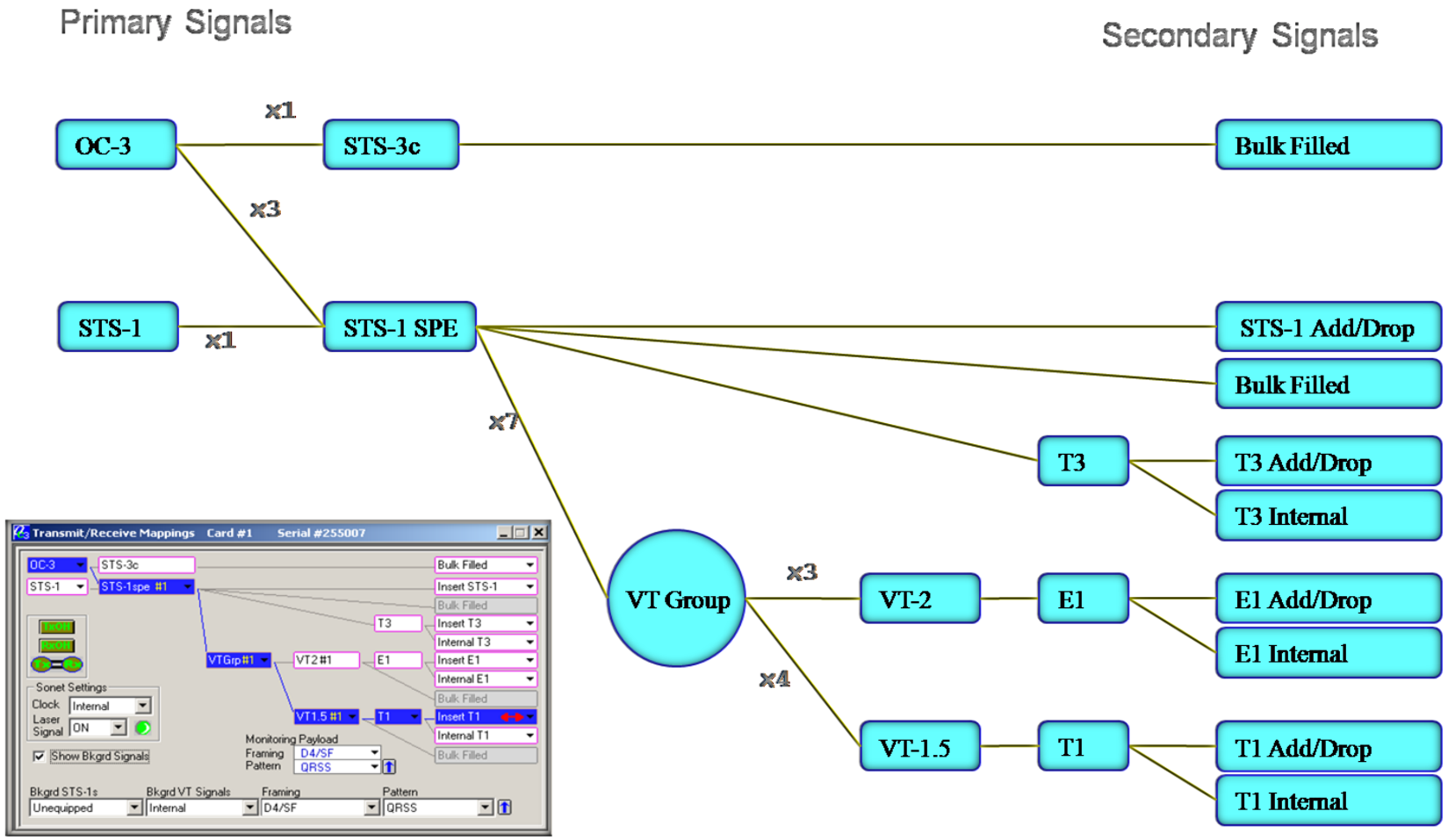
Verify Point to Point Transmission



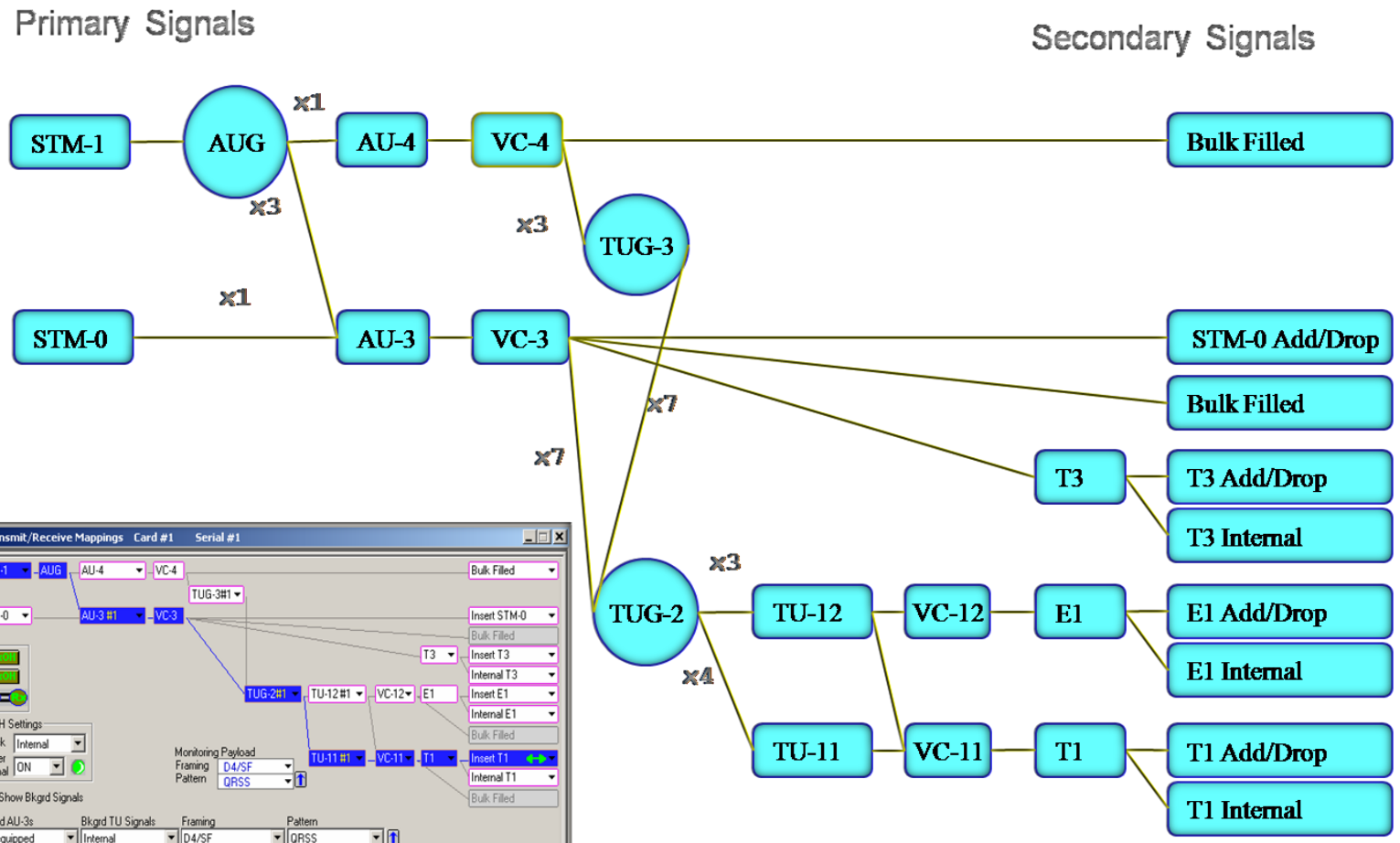
Add Drop Multiplexer



SONET Signal Mappings



SDH Signal Mappings



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THANK YOU!