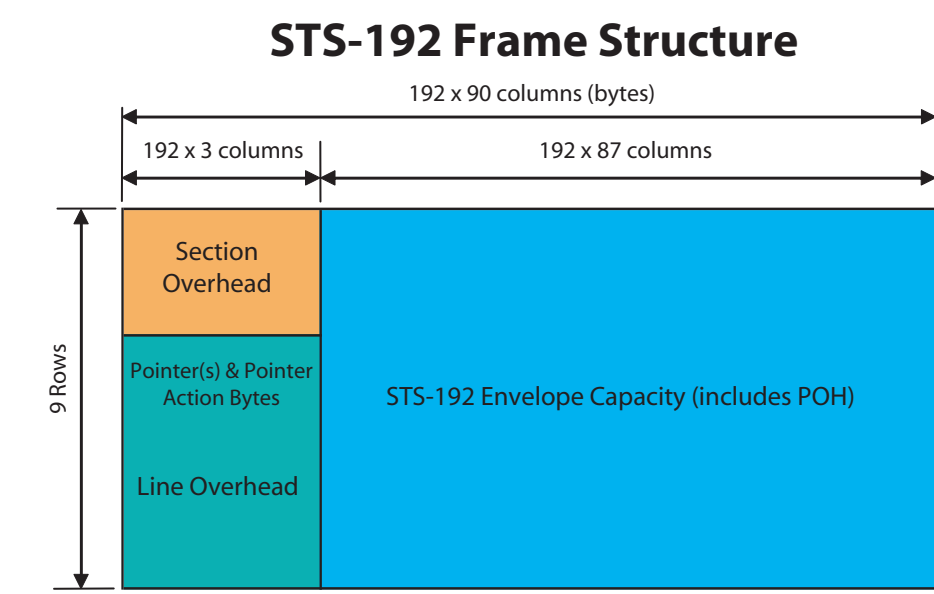
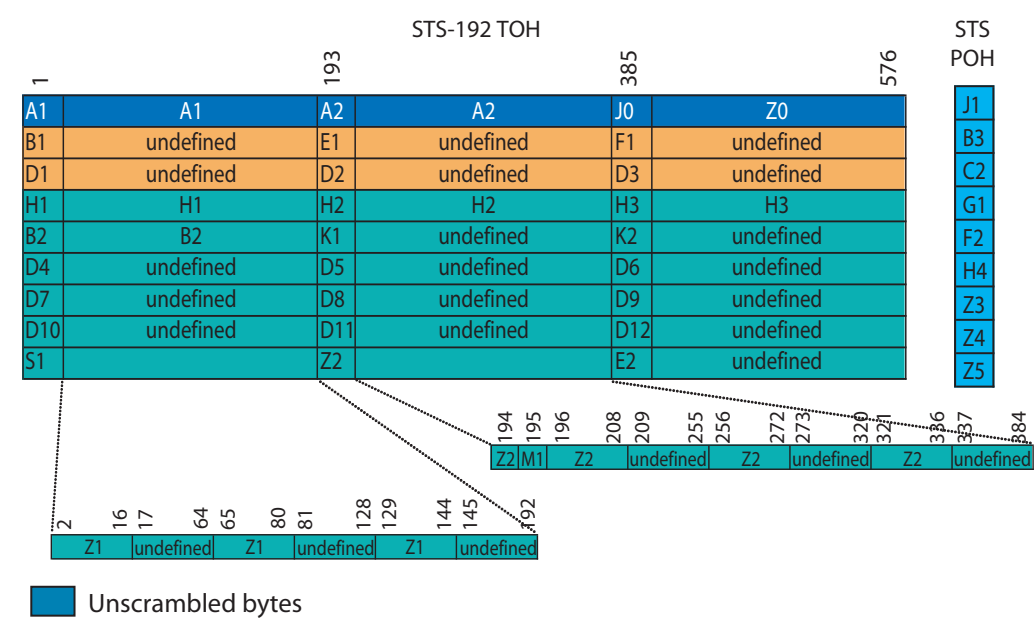


World of 10 Gb/s The Lower Layers

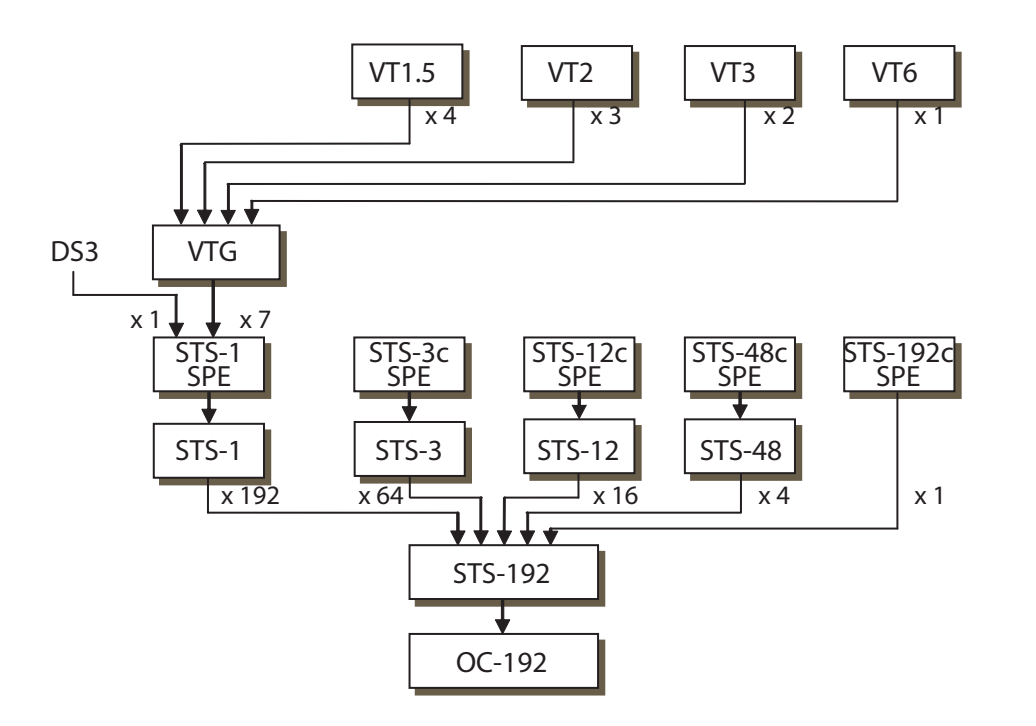
SONET



STS-192 TOH & STS POH

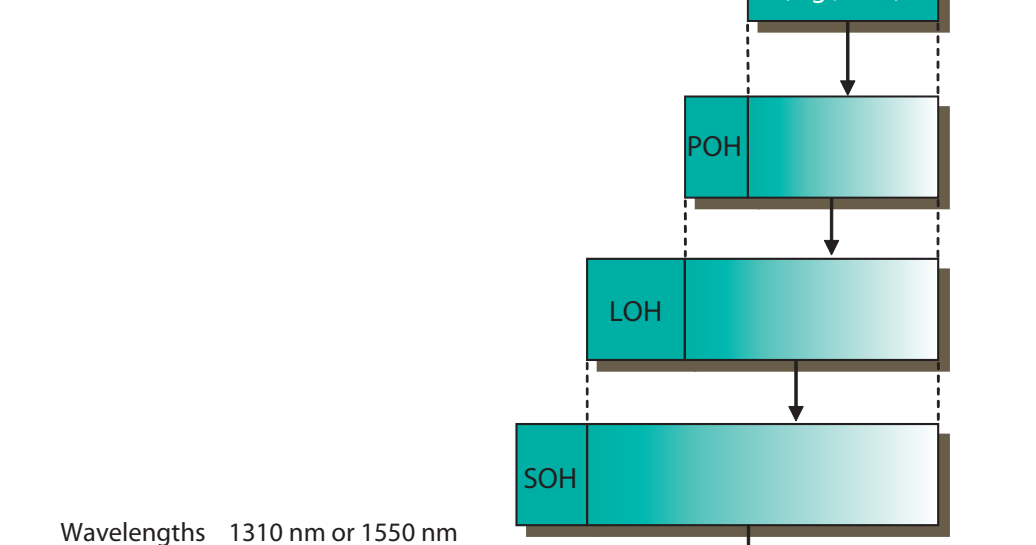


SONET Multiplexing Structure



- SONET Synchronous Optical Network
- VT Virtual Tributary
- VTG Virtual Tributary Group
- SPE Synchronous Payload Envelope
- STS-N Synchronous Transport Signal Level N
- STS-Nc STS-N Contiguously Concatenated
- GFP Generic Framing Procedure
- POH Path Overhead
- LOH Line Overhead
- SOH Section Overhead
- TOH Transport Overhead (section + line overhead)

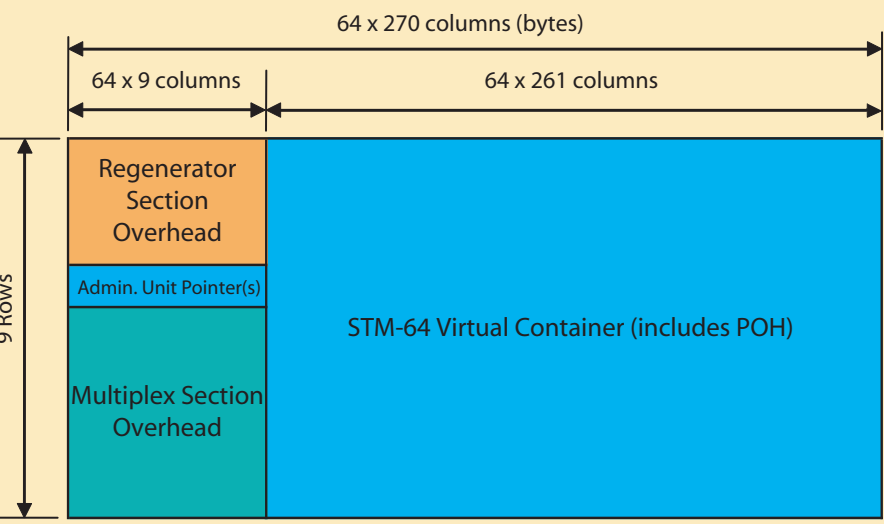
Signal Processing



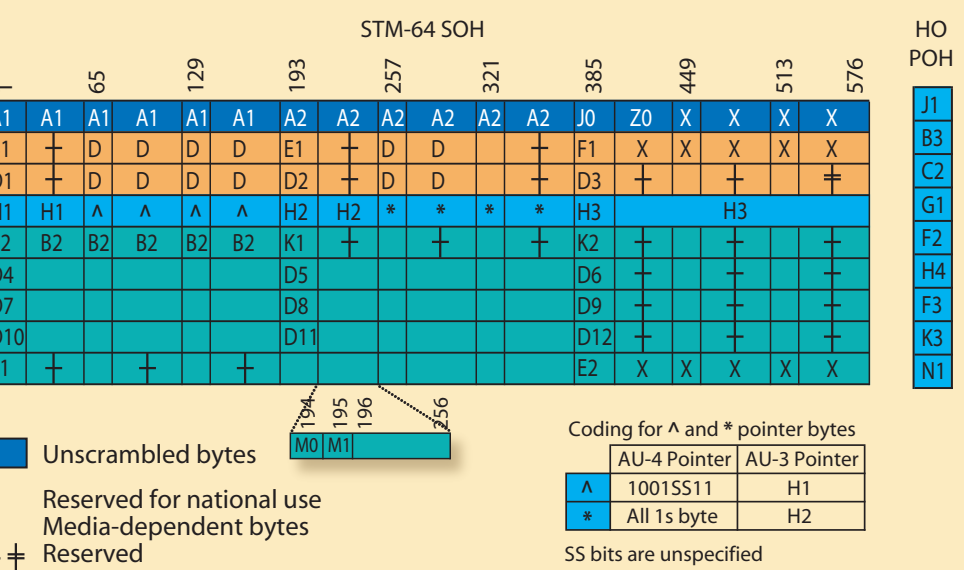
- Wavelengths 1310 nm or 1550 nm
- SR Short Reach
 - IR Intermediate Reach
 - LR Long Reach
 - VR Very-Long Reach
- Examples:
- IR-1 1310 nm
 - IR-2 1550 nm

SDH

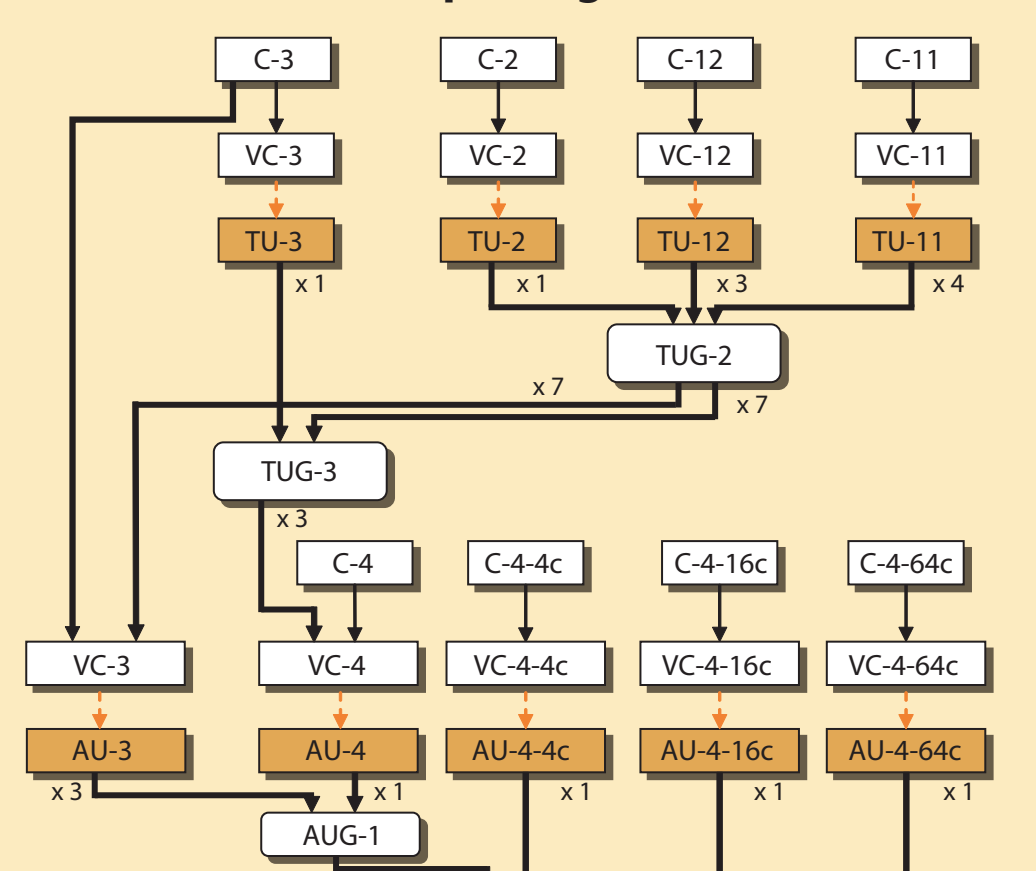
STM-64 Frame Structure



STM-64 SOH & Higher Order POH

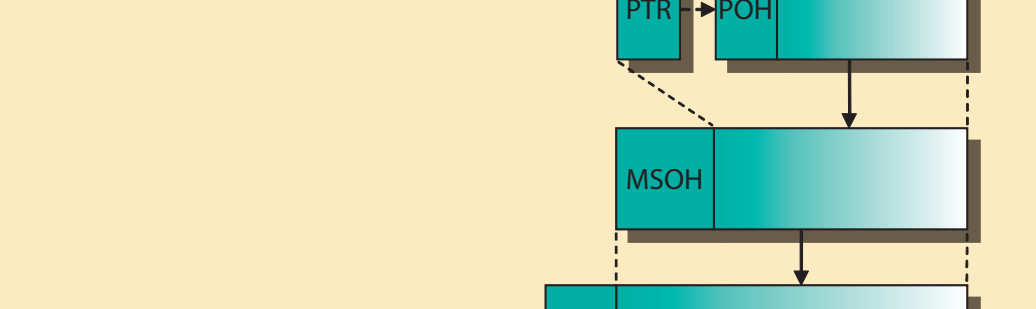


SDH Multiplexing Structure



- VC-N Virtual Container N
- VC-4-Nc VC-4 Contiguously Concatenated
- TU-N Tributary Unit-N
- TUG-N Tributary Unit Group-N
- AU-N Administrative Unit-N
- AUG-N Administrative Unit Group-N
- STM Synchronous Transfer Module
- POH Path Overhead
- MSOH Multiplex Section Overhead
- RSOH Regenerator Section Overhead
- SOH Section Overhead (regenerator section + multiplex section overhead)

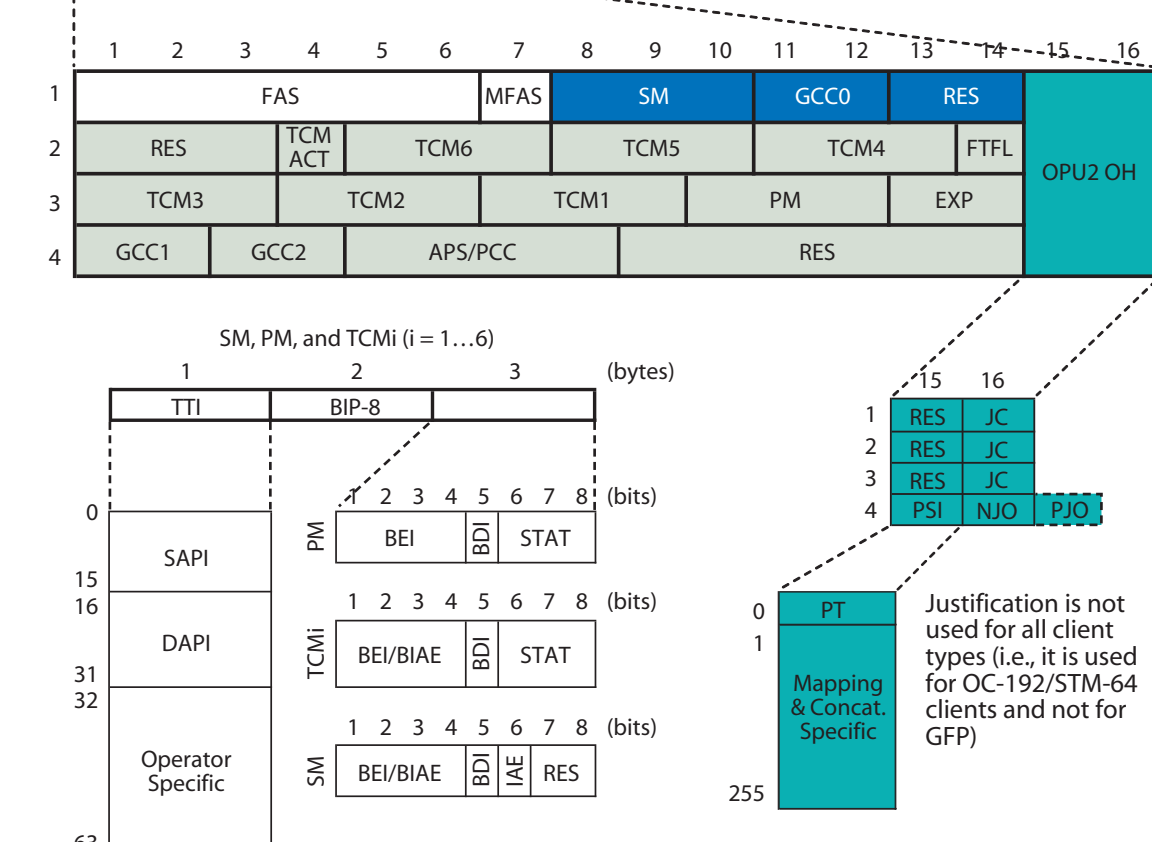
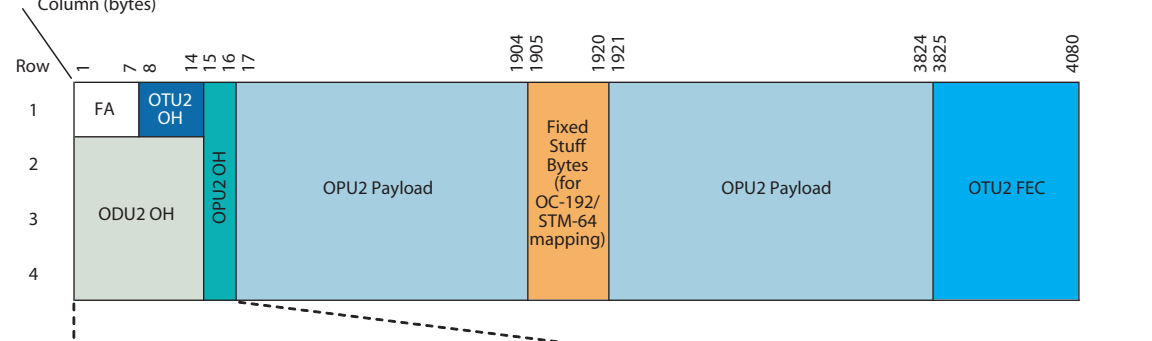
Signal Processing



- Wavelengths 1310 nm or 1550 nm
- S Intra-Office Short-Haul
 - L Long-Haul
- Examples:
- S-64.2b Short-Haul STM-64 1550 nm
 - L-64.1 Long-Haul STM-64 1310 nm

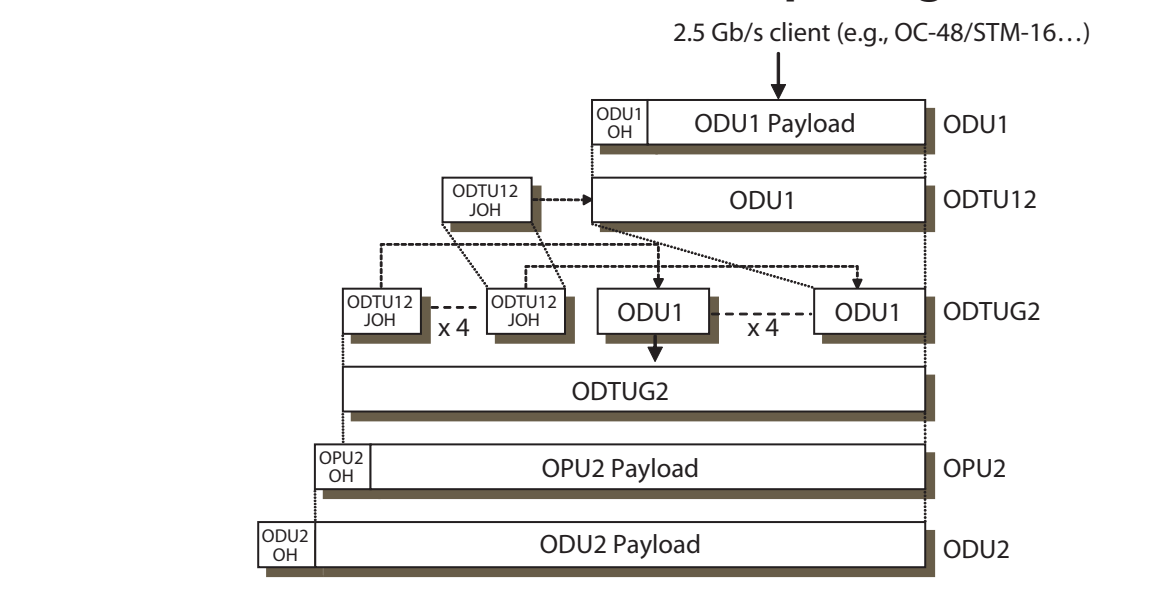
ONT

OTU2 Frame Structure



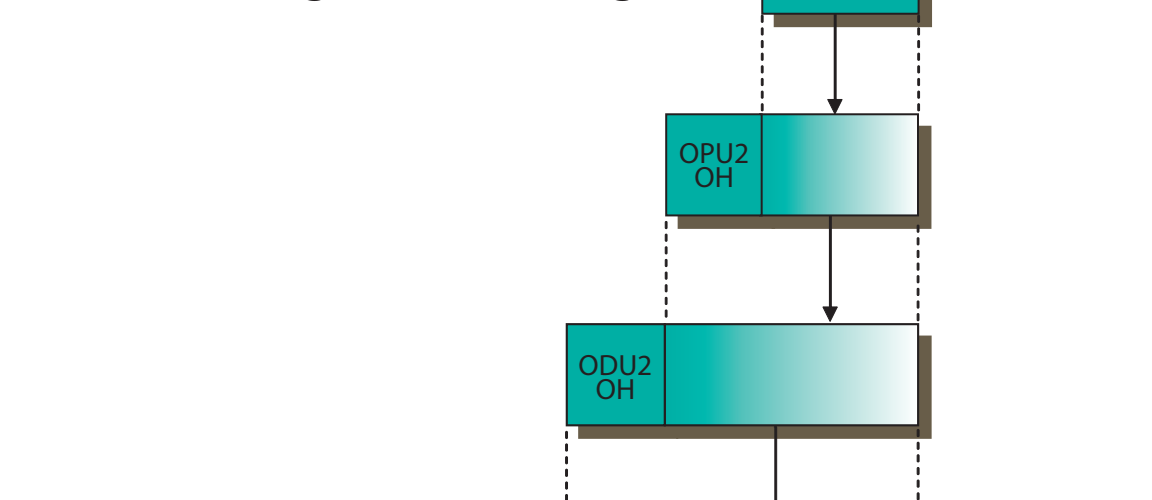
- FAS Frame Alignment Signal
- SM Section Monitoring
- RES Reserved
- TCM ACT TCM Activation
- PM Path Monitoring
- APS Automatic Protection Switching
- TTI Trail Trace Identifier
- SAPI Source Access Point Identifier
- BEI Backward Error Indication
- STAT Status
- IAE Incoming Alignment Error
- PT Payload Type
- NJO Negative Justification Opportunity
- MFAS Multi-Frame Alignment Signal
- GCC General Communication Channel
- TCM Tandem Connection Monitoring
- FTFL Fault Type and Fault Location
- EXP Experimental
- PCC Protection Communication Channel
- BIP-8 Bit Interleaved Parity-8
- DAPI Destination Access Point Identifier
- BDI Backward Defect Indication
- BIAE Backward Incoming Alignment Error
- JC Justification Control
- PJO Positive Justification Opportunity

ODU1 into ODU2 Multiplexing



- OTN Optical Transport Network
- OH Overhead
- ODTU Optical channel Data Tributary Unit
- ODUG Optical channel Data Tributary Unit Group
- JOH Justification Overhead
- OPU Optical channel Payload Unit
- ODU Optical channel Data Unit
- OTU Optical channel Transport Unit
- FEC Forward Error Correction

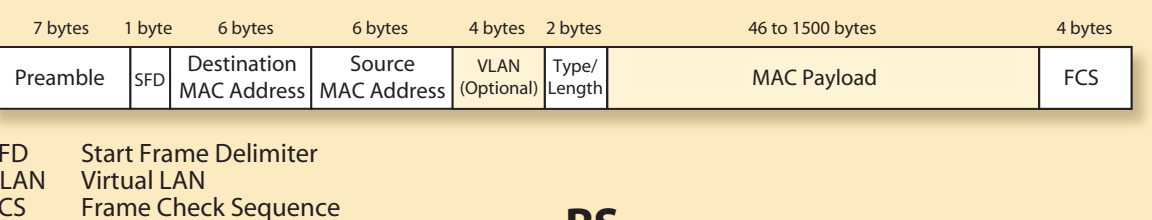
Signal Processing



- Typical Wavelength 1550 nm range
- Examples:
- 10GBASE-W (10 GigE WAN) 9.95328 Gb/s
 - 10GBASE-R (10 GigE LAN) 10.3125 Gb/s

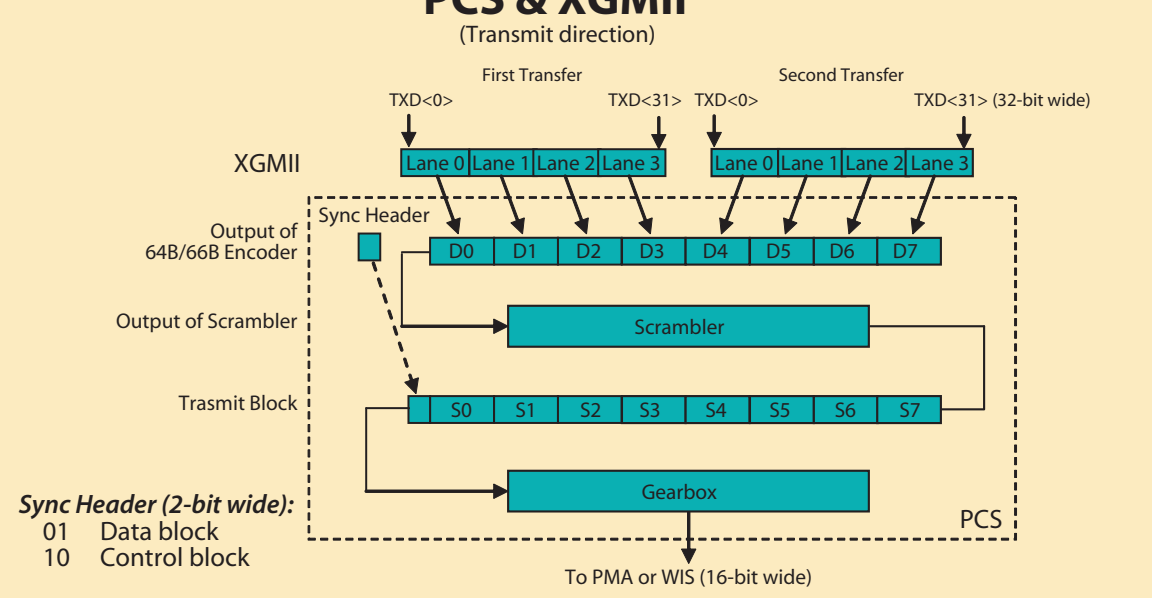
10 Gb/s Ethernet

802.3 MAC Frame Structure

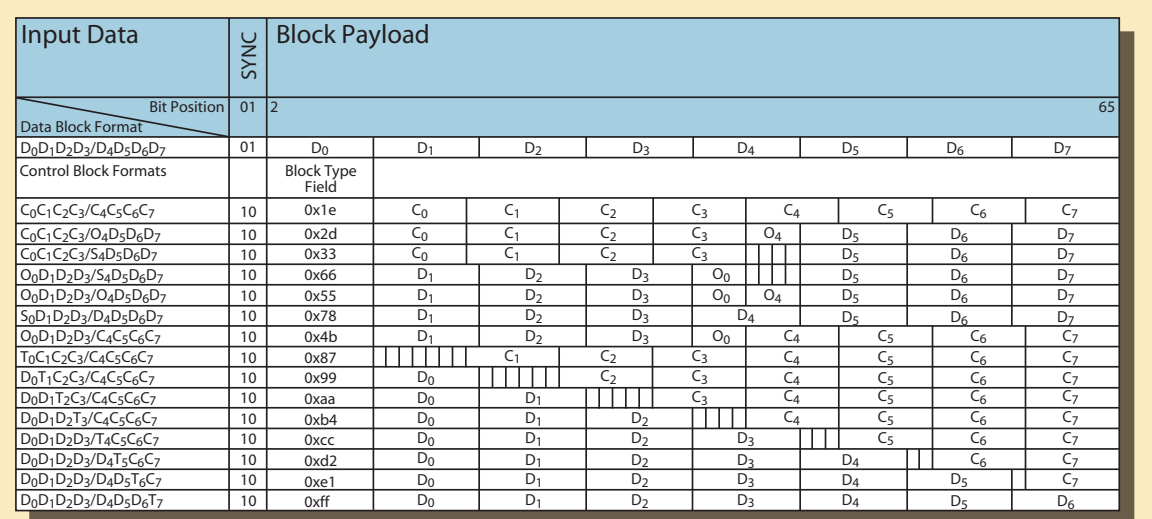


- SFD Start Frame Delimiter
- VLAN Virtual LAN
- FCS Frame Check Sequence

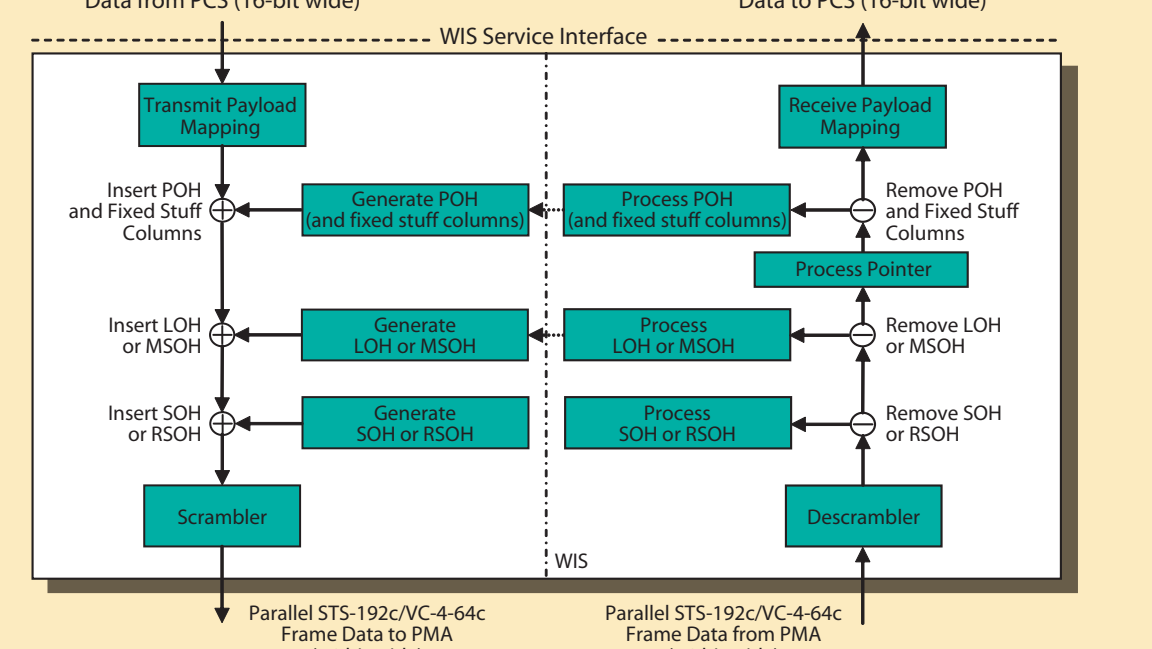
PCS & XGMII



64B/66B PCS Block Format

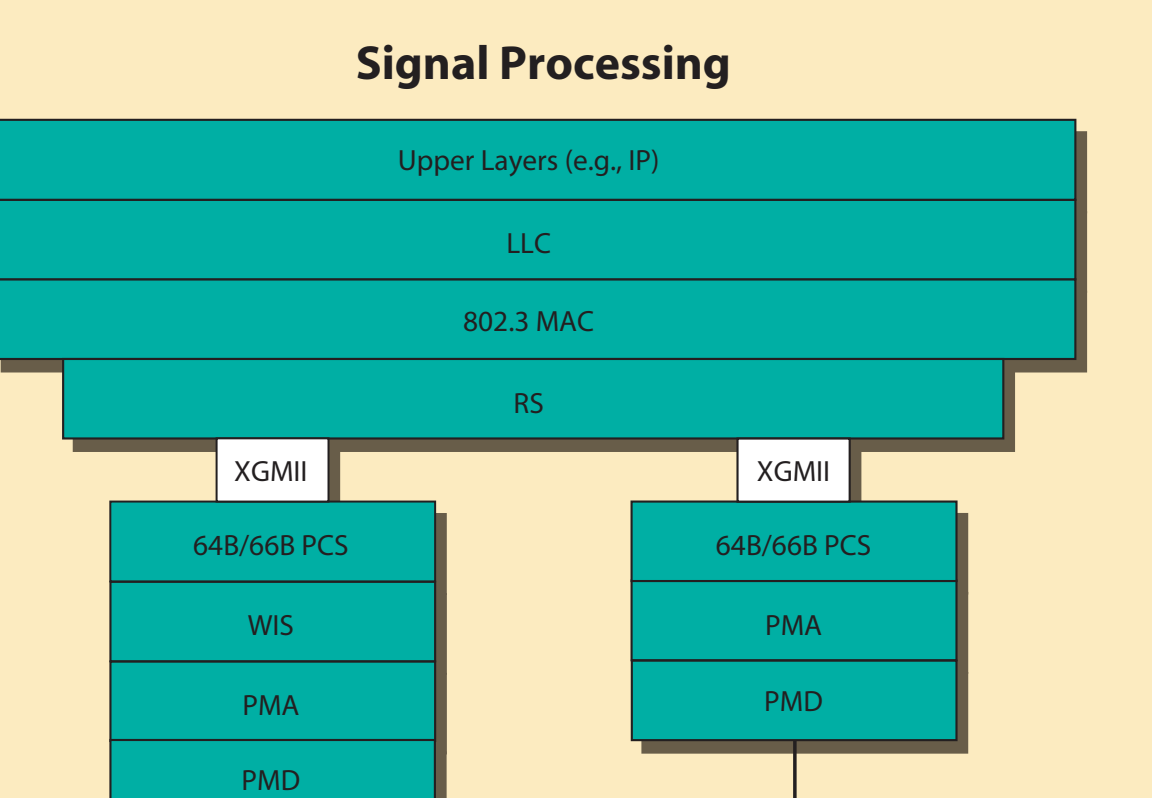


WIS



- LLC Logical Link Control
- RS Reconciliation Sublayer
- PCS Physical Coding Sublayer
- PMA Physical Media Attachment
- MAC Media Access Control
- XGMII 10 Gigabit Media Independent Interface
- WIS WAN Interface Sublayer
- PMD Physical Media Dependent

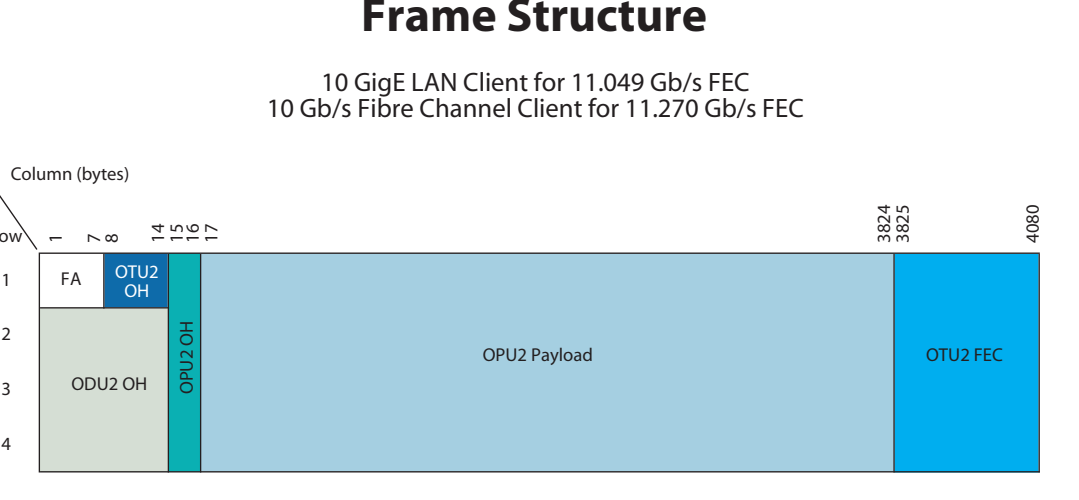
Signal Processing



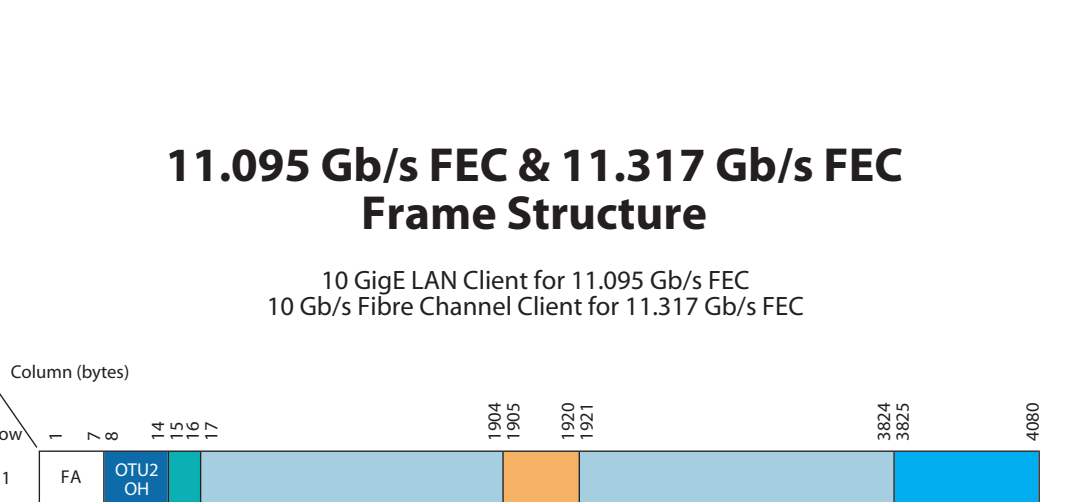
- Optical Serial Interfaces:
- 10GBASE-SW 850 nm WAN
 - 10GBASE-LW 1310 nm WAN
 - 10GBASE-EW 1550 nm WAN
 - 10GBASE-SR 850 nm LAN
 - 10GBASE-LR 1310 nm LAN
 - 10GBASE-ER 1550 nm LAN

10 Gb/s Digital Wrapper

11.049 Gb/s FEC & 11.270 Gb/s FEC Frame Structure

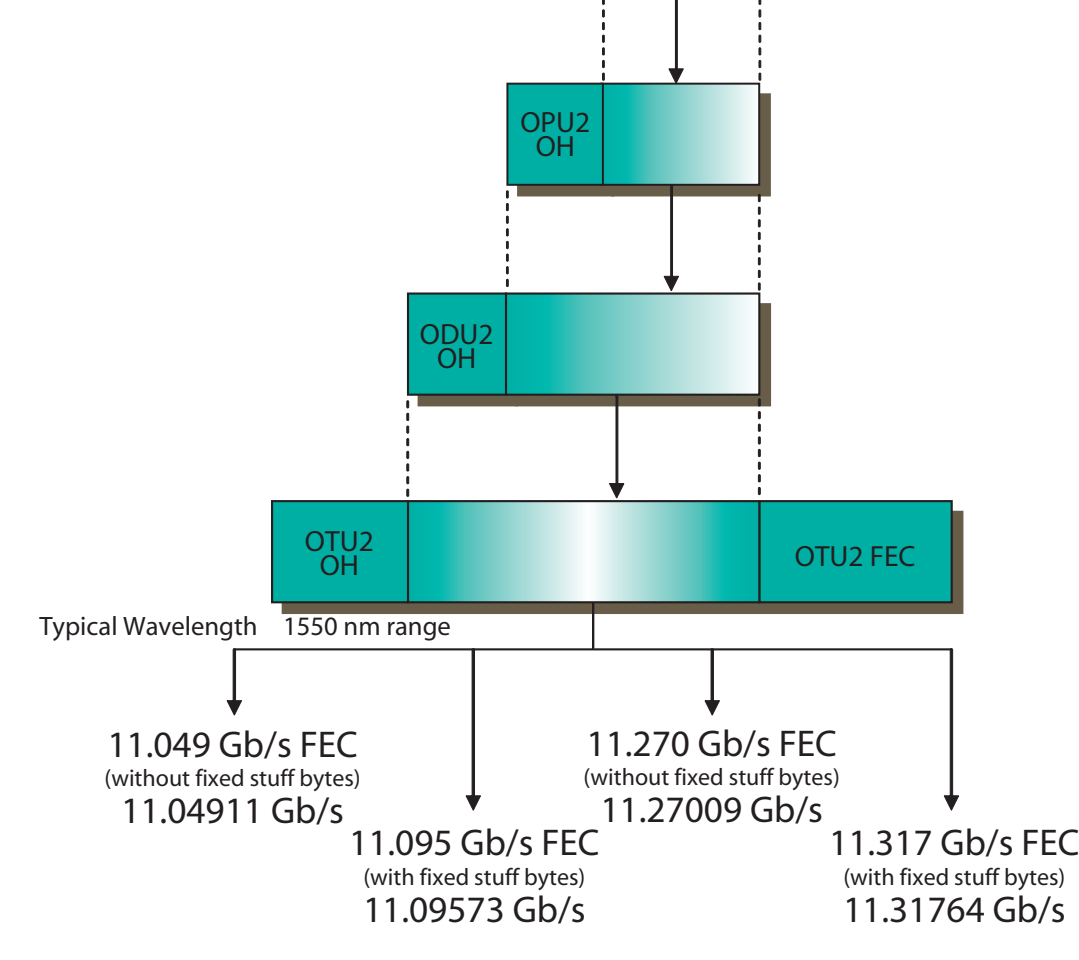


11.095 Gb/s FEC & 11.317 Gb/s FEC Frame Structure



- OH Overhead
 - OPU Optical channel Payload Unit
 - ODU Optical channel Data Unit
 - OTU Optical channel Transport Unit
 - FEC Forward Error Correction
- Note: The terms OPU2, ODU2, and OTU2 are borrowed from the ITU-T G.709 recommendation. These methods are used to extend the transmission distance for 10 GigE LAN and 10 Gb/s Fibre Channel.

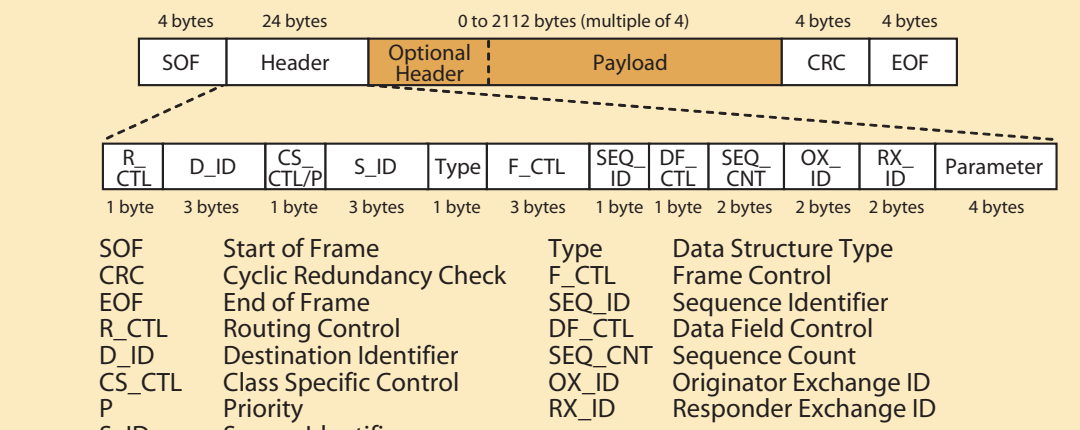
Signal Processing



- Typical Wavelength 1550 nm range
- 11.049 Gb/s FEC (without fixed stuff bytes) 11.04911 Gb/s
 - 11.095 Gb/s FEC (with fixed stuff bytes) 11.09573 Gb/s
 - 11.270 Gb/s FEC (without fixed stuff bytes) 11.27009 Gb/s
 - 11.317 Gb/s FEC (with fixed stuff bytes) 11.31764 Gb/s

10 Gb/s Fibre Channel

FC-2 Frame Structure



10 Gb/s FC Primitives

These map into the 64B/66B PCS and have corresponding primitives used at the Fibre Channel rates (as in FC-FS)

Primitive Name	Function	Ordered Set
SOF1_X	SOF Connect Class 1	K277 D21.5 D230 D230
SOF1_X	SOF Initiate Class 1	K277 D21.5 D232 D232
SOF1_X	SOF Normal Class 1	K277 D21.5 D231 D231
SOF2_X	SOF Connect Class 2	K277 D21.5 D212 D212
SOF2_X	SOF Initiate Class 2	K277 D21.5 D211 D211
SOF2_X	SOF Normal Class 2	K277 D21.5 D212 D212
SOF3_X	SOF Connect Class 3	K277 D21.5 D222 D222
SOF3_X	SOF Initiate Class 3	K277 D21.5 D221 D221
SOF3_X	SOF Normal Class 3	K277 D21.5 D222 D222
SOF4_X	SOF Connect Class 4	K277 D21.5 D250 D250
SOF4_X	SOF Initiate Class 4	K277 D21.5 D249 D249
SOF4_X	SOF Normal Class 4	K277 D21.5 D250 D250
SOF4_X	SOF Fabric	K277 D21.5 D242 D242
EOFR_X	EOF Terminate	D214 D21.5 D213 D213
EOFR_X	EOF Disconnect Terminate Class 1	D214 D21.4 D214 K297
EOFR_X	EOF Disconnect Terminate Class 4	D214 D21.7 D217 K297
EOFR_X	EOF Normal	D214 D21.6 D216 K297
EOFR_X	EOF Invalid	D214 D21.6 D216 K297
EOFR_X	EOF Disconnect Terminate Invalid Class 1	D214 D21.4 D214 K297
EOFR_X	EOF Disconnect Terminate Invalid Class 4	D214 D21.4 D214 K297
EOFR_X	EOF Remove Terminate Class 4	D214 D25.4 D25.4 K297
EOFR_X	EOF Remove Terminate Invalid Class 4	D214 D25.4 D25.4 K297
IDLE	Idle	K07 K07 K07 K07
R_RDY_X	Receiver Ready	K282 D21.4 D102 D102
VC_RDY_X	Virtual Circuit Ready	K282 D21.7 VC_ID VC_ID
BB_SCI_X	Buffer to Buffer State Change (B2B)	K282 D21.4 D22.4 D22.4
BB_SCI_X	Buffer to Buffer State Change (B_RDY)	K282 D21.4 D22.6 D22.6
CLS_X	Offline	K284 D21.1 D104 D104
LR_X	Link Reset	K284 D92 D31.5 D92
LRX_X	Link Reset Response	K284 D21.1 D31.5 D92
LF	Local Fault	K284 D00.0 D00.0 D01.0
RF	Remote Fault (NDS equivalent)	K284 D00.0 D00.0 D02.0

Code Conversion to Bits: Code notation is Zxxx, where Z is D (data) or K (control) xx is a decimal number based on 5 bits: EDCBA y is a number based on 3 bits: HGF Code ZEDCBAHGF corresponds to hex: HGFE DCBA

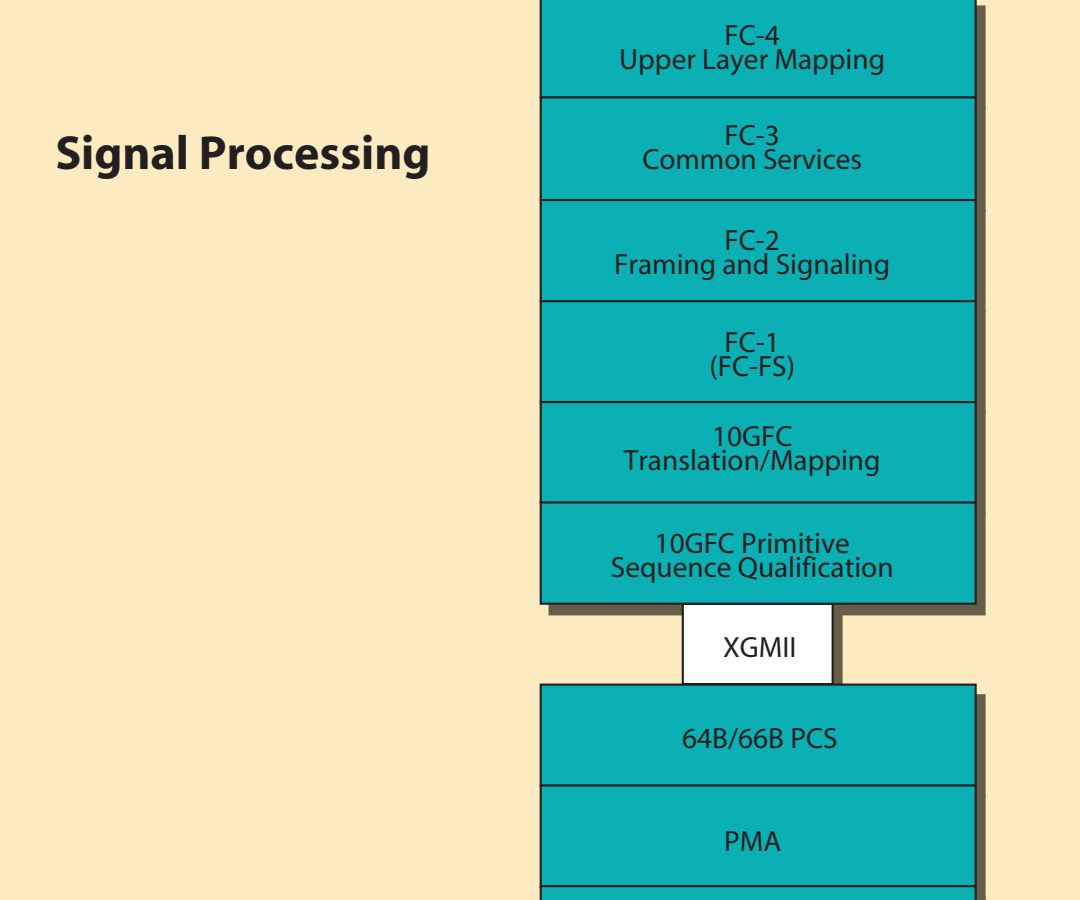
Example: D28.5 corresponds to hex: BC Primitive code D28.5 is 0x8BC at the PCS sublayer

- Classes of Service:
- Class 1 Dedicated Connection
 - Class 2 Multiplex (connectionless with acknowledgment)
 - Class 3 Datagram (connectionless)
 - Class 4 Fractional Bandwidth (uses virtual circuits)
 - Class 6 Multicast Connection

- Fibre Channel Terms:
- Unit of information at FC-2
 - One or more data frames with a common SEQ_ID
 - One or more related sequences identified by OX_ID and RX_ID
 - A word composed of a special character (K) and data characters (D)
 - The maximum number of buffers available to receive frames
 - How a port sets its operating environment with other ports

- PCS Sublayer
- As in 10 GbE, 10 Gb/s FC uses the same:
 - 64B/66B PCS Block Format (see 10 GigE)
 - PCS and XGMII (see 10 GigE)
 - 10 Gb/s FC primitives map into the 64B/66B PCS Block Format
 - FC-FS Fibre Channel-Framing and Signaling
 - XGMII 10 Gigabit Media Independent Interface
 - PMA Physical Media Attachment
 - 10 Gb/s FC Physical Coding Sublayer
 - PMD Physical Media Dependent

Signal Processing



- Optical Serial Interfaces:
- 1200-MX-SN-I 850 nm
 - 1200-SM-L-L 1310 nm
- 10 Gb/s FC 10.51875 Gb/s

To learn more, www.jdsu.com/test

References:

- SONET Telcordia GR-253-Core and ANSIT.105
- SDH ITU-T G.707 and G.691
- OTN ITU-T G.709
- 10 GigE IEEE Std 802.3-2005, Section 4
- 10G FC ANS INCITS 364-2002 and ANS INCITS FC-FST 11/Project 1331-D



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