Lantern
Communications

10 Gig Ethernet for Metropolitan Area Networks

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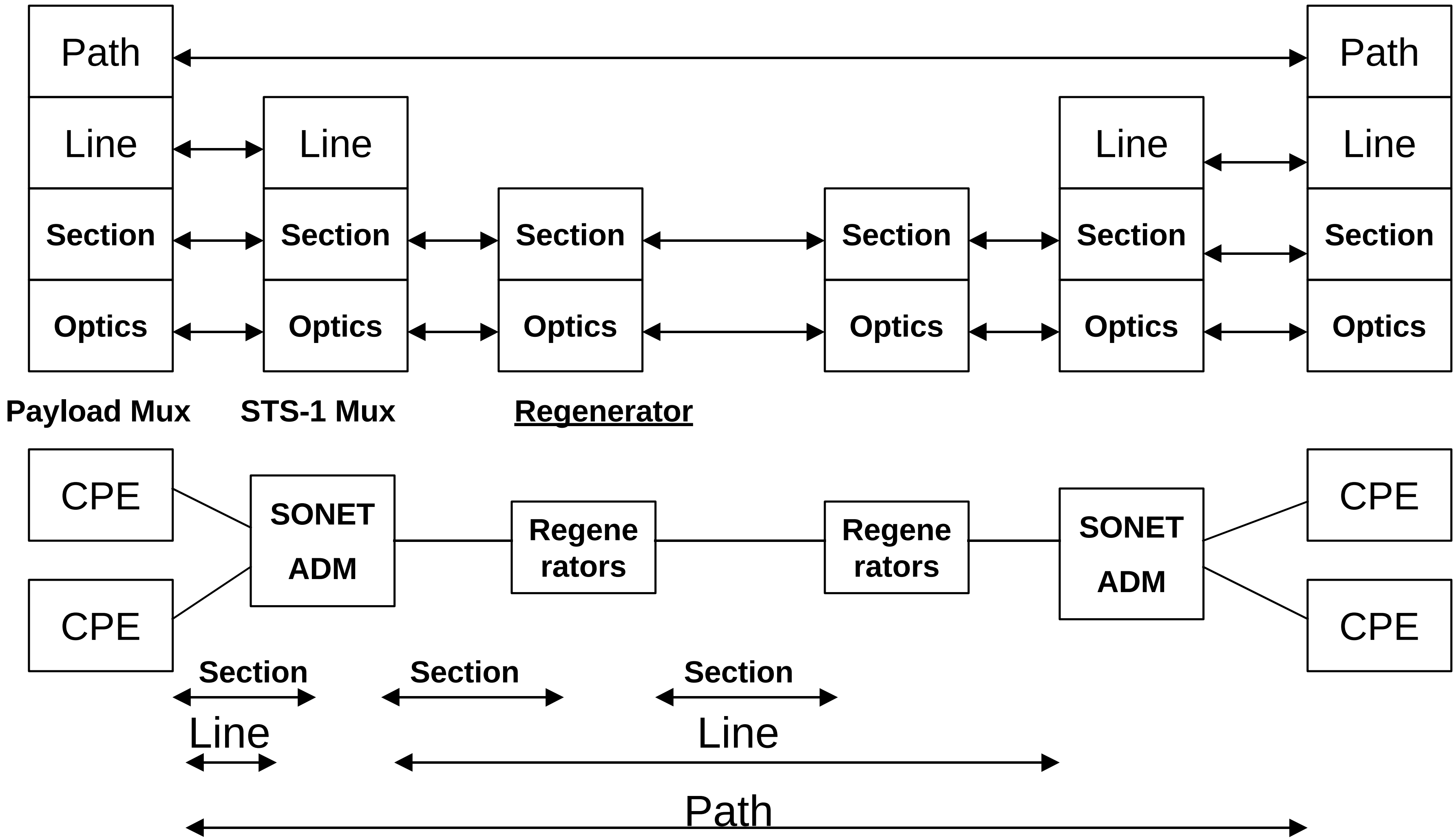
Let’s Go To Town!

- Metro market potential is large in the next few years as Access Providers scramble to reduce costs
  - IP Traffic is expected to increase 800% per year
- Seamless WAN connectivity with IP/Ethernet
  - Much lower costs/complexity than IP/ATM/SONET or IP/SONET
- Ethernet will be the Metro ‘Transport’ of choice for carrying Internet Protocol

What is different about Metro?

- Customers like to sign Service Level Agreements and *watch* Access Providers abide by them
  - High network availability and ‘performance’
  - Re-routing at Layer 3 takes too long!
    - Need Layers 0,1 and 2 fault detection and protection
  - SONET provides these by elaborate section, line and path performance monitoring and protection
    - What are some of the relevant SONET features that need to be provided?
- TDM devices need timing information (synchronization)

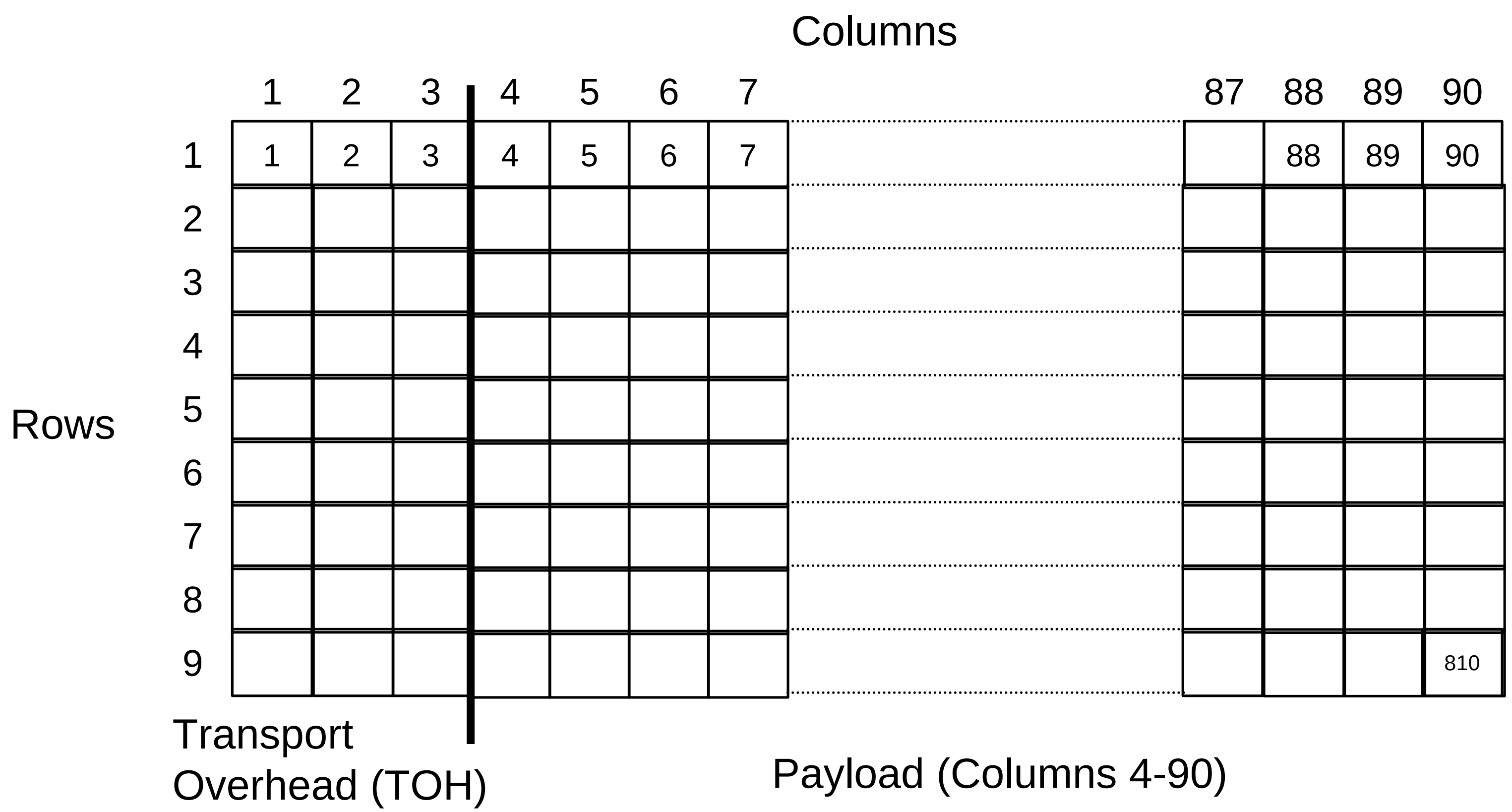
SONET Architecture Overview



SONET Layers Overview

- **Section Layer** refers to the Regeneration Section of the transmission link
  - 9 bytes of SOH per STS-1
- **Line Layer** refers to the Maintenance Span
  - 18 bytes of LOH per STS-1
- TOH = SOH + LOH
- **Path Layer** covers the end-to-end transmission
  - 9 bytes of POH per SPE (SONET Payload Envelope)
  - If SPEs are concatenated (e.g. OC-3c) then only one set of POH is required
- The total overhead is (9+18+9)/810 = 4.44% for OC-n
  - For OC-3c, OH = [3 x 27 + 9] / 2430 = 3.7%

SONET Frame Structure



STS-1 Frame Structure

Section Overhead Bytes

- **Framing Bytes** (A1, A2) = F628
- **Section Trace** (J0) - Traces origin of an STS-1 frame - could be source equipment address
- **Bit Interleaved Parity** BIP-8 (B1) - Even parity per ‘bit position’ of previously scrambled STS-1
- **Orderwire** (E1) - 64 Kb/s ‘voice path’ for maintenance communications (1st STS-1)
- **User** (F1) - Commonly used for OAM&P information (64 Kb/s channel)
- **Data Communication Channel** (D1-3) - For OAM&P use through CMIP (Common Management Interface Protocol) - 192 Kb/s

Line Overhead Bytes

- **Pointer** (H1, H2) - Point to beginning of STS SPE
- **Pointer Action** (H3) - Timing justification of the last byte
- **BIP-8** (B2) - Even parity of LOH and STS-1 prior to scrambling
- **APS** (K1, K2) - Automatic Protection Switching commands and error conditions
- **DCC** (D4-12) - OAM&P messages using Transaction Language 1 (TL1) and CMIP
- **Synchronization Status** (S1) - Select best clocking source for SONET equipment
- **Line Level Remote Error** (M0/M1) - Conveys B2 error count back to source
- **Orderwire** (E2)

Path Overhead Bytes

- **STS Path Trace** (J1): User programmable message field (64 bytes/chars)
- **BIP-8** (B3) - Even parity of previous SPE prior to scrambling
- **STS Path Signal Label** (C2) - Payload identifier - allows simultaneous transport of multiple services
- **Path Status** (G1) - Contains B3 error count (REI-P/FEBE) and Path Remote Defect Indicator (RDI-P)
- **Path User Channel** (F2) - user defined
- **Indicator** (H4) - Used when frame is organized into various mappings (e.g. virtual tributaries)
- **Tandem Connection** (Z5) - Tandem connection maintenance and Path DCC

SONET Error Conditions

- **Loss of Signal (LOS**) - Declared receiver detects an all '0' pattern for more than 10 microseconds
- **Loss of Frame (LOF)** - Absence of valid framing pattern for 3 milliseconds
- **Loss of Path (LOP)** - Absence of valid H1/H2 pointer bytes in 8-10 consecutive frames
- **Alarm Indication Signal** (AIS) - Sent downstream from the device that detected any of the above failures
- **Far End Receiver Failure** (FERF) - Sent upstream by the device that has detected failure on its receiver
- **Remote Alarm Indication** (RAI) - End-to-end failure indication

Failure Classes

- Service Affecting (SA)
- Non Service Affecting (NSA)
- Critical (CR)
- Major (MA)
- Minor (MN)

SONET Management Information

Information Type	Optical	Section	Line	Path
Laser Bias	x			
Optical Power Received	x			
Coding Violations		x	x	x
Out of Frame (OF) Seconds		x		
Errored Seconds (ES)		x	x	x
Severely Errored Seconds (SES)			x	x
Pointer Justifications			H1/H2	VT
Unavailable Seconds (UAS)			x	x
Degraded Minutes			x	x
Protection Switch Duration			x	

Relevant Features

- Many of the SONET features are required to support the SDH ‘hierarchy’
- Many can be handled by Layer Management
- Some ‘may’ need L1 or L2 implementation to handle fast recovery (e.g.):
  - **APS** - Automatic Protection Switching commands and error conditions
  - **Path Status** - Contains B3 error count (REI-P/FEBE) and Path Remote Defect Indicator (RDI-P)
  - **Far End Receiver Failure** (FERF) - Sent upstream by the device that has detected failure on its receiver

Issues

- Fast service restoration - How fast?
  - 10 ms, 50 ms or higher?
- Need full duplex, ‘2 port’ repeaters (Regenerators) to extend the link
  - Repeaters can monitor performance, but needs to signal failure
- Links are terminated in switching equipment - Can use counters and MIB attributes for most OAM&P functions
- Need Far End/Remote Error indication to restore services quickly (e.g. FERF)
- Control packets, extended Link Test functions (or both) for fault detection and protection?
- Synchronization hierarchy not needed, but need timing source for TDM equipment