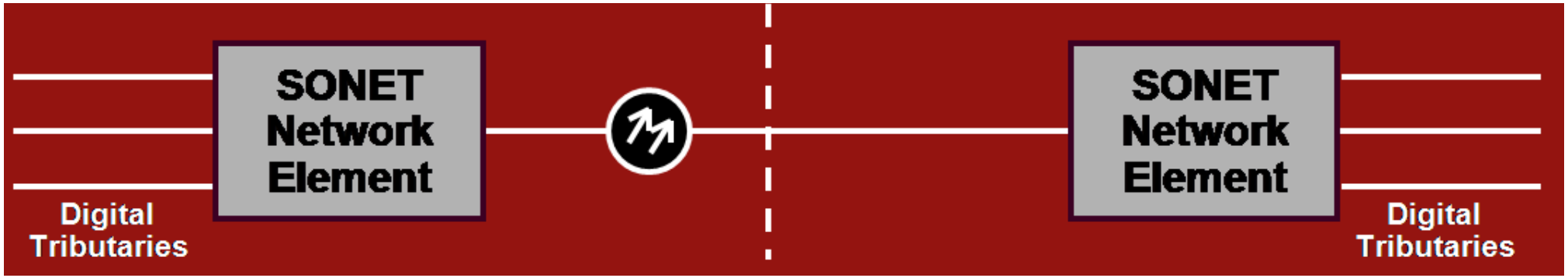
Overview of SONET/SDH Technology

GL Communications Inc.
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: https://www.gl.com

What is SONET / SDH ?

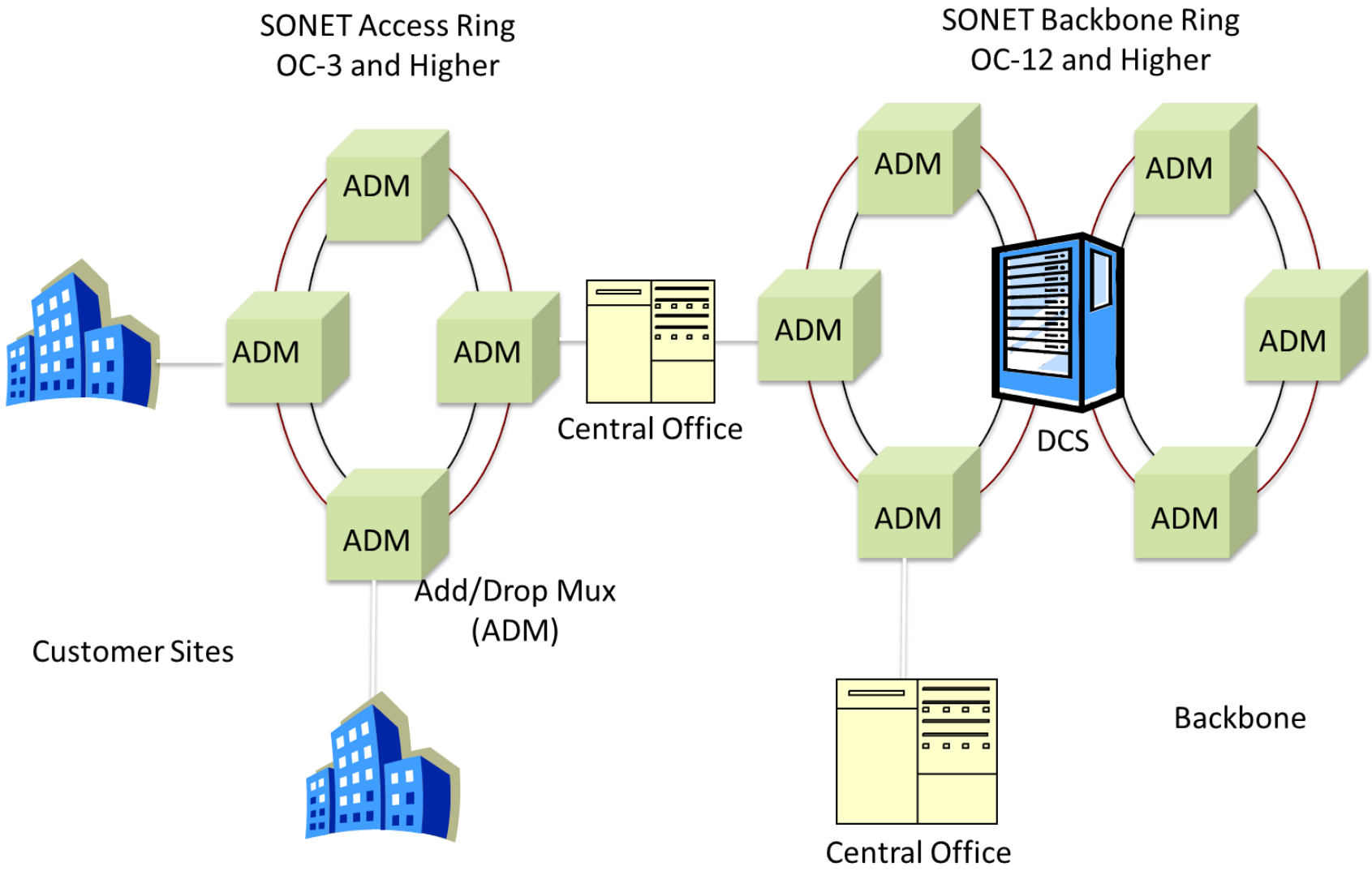


Synchronous Optical Network Standard

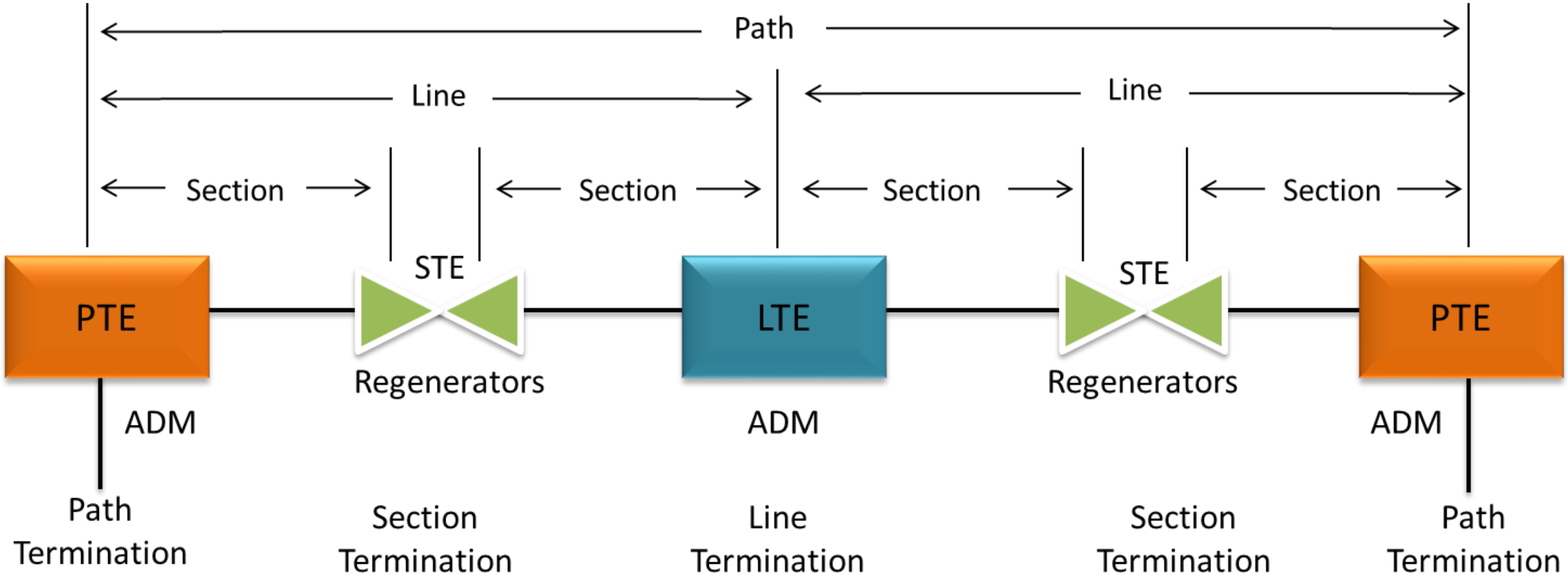
- Synchronous optical networking (SONET) and Synchronous Digital Hierarchy (SDH)
- Both SONET and SDH are standards for a synchronous, fiber-optic transport system
- SONET, is the North American standard (ANSI) and SDH is the similar standard used in the rest of the world (ITU)
- SONET defines interface 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

GL Communications

Network Elements



Terminology used in SONET / SDH



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

GL Communications

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 and 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

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

SONET SDH – An Overview

SONET Rates	Optical	SDH Rates	Bit Rate
STS-1	OC-1	STM-0	51.84 Mbps
STS-3	OC-3	STM-1	155.52 Mbps
STS-12	OC-12	STM-4	622.08 Mbps
STS-24	OC-24	STM-8	1.244 Gbps
STS-48	OC-48	STM-16	2.488 Gbps
STS-192	OC-192	STM-64	9.953 Gbps

- SONET is the North American standard (termed OC-N) defined in Telcordia GR-253-CORE and ANSI T1.105. STS-1 (Synchronous Transport Signal Level -1) is the basic level of electrically framed signal format in SONET. Higher-level signals are integer multiples of STS-1, creating the family of STS-N signals, for N = 1, 3, 12, 48, 192 & 768. The optical counter part for each STS-N signal is designated as OC-N (Optical Carrier level-N)
- SDH is the Asian and European standard (termed STM-N) defined in ITU G.707 and G.708 standard

  An STM-N (Synchronous Transport Module Level-N) are the frame structures used in the SDH

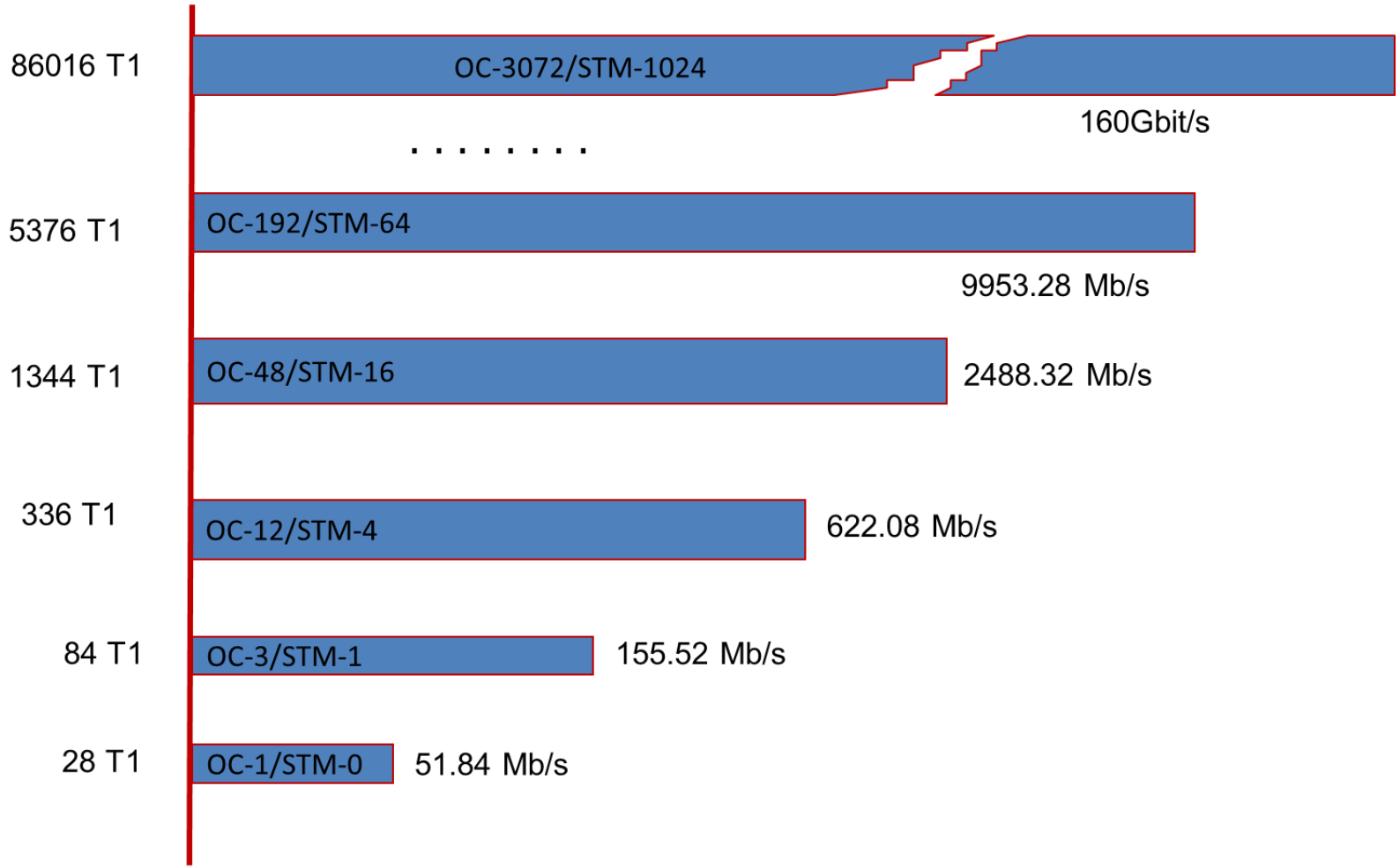
Pulse Code Modulation of Voice

- 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?

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

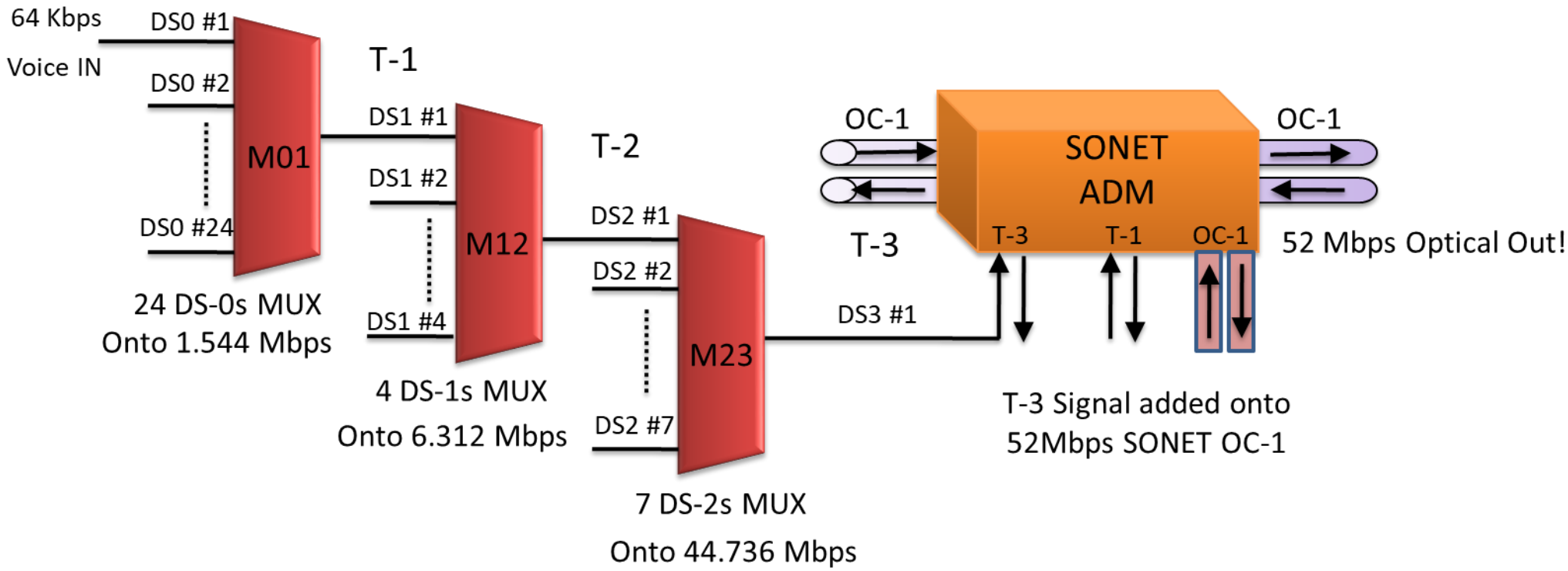
- Basic foundation of SONET consists of groups of DS-0 signals (64Kbits/sec) that are multiplexed to create a 51.84Mbit/sec signal, which is the base signal of SONET and is referred to as STS-1(Synchronous Transport Signal - 1). STS-1 is an Electrical Signal rate that corresponds to the Optical Carrier line rate of OC-1
- T1: 1.544 Mbps
- STS-1/OC-1=51.84Mbps = 24* T1s

SONET /SDH



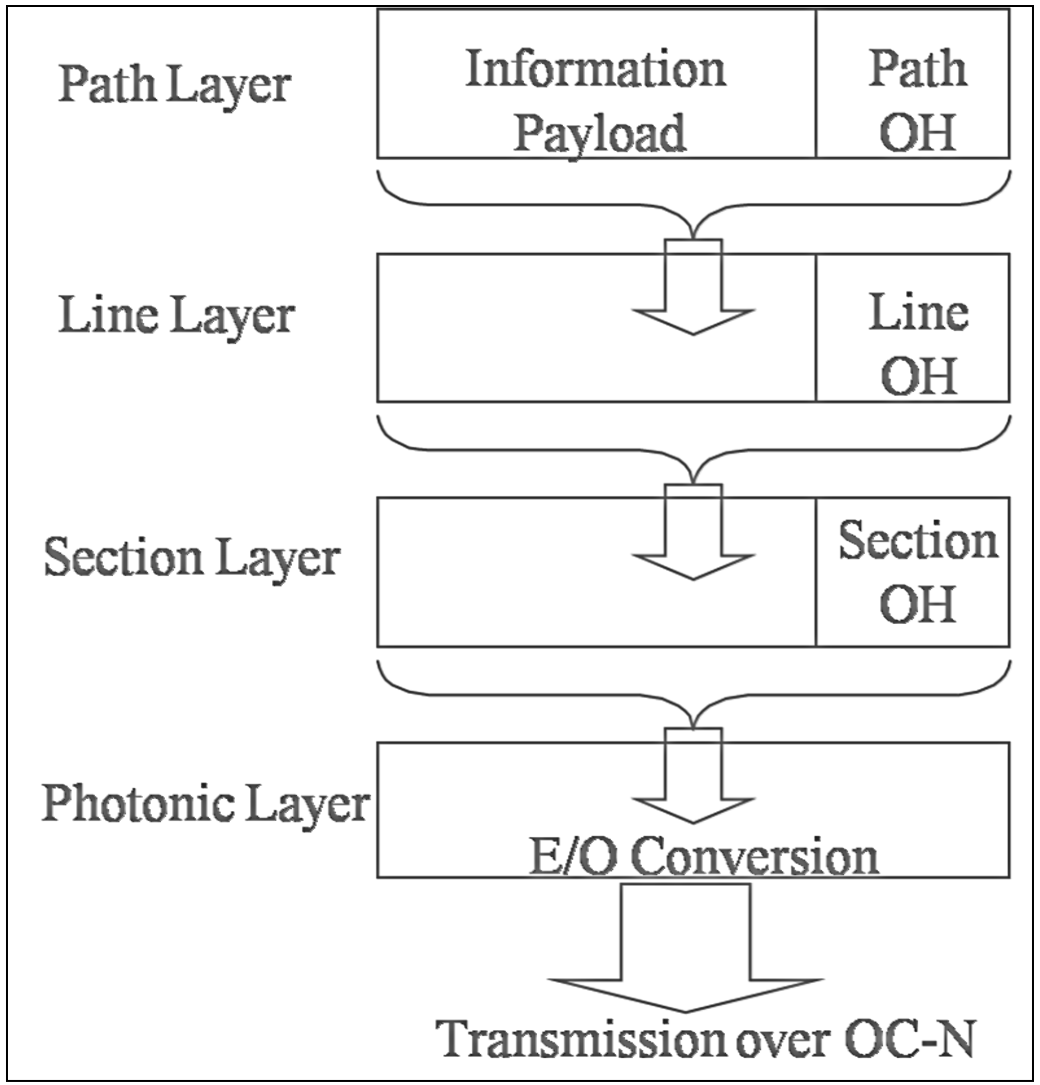
GL Communications

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

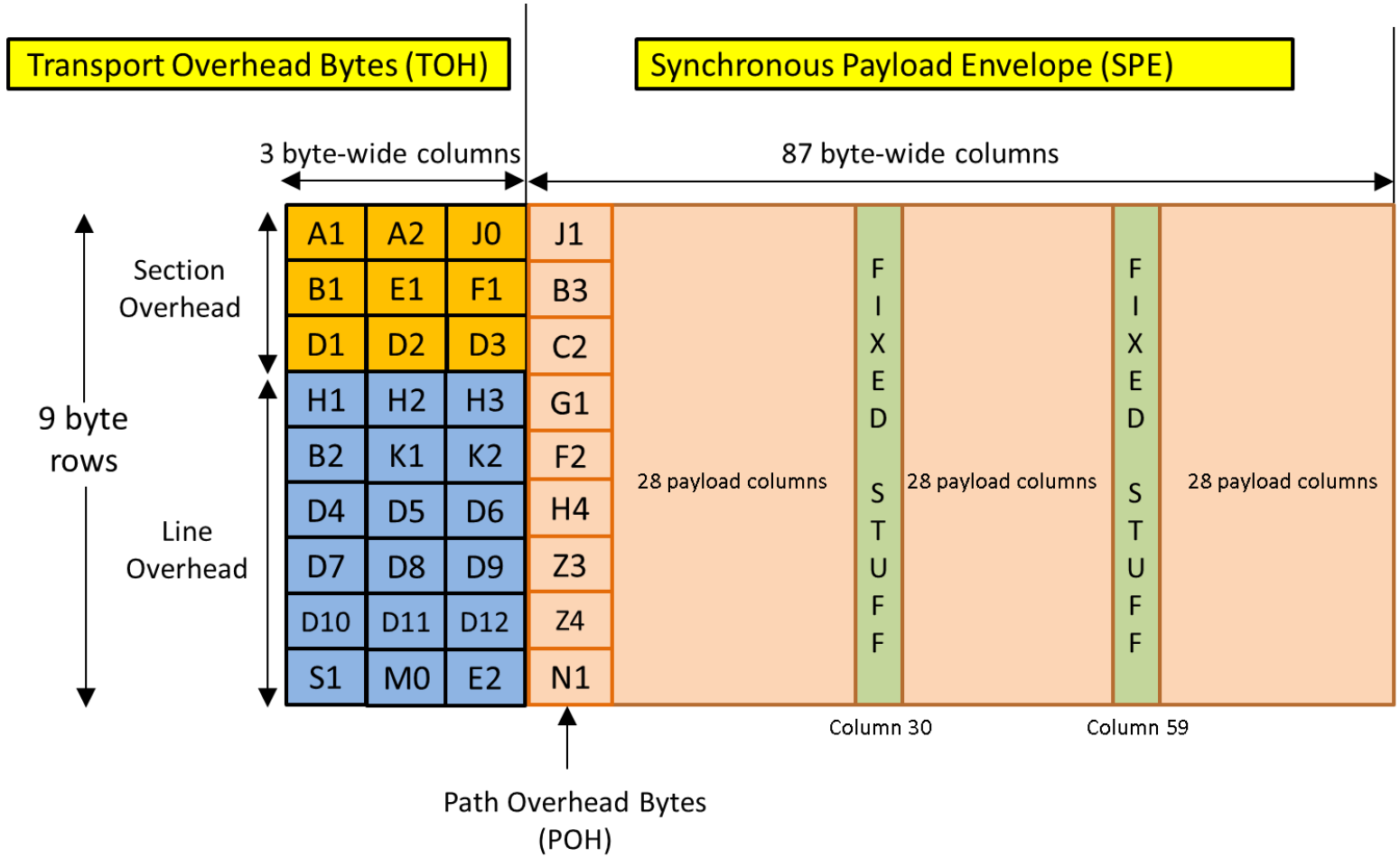
SONET Protocol Stack



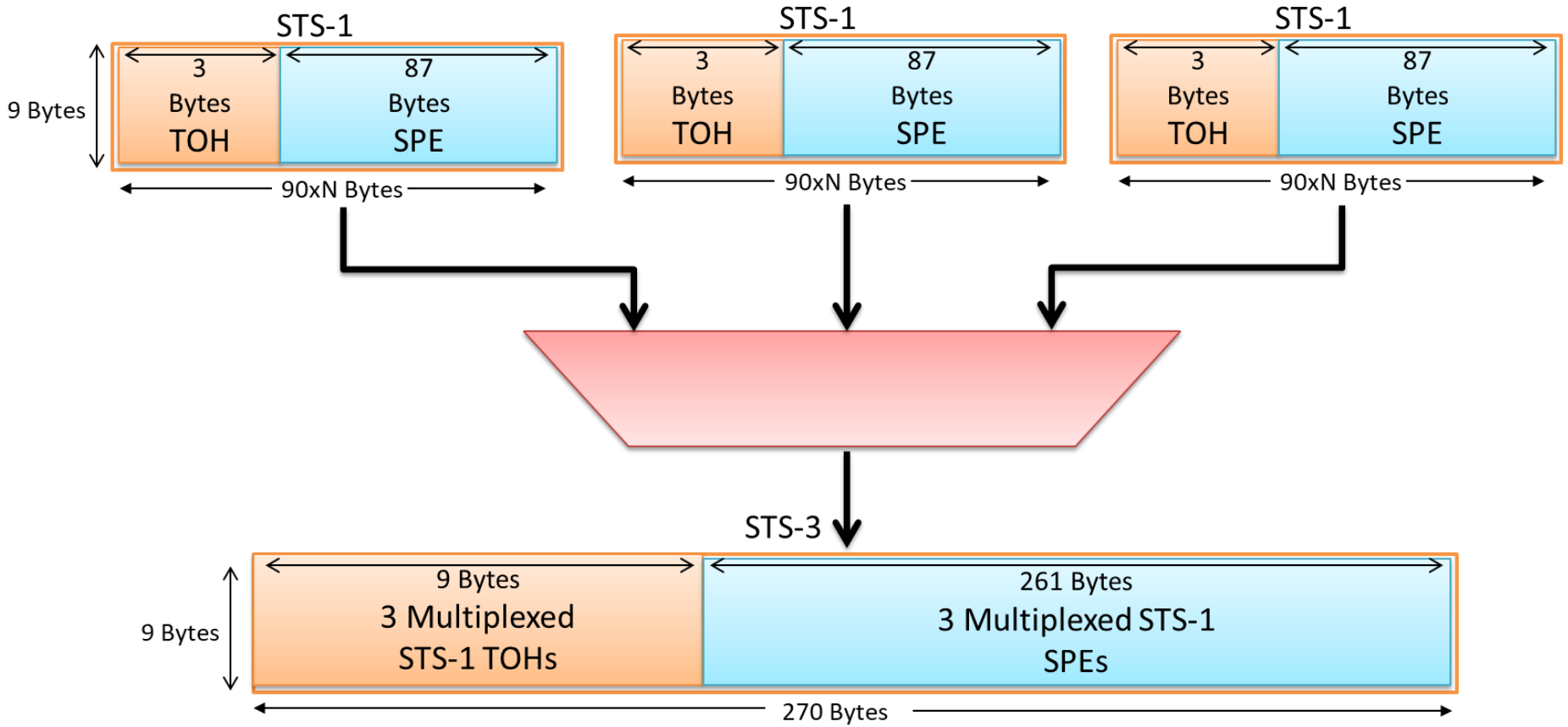
GL Communications

SONET STS-1 Basic Frame Structure

- Frame structure consists of 2 main components with a total of 90 bytes * 9 rows
- Transport Overhead (TOH) - The Transport Overhead (TOH) section consists of the Section Overhead (SOH) layer and the Line Overhead (LOH) layer
- Synchronous Payload Envelope (SPE) - The Synchronous Payload Envelope (SPE) consists of the Path Overhead (POH) layer and the Payload

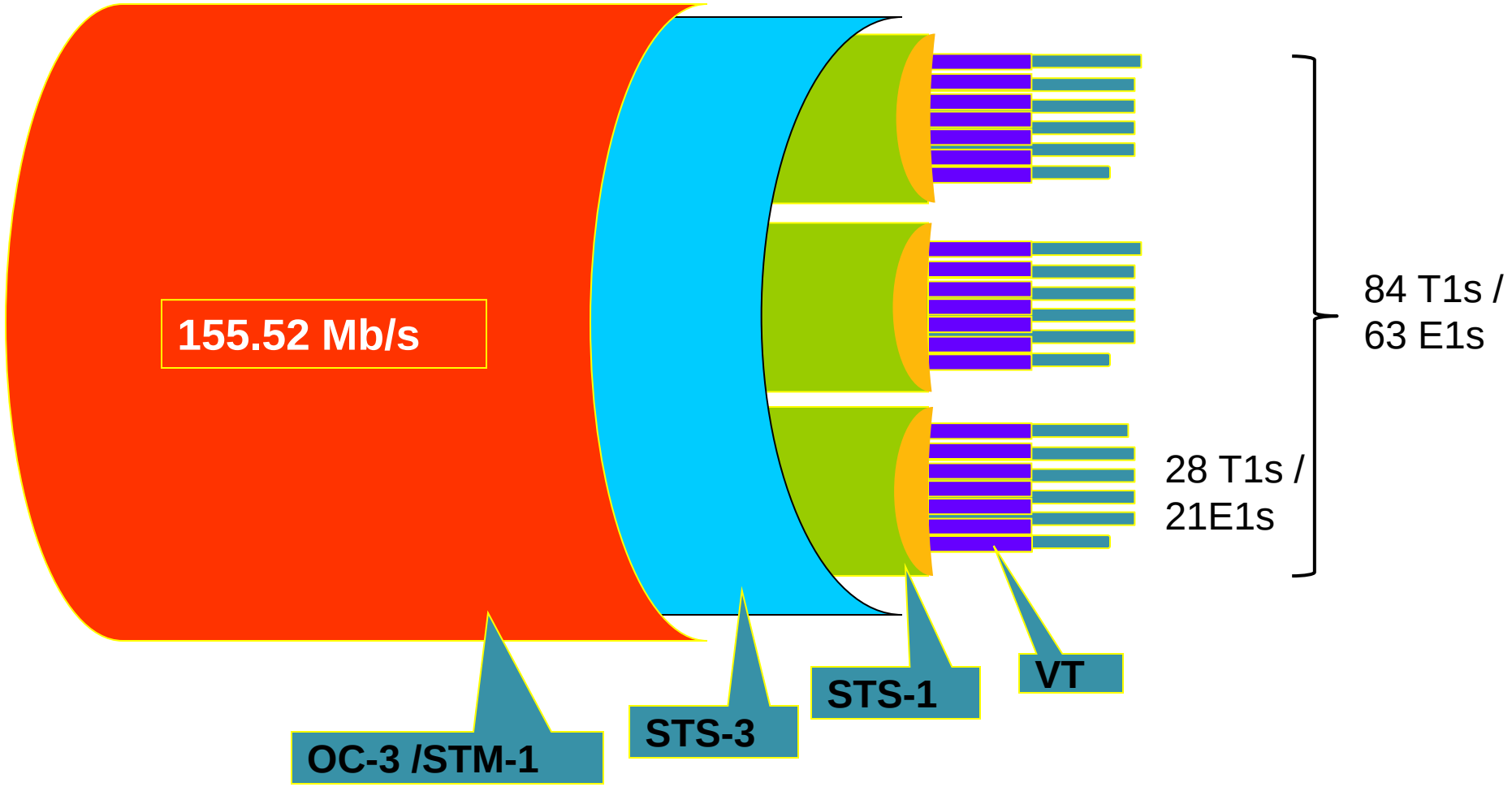


STS-N Frame Format (STS-3 = OC-3/STM-1)



- STS-N frames are formed by byte-interleaving of lower rate STS modules
- 3 STS-1 are multiplexed to create an STS-3, which is equivalent to OC-3 /STM-1 (156Mbps)
- An OC-3/STM-1 has 3 sets of TOHs and 3 SPEs.

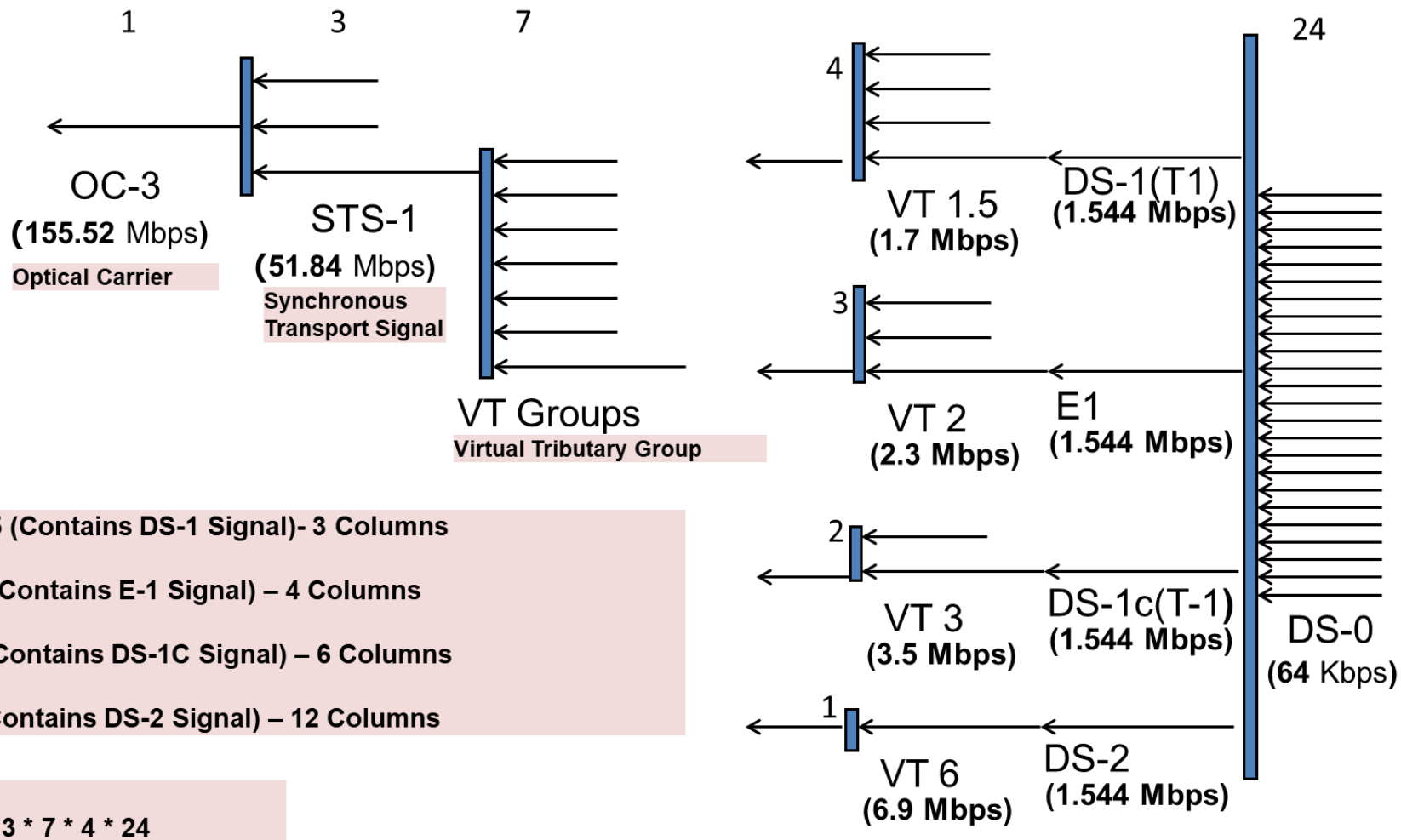
Channelized OC-3/STM-1



TE Carrier to OC-3/STM-1 Mapping

- To carry the T1 E1 carriers in STS-1 payload (SPE), the SONET defines Virtual Tributaries (VTs), SDH defines Tributary Units (TUs)
- An STS-1 can accommodate 7 VT/TU groups as shown in the next slide. A VT/TU group is made-up of 9 rows by 12 byte-wide columns
- VT capacities can be identified as VT 1.5 (1.7 Mbps), VT 2(2.3 Mbps), VT 3 (3.5Mbps), and VT 6 (6 Mbps)
- Each VTG carries one type of the four Virtual Tributary types and seven such VQT groups form an STM-1 payload (SPE) as shown in the next slide
- SDH defines similar organization – where TUs form “Tributary Unit Groups – Level – 2 (TUG2)”. Seven TUG-2s form TUG Level – 3 (TUG-3). TUG-3 then with the addition of 2 more columns forms STS-1 payload (SPE)

TE Carrier to OC-3/STM-1 Mapping in SONET

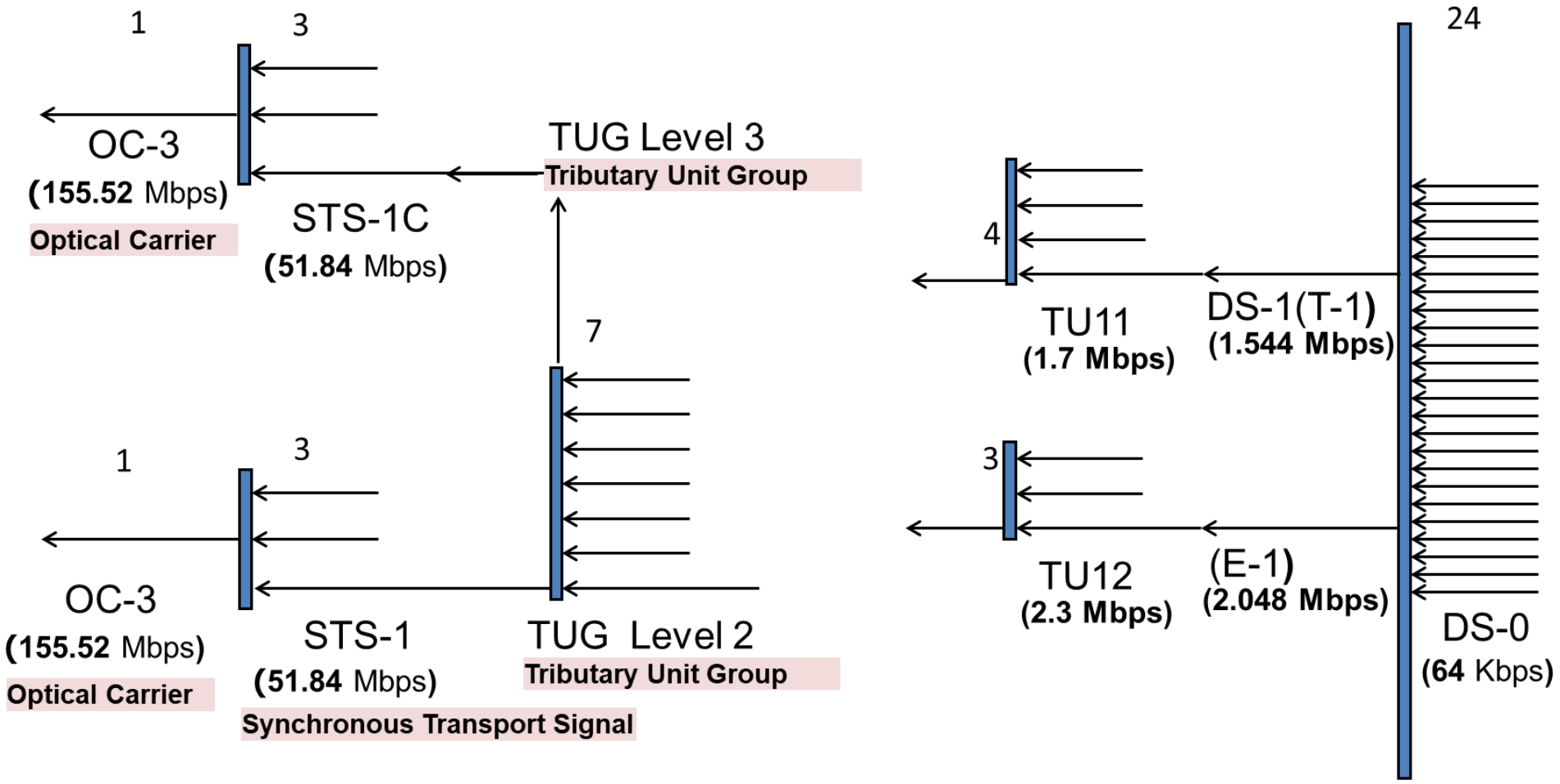


1 VTGroup = 4 * VT 1.5 (Contains DS-1 Signal)- 3 Columns
or
= 3 * VT 2 (Contains E-1 Signal) – 4 Columns
or
= 2 * VT 3 (Contains DS-1C Signal) – 6 Columns
or
= 1 * VT 6 (Contains DS-2 Signal) – 12 Columns

1 OC-3 Signal = 1* 3 * 7 * 4 * 24
= 2016 Voice Channels

GL Communications

TE Carrier to OC-3/STM-1 Mapping in SDH



1 TUG 2 = 4 * TU11 (Contains DS-1 Signal)- 3 Columns
or
= 3 * TU12 (Contains E-1 Signal) – 4 Columns

GL Communications

Thank you