

40GE OTN Support Consideration

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HSSG HSE Approval 40GE Objectives

- Provide appropriate support for OTN
- Support a MAC data rate of 40 Gbps
- Provide Physical Layer specifications which support 40 Gbps operation over:
 - at least 100m on OM3 MMF
 - at least 10m over a copper cable assembly
 - at least 1m over a backplane

	40GE	100GE	
At Least 1m Backplane	4 x KR		
At least 10m Cu Cable	4 x T	10 x T	
At least 100m OM3 MMF	4 x Array	10 x Array	
At least 10km SMF		4 x 25G EML	
At least 40km SMF		4 x 25G EML	

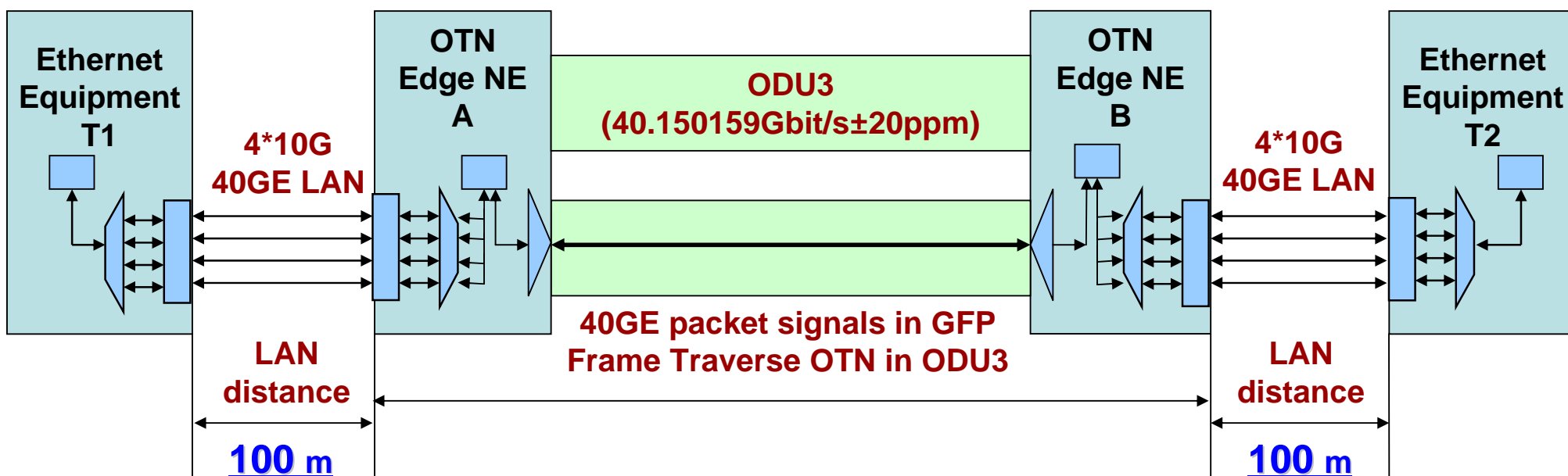
**40GE OTN support is getting a lot of consideration in ITU-T
This will enable reach lengths much greater than the HSSG Objectives.**

40GE OTN Support consideration

Understanding 40GE “Provide appropriate support for OTN” Options

- Transparent MAC frame transmission (Not a problem)
 - MAC Frame Transparency is provided with GFP-F
- Transparent PHY Layer PCS Code-word transmission (under consideration)
 - Lane-Aggregated code-words Transcoding Transparency (PHY)
 - Bundled Multi-lane code-words Transcoding Transparency (PHY Lane)
- Transparent PHY Layer Bit transmission (under consideration)
 - PHY Layer bit transparency (over-clocked ODU3 needs to be defined by ITU-T)
 - Reduce MAC rate to ~38.9G or less and use 64B/66B coding
- Interface Interoperable (under consideration)
 - PHY Interface interoperability

40GE OTN Support Consideration (GFP-F)



- **40GE OTN Support : Transparent transmission of 40GE MAC Frames**
- **Serial transmission in OTN domain**
 - OTN Edge NE A, B do lane skew compensation generated in the LAN interface distance separately in the ingress point while terminating the Multi-lane Ethernet PHY
 - T1, T2 do lane skew compensation generated in the LAN interface distance separately
- **The 40GE signal as a serial data stream could traverse many OTN network domains, without generating skew and differential delay.**

This is an ITU-T standards effort; no work for IEEE.

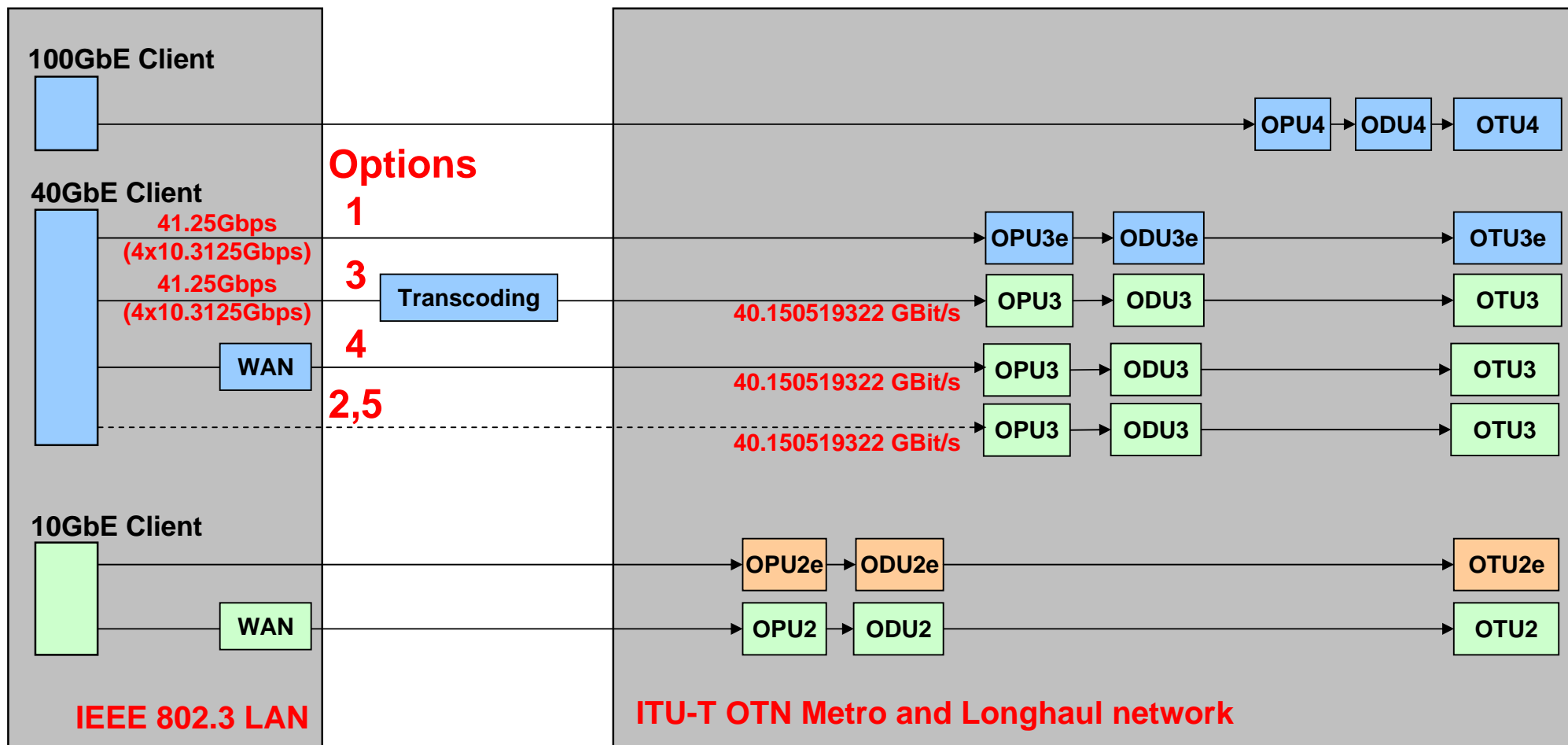
40GE OTN Support consideration (sub-Mac transparency)

- **Option 1 – 40G MAC Rate and 64/66b coding for LAN interface; push ITU-T to define overclocking OTU3e/ODU3e/OPU3e for 40GE transport (ITU-T effort)**
 - Non-standard and requires ITU-T to define a new signal hierarchy.
- **Option 2 – Reduce MAC rate to ~38.9G or less and use 64B/66B coding (IEEE 802.3)**
 - 40G MAC data rate was approved; lower data rate seems to have some resistance in HSSG.
- **Option 3 – 40G MAC Rate and 64/66b coding for LAN interface; transcode when mapping into OTN (ITU-T and/or IEEE 802.3)**
 - This seems to be the most acceptable method for 40GE transport over OTN in OPU3.
- **Option 4 – 40G MAC Rate using 64/66b compatible transcoding for mapping into OTU3/ODU3 payload area, define an interoperable WAN interface (IEEE 802.3)**
 - Compatible with Option 3; but this will make OTN and Ethernet Interoperable.
- **Option 5 – 40G MAC Rate defined with a more efficient line coding than 64/66b (IEEE 802.3)**
 - Need further study for using new line coding methods (e.g. 512/513b)

HSE OTN Support beyond 10G (transparently)

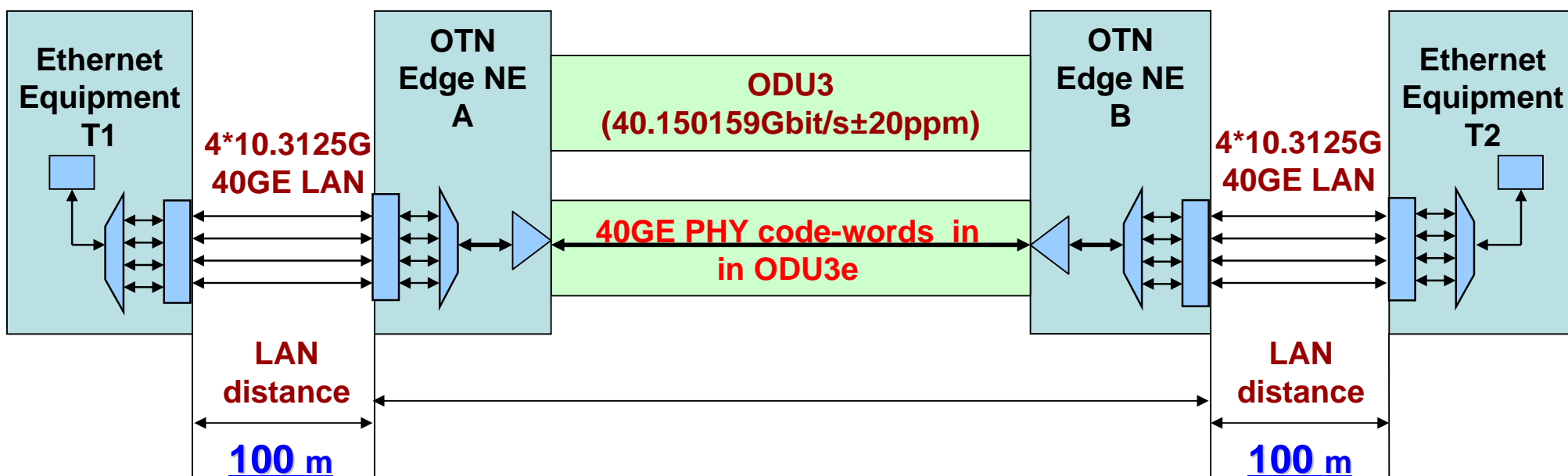
Provide appropriate support for OTN

Provide Multi-service support



■ Standardized
 ■ Non-Standardized
 ■ Under study and standardization discussion

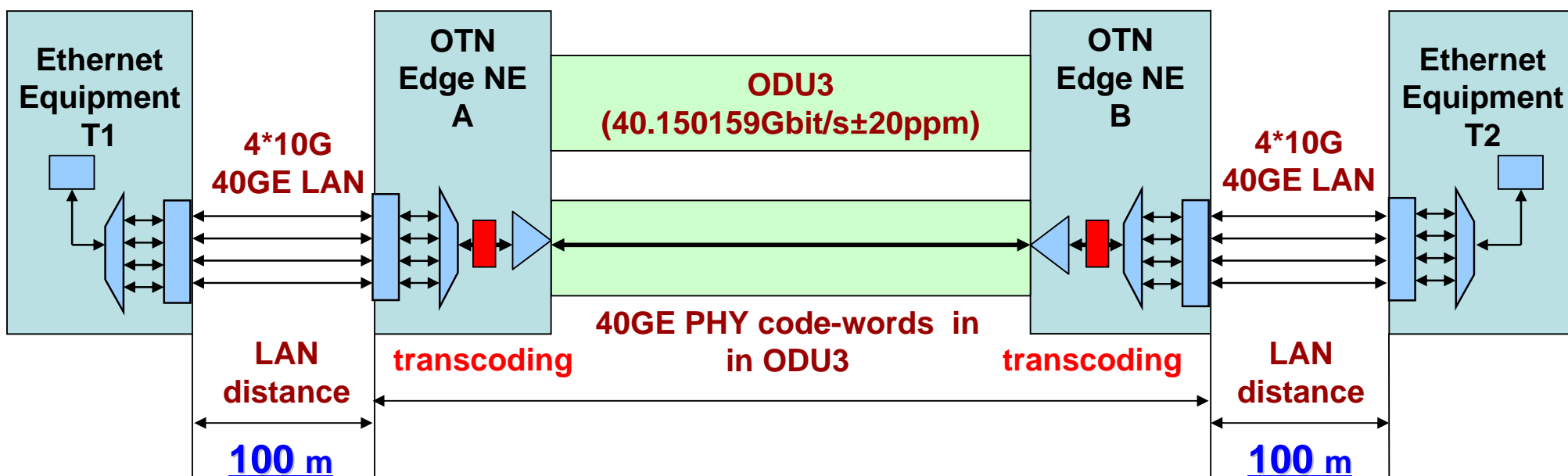
40GE OTN Support Consideration (OTU3e)



- Service provider client requires **Bit Transparency**.
- While considering “Provide appropriate support for OTN”, HSSG was talking about the standardized ODU3/OTU3, not an OTU3e.
- However, there has been some discussion of overclocked OTU3e in ITU-T. If ITU-T defines ODU3e/OTU3e, HSSG has no further work for OTN support for 40GE.
- Studies under way to make it a network solution rather than point to point solution.

If ITU-T proceeds with this alternative, there is no work for IEEE.

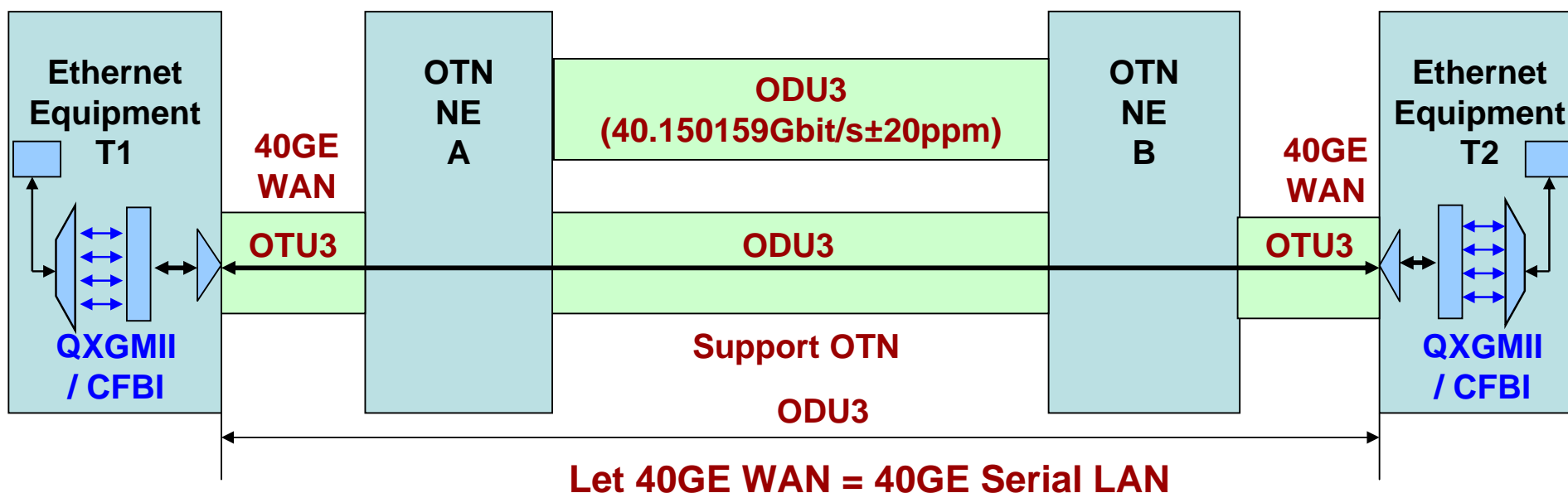
40GE OTN Support Consideration(PHY Transcoding)



- **40GE OTN Support : Transparent transmission of 40GE PHY code-words with transcoding**
 - OTN Edge NE A, B do lane skew compensation generated in the LAN interface distance separately in the ingress point while terminating the Multi-lane Ethernet PHY
 - T1, T2 do lane skew compensation generated in the LAN interface distance separately
- **Multi-lane alignment Markers could be transported if required, and should be transported for complete 40GE PHY code-word transparency**
- **The 40GE signal could traverse many OTN network domains**

IEEE needs to define 64/66b block code-word transcoding.

40GE OTN Support Consideration (WAN Interface)



- 40GE WAN interface (similar to 10GE WAN) is a serial interface signal and the signal transition would not generate Skew and Differential Delay. Skew issues are limited to the electrical interface.
- PHY code-word transcoding could enable 40GE fit in the ODU3 payload area.
- OTN equipment does not need to develop 40GE transport interface line card. OTN network and Ethernet equipment are interoperable.

40GE could provide this support for OTN; but poor history with 10GE WAN reduces interest in this option.

ITU-T Q11/15 Oct15-19 Interim meeting in Shenzhen

- There has been discussion in ITU-T for an evolved OTN hierarchy to support HSE (10GE/40GE/100GE) after HSSG started discussions of 100GE in 2006.
- The most recent **ITU-T SG15 Q11 meeting**, was held in Shenzhen on **Oct 15-19**.
- The requirement to transparently transport **10GE LAN PHY** interfaces made ODU2e/OTU2e (over-clocking) the only solution for 10GE LAN PHY signal to be carried over OTN network. ITU-T OTN hierarchy is now facing the requirement for supporting GE, 10GE, 40GE, and 100GE transport.
- The meeting generated **a table of client signals** for considering the evolution of OTN to 100G. The client signal list includes **GE, 10GE, 40GE, and 100GE**.
- ITU-T SG15 Q11 discussed possible mappings of **4x10GbE LAN PHY into ODU3**.
 - **Transcoding** of 4x10GbE LAN PHY into ODU3
- It seems the mapping of 4x10GbE LAN PHY into standard ODU3 has far more support than the over-clocked ODU3 solution.
- However, there is also a requirement for carrying **4x10GbE LAN PHY** signals in an ODU3 like signal with **full bit transparency** (i.e. **over-clocked ODU3e/OTU3e signal**).

ITU-T Q11/15 Oct15-19 Interim meeting in Shenzhen

- OTU3 was originally defined to transport STM-256/OC-768 client rather than 40GbE. **40GE** is expected to be carried over the deployed standard OTN transport network at 40 Gbit/s in ODU3 (ODU3 has a payload rate of 40,150,519.322 kbit/s \pm 20 ppm).
- For 40GE, PHY layer PCS coding will be one of the key points that determines whether we could make 40GE and OTN meet at standardized OTU3/ODU3.
- Transcoding of 64/66b code-words was discussed as a expected solution for 40GE to meet the standard ODU3 in OTN hierarchy. Mapping 40GE signals into standard ODU3 has far more support rather than in an over-clocked ODU3e signal.
- However, transcoding was thought to be not exactly a transparent transport solution for 40GE with 64/66b 41.25Gbps PHY Layer signal. Overclocking (ODU3e/OTU3e) was also presented as a solution for OTN to support 40GE at the meeting. But this will cause much confusion for the already deployed OTN hierarchy.

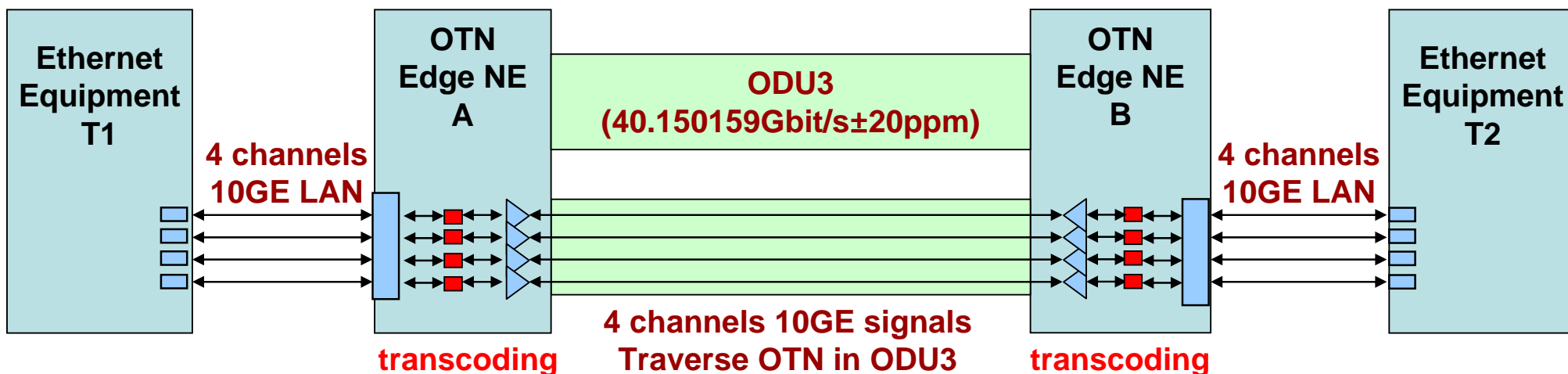
ITU-T Q11/15 Oct15-19 Interim meeting in Shenzhen

- Finding a solution to support 40GE in a standard ODU3/OTU3 could also provide a solution for 4x10GE LAN PHY signal transport in an “OTN friendly” standardized ODU3/OTU3.
- After discussion at the meeting, the below new concept was presented:
- In NG OTN, a “wrapper (i.e. ODU per service (with or without bundling))” is mandatory for every client signal. The service includes Individual service and Bundled services.
 - Individual services: each client_CI instance is wrapped into an ODU;
 - Bundled services: a set (bundle) of client_CI is aggregated and the aggregate is mapped into an ODU.
- Since 40GE may be defined as a four-lane parallel interface, we would like to make both 40GE and 4x10GbE LAN PHY signals compatible with the standardized ODU3/OTU3 rate.
- Next we review the consideration of “provide appropriate support for OTN”; and raise the idea to support both 40GE and 4x10GE.

40GE and 4x10GE OTN support

- **Additional requirements for mapping 4x10GE in standard ODU3/OTU3:**
 - The mapping should be suitable for transporting Ethernet timing
 - If possible, each 10GE should be manageable in the OTN domain, transported with the overhead of an ODUk is preferred.
 - If possible, each 10GE should be independently switch-able. Make it a network solution (rather than point-to-point).
 - If possible, each 10GE should fit into a standard ODU2.
- **The next page shows an approach to make each 10GE manageable.**
- **We use OAM 64/66b code-words for 10GE LAN PHY signals OAM. Those OAM code-words are then transcoded together with other 10GE LAN PHY 64/66b code-words. .**
- **When transporting a 40GE LAN PHY signal, we could use those OAM code-word spaces for Alignment Marker transport.**

4x10GE OTN Support Consideration

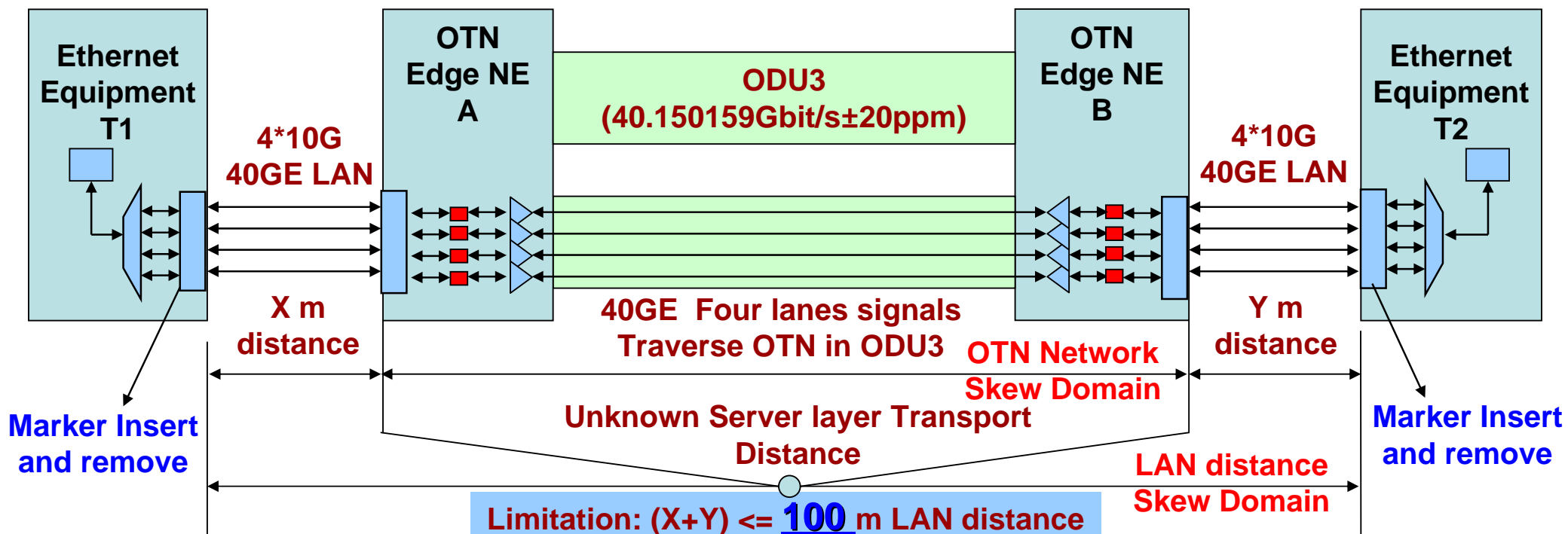


Code word space used for 10GE performance monitoring (OAM) in each 10GE LAN signal within an ODU3 can be used for 40GE alignment marker transport for lane skew and differential delay compensation.

IEEE needs to define the 64/66b block code-word transcoding.

We could then compatibly provide appropriate support for 4x10GE in ODU3 and consider appropriate support for 40GE in ODU3.

40GE OTN Support Consideration (PHY Lane)



- **40GE lanes transported independently but bundled to traverse OTN network domain**
 - OTN Edge NE bonds the four lanes together but does not do lane skew compensation (generated in the LAN interface domain) at the ingress point
 - T1, T2 do lane skew compensation generated in the LAN interface distance (X+Y) meters
- **Multi-lane alignment Markers must be transparently transported**
- **The total LAN interface span distance is limited by the LAN interface de-skew capability**

IEEE needs to define the 64/66b block code-word transcoding.

Summary

- **40GE OTN support in overclocked ODU3e/OTU3e**
 - Need to collaborate with ITU-T; prefer a standard ODU3 to ODU3e.
- **40GE OTN support in standardized ODU3/OTU3 (PHY Lane aggregated)**
 - Need to aggregate multi-lane signals, thus need to do skew compensation:
- **40GE OTN support in standardized ODU3/OTU3 (PHY Lane Independently)**
 - Lane independent mapping, do not need skew compensation at OTN NE
- **40GE WAN interface with ODU3/OTU3 format**
 - Not a successful idea for 10GE.
- **While providing appropriate OTN support for 40GE in ODU3, we should also consider providing compatible OTN support for 4x10GE LAN in ODU3. PHY lane independent mapping could enable this.**
 - Thus also providing 4 channels of 10GE support for OTN.
 - PHY lane independent transport of 40GE in ODU3 could enable compatible designs for supporting both 40GE and 4x10GE in ODU3.

Study is under way in ITU-T for 4x10GE LAN PHY signal transport in ODU3.

Thank You

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