OTN Digital Wrapper

The Fine Print

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10GbE LAN PHYs and WAN PHY Are Independent Plesio-Isosynchronious

•10GbE is a data centric optical communications protocol technology

•The transmitters are clock independent of the receivers

•Each transmitting interface/port in a data switch can operate with a different and independent clock

•The receivers synchronize only with data stream sent by the up stream transmitter at the data character/frame level

•The transmitters operate within a “loose” timing specification because the information in the communications stream is multiplexed at the data frame level (OSI Layer 2), not the time domain multiplexed payload level (OSI Layer 1).

ITU-T SG15 OTN Is Isosynchronous

•ITU-T Optical Transmission Networking is a telephony centric optical communications protocol technology/architecture.

•The OTN uses the Digital Wrapper (DW) to multiplex data streams from various sources into common telephony based payloads. DW bandwidths are at 2.5 Gb, 10 Gb, and 40 Gb. Multiple data streams from different sources are mapped into the same DW bandwidth at time domain multiplexing (TDM) payloads. This is the same functionality that exists the TDM telephony networks today. All communications steams are treaded as “clients” of the network.

•Normal operation of the network is isosynchronous with each transmitter locked to a common clock source. Alternatively the transmitter is locked to the receiver which is locked to an upstream transmitter which is locked to the common clock.

•The transmitters operate within a tight timing specification because the information in the communications stream is multiplexed at the TDM payload level (OSI Layer 1), not the data frame level (OSI Layer 2).

Packet Over SONET Can Be A Guide

•Packet Over SONET (POS) is an optical data communications protocol that was developed and began deployment in 1996. (Roy Bynum was on of the first people to deploy POS in North America.)

•POS began as an independent plesio-isosynchronous protocol with +/-20PPM clock tolerance to provide for receiver lock at the transmission synchronous client interface, operating in “maintenance mode”. This caused synchronization alarms within the transmission network and much higher data errors than occurs over DS1/DS3 circuits. (It is hypothesized to be because of the clock pointer offsets that were occurring as the POS interface clock drifted between tolerance boundaries.)

•When POS interfaces where converted to full support for “loop timing” and/or Primary Reference Source (PRS) support the synchronization alarms and the higher data errors were eliminated.

The Experience with POS Indicates that a client systems of isosynchronous networks need to support full isosynchronous clock timing

10GBaseW Over OTN

•OTN is an isosynchronous network infrastructure

•If 10GBaseW is interfaced to OTN as an OC192, it will be a “client” on that isosynchronous network.

•Experience with POS indicates that 10GbaseW only has a +/-20PPM clock tolerance to support functioning as an isosynchronous network “client” it will have higher than normal data errors and cause “synchronization alarms” within the OTN infrastructure.

•If the 10GbE standard attempts to support operation within OTN is will need to support full isosynchronous clock timing. This means “loop timing” or PRS support (T1X1.416-1999 Section 6).

I Do Not Believe That This Is What The P802.3ae TF Wants

802.3 Ethernet standards normally provide for reliable functionality under with a wide range of operating conditions

Clock Tolerance and Compensation Provides For:

- Different component manufacturers with differing quality tolerances
- Different system manufacturers with differing quality tolerances
- Multiple systems in series with the data stream
- Different ages of systems within a data network over a period of time

IPG idle bytes are used to provide a wide tolerance for transmitter clock drift accumulation over multiple systems of different age and manufacture quality

Section 4.4.2 of Draft 3.1 reads:

"Note: For 10Gb/s implementations, the spacing between two packets, from the last bit of the FCS field of the first packet to the first bit of the preamble of the second packet, can have a minimum value of 40 BT (bit times), as measured at the XGMII receive signals at the DTE. This interFrame Gap shrinkage may be caused by variable network delays and clock tolerances."

To Support The P802.3ae LAN PHY, OTN G.gfp In The Digital Wrapper Has To Payload Rate Compensate

•The OTN DW payload rate is 9953.208Mb/s

•The OTN G.gfp replaces the IPG, Preamble, and Start of Frame Delimiter with a Header Error Check (HEC) Frame and extension.

•G.gfp in the DW wants to use the ability to drop IPG idle octets to compensate for 46.12Mbs difference between the LAN PHY and DW Payload. 5765000 octets per second must be available for deletion or data frame errors can occur. 9727620 octets are available under ideal operating conditions.

•At the extreme allowed operation point of 40 bit times of IPG with full load of maximum current MTU frames, there are only 4071660 octets per second available for deletion.

G.gfp in the Digital Wrapper Under OTN can not support the 10GbE LAN PHY

OTN Support Of 10GbE

Statement: OTN will support the 10GbE WAN PHY, only requiring +/- 20 PPM clock tolerance to allow for clock compensation range within the isosynchronous overhead.

> ***Fine Print:*** This is a marginal solution. What is actually required is full isosynchronous support in the 10GbE WAN PHY for proper operation

Statement: OTN can support the 10GbE LAN PHY by deleting octets from the IPG.

> ***Fine Print:*** This works well under ideal operating conditions, but will fail and loose data under allowable reduced IPG operating conditions.

What Is The Alternative To OTN And The Digital Wrapper?

•Early SONET/SDH deployments were linear point to point systems using linear point to point support technology, not the ring systems with the ring based technology of today.

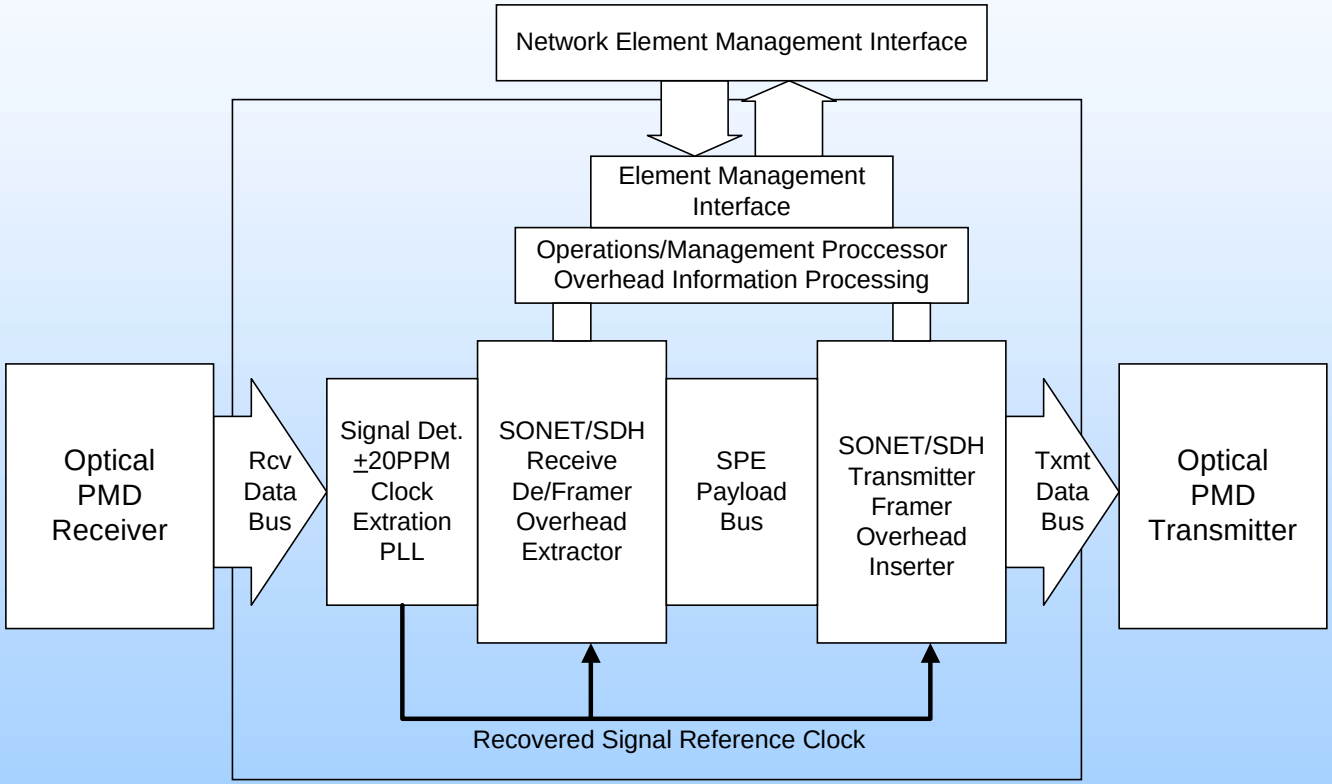
•Early linear SONET/SDH systems used systems for regeneration called the Line Regenerating Element (LRE) and the Section Regenerating Element (SRE). LREs and SREs provided Operations, Administration, and Maintenance (OAM) overhead support and performance monitoring. LREs do full Line and Section level overhead termination and re-insertion. SREs only do Section level overhead termination and re-insertion. SREs are still used today in extended distance SONET/SDH rings.

•Except for the additional support of the Data Communications Channel (DCC) and Order Wire (OW) the LRE functions are the same as the ELTE functions.

The functional description of the ELTE is the same as the LRE

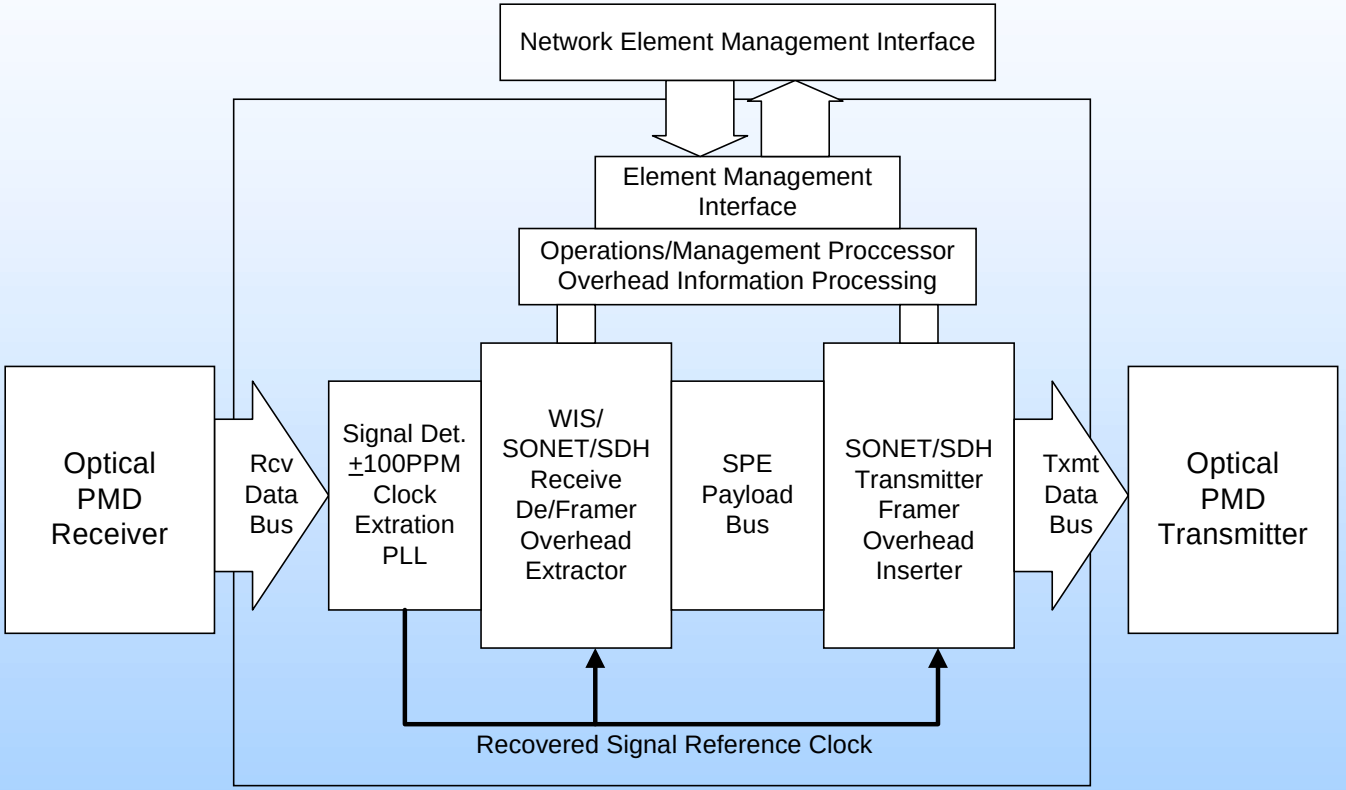
A Deployed Existing DWDM Line Regenerating Element (LRE)

- Is independent plesio-isosynchronous at +/-20PPM Clock Tolerance
- Is a "bridge/processor" at the SONET/SDH overhead and frame level
- Is a "repeater" at the service payload level



A DWDM SONET/SDH Standard LRE Will operate with either SONET/SDH or 10GBaseW Ethernet at +/-20PPM

Except For Clock Tolerance, An ELTE Is Actually An Existing LRE



A 10GbE/SONET/SDH compatible ELTE/LRE
Will operate with either SONET/SDH
or 10GBaseW Ethernet

Without OTN The 10GbE WAN PHY Will Be Too Expensive To Deploy

Statement: The 10GbE WAN PHY will require entirely new infrastructure.

> ***Fine Print:*** The current linear deployment of High Count Dense Wavelength Division Multiplexing systems (up to 160 wavelengths) will support the 10GbE WAN PHY without need for modification at +/-20PPM clock tolerance. A +/-100PPM clock allowance is an upgrade to the existing HC DWDM systems.
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> ***Additional Fine Print:*** The OTN is actually the new infrastructure, not the linear LREs and SREs to support 10GbE WAN PHY.

Statement: +/-100PPM Clock Tolerance LREs and SREs will be more expensive than existing +/- 20PPM Clock LREs and SREs

> ***Fine Print:*** The actual cost increase is 0.01% to 0.03%

Without OTN, Support For 10GbE WAN PHY Will Not have Have High Speed Service Protection And Will Not Be Reliable Like SONET/SDH

Statement: For optical service protection switching over rings requires a new operations service overhead protocol.

> ***Fine Print:*** Protection switching of wavelength services is done at the optical level not the electrical level like SONET/SDH. The Optical Control Plane controls the optical service provisioning and service protection switching, not the optical channel service overheads.

Statement: The 10GbE WAN PHY requires Forward Error Correction (FEC).

> *Fine Print:* FEC is only needed for long distances between amplifiers and regenerators. Except for submarine cable systems and a few other places in the world, most operational spans are less than 600Km, which supports OC192 systems today without FEC.

Conclusions:

•Optical DWDM service support for 10GbE WAN PHY does not “require” a transmission clock tolerance of +/- 20PPM. For OTN Digital Wrapper, having a +/- 20PPM clock is inadequate.

•OTN Digital Wrapper G.gfp can not properly support the 10GbE LAN PHY.

•Deployment of a new infrastructure is not required to support 10GbE WAN PHY at +/-20PPM clock tolerance and upgrade of existing infrastructure to support +/-100PPM clocking is minimal.

Customer and Service Provider Support For 10GbE Does Not Require A New Infrastructure And Does Not Require ITU-T OTN.