Mapping of 100 Gbit/s Ethernet into OTN and the need for a Lane Independent PCS

IEEE 802.3 Higher Speed Study Group

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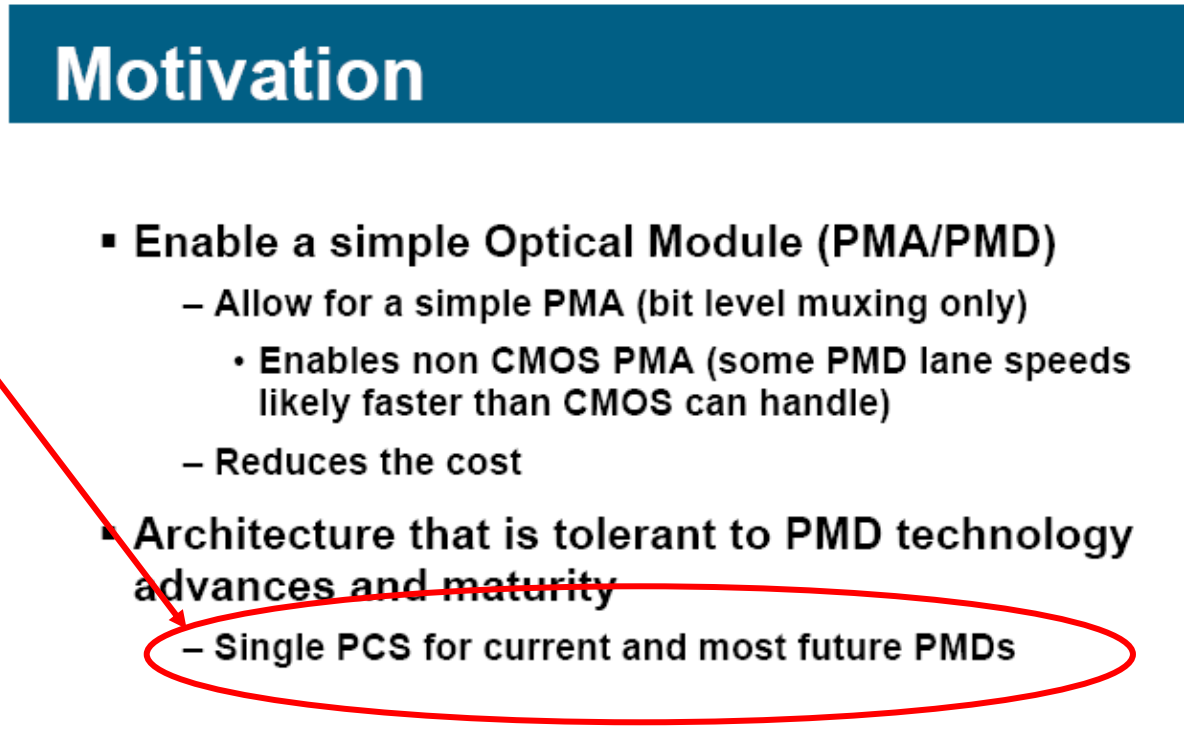
Supporters

- Martin Carroll -Verizon
- Ralf-Peter Braun - Deutsche Telekom, AG
- Ted Woodward – Telcordia
- Ghani Abbas –Ericsson
- Arne Alping – Ericsson
- George Young – AT&T

Requirements addressed by gustlin_0107

- Not every PMD has the same number of "lanes"
- The number of lanes of the CBTI is not necessarily the same number of lanes of the PMD
- ALL PMDs should use the same PCS! Not just "most"



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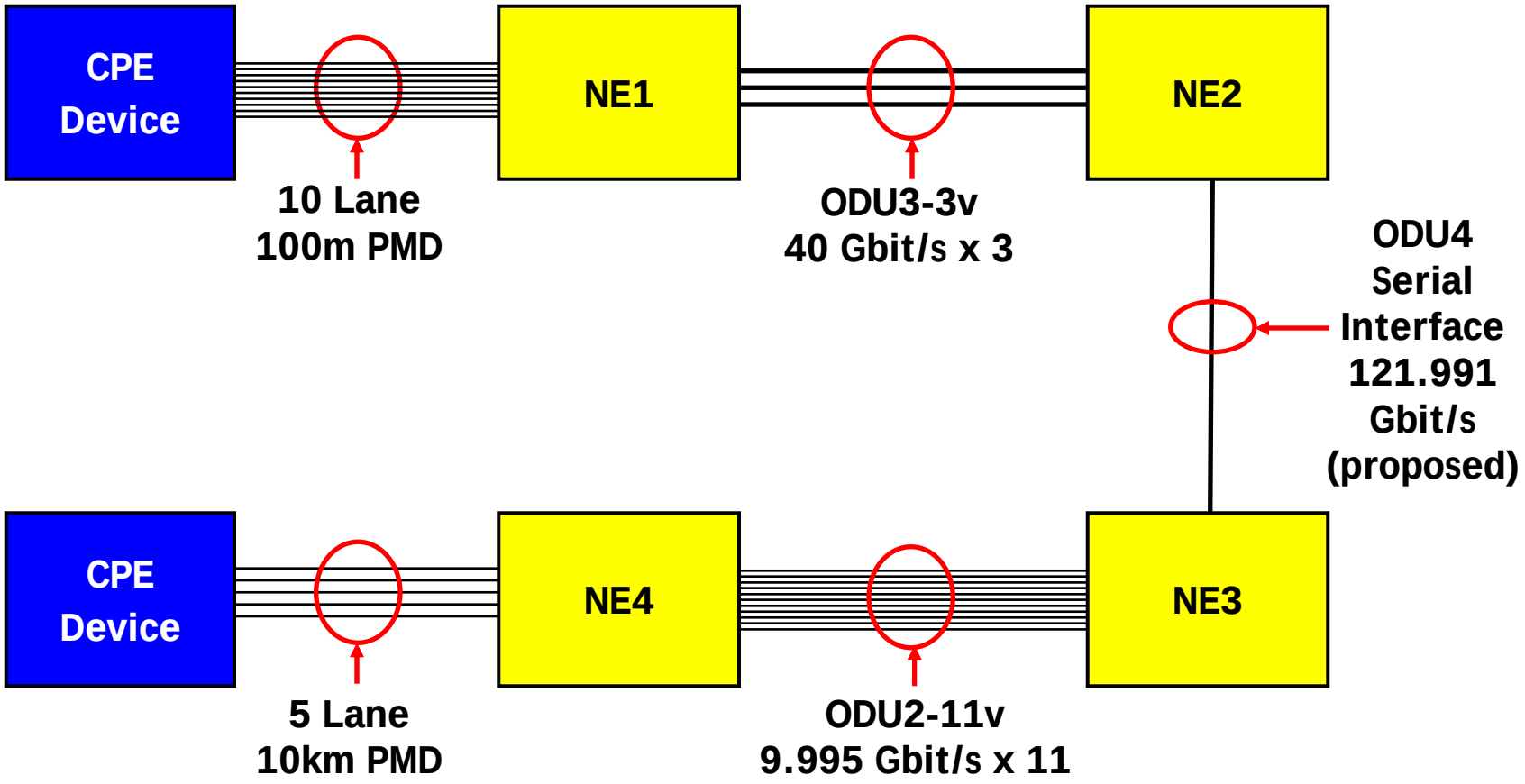
Examples of Differing number of Lanes for 100 Gbit/s Ethernet in LAN and transport networks

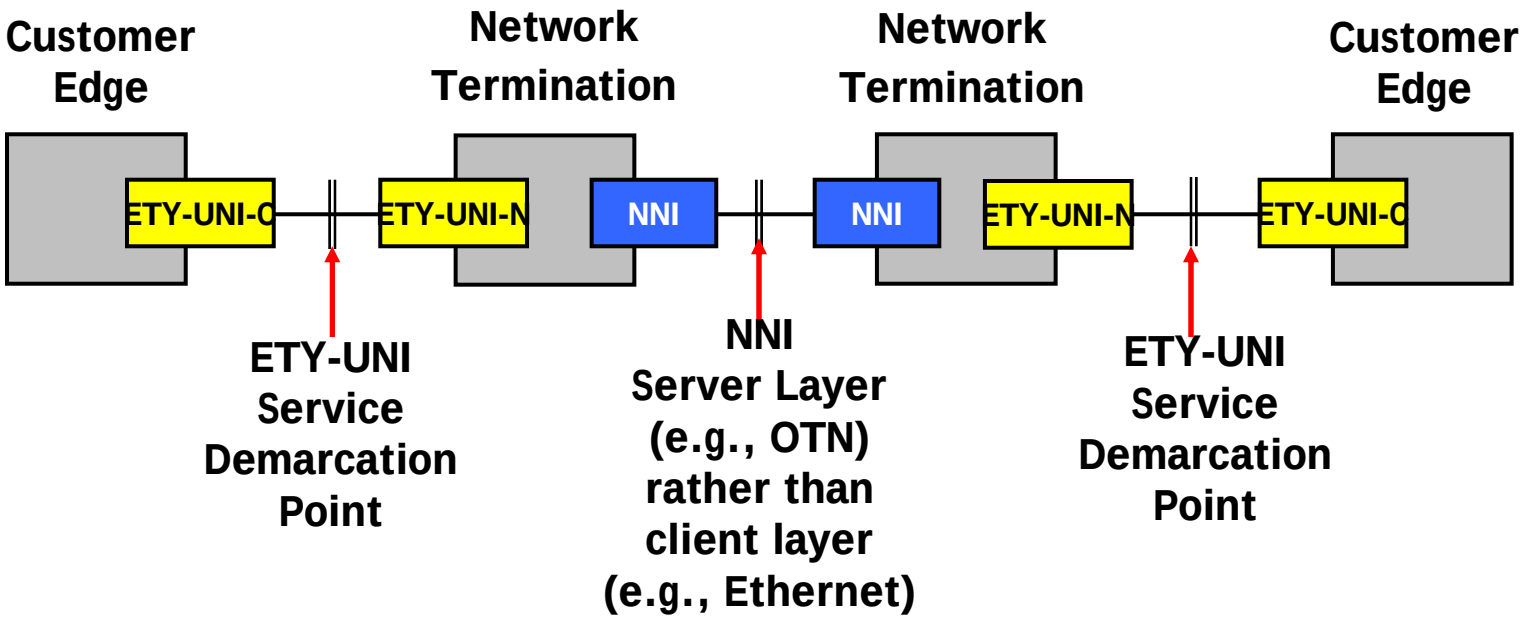


Common Electrical Interface and PCS enables not only different numbers of lanes in each PMD, but “stitching” together spans with different lane counts to provide the end-to-end service

Some ITU-T Ethernet Terms

ETYn	Ethernet Physical Layer of order n n=1 10 Base n=2 100 Base n=3 1000 Base n=4 10G Base *n=5 100G Base*
ETCn	Ethernet Physical Coding Layer (PCS) of order n
ETH	Ethernet MAC Layer Network Non-continuous flow of traffic units (DA, SA, MAC SDU)
ETH_FP	Flow point of Ethernet MAC Layer Network

Ethernet over Transport Networks – OTN Example



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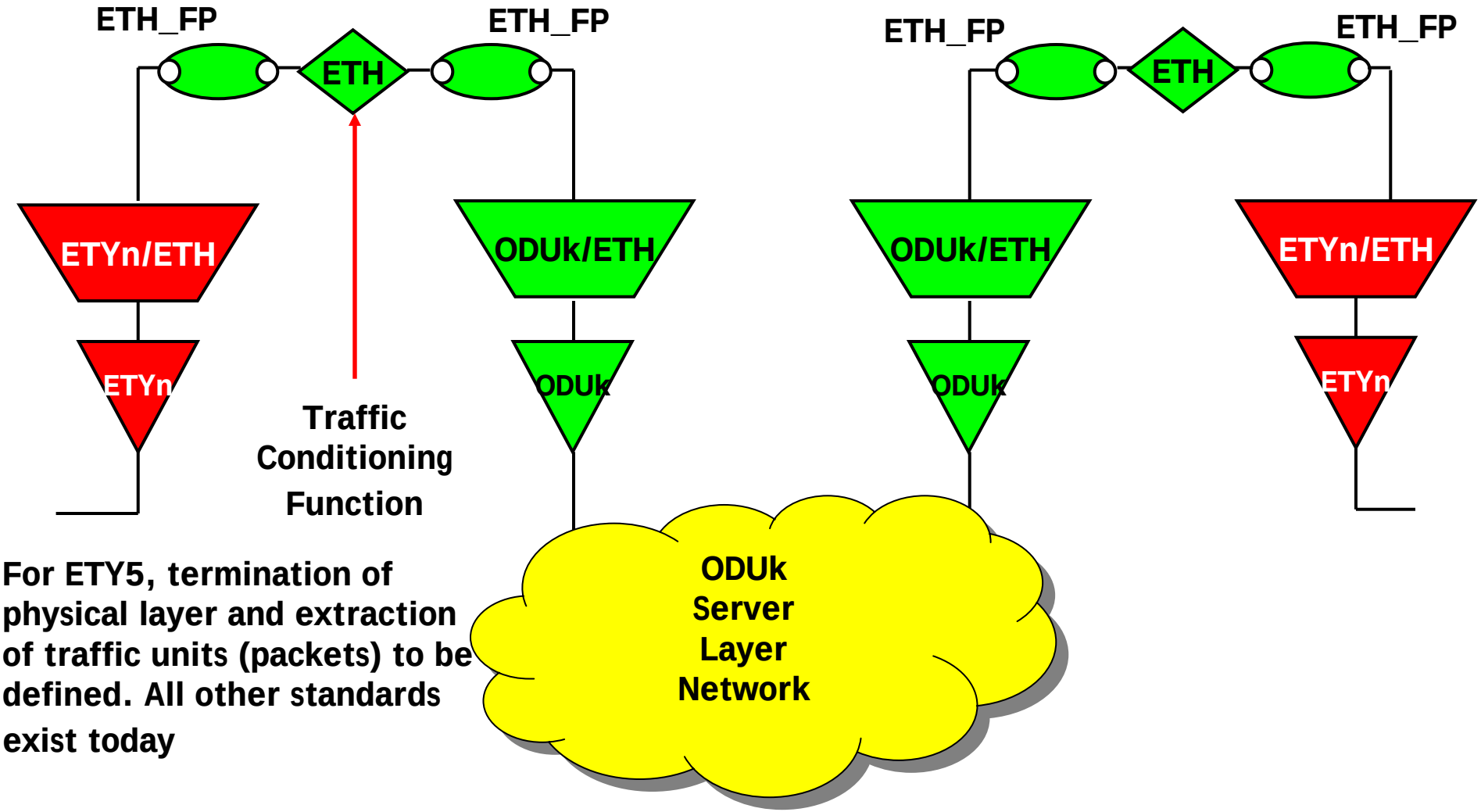
Ethernet Services supported between UNI demarcation points

- Ethernet Private Line Service – Point to Point full-duplex connection between two Ethernet UNIs over a dedicated server layer network
  - Type 1 – ETH Layer Network Connectivity – the Ethernet packets received at the ingress UNI are delivered to the egress UNI. Example:
    - GFP-F encapsulation of Ethernet frames over SDH or OTN networks
  - Type 2 (and Type 2+) – ETCn Connectivity at the PCS sublayer. Examples:
    - 10G Base-W transporting 64B/66B encoded data as STM-64
    - 1G Base signal with 8B/10B encoded data transported via GFP-T as VC-4-7v
    - 10G Base-R signal transported via over-clocked ODU1e/ODU2e (per G.sup43)
- Ethernet Virtual Private Line Service – Point to Point full-duplex connection (ETH) between two Ethernet UNIs over a shared server layer network
- Ethernet Virtual Private LAN Service – Multi-Point to Multi-Point connection between multiple Ethernet UNIs
- Ethernet Tree (E-Tree) Service – Root to (multiple) Leaf connectivity – e.g., BRAS to Subscriber
- **Note: EPL Type 2(+) Services are the ONLY types of services where connectivity is at the PCS sublayer rather than the MAC/Packet Layer**

Modeling of EPL Type 1 Service

Similar principles apply to EVPL, EVPLAN, E-Tree

Ethernet Private Line Service – Type 1 into ODUk Server Layer Network



For ETY5, termination of physical layer and extraction of traffic units (packets) to be defined. All other standards exist today

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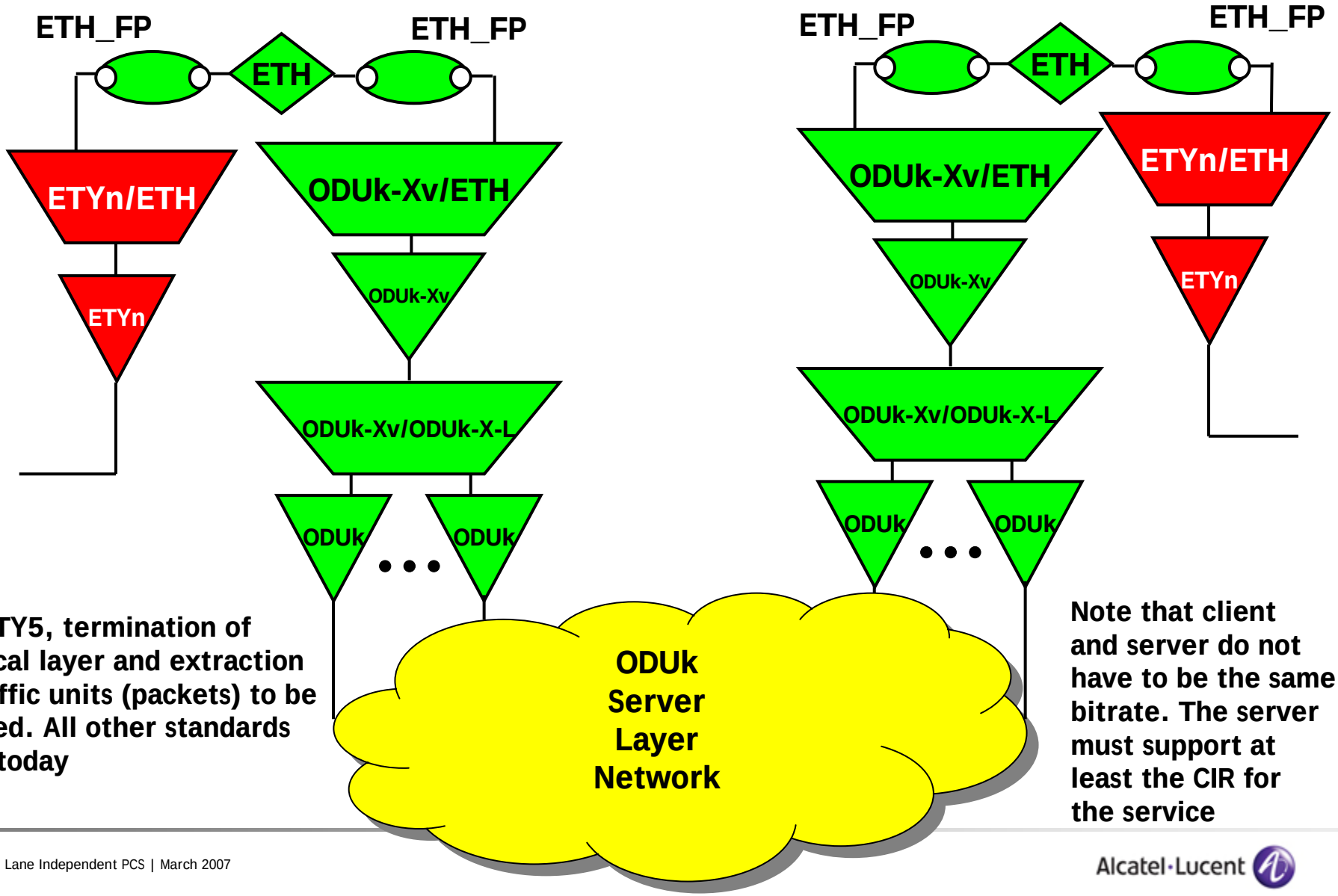
Ethernet Private Line Service – Type 1 –
Virtual Concatenation into lower rate Server layer



For ETY5, termination of physical layer and extraction of traffic units (packets) to be defined. All other standards exist today

Note that client and server do not have to be the same bitrate. The server must support at least the CIR for the service

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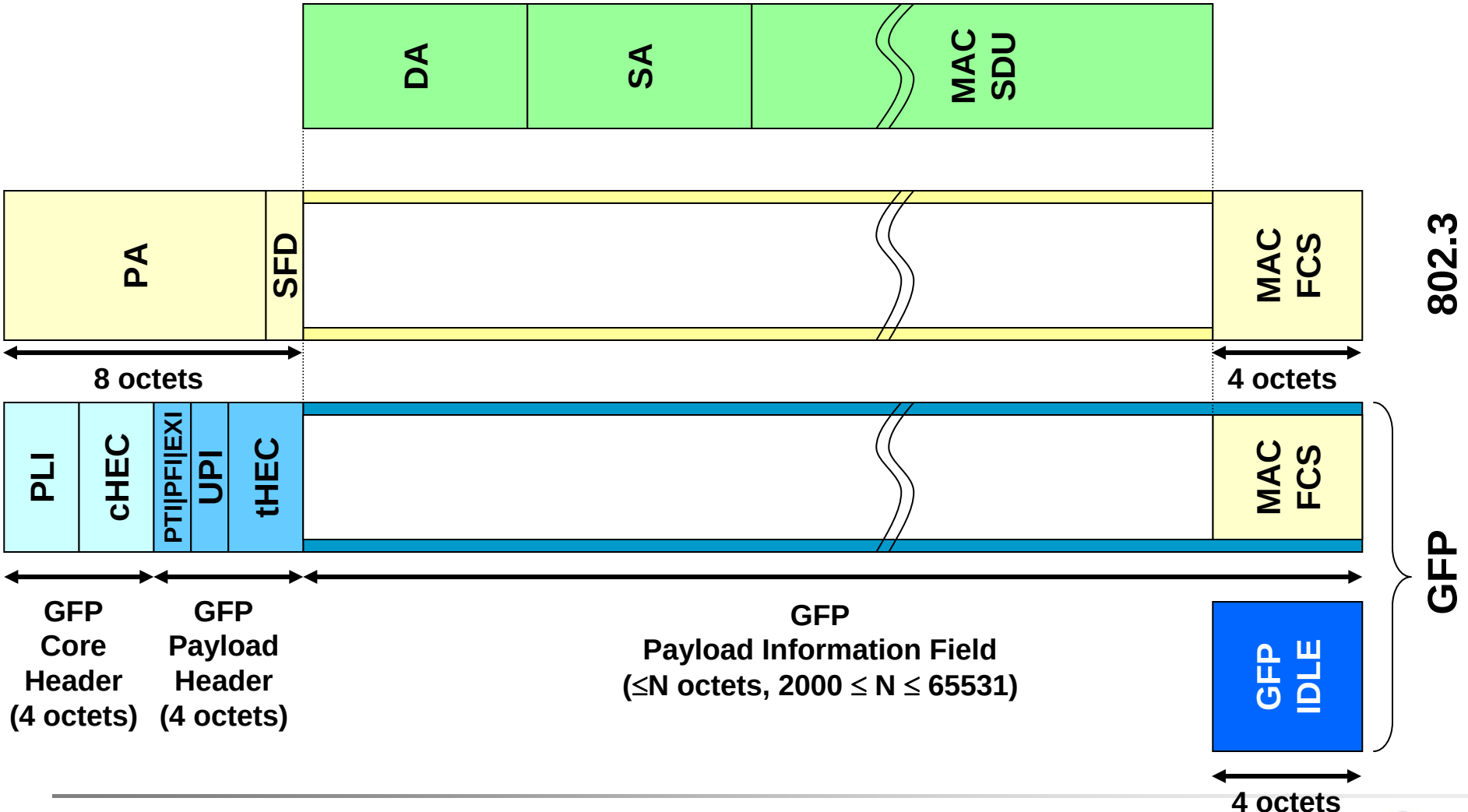
Encapsulating Ethernet Frames in 802.3 & GFP
Part of ETH/ODUk or ETH/ODUk-Xv Adaptation

ODUk-Xv/ETH



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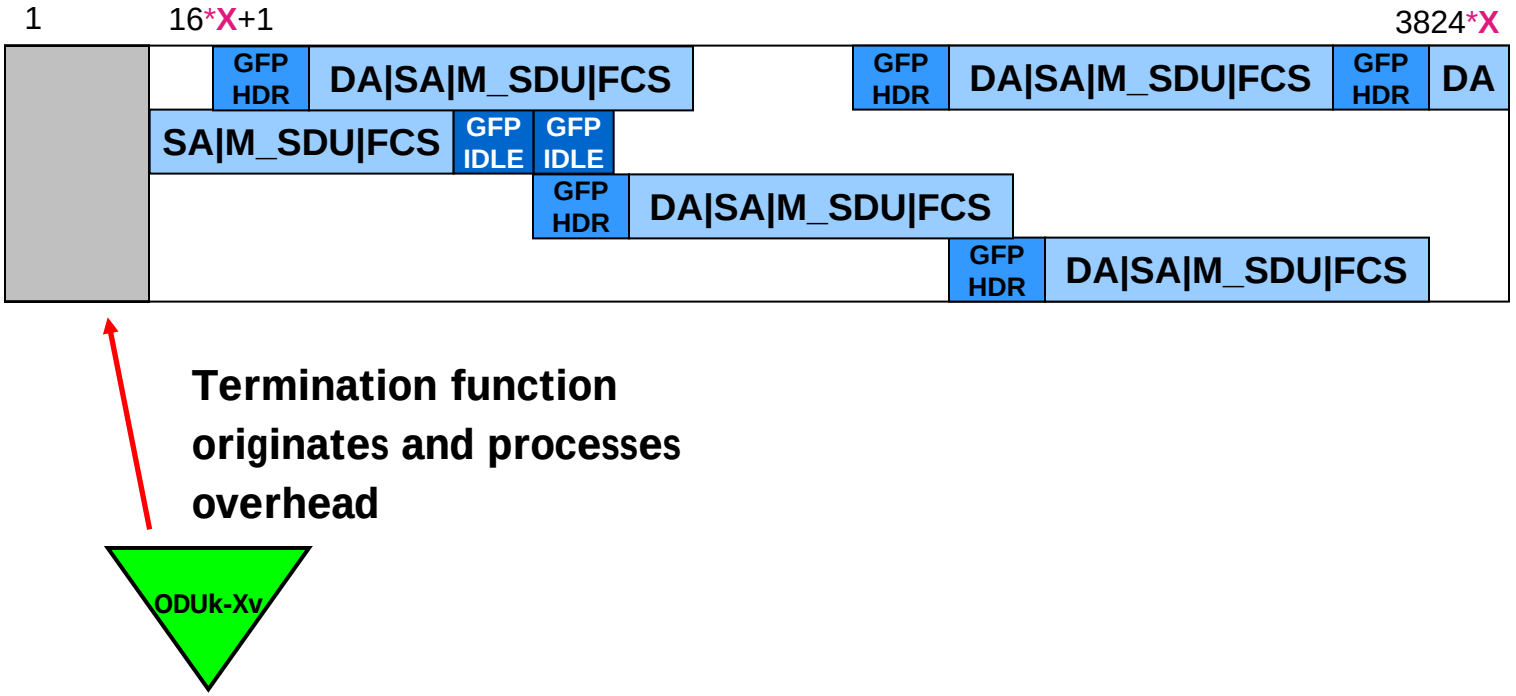
Insertion of MAC frames into ODUk-Xv payload area remainder of ODUk-Xv/ETH adaptation function



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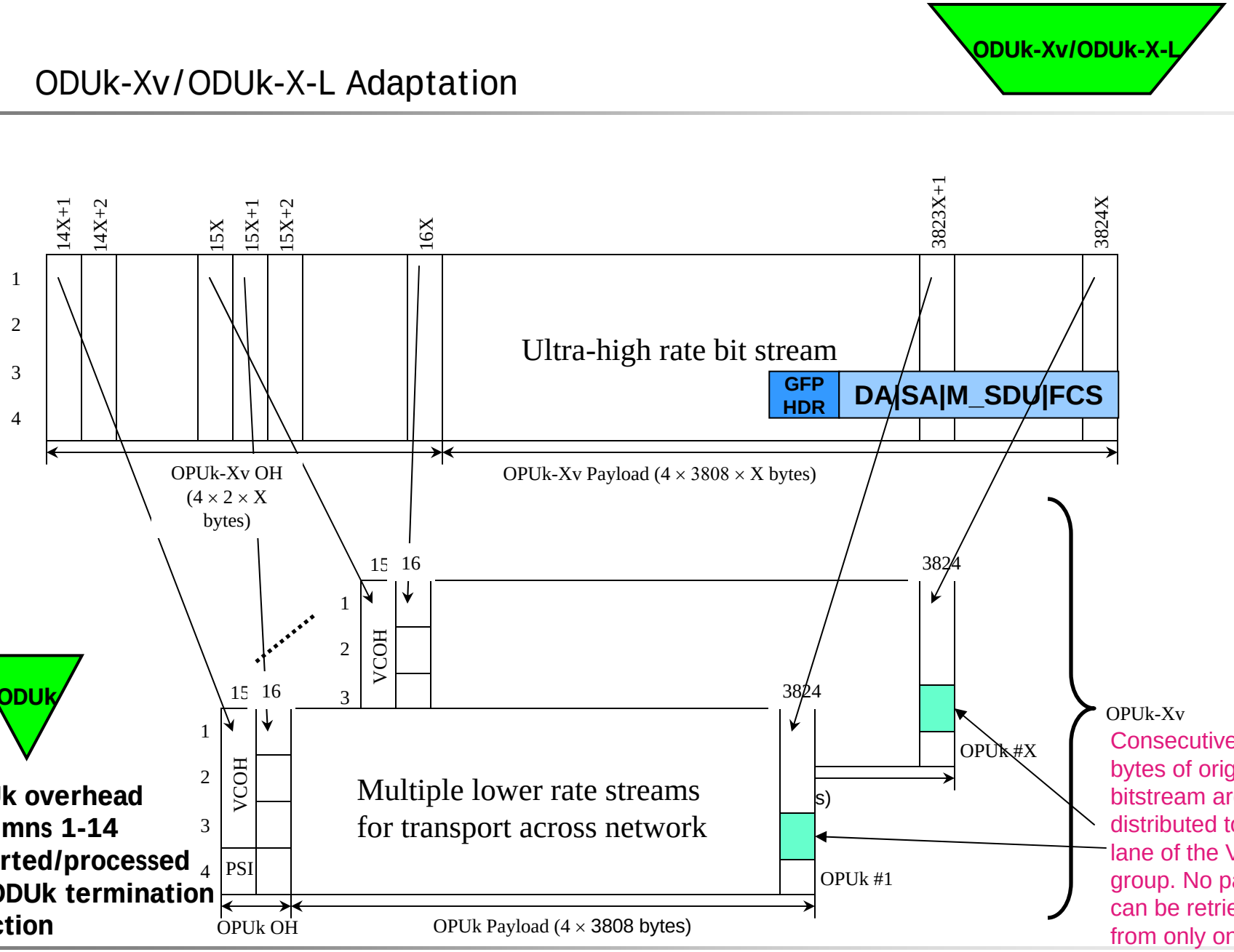
ODUk-Xv/ODUk-X-L Adaptation



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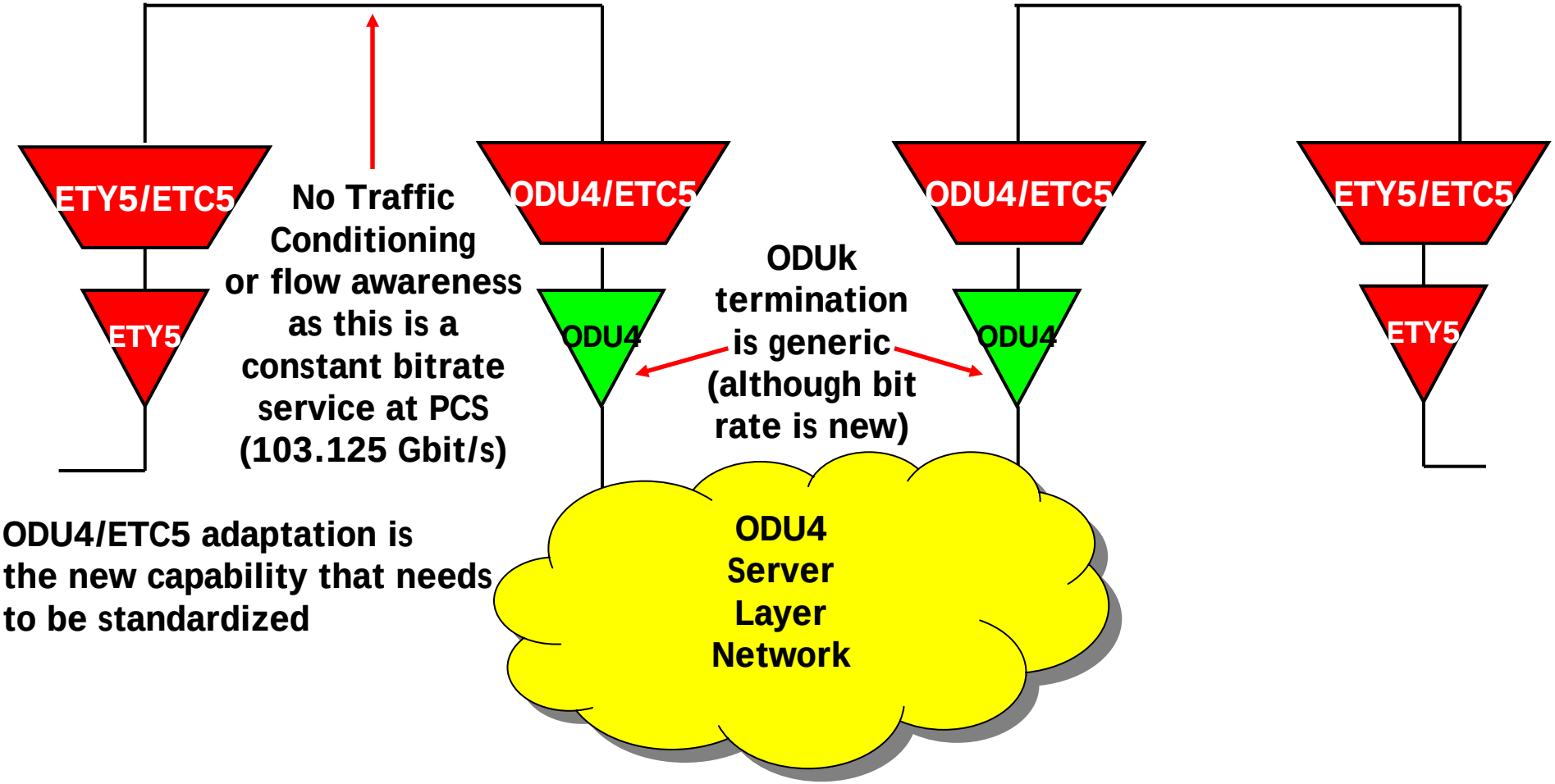
Modeling of EPL Type 2+ Service

Why would you need EPL type 2+ instead of EPL type 1?

- Support a variety of Ethernet "like" signals
- Proprietary use of the Preamble and/or IPG
- Proprietary use of PCS encoding
- Encrypted signals that must be bit transparent to support the coding

Ethernet Private Line Service – Type 2+ into new ODU4 Server Layer Network



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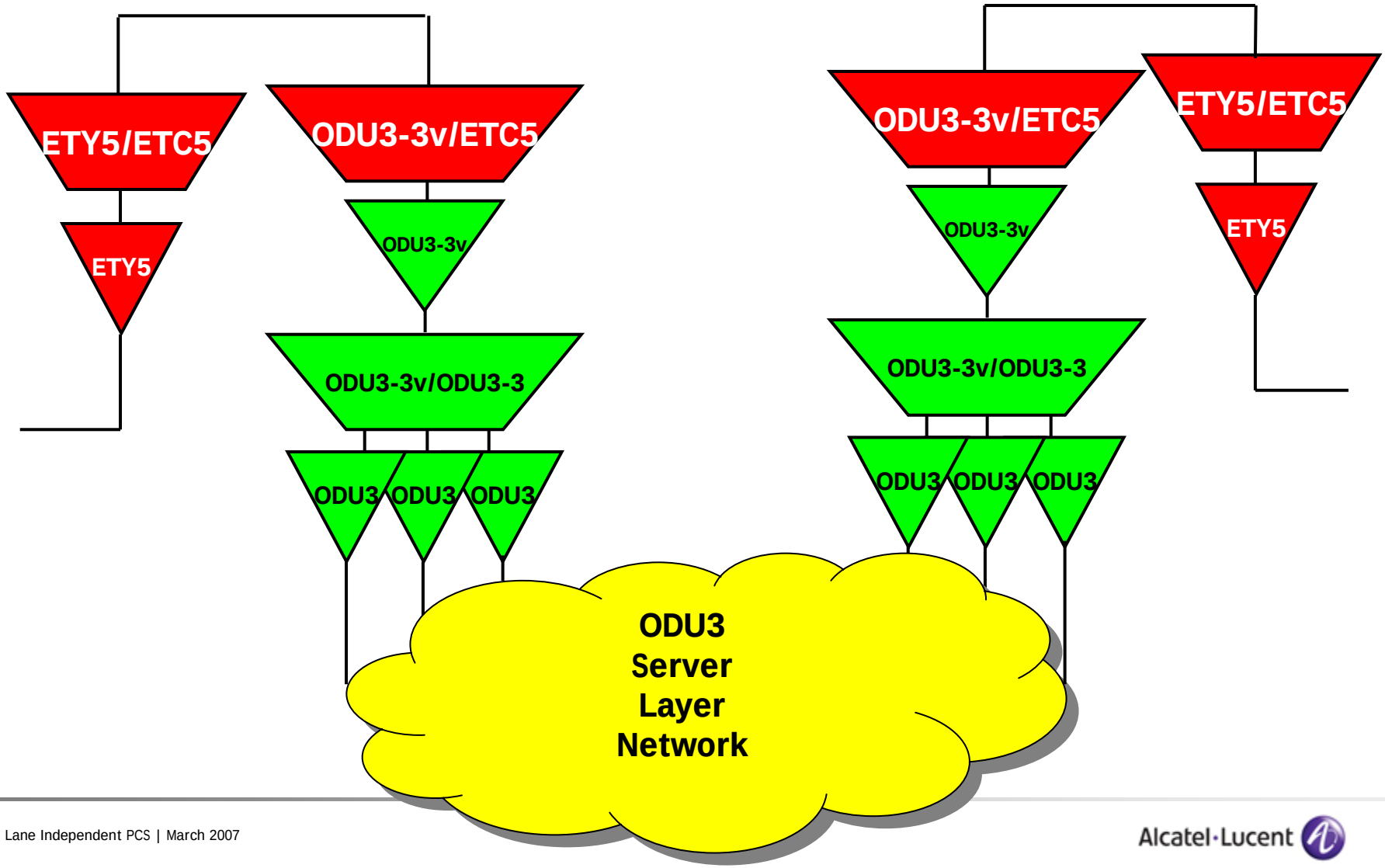
Ethernet Private Line Service – Type 2+ using Virtually Concatenated Server ODU3-3v



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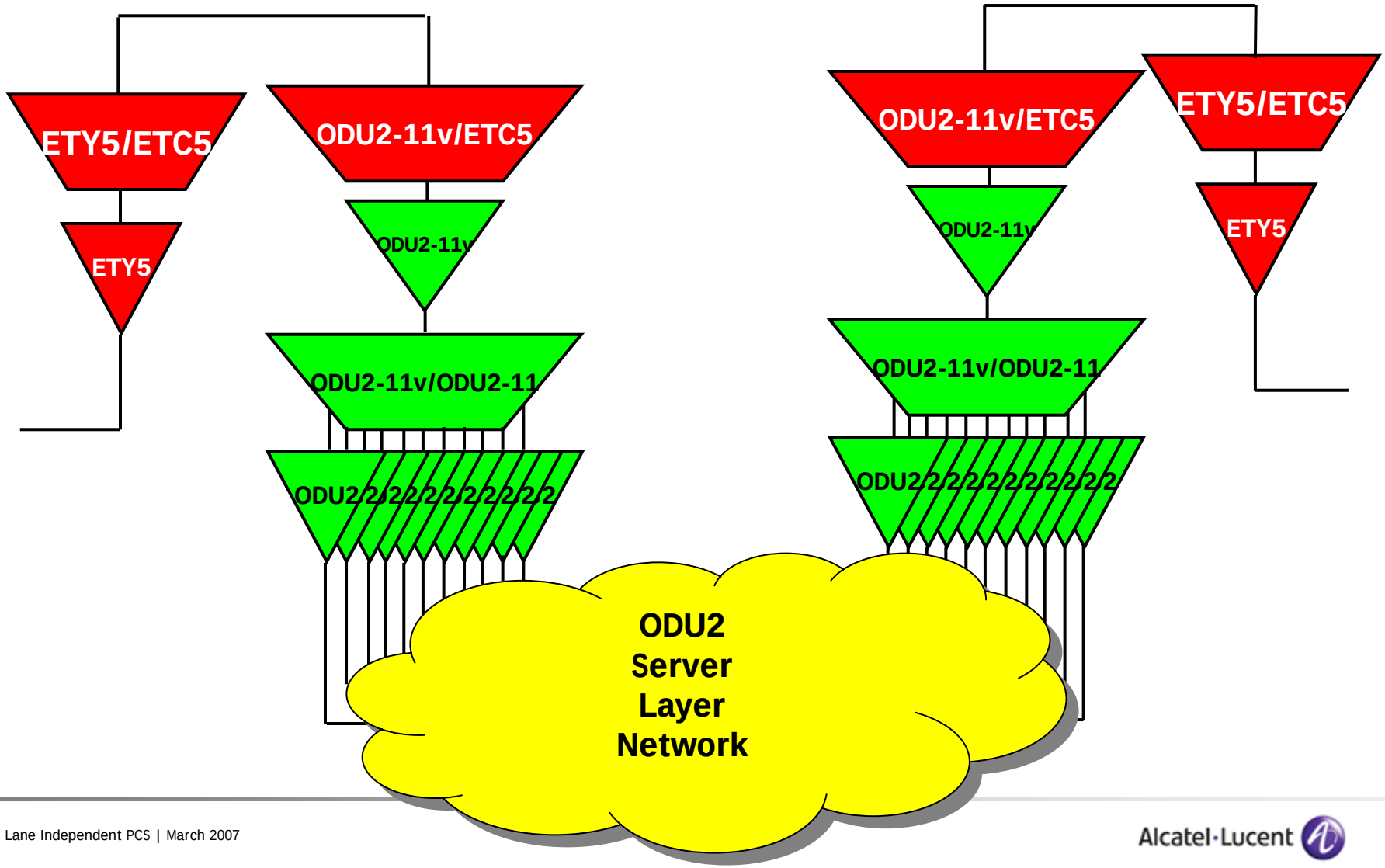
Ethernet Private Line Service – Type 2+ using Virtually Concatenated Server ODU2-11v



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How do we build ODU4/ETC5, ODU3-3v/ETC5, ODU2-11v/ETC5 Adaptation Functions

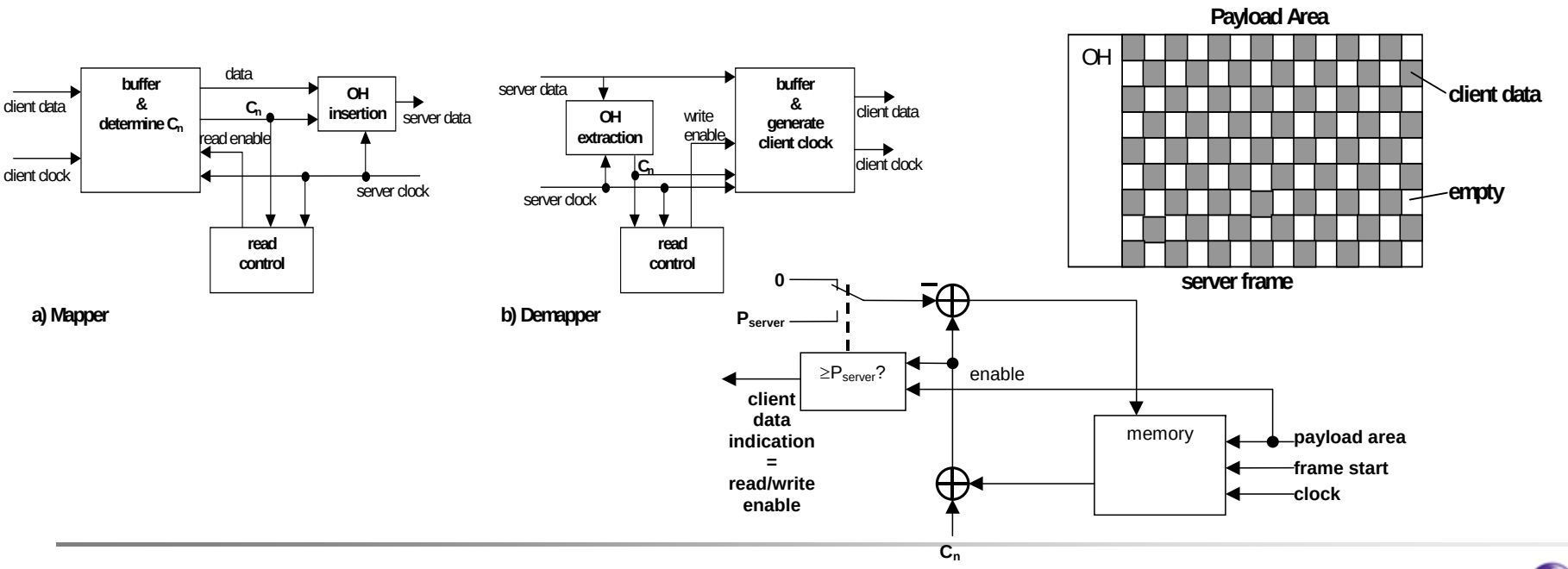
Signal	-100ppm	Nominal Bitrate	+100ppm
100 GbE	103.114 Gbit/s	103.125 Gbit/s	103.135 Gbit/s

Signal	-20ppm	Nominal Frame Rate	+20ppm
ODU2(-Xv)	82023.68 frames/sec	82025.32 frames/sec	82026.96 frames/sec
ODU3(-Xv)	329484.94 frames/sec	329491.53 frames/sec	329498.12 frames/sec
ODU4	996903.14 frames/sec	996923.08 frames/sec	996943.02 frames/sec

Mapping	-100ppm client over +20 ppm server	Nominal client bytes/frame	+100ppm client over -20ppm server
ODU2-11v 167552 bytes/frame	157135.37 bytes/frame	157154.22 bytes/frame	157173.08 bytes/frame
ODU3-3v 45696 bytes/frame	39118.09 bytes/frame	39122.78 bytes/frame	39127.48 bytes/frame
ODU4 (proposed rate) 15296 bytes/frame	12928.86 bytes/frame	12930.41 bytes/frame	12931.96 bytes/frame

Methods for Mapping of Ethernet Payload

- CBR103.125G mapping – Allocate fixed stuff bytes in ODU4, ODU3-3v, ODU2-11v frame to compensate difference in nominal bitrate. Provide variable "justification opportunities" to compensate clock rate (likely ±100ppm client, ±20ppm server)
- Use a bitrate agnostic mapping to encode a variable number of client bytes in each server frame



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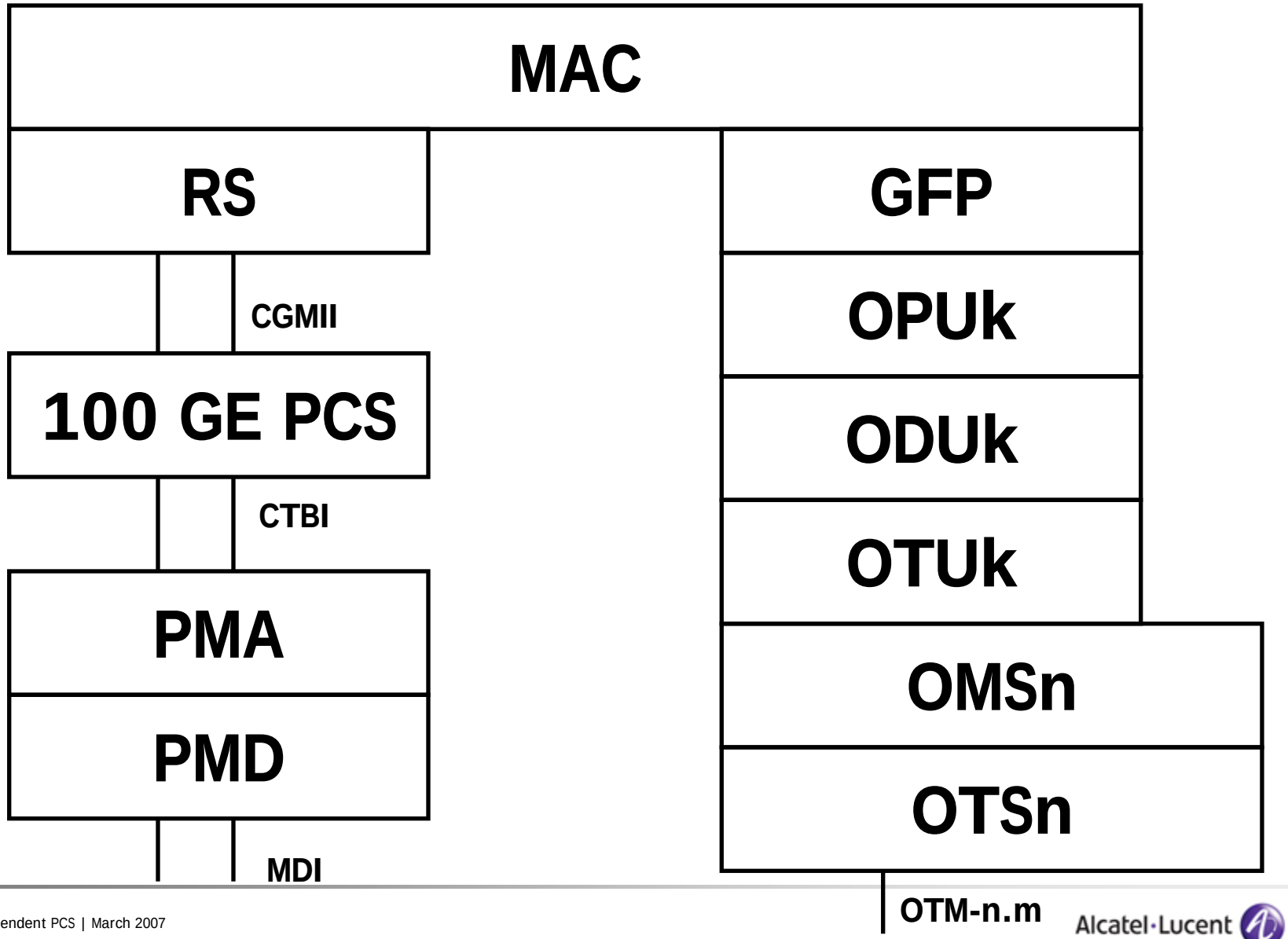
Conclusions

- A single, lane independent (and independent of LAN/MAN vs. WAN/OTN) PCS is needed both to allow a simple optical module for the LAN, but also to allow specification for interworking with optical transport networks
- For the majority of Ethernet Services (EPL type 1, EVPL, EVPLAN, E-Tree), the mapping into OTN (or any other transport technology) is at the packet level (via GFP-F encapsulation), and can be built based on existing transport standards once the 100 GbE standard is complete
- EPL type 2+ will require standardization of new mapping(s). Likely mappings of the PCS will be into ODU4, ODU3-3v, ODU2-11v. ITU-T will develop these mappings once IEEE has specified the PCS.

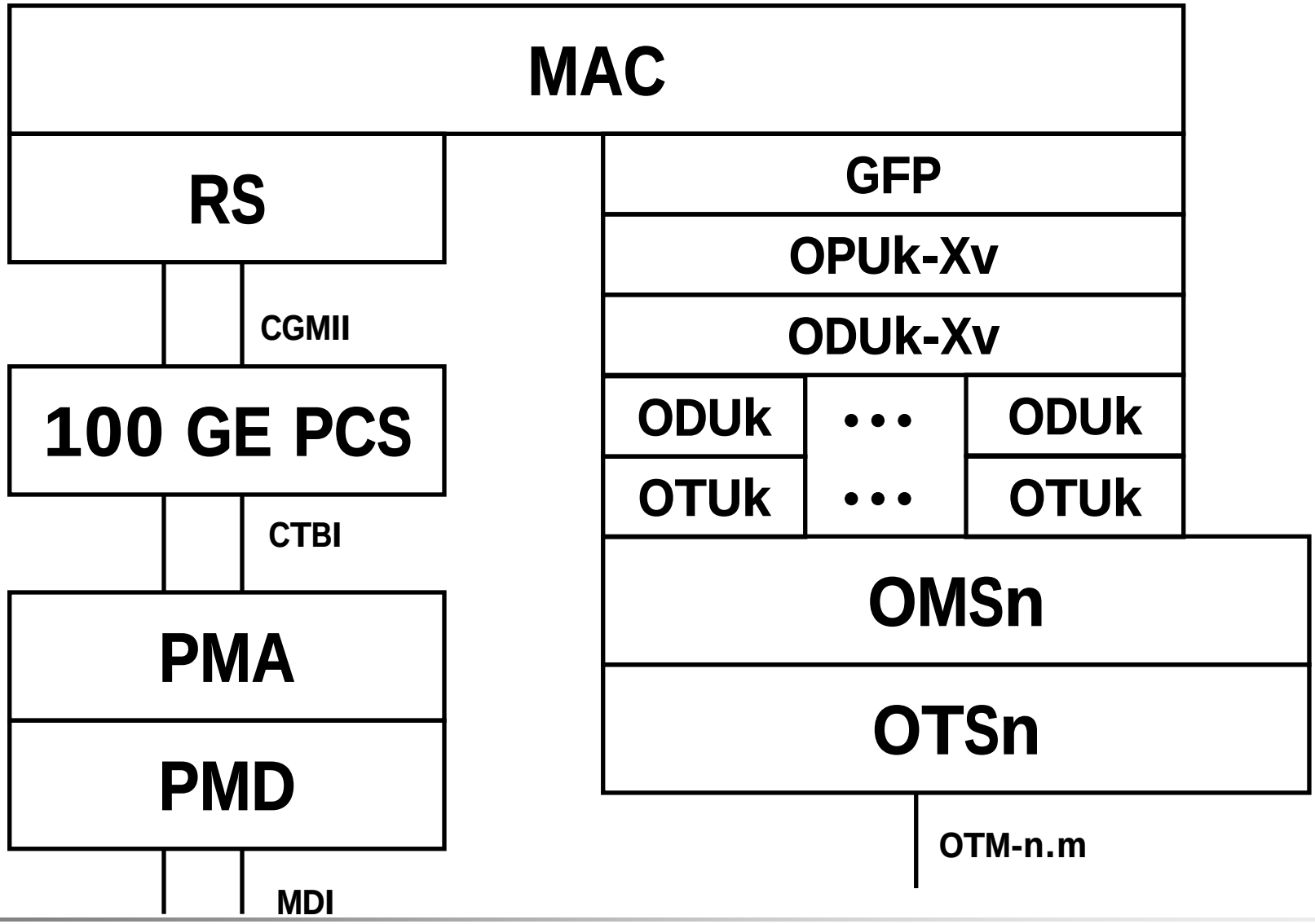
- Propose that HSSG adopt an objective to specify a single PCS for all current and future PMDs

Backup
Alternative Modeling Diagrams

Model for EPL Type 1, EVPL, EVPLAN, E-Tree into single server layer



Model for EPL Type 1, EVPL, EVPLAN, E-Tree into virtually concatenated server layer



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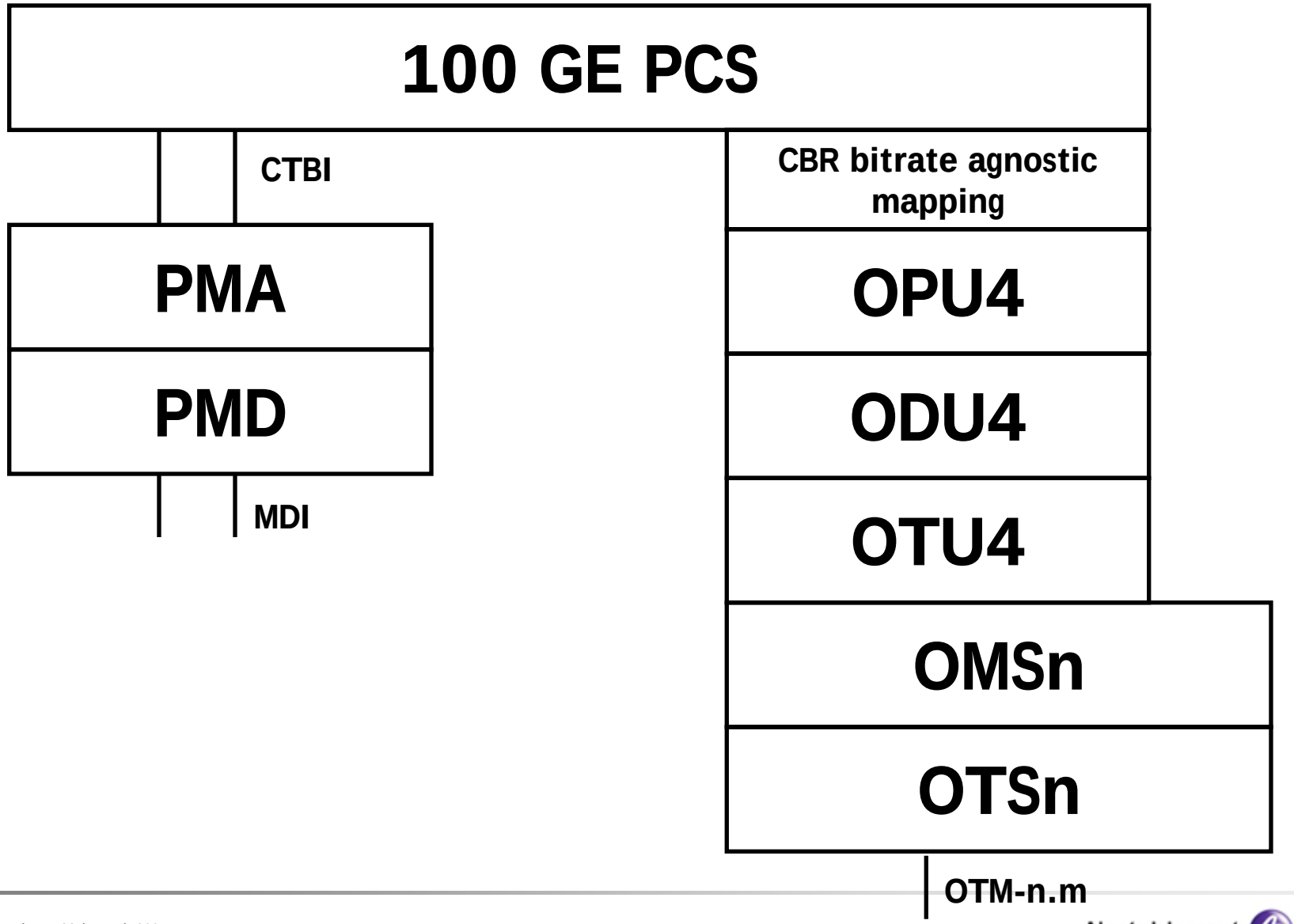
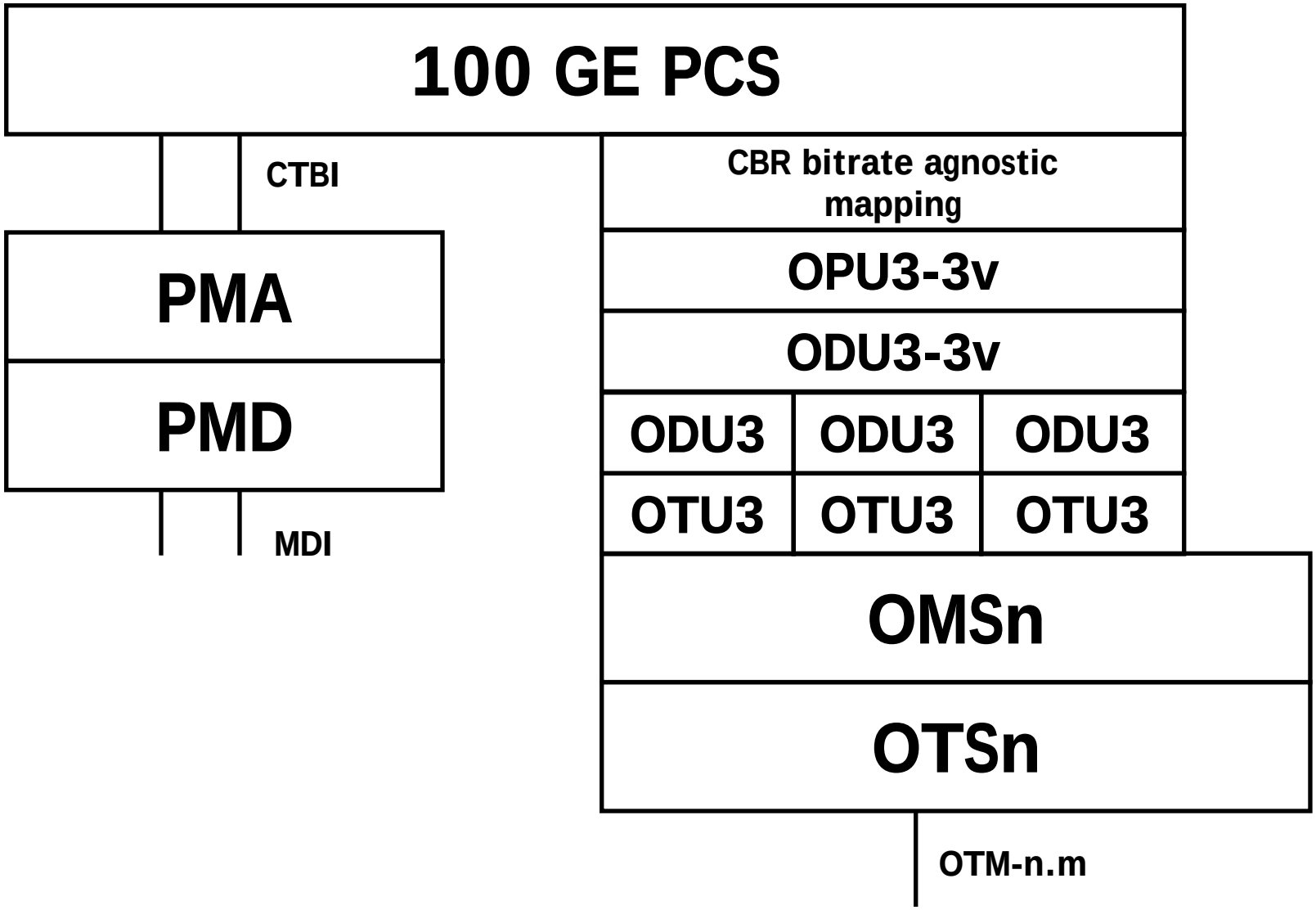
Model for EPL Type 2+ into single server layer



Model for EPL Type 2+ into virtually concatenated server layer – ODU3-3v



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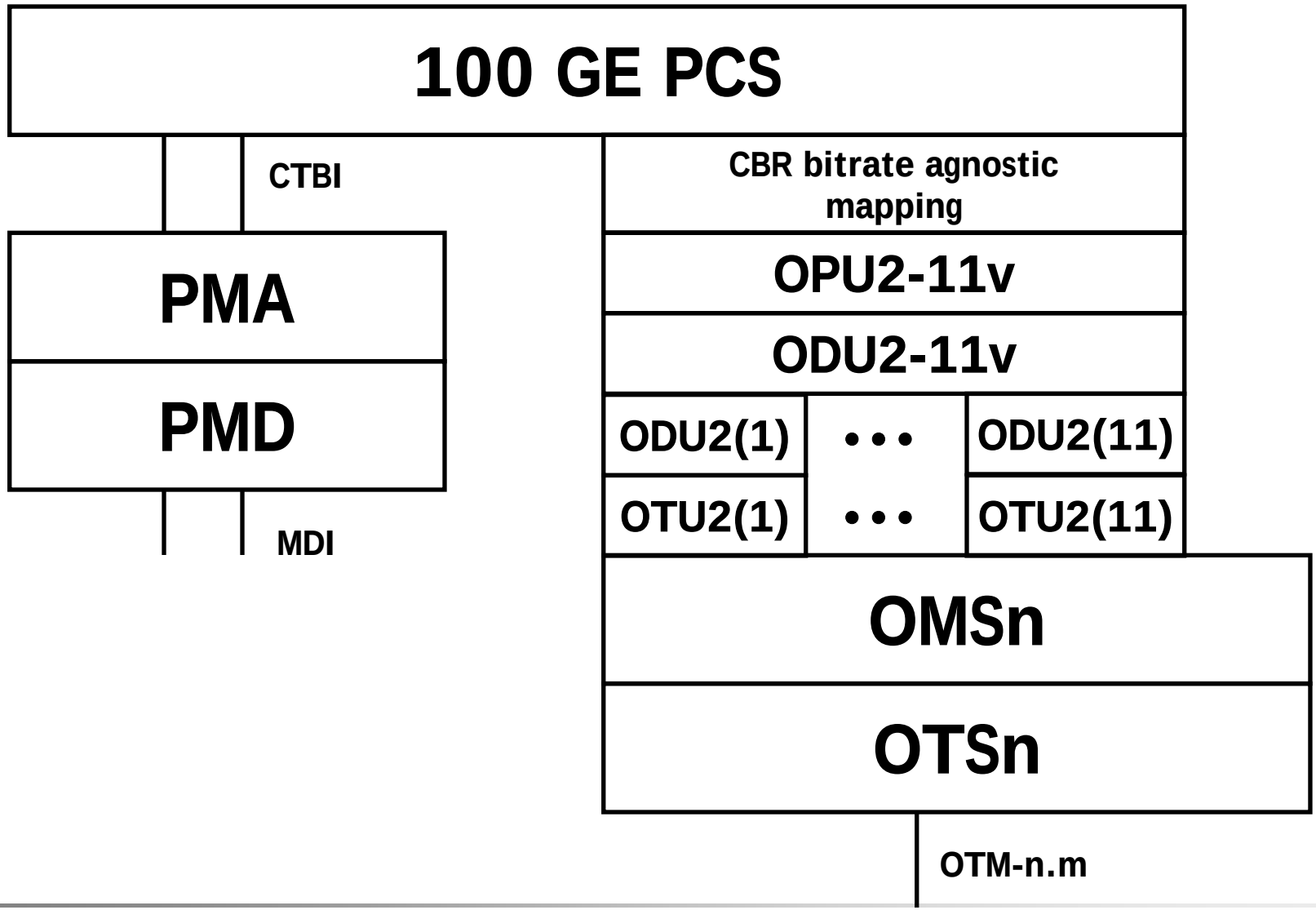
Model for EPL Type 2+ into virtually concatenated server layer – ODU2-11v



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