OFC

ITU-T SG15 standards update

Wednesday, 27 March, 12:45 – 13:45

IEEE ComSoc IEEE Communications Society

IEEE Photonics Society

OPTICA Formerly OSA

ITU-T SG15 Standards update panel

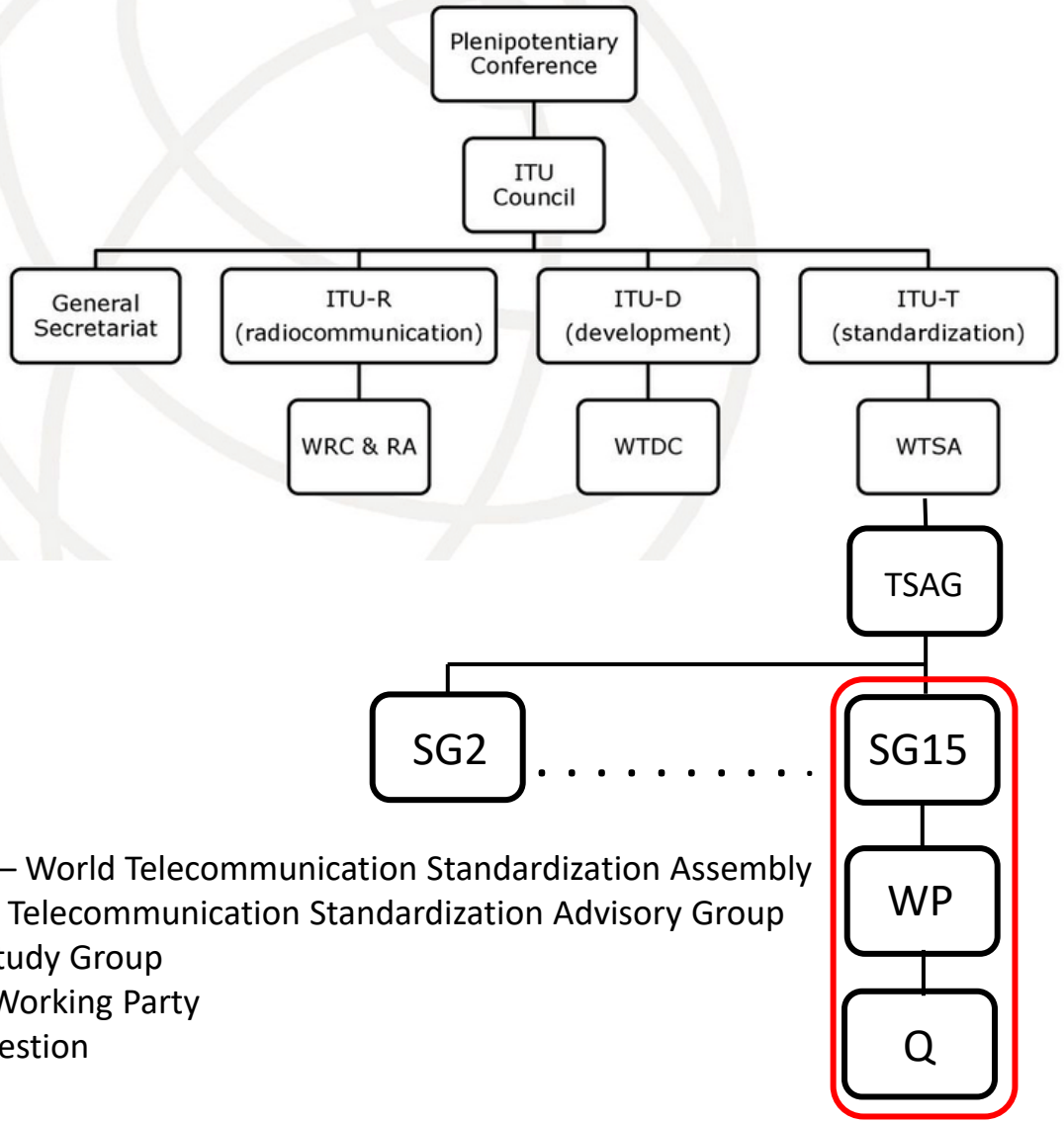
- **Moderator**
  - Glenn Parsons, *Ericsson, Canada*
    - *Chair SG15*
- **Panelists**
  - Frank J. Effenberger*, Futurewei Technologies, USA*
    - *Rapporteur Q2, WP1*
  - Paul Doolan, *Infinera, USA*
    - *Chair WP2*
  - Tom Huber, *Nokia, USA*
    - *Vice Chair SG15 and Vice Chair WP3*

Study Group 15 is responsible for the development of **standards** on:

- optical transport network
- optical access network
- home network and power utility network infrastructures
- equipment
- Gigabit copper transmission
- maintenance
- optical fibers and cables and their related installation
- management
- instrumentation and measurement techniques
- test
- control and management plane technologies

Next plenary meeting is in Montreal, Canada – July 1-12, 2024

ITU Structure and organization



WTSA – World Telecommunication Standardization Assembly
TSAG - Telecommunication Standardization Advisory Group
SG – Study Group
WP – Working Party
Q - Question

Leadership of ITU

- Plenipotentiary Conference (PP-22) - October 2022
  - Member states elect leadership of ITU

Doreen Bogdan-Martin
Secretary-General ITU

Tomas Lamanauskas
Deputy Secretary-General ITU

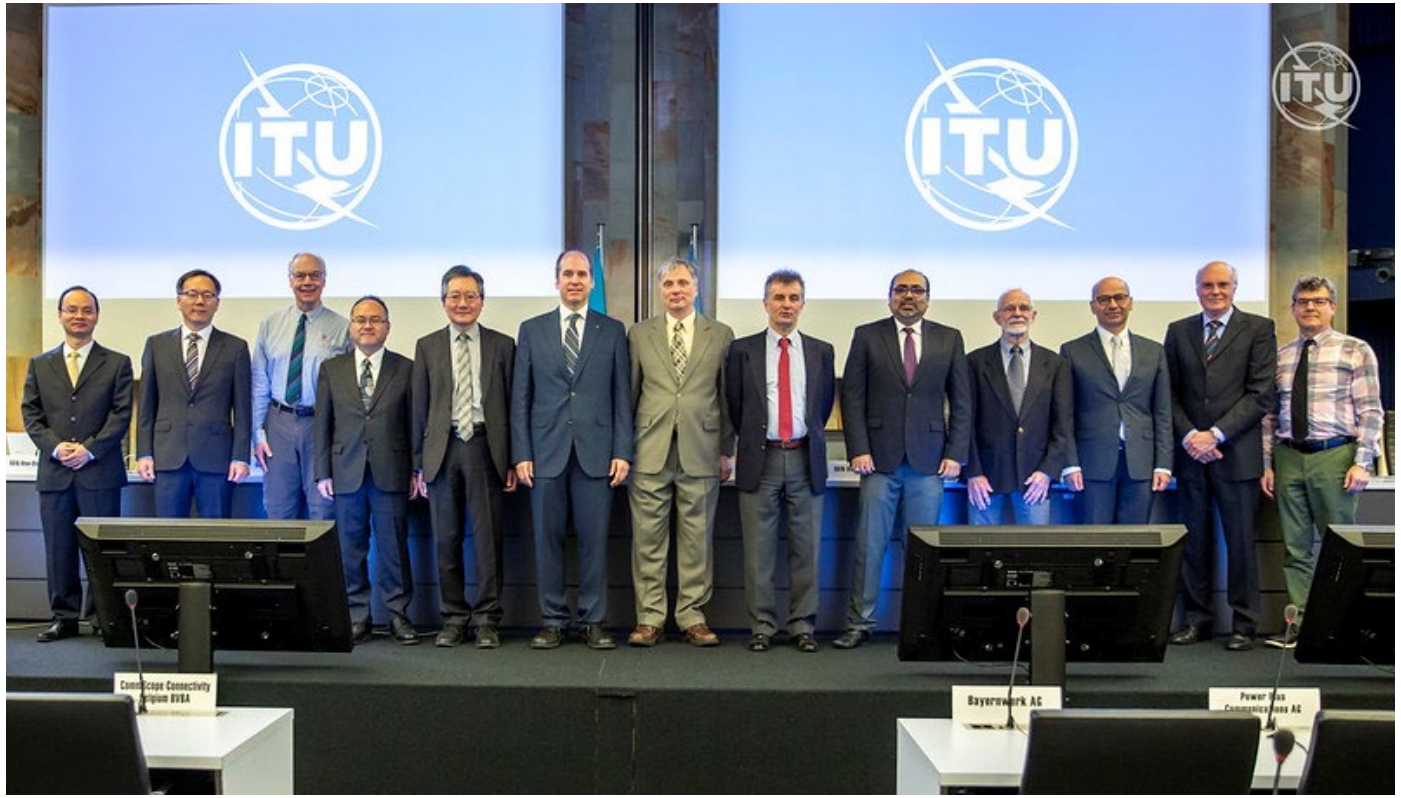
Seizo Onoe
Director of the Telecommunication Standardization Bureau (TSB)

Leadership of ITU-T SG15

- WTSA-20 - March 2022.
  - Appoints leadership of SGs

Glenn Parsons
Chair, ITU-T SG15
(Ericsson Canada)

ITU-T SG15 management team



- Vice Chairs
  - Mohamed Amine BENZIANE
  - Sudipta BHAUMIK
  - Taesik CHEUNG
  - Tom HUBER
  - Emanuele NASTRI
  - Cyrille Vivien VEZONGADA
  - Fatai ZHANG
- WP1/15
  - Tom STARR
  - Ian HORSLEY
- WP2/15
  - Paul DOOLAN
  - Sudipta BHAUMIK
- WP3/15
  - Malcolm BETTS
  - Tom HUBER
- Promotion and Coordination
  - Jean-Marie FROMENTEAU
  - Vince FERRETTI

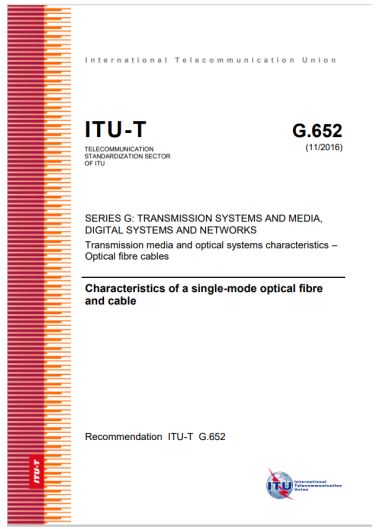
Questions and Working Parties of SG15

	Question Number	Question title
WP1	1/15	Coordination of Access and Home Network Transport Standards
	2/15	Optical systems for fibre access networks
	3/15	Technologies for in-premises networking and related access applications
	4/15	Broadband access over metallic conductors
WP2	5/15	Characteristics and test methods of optical fibres and cables, and installation guidance
	6/15	Characteristics of optical components, subsystems and systems for optical transport networks
	7/15	Connectivity, Operation and Maintenance of optical physical infrastructures
	8/15	Characteristics of optical fibre submarine cable systems
WP3	10/15	Interfaces, interworking, OAM, protection and equipment specifications for packet-based transport networks
	11/15	Signal structures, interfaces, equipment functions, protection and interworking for optical transport networks
	12/15	Transport network architectures
	13/15	Network synchronization and time distribution performance
	14/15	Management and control of transport systems and equipment

WP: Working Party

ITU-T SG 15 deliverables

- Work products:
  - Recommendations
  - Supplements
  - Technical papers and reports
  - Flyers


International Telecommunication Union

ITU-T G.652 (11/2016)

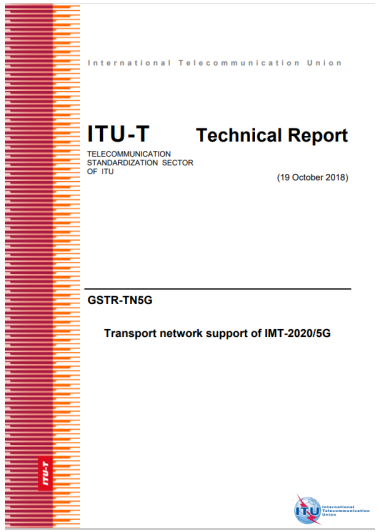
TELECOMMUNICATION STANDARDIZATION SECTOR OF ITU

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Transmission media and optical systems characteristics – Optical fibre cables

Characteristics of a single-mode optical fibre and cable

Recommendation ITU-T G.652


International Telecommunication Union

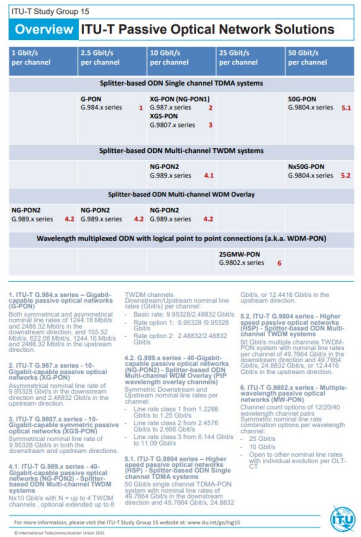
ITU-T **Technical Report**

TELECOMMUNICATION STANDARDIZATION SECTOR OF ITU

(19 October 2018)

GSTR-TN5G

Transport network support of IMT-2020/5G


ITU-T Study Group 15

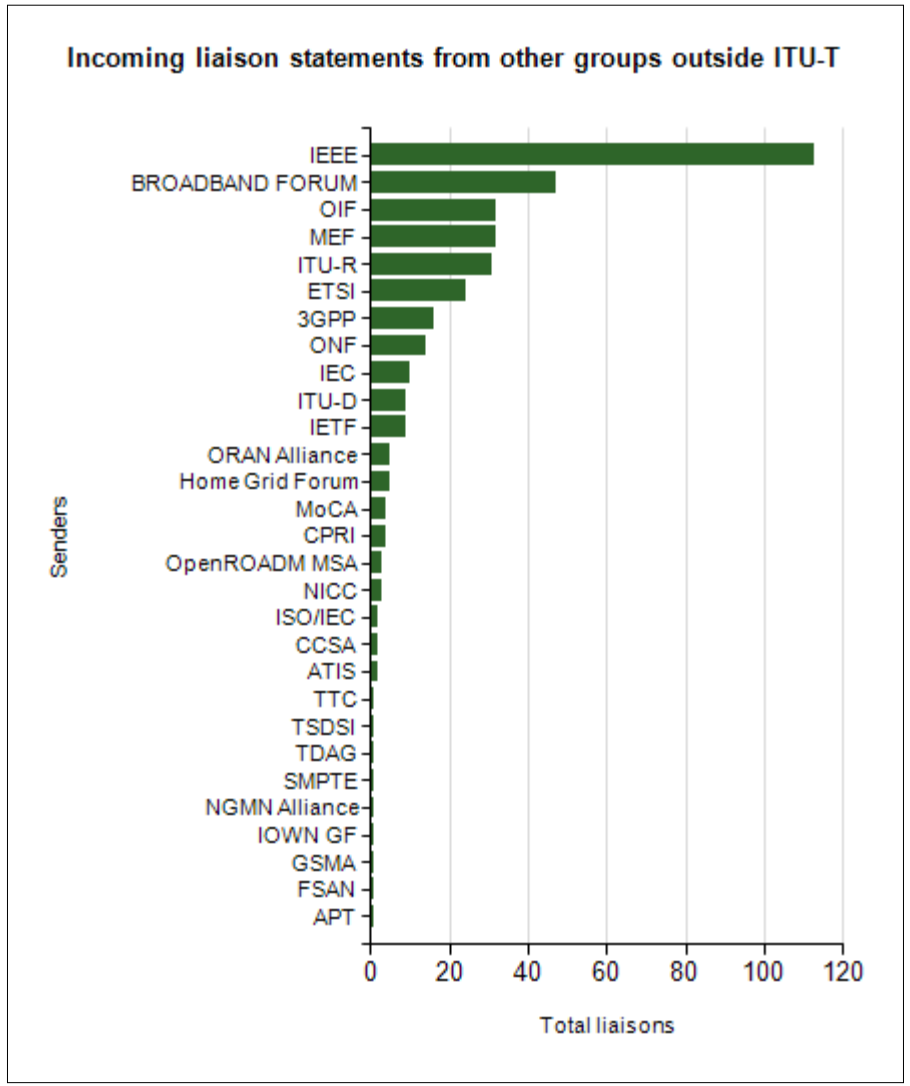
Overview ITU-T Passive Optical Network Solutions

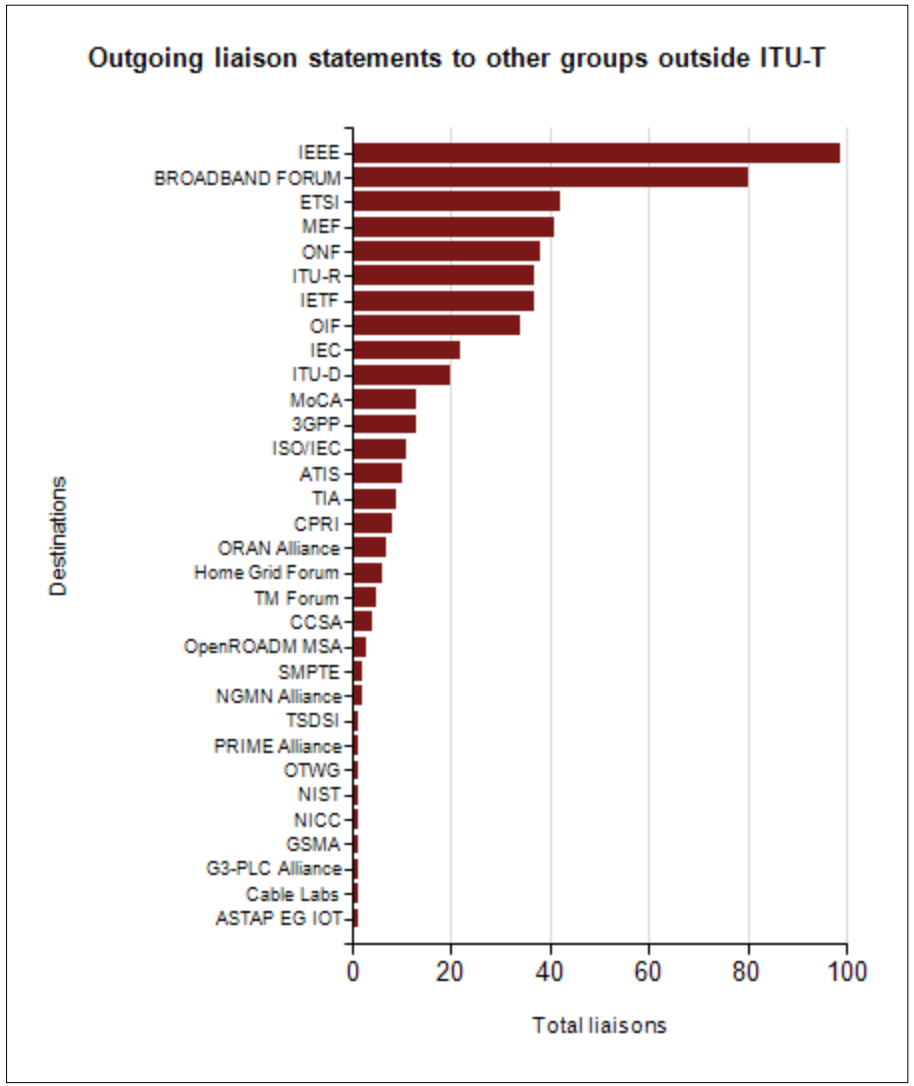
1 Gbit/s per channel	2.5 Gbit/s per channel	10 Gbit/s per channel	25 Gbit/s per channel	50 Gbit/s per channel
Splitter-based ODN Single channel TDMA systems				
G-PON G.984.x series 1		XG-PON (NG-PON1) G.987.x series 2 XGS-PON G.9807.x series 3		50G-PON G.9804.x series 5.1
Splitter-based ODN Multi-channel TWDM systems				
		NG-PON2 G.989.x series 4.1		Nx50G-PON G.9804.x series 5.2
Splitter-based ODN Multi-channel WDM Overlay				
NG-PON2 G.989.x series 4.2	NG-PON2 G.989.x series 4.2	NG-PON2 G.989.x series 4.2		
Wavelength multiplexed ODN with logical point to point connections (a.k.a. WDM-PON)				
			25GMW-PON G.9802.x series 6	

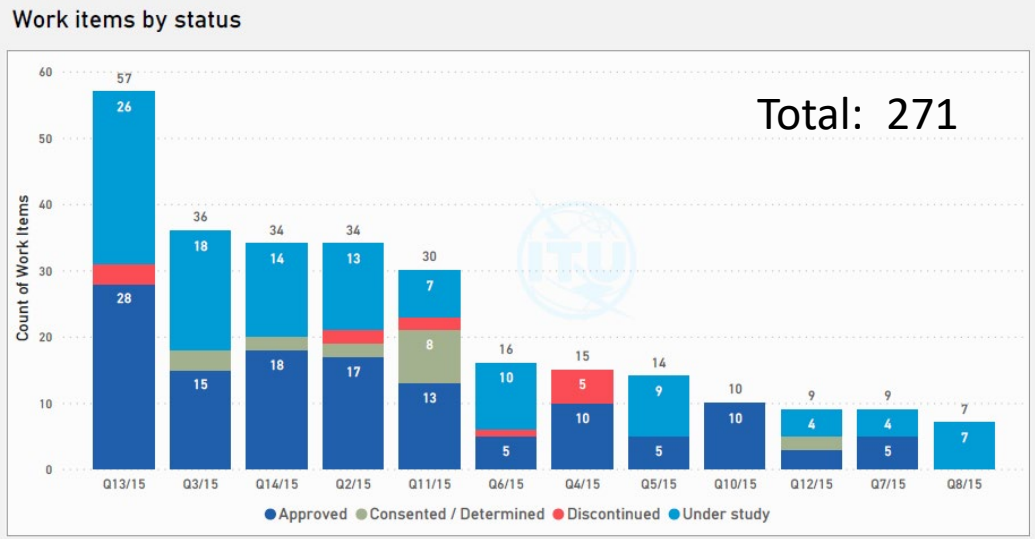
- Recommendation series

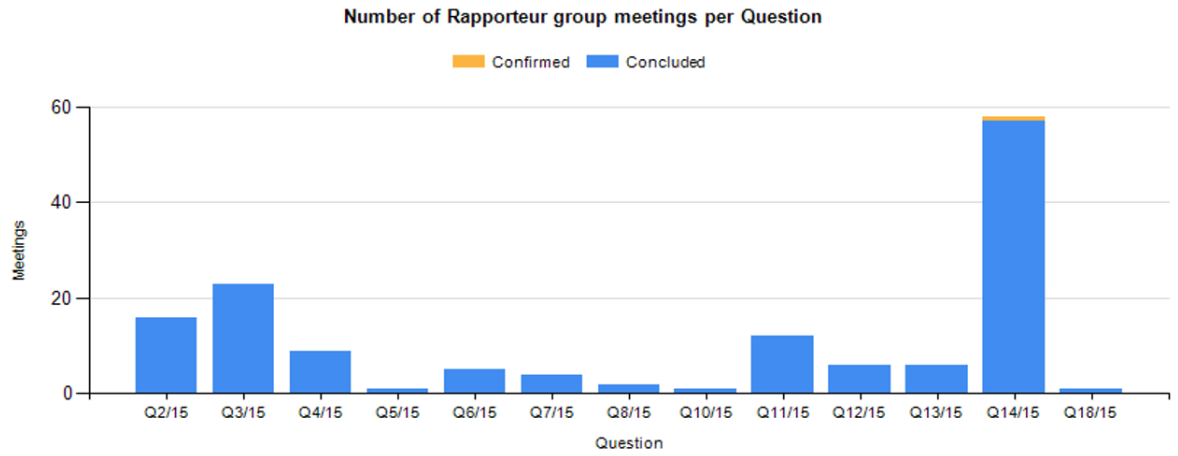
- G.600-G.699: Transmission media and optical systems characteristics
- G.700-G.799: Digital terminal equipments
- G.800-G.899: Digital networks
- G.900-G.999: Digital sections and digital line system
- G.7000-G.7999: Data over Transport – Generic aspects
- G.8000-G.8999: Packet over Transport aspects
- G.9000-G.9999: Access networks
- G supplements: Supplements to ITU-T G-series Recommendations

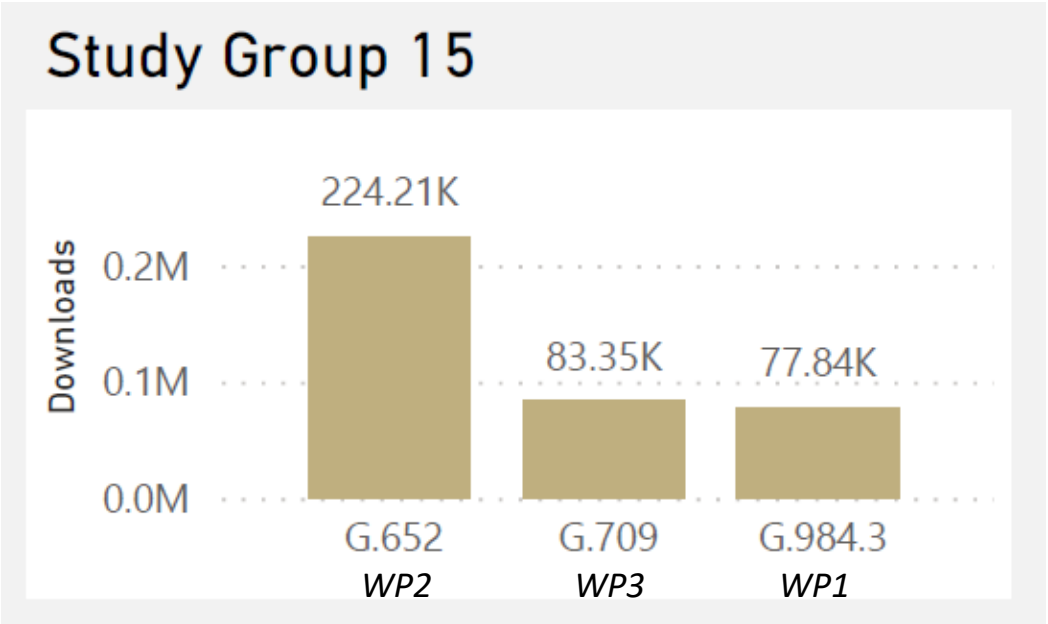
SG15 – a collaborative player in the ecosystem

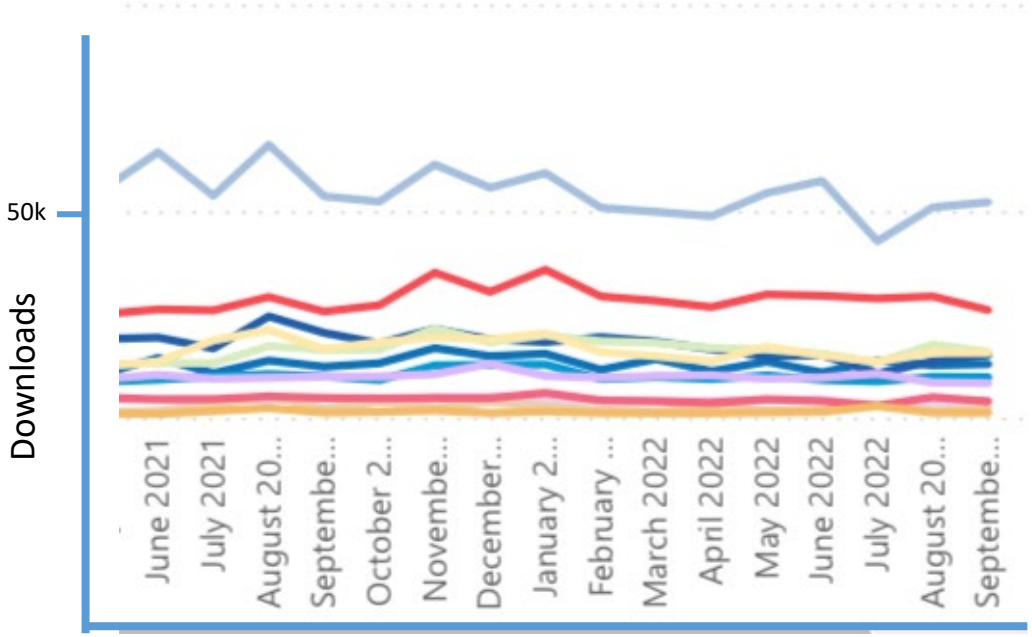





Work items by status
Total: 271
Count of Work Items
Q13/15 Q3/15 Q14/15 Q2/15 Q11/15 Q6/15 Q4/15 Q5/15 Q10/15 Q12/15 Q7/15 Q8/15
Approved
Consented / Determined
Discontinued
Under study


Number of Rapporteur group meetings per Question
Confirmed
Concluded
Meetings
Q2/15 Q3/15 Q4/15 Q5/15 Q6/15 Q7/15 Q8/15 Q10/15 Q11/15 Q12/15 Q13/15 Q14/15 Q18/15
Question


Study Group 15
Downloads
224.21K
83.35K
77.84K
G.652
G.709
G.984.3
WP2
WP3
WP1


50k
Downloads
June 2021
July 2021
August 20...
Septembe...
October 2...
Novembe...
December...
January 2...
February ...
March 2022
April 2022
May 2022
June 2022
July 2022
August 20...
Septembe...

Highlights of WP1
Optical Networks for Access and Home

Frank Effenberger
Rapporteur, Q2/15

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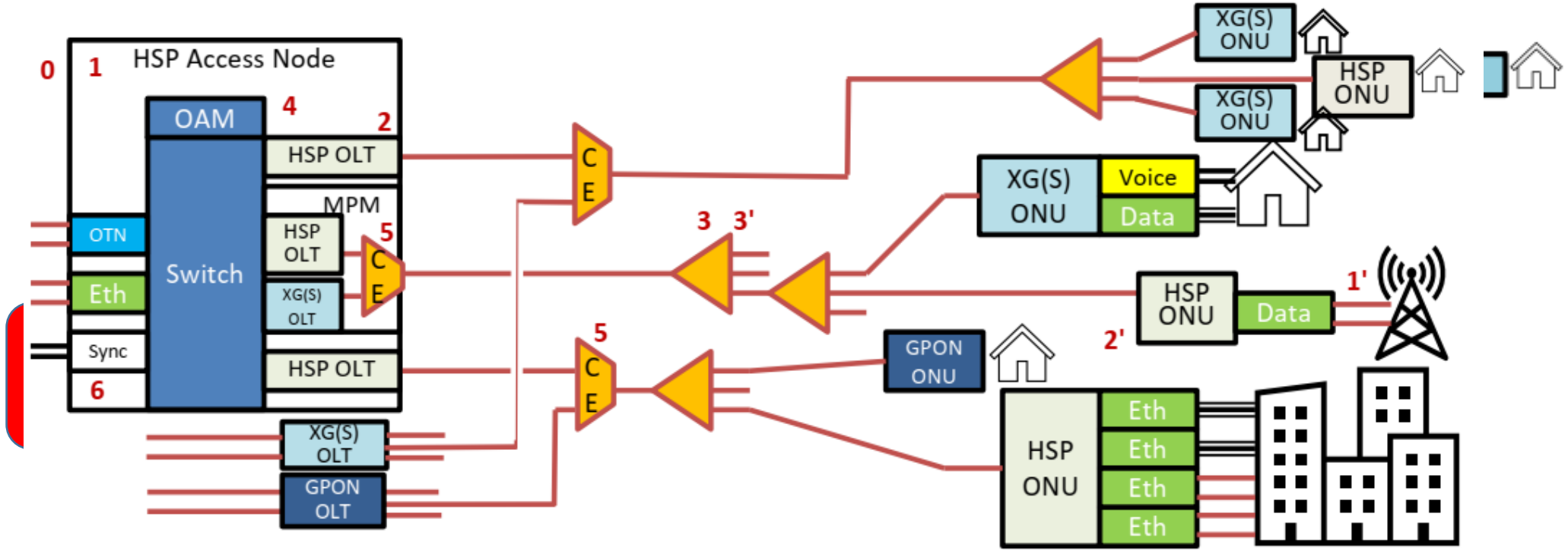
WP1 major projects under development

- Working party 1 is responsible for broadband access and home networks
- Passive Optical Network (PON) technology is being developed in Q2/15, in a long series of standards
  - G.982 pi-PON
  - G.983 A/B-PON
  - G.984 G-PON << The most successful PON in the world
  - G.98(0)7 XG(S)-PON << The upgrade system for G-PON
  - G.989 TWDM-PON << First multi-wavelength PON standard
  - G.9804 50G-PON << The upgrade system for XG(S)-PON
  - G.sup.VHSP << What comes after that
- Fiber in-home Network (FIN) technology is being developed in Q3/15
  - G.9930 P2P systems
  - G.9940 P2MP Architecture
  - G.9941 P2MP Physical layer
  - G.9942 P2MP Data link layer
  - G.9943 P2MP Management

ITU-T Study Group 15

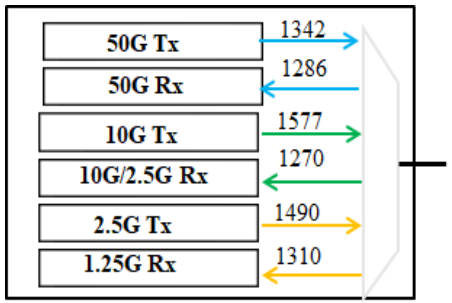
G.9804 HSP: Higher Speed Passive Optical Networks

- Full-service support – including voice, TDM, Ethernet (10/100/1000/10G/25G BASE), xDSL, wireless xhaul
- Basic physical reach is 20 km. Logical reach of up to 60 km. System is wavelength coexistent with G-PON, XG(S)-PON, 10G-EPON
- Support for bit-rate options, 50 Gbit/s downstream and 12.5 or 25 or 50 Gbit/s upstream
- Powerful OAM&P and system protection capabilities
- providing a feature rich and reliable service management system
- Advanced security features including authentication, rogue detection, and information privacy
- Power saving features on top of the already considerable low power nature of fibre access

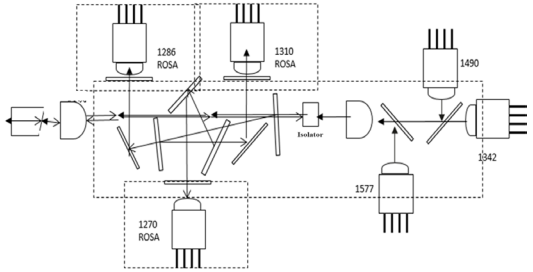


50G-PON Triple and dual generation coexistence Field Trial

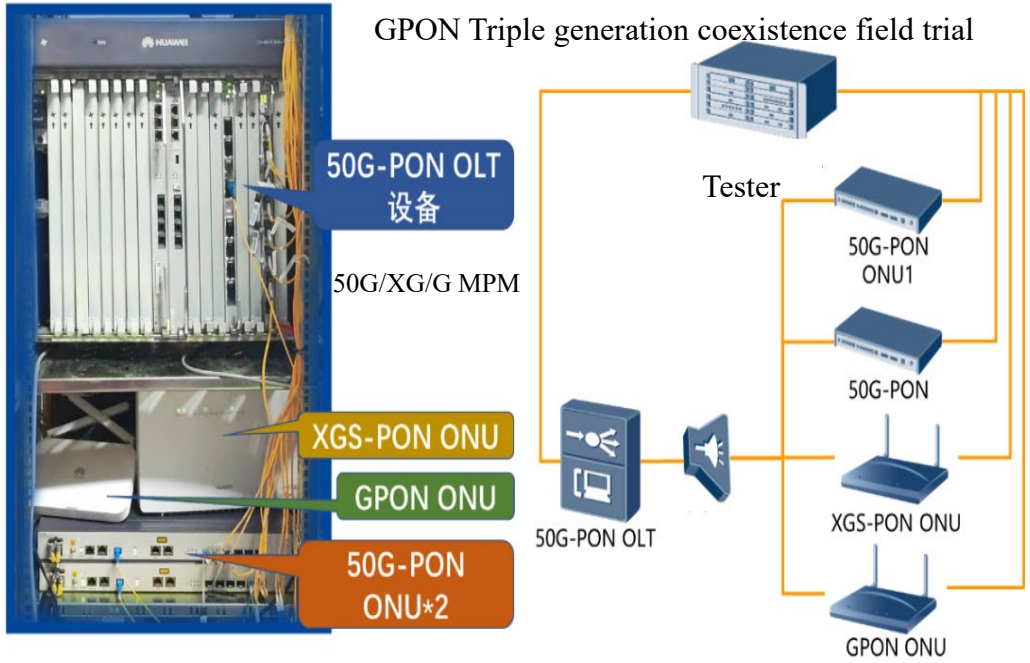
50G-PON/XG-PON/GPON MPM field trial



50G/XG/G-PON OLT MPM module



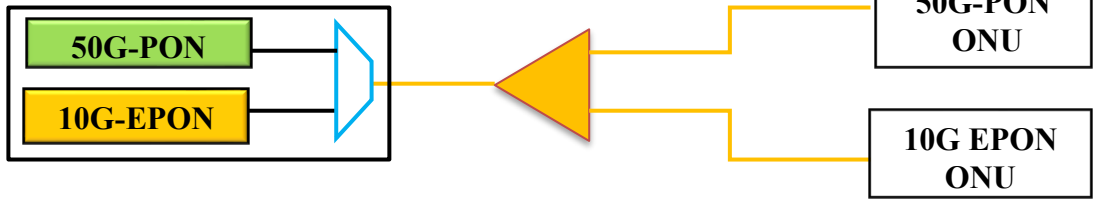
GPON Triple generation coexistence field trial

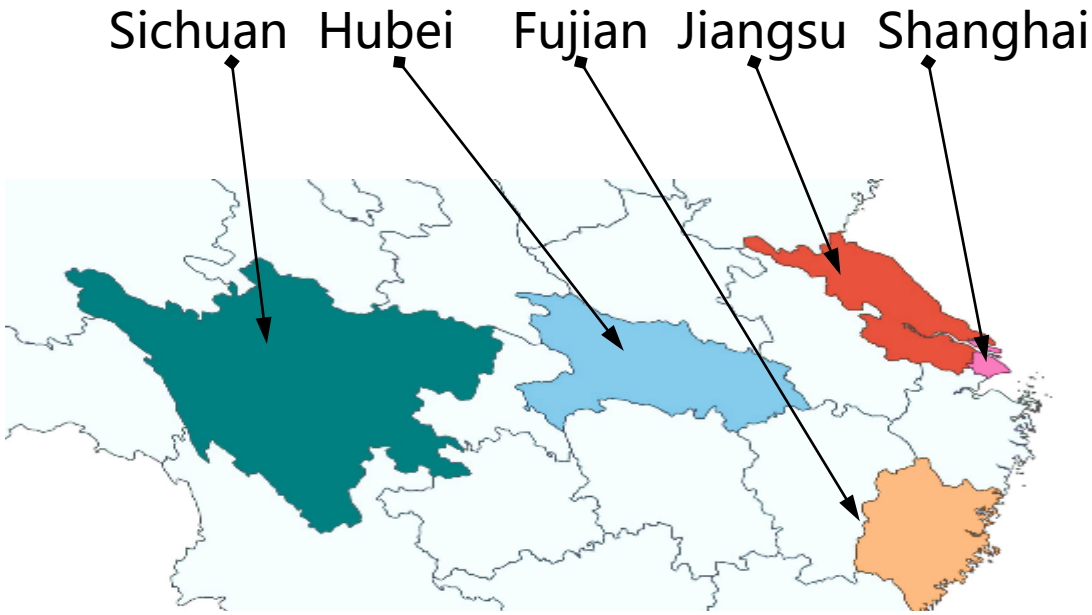


Source : https://www.c114.com.cn/4app/3542/a1238387.html

50G-PON/10G-EPON MPM field trial

50G-PON&10G-EPON MPM





Five province 10G-EPON&50G-PON Field Trials with CTC in China

Global 50G-PON Field test by 2023

Region	Operators
Asia Pacific *(15+)*	CTC
	CMCC
	CUC
	HKT
	Trailhand TRUE
	Malaysia Maxis
	SoftBank
Europe (10+)	Swisscom
	Spain TDE/VDF
	Deutsche Telekom
	Orange
	Netherlands TMNL
	Tuckey telecom
	Finland Lounea
	Romania Telekom
middle East *(3+)*	STC
	UAE DU
	UAEET

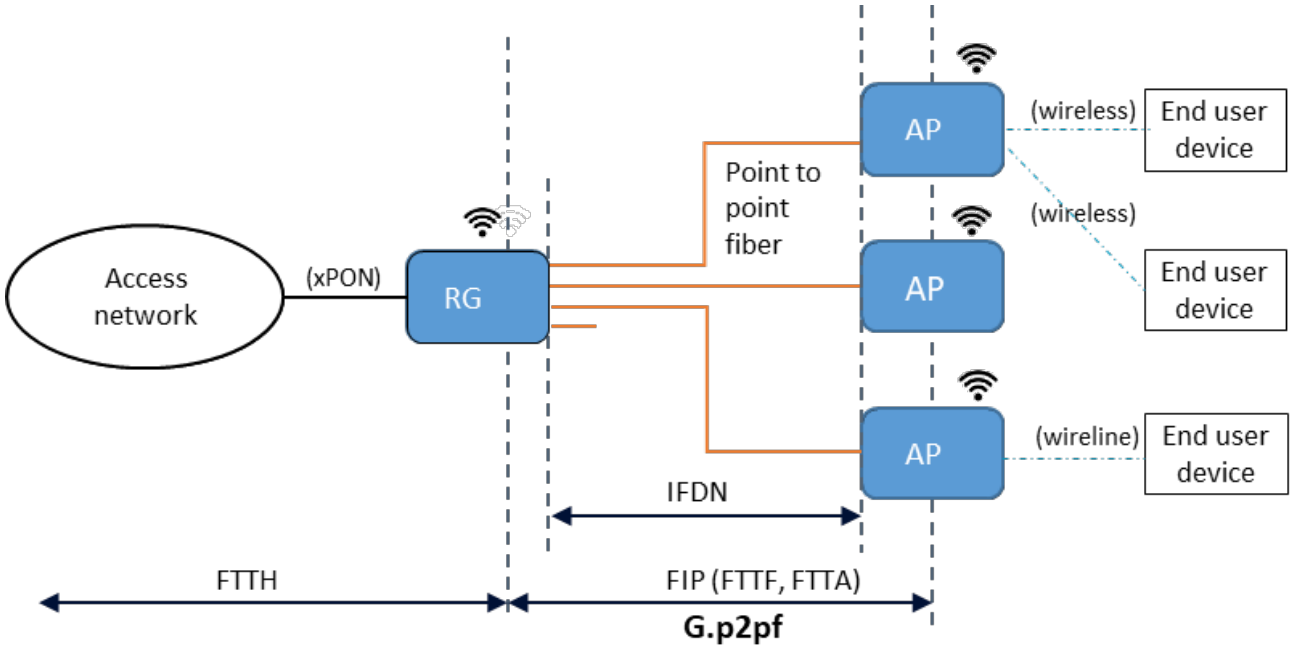
Many operators over the world have done 50G-PON field tests

50G PON is expected to be deployed starting in 2024

Very High Speed PON supplement

- Now that 50G-PON is moving into deployment, the industry has started work to consider what comes next
- Approximate target is 200 Gb/s system payload capacity, with user interface rates up to 100 Gb/s
- The problem here is 200 Gb/s IM-DD is technically difficult using the same PON infrastructure
  - G.652 fiber dispersion becomes a very significant issue
  - Supporting ~30 dB loss budget continues to raise the difficulty
- Perhaps coherent techniques will be used for VHSP
- Alternatively, all sorts of multiplexing methods are fair game

G.9930 Point to Point Architecture



Source: G.9930 draft – Under review in the approval process

Description

- Optical Ethernet connections are used for connecting RG and repeaters
- Two types of connectivity:
  - RG/Repeaters are connected directly to the fibre infrastructure (IFDN) using devices with optical outputs
  - RG/Repeaters are connected to external optical/electrical converters using Ethernet. In this case, an external switch is needed on the RG side

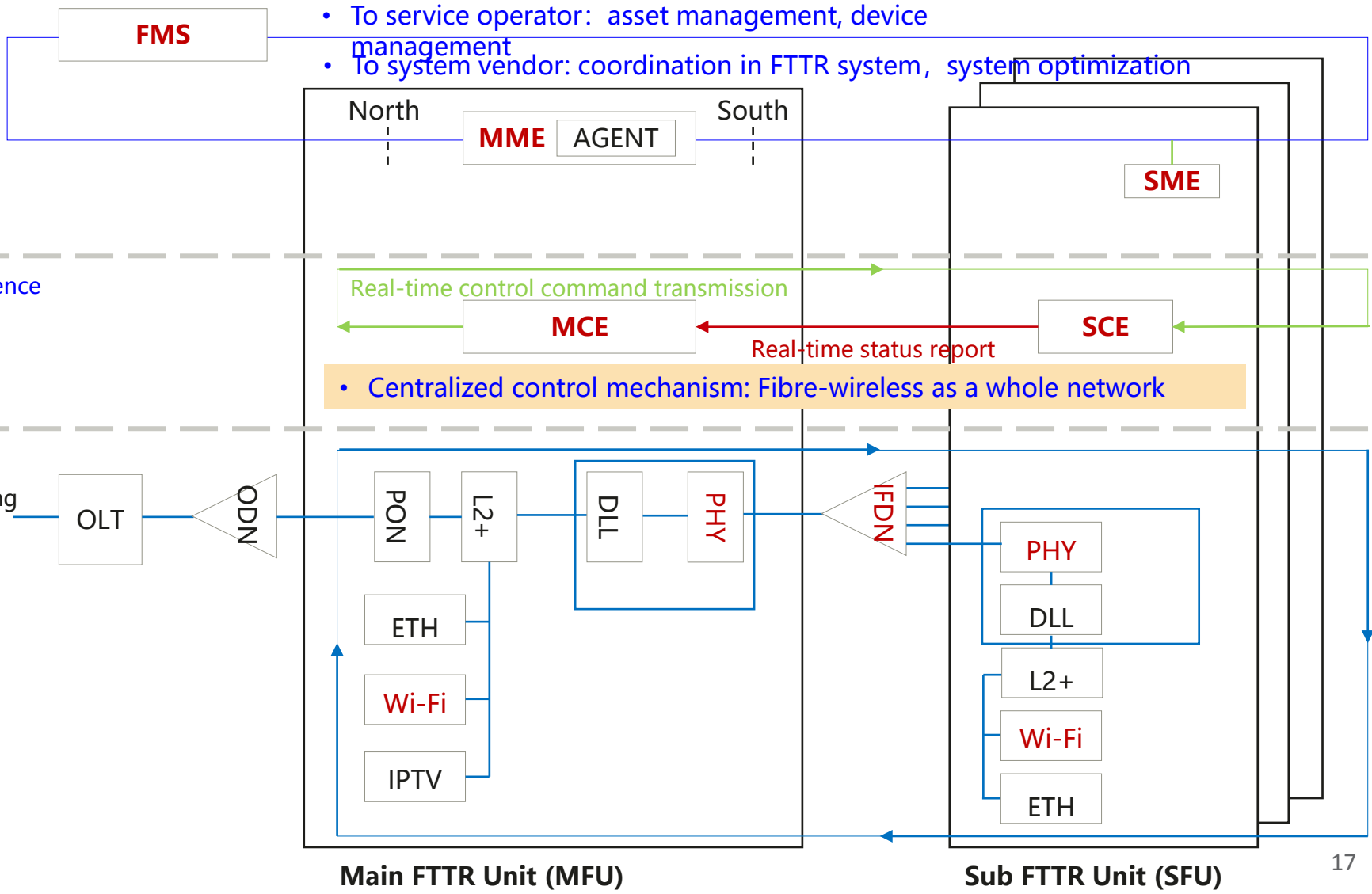
G.9940: Fiber In-home Network Point to Multipoint architecture

Management Registration, networking, authentication, power consumption
- MFU manages SFU
- NCE manages MFU
- unified management
- Management tunnel

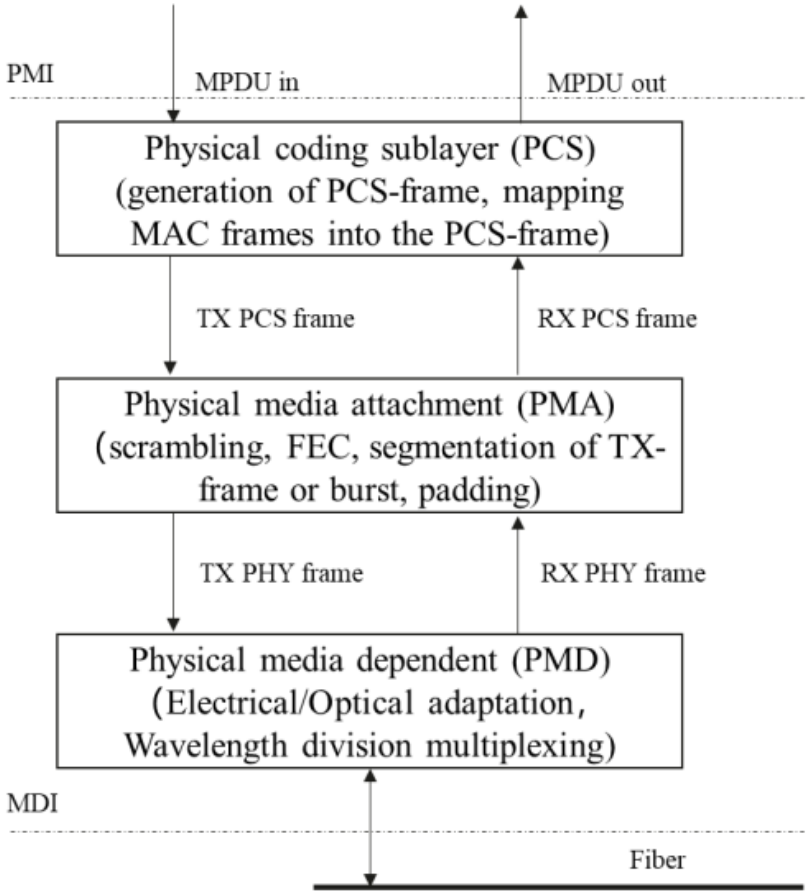
Control Dynamic resource allocation, interference mitigation、handover
- MFU controls SFU
- Centralized control
- Guaranteed QoS

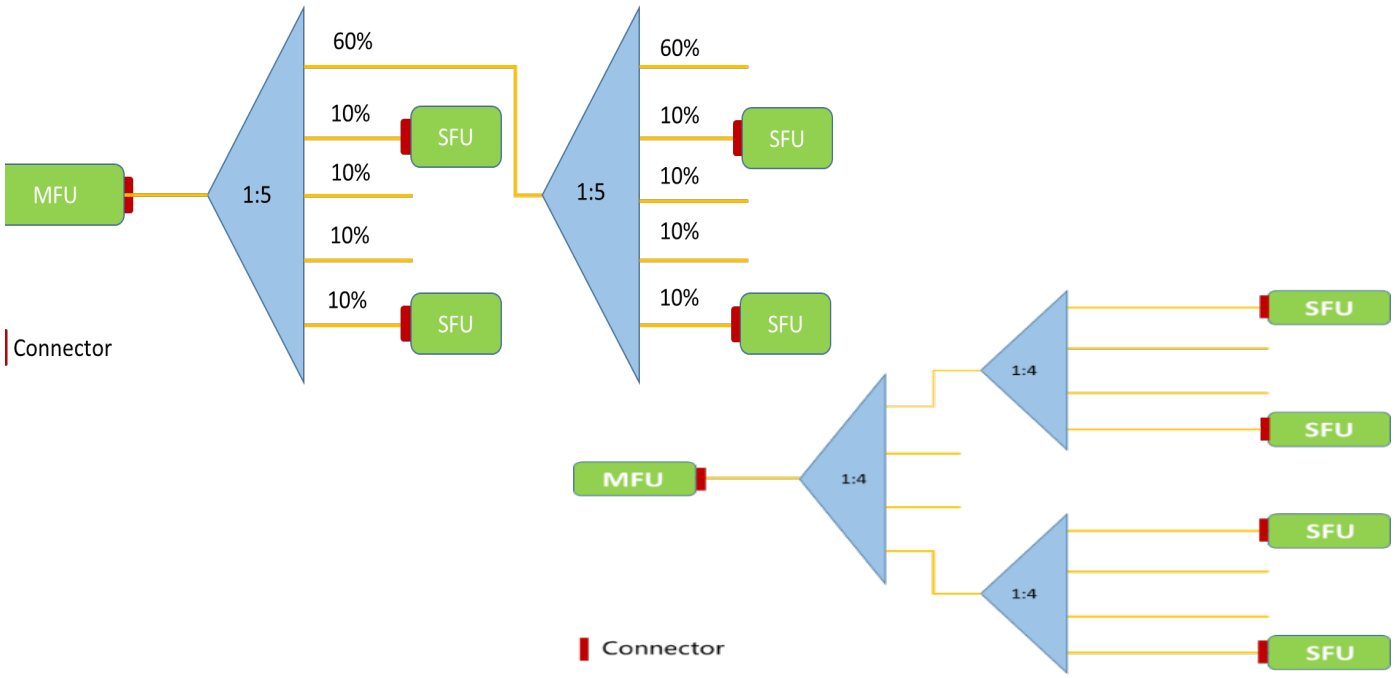
Data Real-time data streaming
- P2MP topology, East-west streaming
- Gigabit+
- Network QoS/SLA
- Support management/control signaling

Coordination Exchanging between different planes
- Management ←→ Control
- Management ←→ Data
- Control ←→ Data



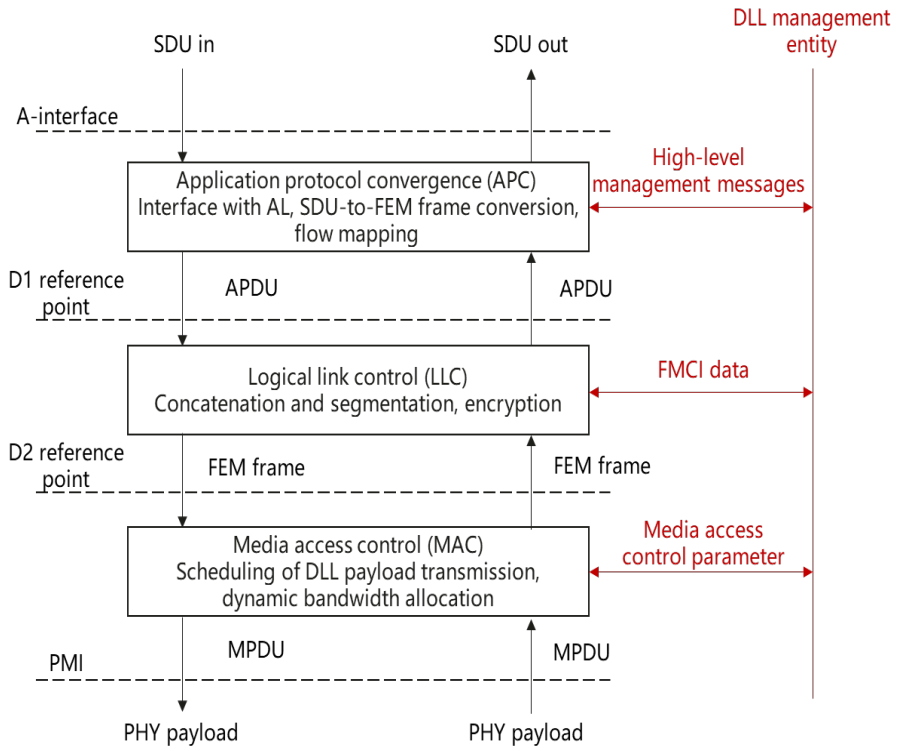
G.9941: FIN PHY layer

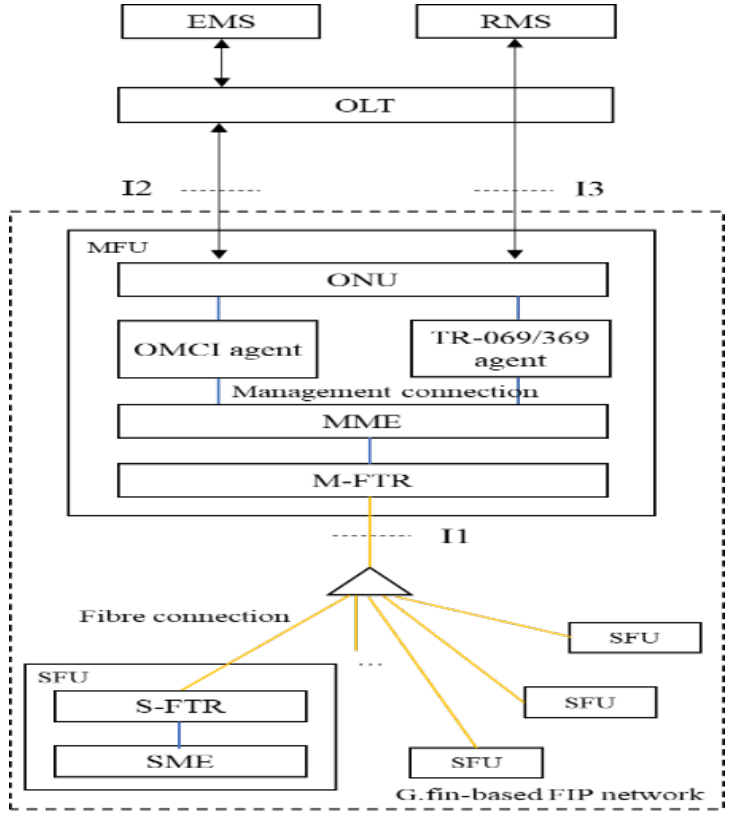


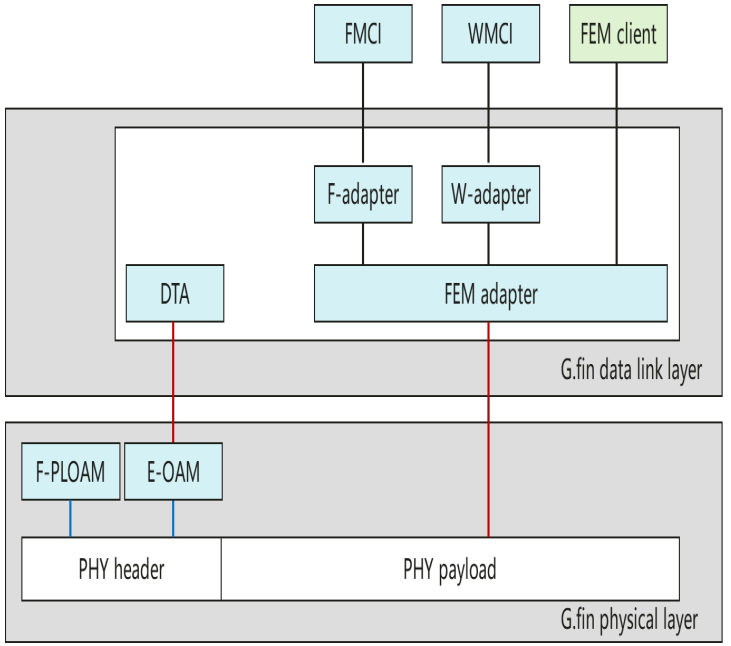


Optical link budget	Typical splitting ratio	Upstream/downstream wavelength set	
		2.5/2.5 Gbit/s	10/10 Gbit/s
0-18 dB (home)	1:8	Up: 1300-1320 nm Down: 1480-1500 nm	Left for further study
13-28 dB (SME)	1:32	Up: 1300-1320 nm Down: 1480-1500 nm	Option 1: Up: 1300-1320 nm Down: 1480-1500 nm Option 2: Up: 1260-1280 nm Down: 1567-1587 nm

G.9942: FIN DLL

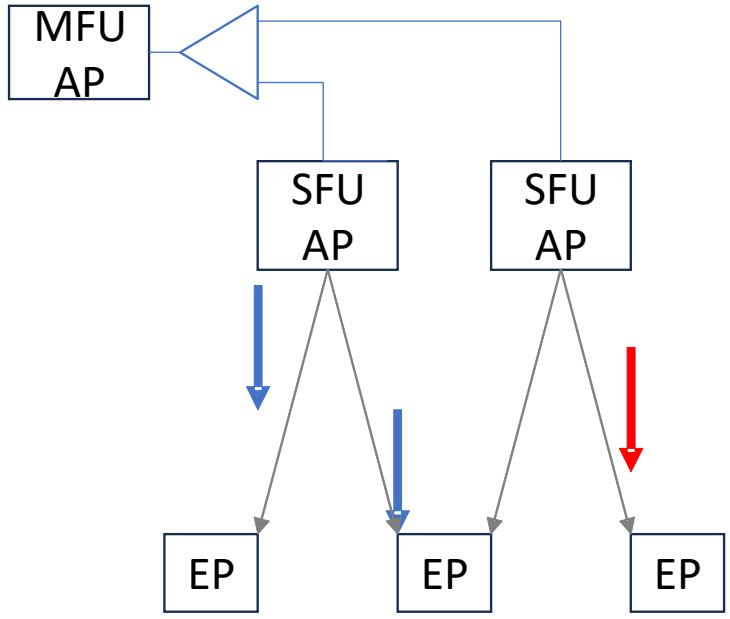




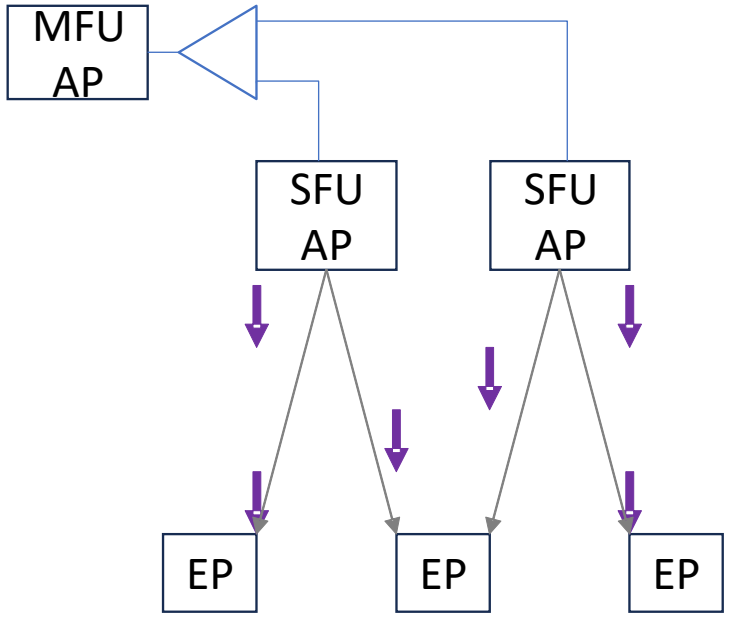


G.WMCI: Wireless management and control interface

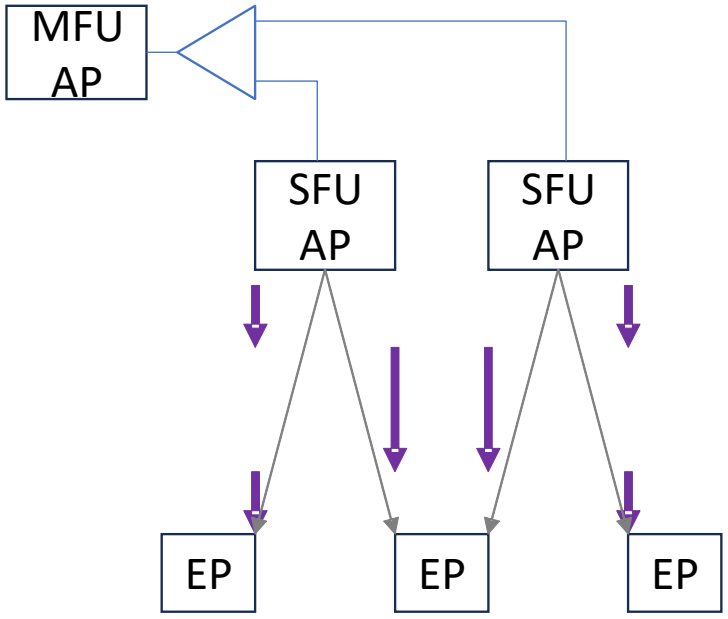
- FTTR will feed Wi-Fi access points in the home
- The key problem with Wi-Fi is coordination
  - There are different levels that can be contemplated, from simple to exotic



Coordinated configuration



Coordinated scheduling



Coordinated multipoint transmission

Highlights of WP2 work

Optical technologies and physical infrastructures

Paul Doolan, Chairman WP2/15

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IEEE ComSoc IEEE Communications Society

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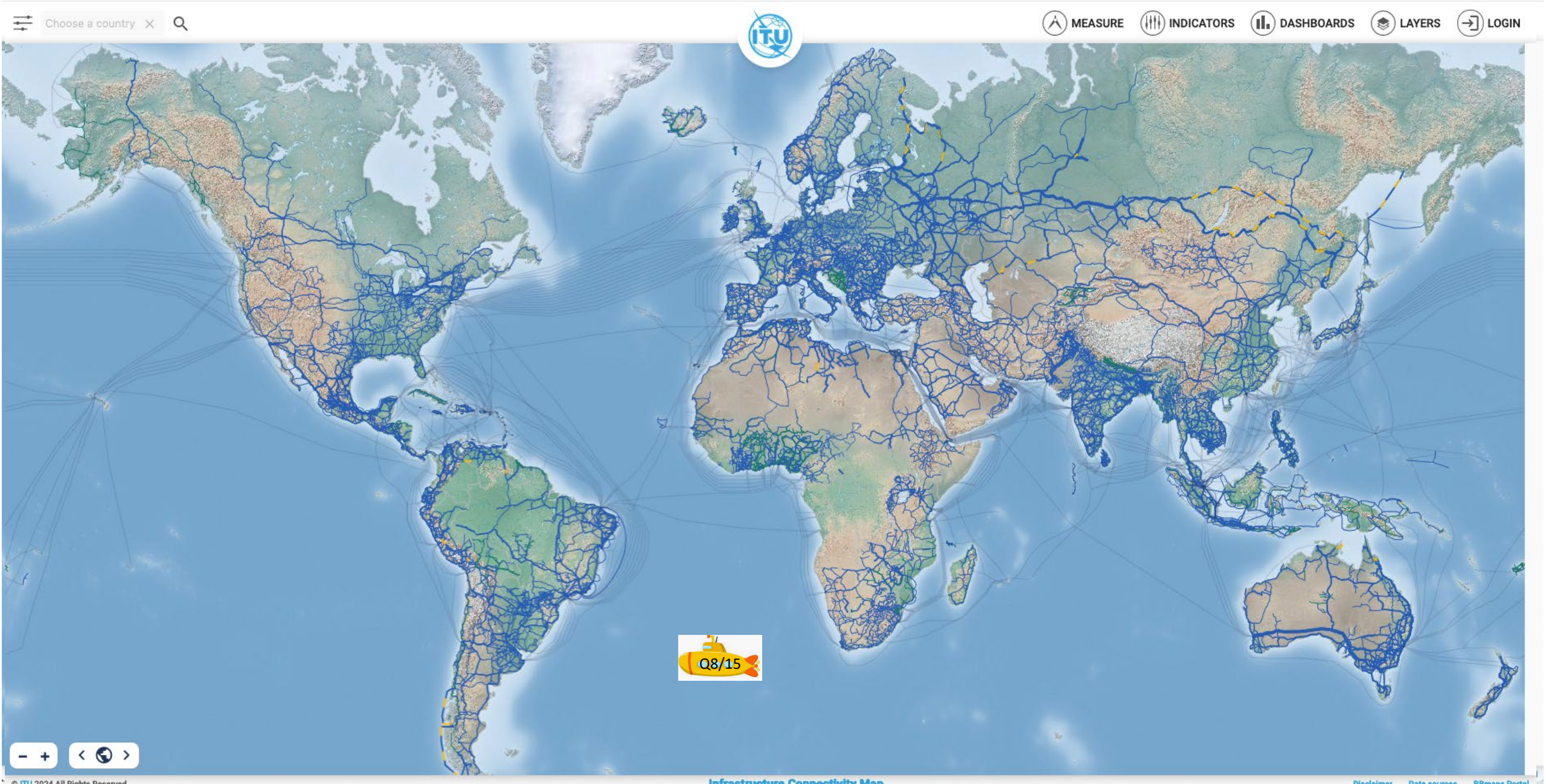

Choose a country
MEASURE
INDICATORS
DASHBOARDS
LAYERS
LOGIN
Q8/15

Optical networks & 5G: a marriage of convenience

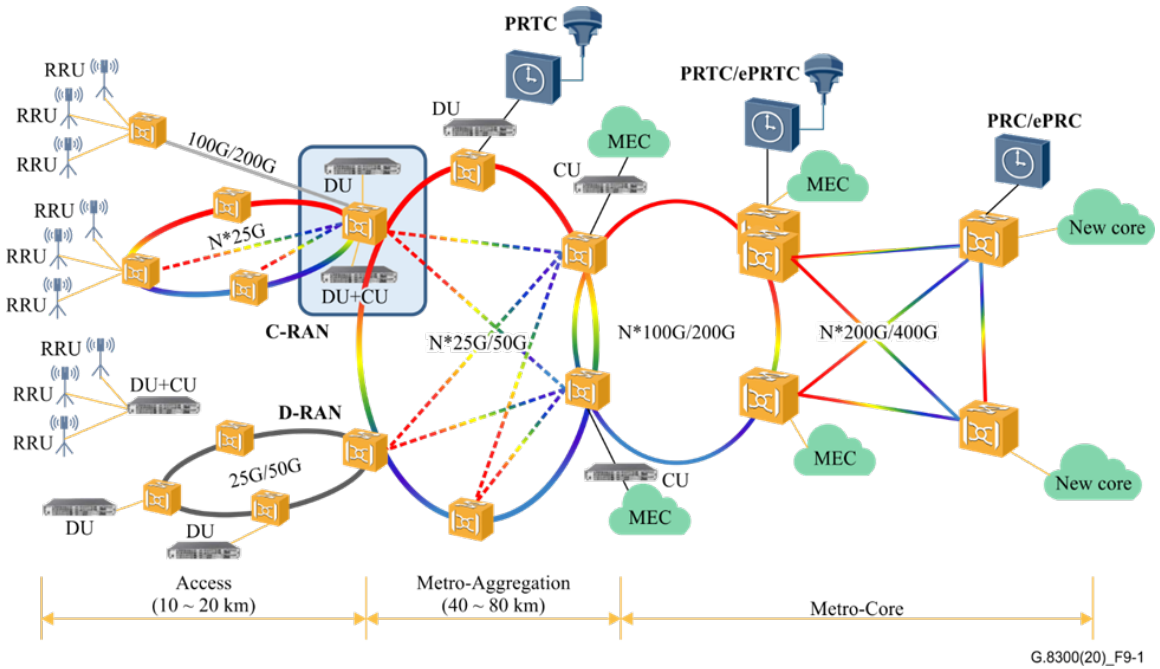
5G led to the introduction of a new "mobile transport network" segment, with its own peculiarities

- Short distances, as in access networks
- High capacity and multiple topologies, as in WANs
- New advanced features, such as self-configurable components and low latency transmission and switching.

What does it imply for optical components?

- Potential product volumes are high, as in datacom
- Target cost is low, as in access
- Required features are demanding, as in WAN

Example of mobile transport network topology, from ITU-T Recommendation G.8300



5G requires new optical components: the high volumes make the business opportunity appealing but initial investments and risks are big too

- Standardization is the key to mitigate the risks in introducing the required new technologies
- New Recommendations: G.698.5, G.698.6 - Multichannel DWDM applications with single-channel optical interfaces in the O-band

New work items

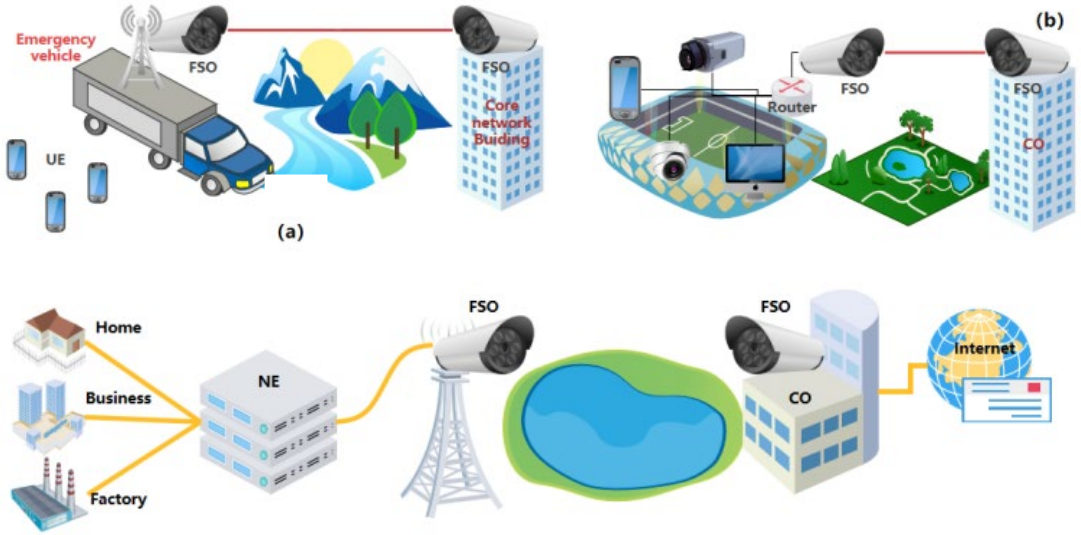
Working title	Question	Subject
G.Sup.G.65x	Q5	Roadmap for SDM optical fibres concerning the development of G.65x series Recommendations
G.dfos[1]	Q6	Distributed fibre optic sensing system for terrestrial optical transmission system
G.fso	Q6	Terrestrial free space optics for mobile backhaul with short reach interfaces
L.pcc	Q7	Pre-connectorised cabling components for FTTx infrastructures
G.dsssc	Q8	Dedicated scientific sensing submarine cable system
G.smart	Q8	Scientific Monitoring And Reliable Telecommunications submarine cable systems
G.698.2 Rev	Q6	800G applications codes for metro systems over a distance of up to 400-450 km.

1. G.dfos editor (J. S. Wey) presented at the F5G panel here at OFC

G.fso - *Terrestrial free space optics for mobile backhaul with short reach interfaces*

Applications

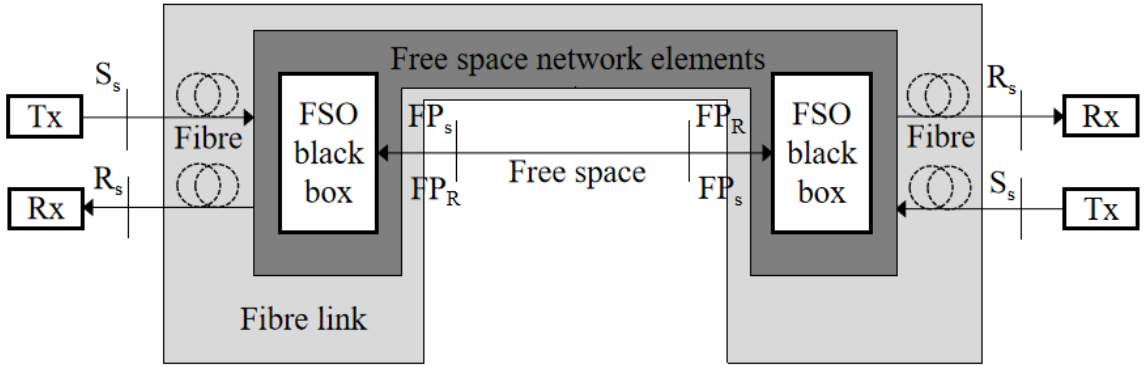
Free space optics has potential uses in “cable-cannot-reach” and in temporary or emergency scenarios, such as last mile access, over lake/river/sea, in mountains or deserts, satellites, broadcasting and disaster recovery. This technique has the advantage of combining fibre and wireless communication.



typical applications

Summary

The Recommendation will provide optical interface specifications for FSO applications, primarily intended for mobile backhaul with short reach. Applications are defined using optical interface parameters. The Recommendation will specify both the FSO interface and the fibre interface.



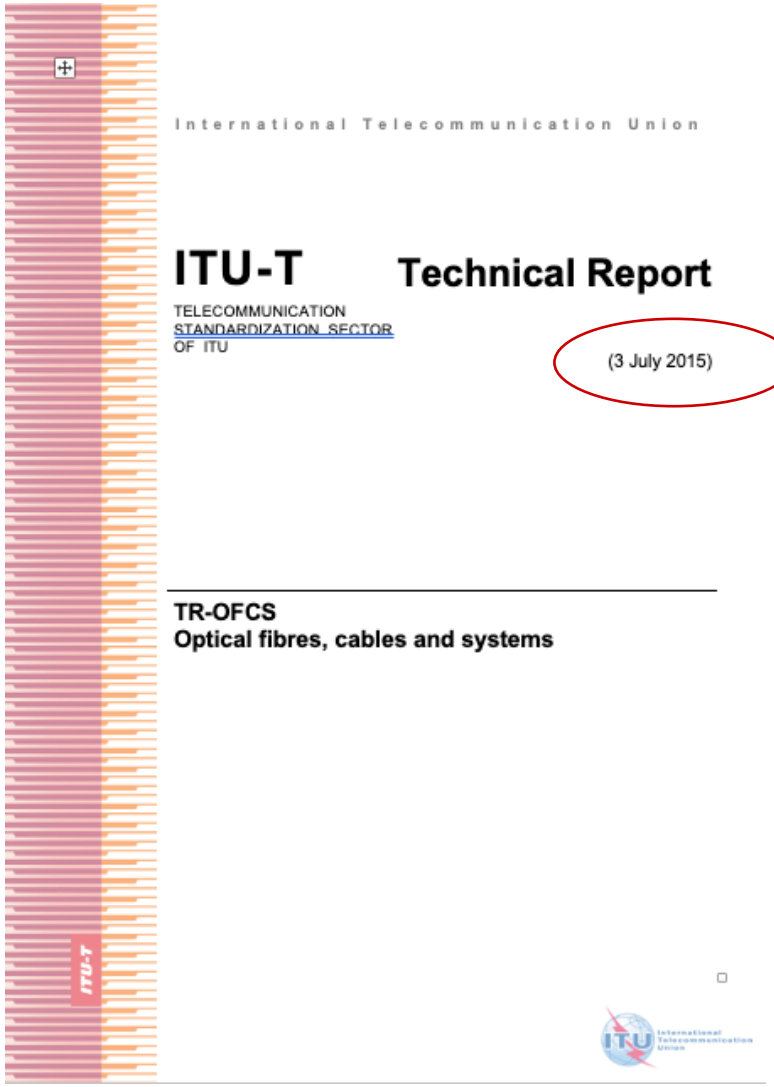
System configurations of G.fso

By defining the free space interface parameters, G.fso gives specifications to enable MVIO when deploying pairs of FSO devices in point to point configurations.

WP2 collaboration with other SDOs/MSAs

- Fibre, cables (Q5,6,7)
  - IEC SC86A, IEC SC86B, IEC SC 86C WG2,
  - ITU-T SG5, ITU-D Q6/2, ITU-D Q5/2, ITU-T SG2 Q3/2
- Optical interfaces (Q6)
  - OIF, IEEE, OpenROADM
- Hot collaboration topics
  - ZDW in G.652 fibre – IEEE
  - EVM for complex modulation – OIF/IEEE

Update of TR-OFCS



CONTENTS

This is an excellent resource and an updated version is coming this year.

Kudos to Mr Bhaumik (Vice Chair WP2) for leading this effort.

Highlights of recent WP3 work

Enabling 800G transport

Tom Huber
WP3 vice chair, SG15 vice chair

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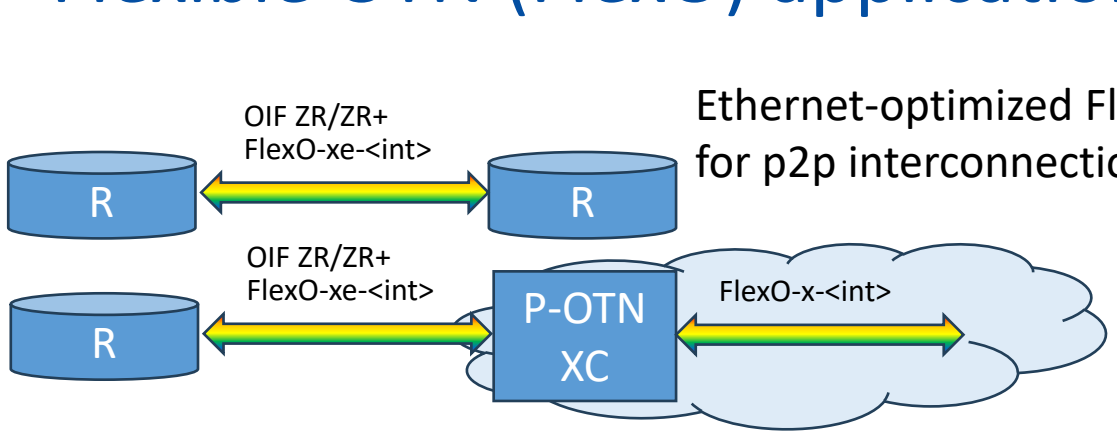
Transport network extensions focused on 800G (Q11, 12, 14)

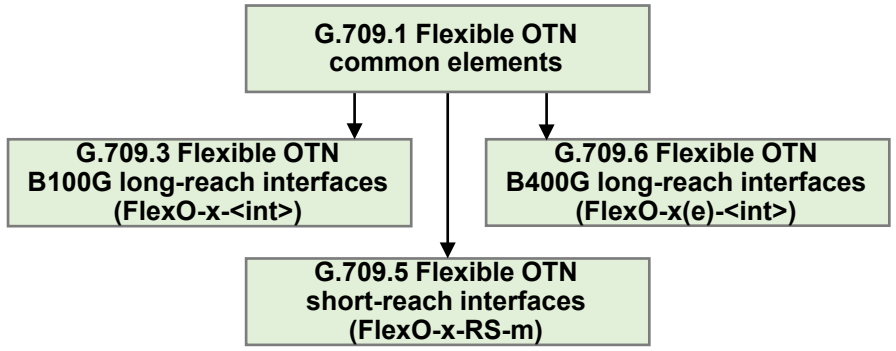
- Client mappings, frame formats, and network architecture (Q11/15, Q12/15)
  - Mapping 800G Ethernet clients into OTN (G.709 Amd 3)
  - Flexible OTN (FlexO) frames for 800G transmission (G.709.1, G.709.5, G.709.6, G.872)
    - Standardized frame format and FEC frames for ODUC8/OTUC8
  - Ethernet-optimized FlexO formats at 400G and 800G (G.709.1, G.709.6, G.872)
    - OIF 800ZR uses the same formats and client mappings as FlexO-8e-DO-16QAM
- Management/control (Q14/15) extensions will be completed in 2024
- Optical interfaces at 800G (Q6/15) are under discussion
- Interoperable FlexO is being demonstrated in the OIF booth (#1323)

OIF

Flexible OTN (FlexO) applications and overview

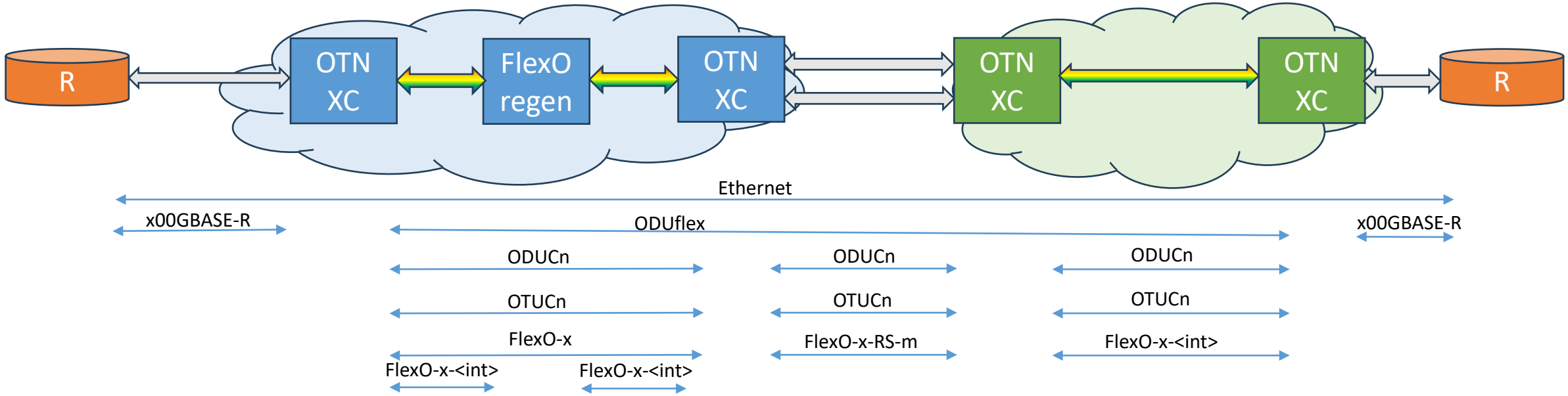


Ethernet-optimized FlexO-xe for p2p interconnection



Note: OIF ZR/ZR+ uses FlexO-xe<int> frame formats

Transport network applications for FlexO short-reach and long reach interfaces



Network Synchronization enhancements (Q13)

- Enhanced holdover and cnPRTC for time sources (G.8272.x)
- Enhanced PTP clocks (Class C related) and network limits (G.8271.x, G.8273.x)
- Clock specifications updated with new optical interfaces (e.g., PAM4) (G.8273.x)
  - Demonstration of timing performance verification at ITU booth (#5226)
- New versions of the PTP telecom profiles to improve PTP and network performance monitoring capabilities, management and operations (G.8275.x)
- Terminology aligned with IEEE Std. 1588g™-2022
- Ongoing topics of discussion include:
  - Continued enhancement of packet network synchronization Recommendations
  - Joint efforts with Q14 on defining YANG models for PTP and SyncE (G.8275.x, G.781, G.7721)
  - Secure transport of PTP

WP3 collaboration with other SDOs/MSAs

- Q14 continues to work in cooperation with IEEE 802.1, IEEE 802.3, IEEE 1588, MEF, BBF, and IETF to promote consistent information models and YANG data models for transport networks
  - Monthly conference calls with all interested stakeholders
  - Common Modeling work from ONF is being brought into Q14
- Q13 work on telecom profiles for PTP (G.8275.x) and associated Q14 work to augment the YANG models builds on the foundation of IEEE 1588, adapting it to the needs of transport networks
- Q11 revised the structure of the FlexO Recommendations (G.709.x) to facilitate reuse of the frame formats and promote a common ecosystem for high-speed coherent interfaces

Beyond 1T transport networks

- Both IEEE 802.3 and OIF are developing 1.6T interfaces
- While pluggable DWDM interfaces enable simpler point-to-point network configurations, there is still a need for flexible connectivity in Layer 1 and Layer 0, so the transport network will need to evolve and support interfaces at 1.6T and beyond
- The existing ODUCn/OTUCn formats were designed to support up to n = 256, so a simple option is to retain those formats and specify a FlexO-16 frame and associated FEC frames
- However, the ODUCn/OTUCn frame is based on the original OTN frames designed 25 years ago to support 2.5 Gb/s transmission with SDH as the primary client signal
- With transmission rates now 2-3 orders of magnitude faster and Ethernet as the primary client, Q11/15 will be considering whether new (Ethernet-optimized) frame formats should be defined

WP3/15 Recommendations related to optical transport networks

Topic	Common	OTN	Media and Optical Signals	Transport Ethernet	Sync
Transport Architecture	G.800, G.805	G.872	G.807	G.8010	G.826x, G.827x
Interfaces	-	G.709, G.709.x	G.698.x	G.8012, Y.1731	G.703, G.8271
Protection	G.808.x	G.873.x	-	G.803x	-
Equipment	G.806	G.798	-	G.8021, G.8023	G.781, G.781.1
DCN	G.7712	G.7712	-	G.7712	-
Management and Control Architecture	G.770x	-	-	-	-
Management Requirements	G.7710 G.7716 G.7718	G.874	G.876	G.8051	G.7721
Management Info Model	G.7711 G.7719	G.875	G.876	G.8052 G.8052.x	G.7721 G.7721.1

ITU Booth #5226

Thank you!

Questions?

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