

ITSF 2009

Optical Transport Networks- Enhanced Hierarchy Standards

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Topics

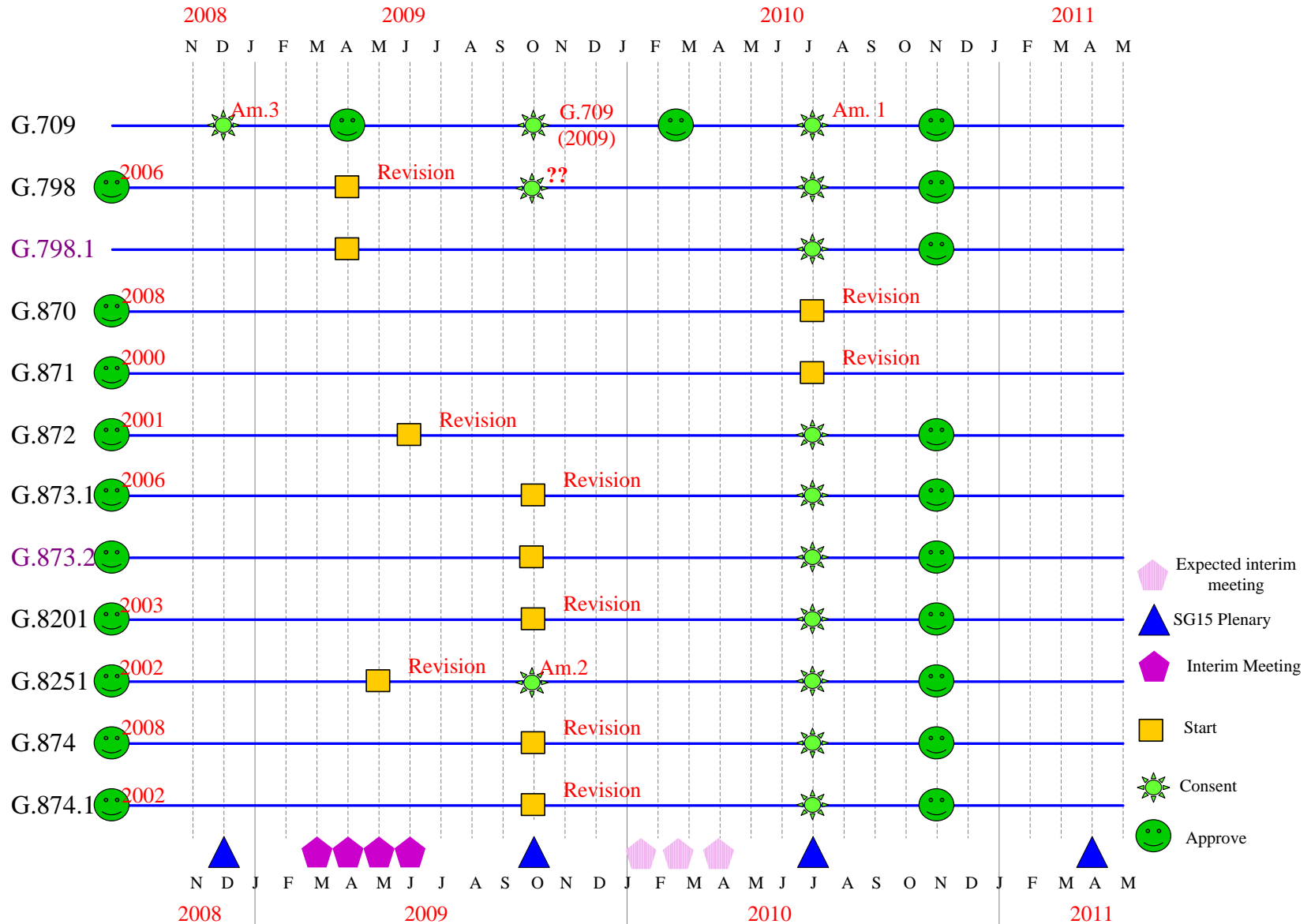
- Traffic Growth and its impact on the network infrastructure
- ITU-T OTN Standards
- G.709 : Interfaces for OTN
- G.798 : OTN Equipment functional characteristics
- G.8251 : OTN Jitter and Wander
- Conclusions

Traffic Growth and Its Impact on the Network Infrastructure

- Despite the global recession strong traffic growth is seen in mobile and broadband services (internet, IPTV etc)
- New service requirements and traffic growth puts pressure on the network infrastructure
- High bandwidth peer to peer, gaming and consumer video services demand capacity in all areas of the network
- The changing service mix requires new levels of flexibility
- Fixed DWDM delivers bulk capacity but not flexibility
- Flexible transparent DWDM offers the potential for economic service delivery, but the technology is still evolving
- OTN provides flexibility, performance, resilience and OAM

OTN emerging to “replace” SDH OTN is complementary to WDM

ITU-T OTN Recommendations



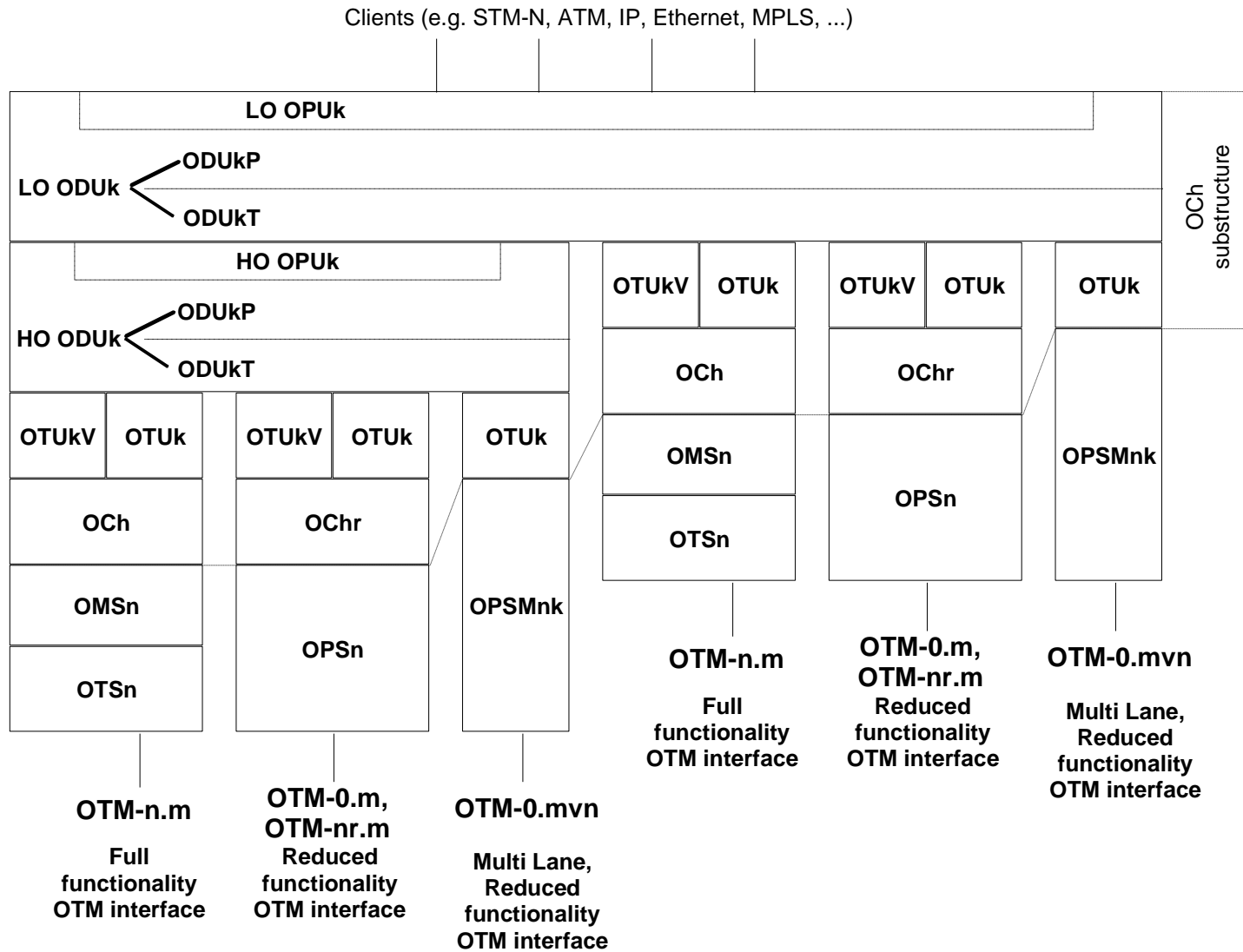
G.709 : Interfaces for the Optical Transport Network (OTN)

This Recommendation defines the requirements for the transport of optical transport module of order n (OTM n) signals of the optical transport network, in terms of:

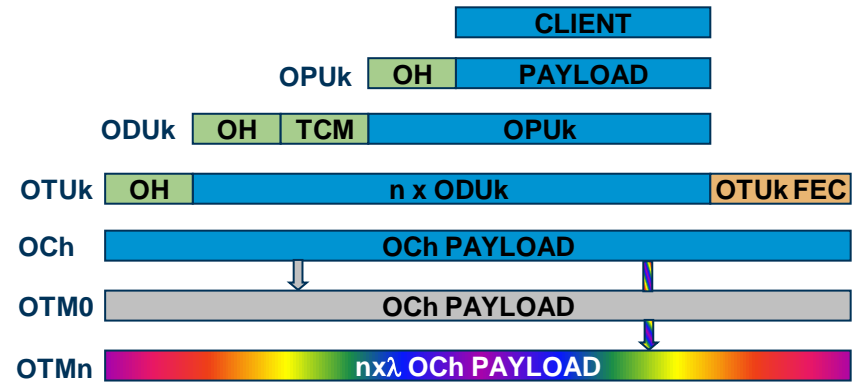
- Optical transport hierarchy (OTH), Frame structure and bit rates
- Functionality of the overhead in support of multi-wavelength optical networks
- Formats for mapping client signals.

The new version of G.709 supports an extended set of constant bit rate client signals, a flexible ODUk, which can have any bit rate and a bit rate tolerance up to 100 ppm, a client/server independent generic mapping procedure to map a client signal into the payload of an OPUk, or to map an ODUj signal into the payload of one or more tributary slots in an OPUk. It also provides ODUk delay measurement capability.

G.709 : OTN layers



G.709 : OTN Key Features



- The OTN layer provides a solution for the transport of transparent services and a complementary, value-add solution for the transport of IP/MPLS and Layer 2 services
- Initial G.709 standard covered 2.5/10/40G clients (in ODU-1/2/3) with multiplexing and switching flexibility....
 - but required over-clocking for fully transparent 10GbE LAN PHY transport
- The requirement to extend OTN standards to support a new 100GE client (in ODU-4) has driven a major revision of G.709 to accommodate new clients:
 - 1GE in a new ODU-0, 40GE, ODUflex, FC rates
 - and multiplexing and switching for Ethernet rates

OTN is now widely accepted as the value-add solution for carrier class WDM transport

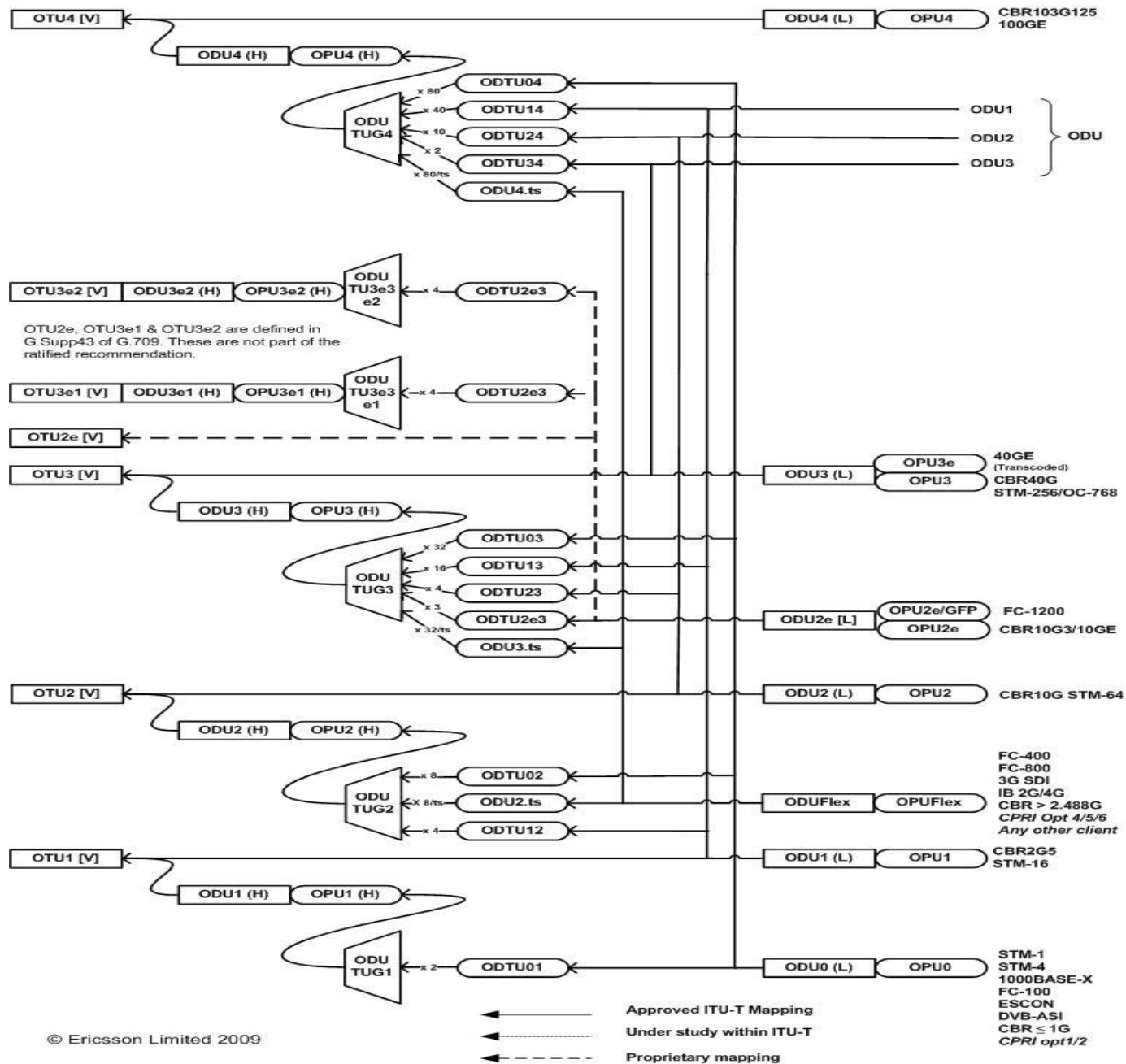
G.709 : Key Features

- Generic Mapping Procedure (GMP)
 - Client/server agnostic, asynchronous mapping method
 - Groups of M-bytes of client data mapped using sigma/delta distribution algorithm
 - Default 8-bit timing information (1-bit optional)
- Flexible ODU (ODUflex)
 - Any bit rate in the range 1.25G to 104G
 - Transported in one or more HO OPUk Tributary Slots

Two flavours

- CBR clients
 - Bit rate is “239/238 of client bit rate”, tolerance is the “client tolerance”
 - Meets stringent client jitter/wander performance specifications
 - Supports synchronous clients (STM-N, syncE)
 - Packet clients
 - sub Lambda
 - Bit rate recommended to be locked to HO ODUk clock
 - $n \times 1.249\text{G}$ ($n=1..8$), $n \times 1.254\text{G}$ ($n=9..32$), $n \times 1.301\text{G}$ ($n=33..80$)
- Relaxed performance specifications, no jitter/wander requirements
 - Will the ODUflex(GFP) able to carry network synchronisation/timing information to complement STM-N and syncE --- under study

- Delay Measurement using the overhead



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OTN applications

- L1 network (access, metro, core)
 - Support L2 and L3 interfaces
 - Support business services
 - Support Gbit/s carrier-carrier/wholesale services
- L2 core domain technology (sub λ Switched Path)
- L3 core domain technology (s λ SP)
- Broadcast TV distribution (to e.g. DSLAMs, OLTs)
 - “multi/broadcast” best handled by circuit technology
 - TV channels into 1GE
 - Map 1GE into ODU0
 - Unidirectional p2mp ODU connection to OTN edge
 - Demap 1GE from ODU0
 - Connect via 1GE to DSLAM

Clients into LO OPUk mapping

	OPU0	OPU1	OPU2	OPU2e	OPU3	OPU4	OPUflex
STM-1	GMP	-	-	-	-	-	-
STM-4	GMP	-	-	-	-	-	-
STM-16	-	AMP, BMP	-	-	-	-	-
STM-64	-	-	AMP, BMP	-	-	-	-
STM-256	-	-	-	-	AMP,BMP	-	-
1000BASE-X	GMP	-	-	-	-	-	-
10GBASE-R	-	-	-	BMP	-	-	-
40GBASE	-	-	-	-	GMP	-	-
100GBASE	-	-	-	-	-	GMP	-
FC-100	GMP	-	-	-	-	-	-
FC-200	-	GMP	-	-	-	-	-
FC-400	-	-	-	-	-	-	BMP
FC-800	-	-	-	-	-	-	BMP
FC-1200	-	-	-	BMP	-	-	-
ESCON	GMP	-	-	-	-	-	-
DVB-ASI	GMP	-	-	-	-	-	-

G.709 – LO ODUs into HO OPUs

2.5G TS

1.25 G TS

	HO-OPU1	HO-OPU2	HO-OPU3	HO-OPU1	HO-OPU2	HO-OPU3	HO-OPU4
LO-ODU0	*	*	*	AMP	GMP	GMP	GMP
LO-ODU1	-	AMP	AMP	-	AMP	AMP	GMP
LO-ODU2	-	-	AMP	-	-	AMP	GMP
LO-ODU2e	-	-	-	-	-	GMP	GMP
LO-ODU3	-	-	-	-	-	-	GMP
LO-ODflex	-	-	-	-	GMP	GMP	GMP
PT	←----- 20 -----→			←----- 21 -----→			

* Mapped into ½ of 2.5G Time Slots (TS)

PT = Payload Type LO : Low Order HO: High Order

GMP : Generic Mapping Procedure

AMP: Asynchronous Mapping Procedure

Implementation/Management should be based on 1.25TS

2.5G TS will be managed as 2X1.25TS

BMP : Bit-synchronous mapping procedure

G.798 OTN atomic functions status

- Draft revised G.798 is available, more work is needed
- Need to add atomic functions supporting new features to align with the newly consented G.709
- Possible to consent a revised G.798 in June 2010

G.798.1 Types & Characteristics of OTN equipment

- Development started in Sep/Oct 2009 SG15 meeting
- Agreement reached on
 - Multi-domain network architecture
 - Associated layer network stack
- Need to develop
 - UNI-N port models
 - I-NNI port models for LO ODU XC and for HO ODU/OCh XC
 - E-NNI port models for LO ODU XC

G.8251 OTN Jitter/Wander

Item	Status	Description
1GE jitter/wander	Under study	Does not meet the wideband jitter requirements with 300 Hz desync. Additional 1GE input noise to be incorporated; simulations re-run required
STM-1 jitter/wander	Under study	Does not meet the requirements with 300 Hz desync; lower bandwidth desync and 1-bit timing information (C_1). Additional input noise to be incorporated. simulations re-run required.
CPRI jitter/wander	Under study	Not enough information to complete study. (e.g. 0.002 ppm rms requirement to be clarified). CPRI industry forum members have been contacted to request clarification.
HD SDI jitter/wander	Under study	Not enough information to complete study; 802.1 has sent a liaison to SMPTE to request clarification

Conclusions

- OTN standards are in good shape
- OTN equipment that meet these standards are likely to be deployed soon in the network
- The newly revised G.709 allows any client rate to be mapped into the enhanced OTN hierarchy
- Standards work on jitter/wander for the transport of newly standardised clients over the OTN are under study within the ITU-T
- Transport of Sync Ethernet messages over OTN using ODUflex is under study

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