

OFC

The future of optical networking
and communications

ITU-T SG15 Standards Update

Thursday, 19 March, 2:45pm – 3:45pm



OPTICA

Workshop speakers

Program Chairs



Glenn Parsons
Ericsson, Canada
Chair, ITU-T SG15

Panelists



Tony Zeng
Huawei, France
Associate Rapporteur Q3, WP1



Kazuhide Nakajima
NTT, Japan
Rapporteur Q5, WP2



Tom Huber
Nokia, USA
Vice Chair SG15 and Chair WP3

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The future of optical networking
and communications

Introduction

Glenn Parsons – Chair, ITU-T SG15



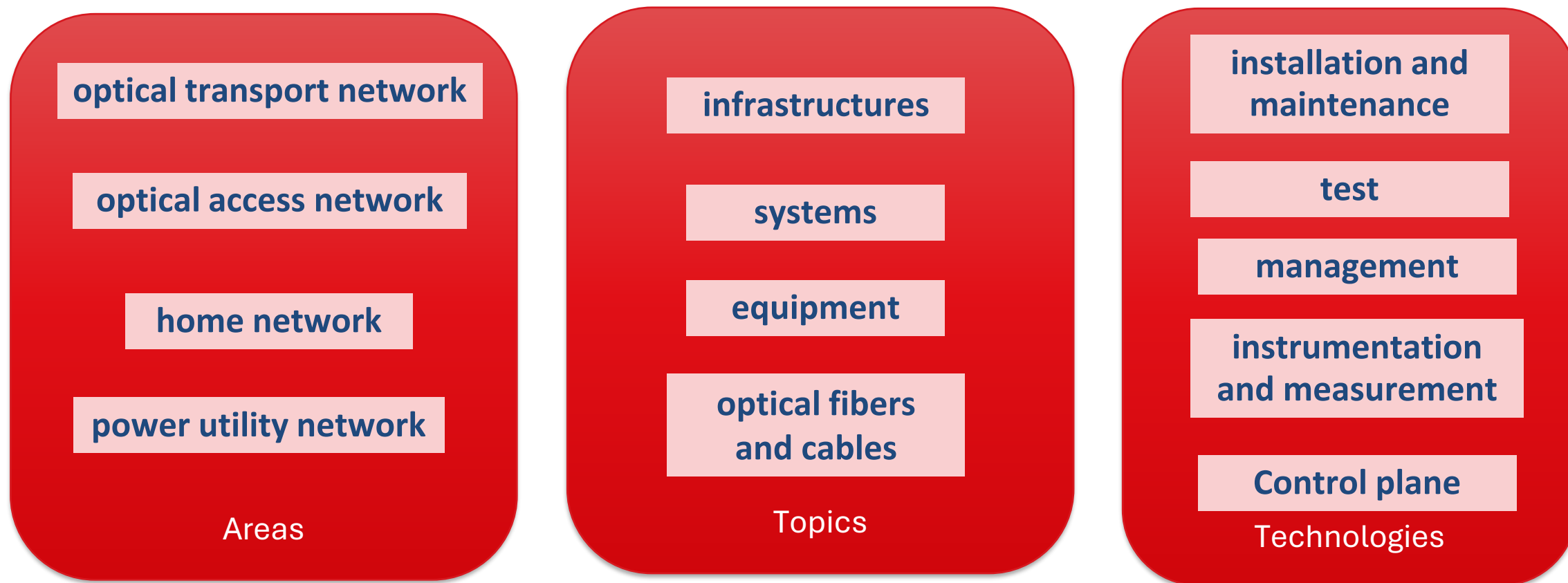
ITU-T
Telecommunication
Standardization Sector



OPTICA

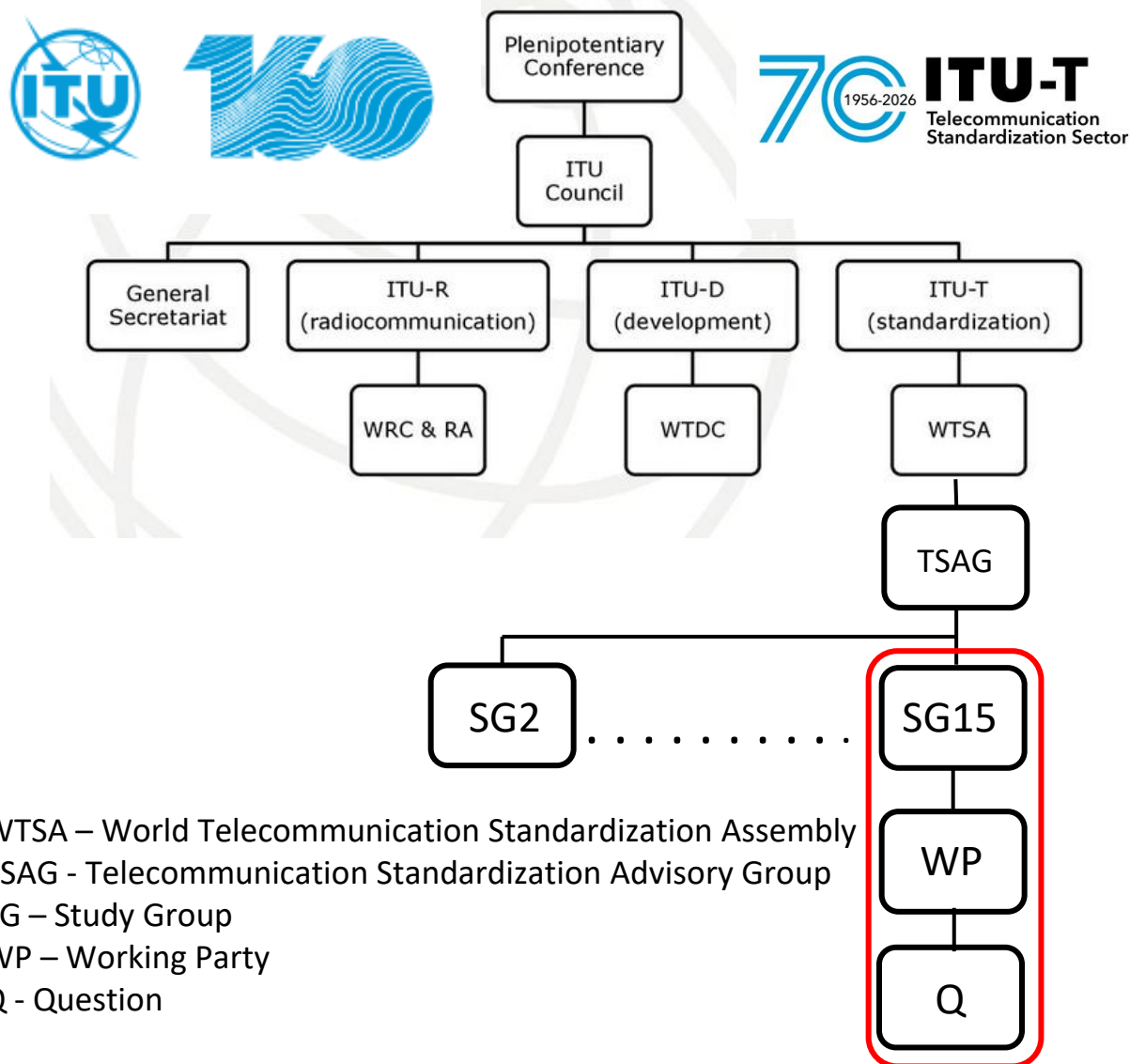
Responsibility of Study Group 15

The development of **standards** on:



to enable the evolution toward intelligent optical networks ...

ITU Structure



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)

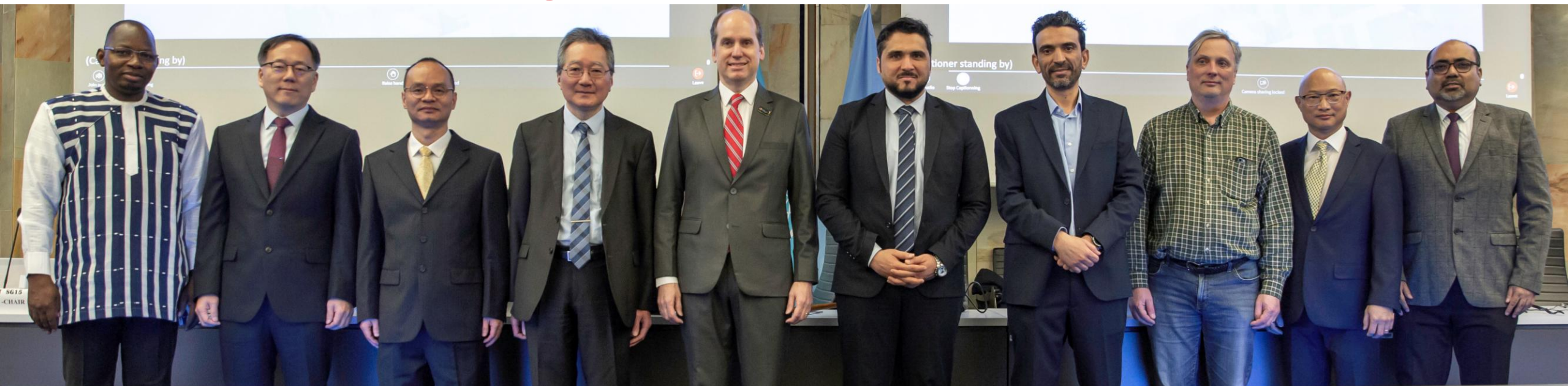
Leadership of ITU-T SG15

- WTSA-24 – October 2024
 - Appointed leadership of Study Groups



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

ITU-T SG15 management team (2025-2028)



Vice Chairs

- Mohamed Amine BENZIANE
- Sudipta BHAUMIK
- Taesik CHEUNG
- Adel HLILOU
- Thomas HUBER
- Umarbek IZBASAROV
- Marcel KEBRE
- Stephen SHEW

- Fatai ZHANG

WP1/15

- Ian HORSLEY
- Frank Van der Puten

WP2/15

- Paul DOOLAN
- Sudipta BHAUMIK

WP3/15

- Tom HUBER
- Silvana RODRIGUES

Promotion and Coordination

- Taesik CHEUNG
- Vince FERRETTI

TSB counsellors

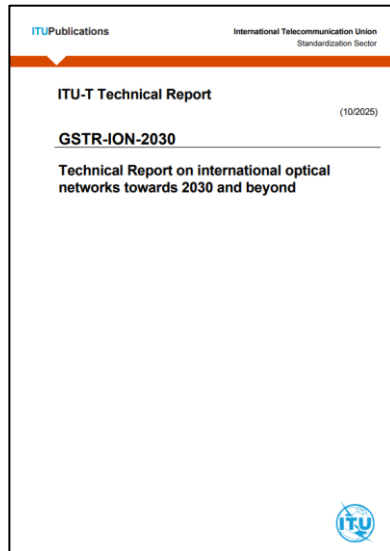
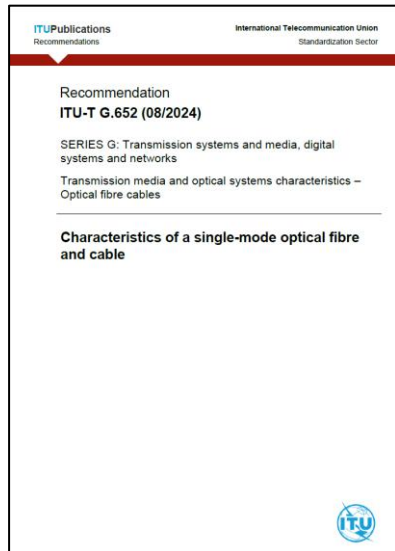
- Hiroshi OTA
- Hiyato FUKUZONO

Questions and Working Parties of SG15

Question Number		Question title
WP1		Optial Access and Home
WP2		Optical Technology & Physical Infrastructure
WP3		Transport Network Characteristics

ITU-T SG 15 deliverables

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



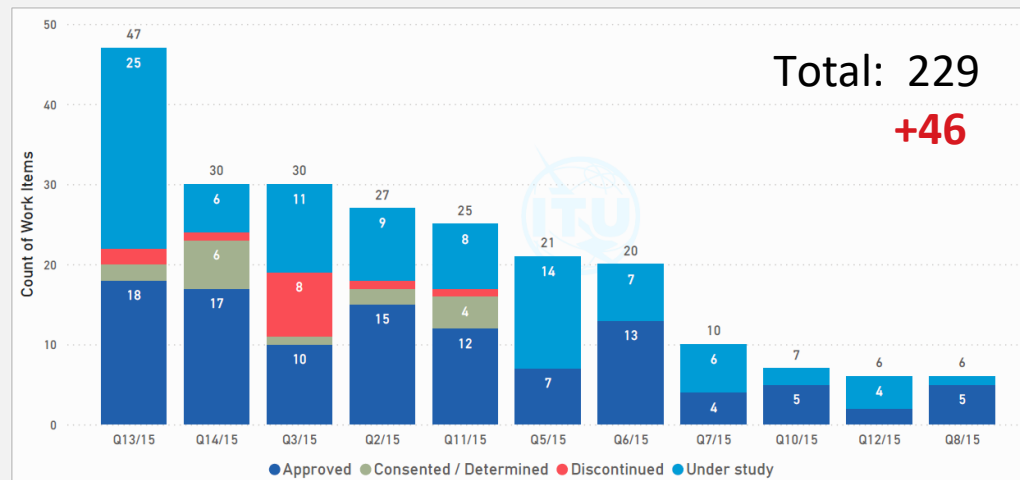
1 Gbit/s per channel	2.5 Gbit/s per channel	10 Gbit/s per channel	25 Gbit/s per channel	50 Gbit/s per channel
Splitter-based ODN Single channel TDMA systems				
G-PON G.884.x series	1 G.887.x series NG-PON G.9807.x series	2 XG-PON (NG-PON1) G.9807.x series	3 SAG-PON G.9804.x series	5.1
Splitter-based ODN Multi-channel TWDM systems				
	NG-PON2 G.989.x series	4.1 G.989.x series	5.2 NG-PON2 G.989.x series	
Splitter-based ODN Multi-channel WDM Overlay				
NG-PON2 G.989.x series	4.2 G.989.x series	4.2 G.989.x series	4.2 G.989.x series	
Wavelength multiplexed ODN with logical point-to-point connections (a.k.a. WDM-PON)				
			25 Gbit/s PON G.9802.x series	6

For more information, please visit the ITU-T Study Group 15 website at: www.itu.int/itu-t/sg15

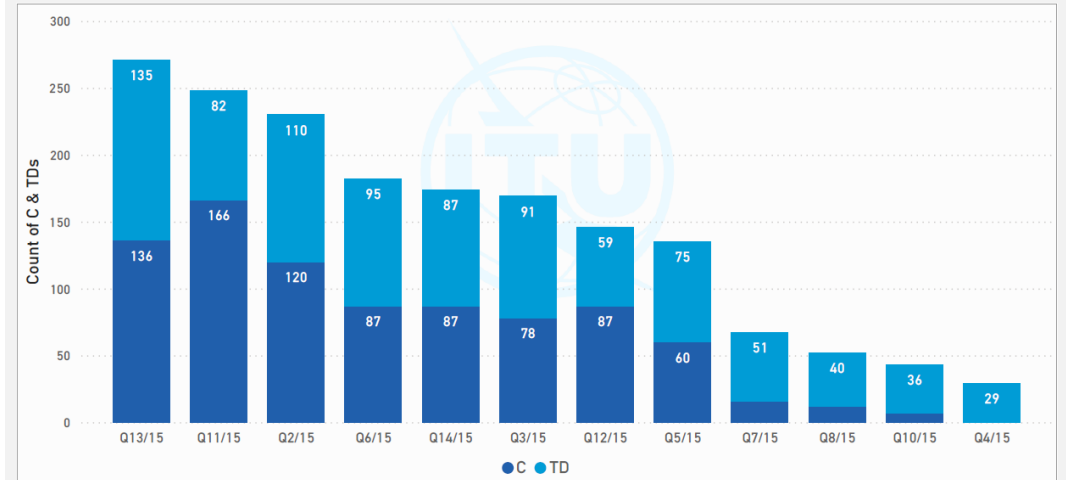
Recommendation series

- + 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
- + L.100-L.199: Optical fibre cables
- + L.200-L.299: Optical infrastructures
- + L.300-L.399: Maintenance and operation
- + L.400-L.429: Passive optical devices
- + L.430-L.449: Marineized terrestrial cables
- + L supplements: Supplements to ITU-T L-series Recommendations

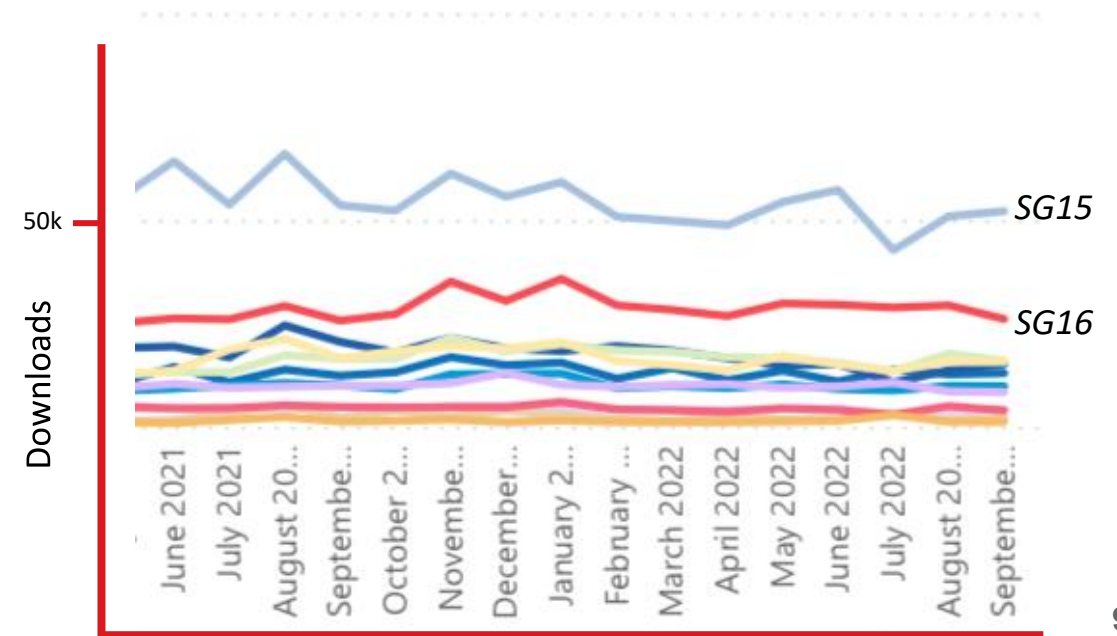
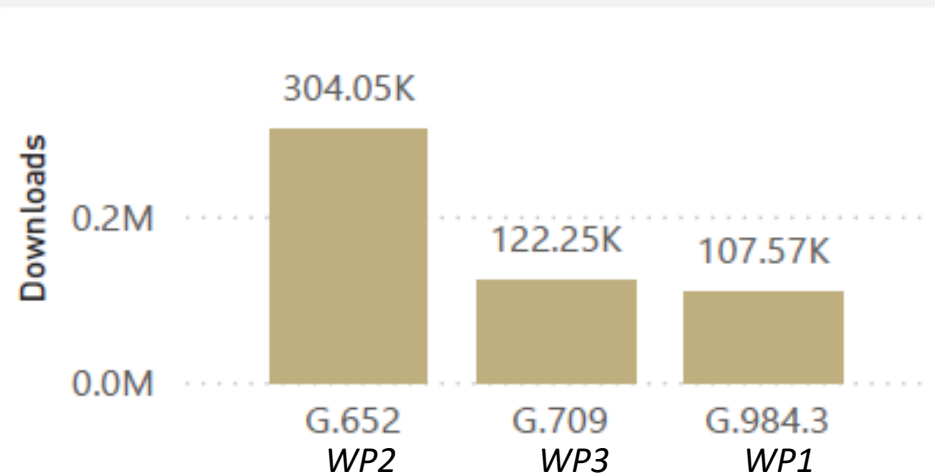
Work items by status



Contributions and TDs by Questions



Study Group 15



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The future of optical networking
and communications

Fibre in-premises network in WP1

Tony Zeng

Associate Rapporteur, ITU-T SG15 Q3

ITU-T SG15/Q3 experts group

Q3: Technologies for in-premises networking and related access applications

Main Projects:

- **G.hn (G.996x series): Unified high-speed wire-line based home networking transceivers**
 - Operation over coax, twisted pair, powerline and POF
 - PHY layer (G.9960), DLL (G.9961), management layer (G.9962), MIMO (G.9963), Spectrum (G.9964)
- **G.vlc (G.999x series): High speed indoor optical wireless communications**
 - Enable free space optical communication based on G.hn technology
 - Goal to produce Technical Papers on narrow beam OWC and channel adaptive OWC
- **G.fin/G.Xfin (G.994x series): High speed fibre-based in-premises transceivers**
 - Enable in-premises P2MP fibre backhaul for Wi-Fi and provide fibre & Wi-Fi coordination
 - Architecture (G.9940), PHY (G.9941), DLL (G.9942), NM (G.9943), Wi-Fi coordination (G.wmci), Technical paper & supplement on use cases and requirements
- **G.p2pf (G.9930): Optical ethernet for in-premises network**
 - Enable in-premises P2P fibre backhaul for Wi-Fi

Ecosystem: Chip vendors, system vendors, service providers

End customers: Telco operators, Power Utilities, Lighting companies, retail channels

Main liaisons: ITU-R, ETSI TC ATTM, ETSI ISG F5G, CCSA TC6, IEEE, Broadband Forum, and HomeGrid Forum

Recently consented or approved Recommendations

G.hn project

- G.9960 (2023) AMD 2 (**approved** in 03/2025), Unified high-speed wireline-based home networking transceivers - System architecture and physical layer specification
- G.9961 (2023) Corr1 (**consented** in 03/2025), Unified high-speed wireline-based home networking transceivers - Data link layer specification

FTTR (G.fin/G.Xfin/G.p2pf)

- G.9930 (**approved** in 07/2024), Point-to-Point fibre in the Premises
- G.9930 (2024) Amd1 (**agreed** in 03/2025), Point-to-Point fibre in the Premises
- G.9941 (**approved** in 07/2024), High speed fibre-based in-premises transceivers - physical layer specification
- G.9942 (**approved** in 07/2024), High speed fibre-based in-premises transceivers – data link layer
- G.9943 (**approved** in 10/2025), High speed fibre-based in-premises transceivers – network management
- G.9949 (**approved** in 10/2025), WLAN management control interface (WMCI) for in-premises network
- G.Suppl.78/91 (**agreed** in 2022/25), Use case & requirements of FIP networking for small business application (FIP4B)
- G.Suppl.80 (**agreed** in 07/2024), Use case & requirements of FIP networking for home application (FIP4H)
- G Suppl. 89 (**agreed** in 10/2025), Coordinated management of access and fibre in premises networks
- G Suppl. 90 (**agreed** in 10/2025), Coexistence between G.fin and G.Xfin systems

Future deliverable timeline

G.DoP project

- **G.DoP: Data Over Power – Vehicle Network. System, PHY and MAC Specification**
 - Usage of G.hn-based technology in intra-vehicle communications – Expected 2H26/1H27

FTTR (G.fin/G.Xfin/G.p2pf)

- **G.9949 (WMCI) Amendment 1: WLAN management control interface (WMCI) for in-premises network**
 - Addition of new features to the basic mechanisms already consented – Expected approval in 7/2026
- **G.Xfin-PHY/G.xfin-MAC, High speed fibre-based in-premises transceivers (10G), PHY and DLL**
 - Development of new standard – Goal to consent 2H26/1H27

General

- **G.hetnet: Terminology and overview of the architecture of a Heterogeneous Home Network**
 - Architecture of heterogeneous networks

Future deliverable timeline – TPs & Supplements

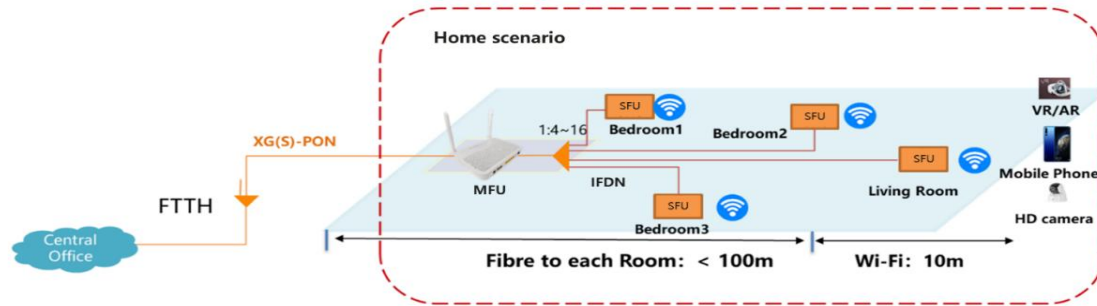
Technical papers:

- Technical paper on the use of G.hn technology for smart grid (GSTP-HNSG),
- Technical paper on the use of ITU-T G.hn technology for in-home networking (TP-UC-HN),
- Technical paper on the use of ITU-T visible light communication technology (TP-VLC),

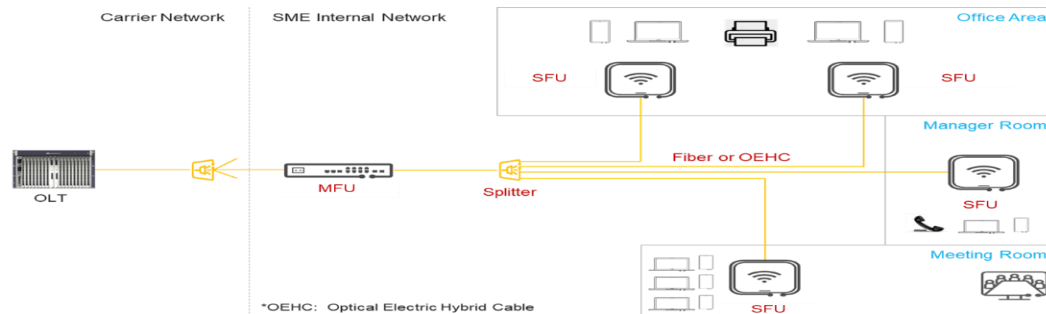
Supplements:

- Enhanced in-premises networking with computing functions (G.suppl.Edge4Home),
- Digital twin network on in-premises networking (G.suppl.TwinHome)
- Use cases, requirements and technical vision of Integrated Sensing And Communication (ISAC) for in-premises networks (G.Suppl.ISAC)
- Beyond 10Gbps fibre in-premises network: use cases, system requirements & technology options (G.Suppl.FIP4B10G)
- AI-enhanced home networking (G.suppl.ION-aiHome)

System architecture of G.fin (1)

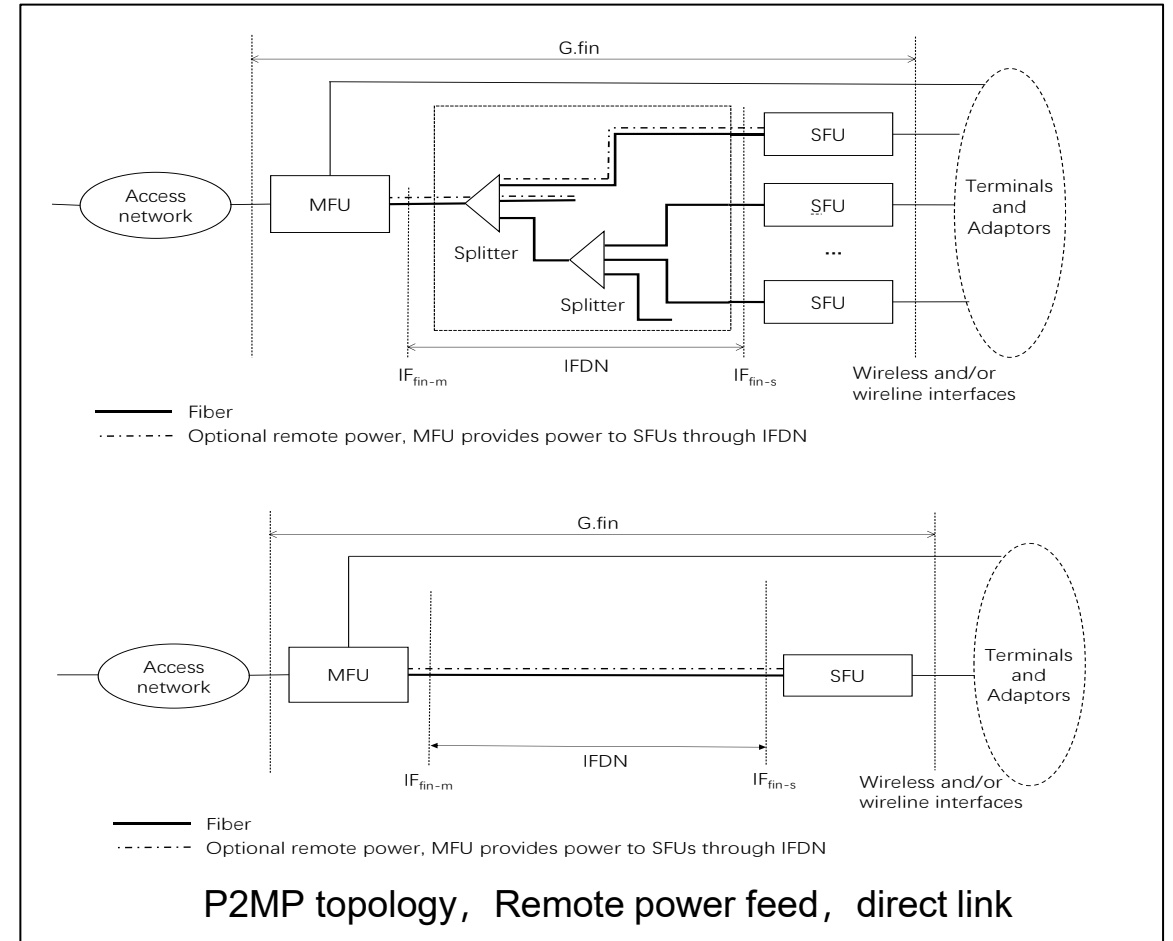


● Home scenario

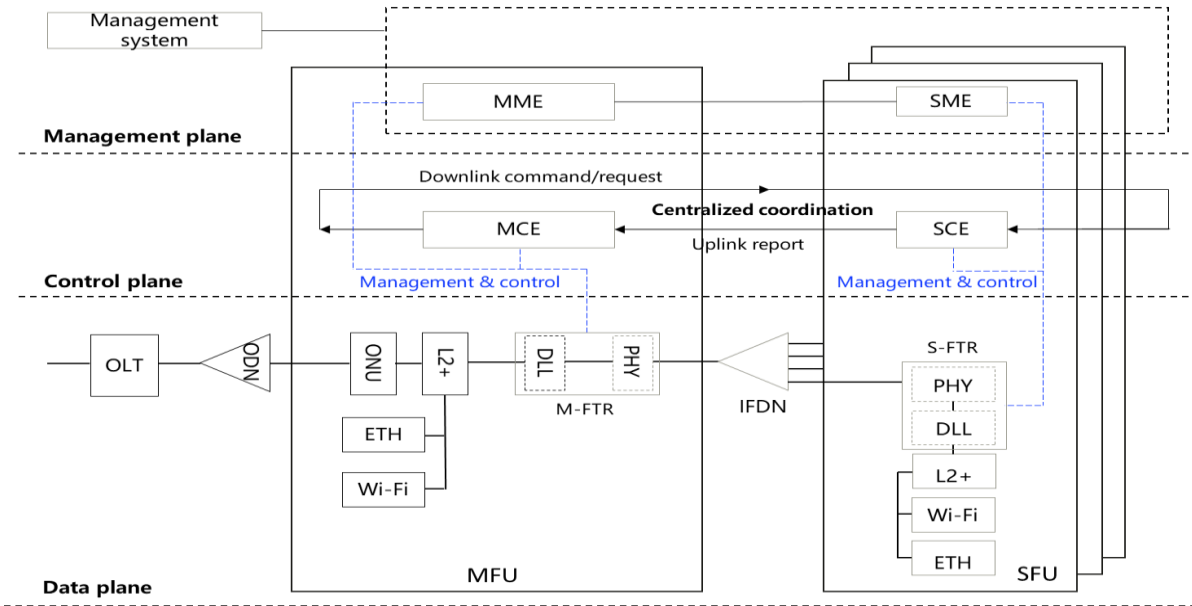


● Business scenario

Source: ITU-T SG15 Q3, G.9940, approved in Nov plenary of 2023

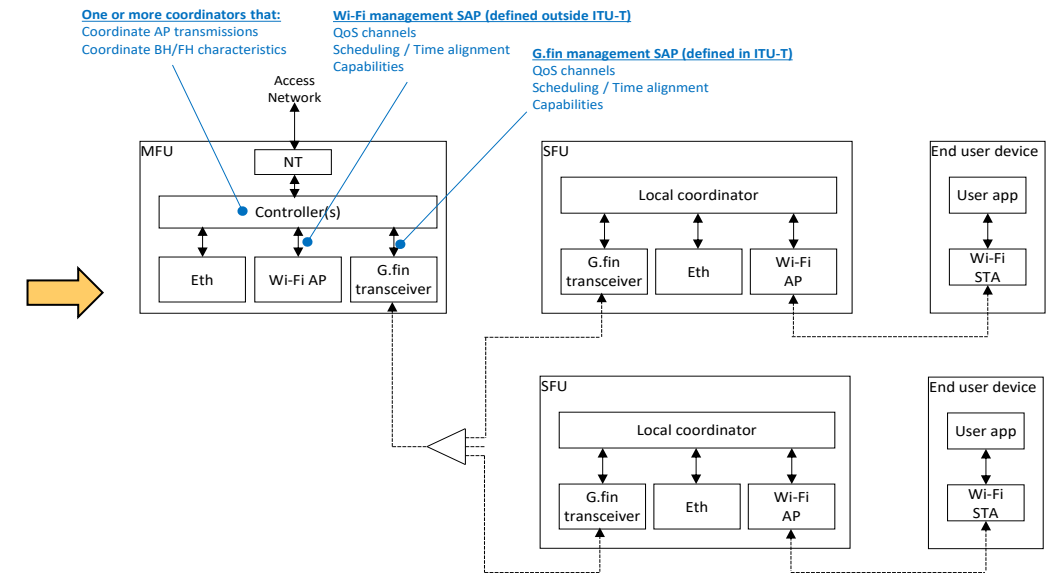


System architecture of G.fin (2)



Functional framework of G.fin system

Source: ITU-T SG15 Q3, G.9940, approved in Nov plenary of 2023

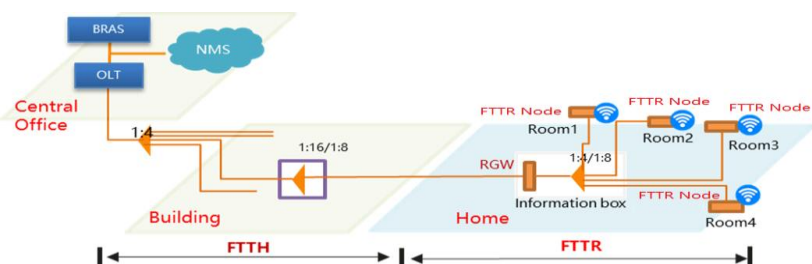


- **Mechanism:**

1. Identify service flow and differentiate the service QoS
2. MFU dynamically collects the Wi-Fi and network relevant information such as data buffer, link status, etc.
3. The MFU controller does analysis and makes decision
4. The decision is sent to each SFU through the fibre network

Typical use cases for Home environment

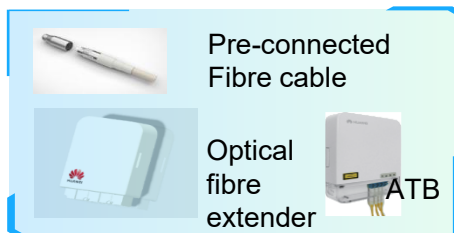
① High Quality Wi-Fi Backhauling



- Throughput 100Mbps → 1Gbps → 10Gbps
- Roamin 1s → 10ms → <1ms

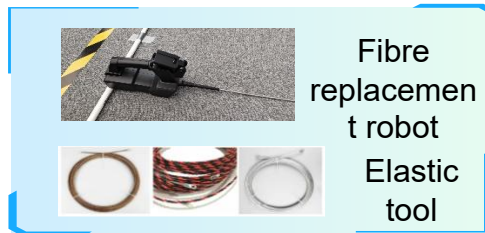
9

③ Low Complexity and Easy ODN



In-premises ODN

Pre-connectorized fibre

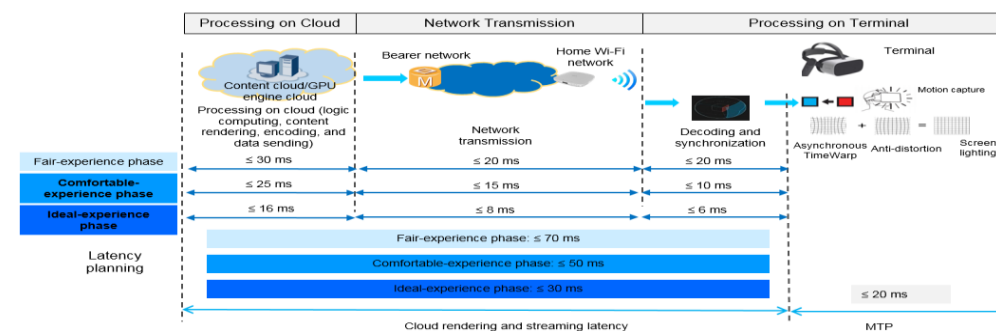


Engineering Tool

fast fibre installation, high successful rate

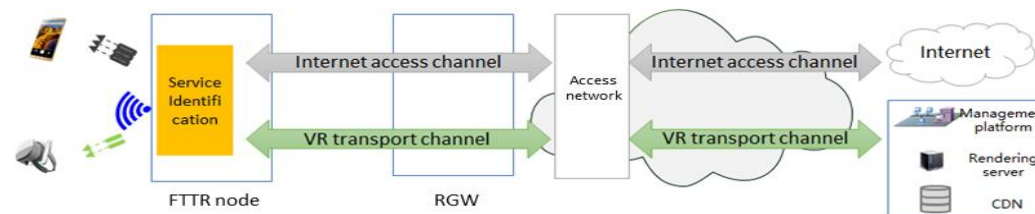
Source: ITU-T SG15 Q3, FTTR use cases & network requirement, 2021

② Support of Extremely low latency



- Stable networking, extremely low latency: <1ms, jitter<1%

④ Slicing



- Service type recognition, high priority channel
- Fibre + Wi-Fi coordination & optimization

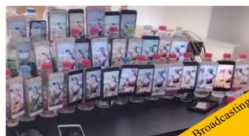
Typical use cases for Small & Medium Enterprises

① Live applications

Live selling



Live broadcasting



Game studio

Service:

- 4K/8K video stream for UL/DL
- Real-time control message

Requirement:

- Guaranteed UL throughput
- E2E Low latency
- Stable connection

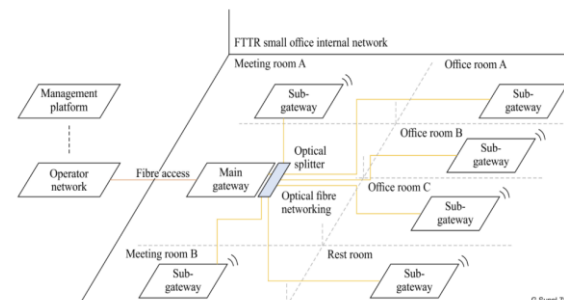
② Smart office

Service:

- Combination of network service
- Diversified connection

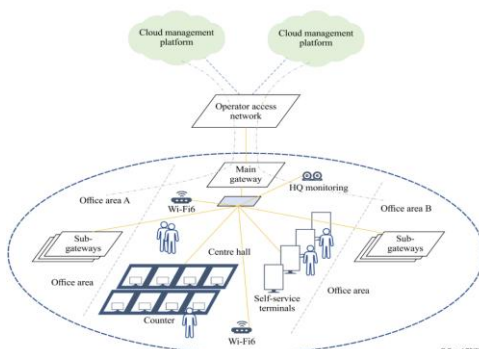
Requirement:

- 32-128 links @1km
- O/E cable, East to west, O&M
- Controllable network jitter



G Suppl.78(22)

③ Smart service hall



G Suppl.78(22)

Service:

- Customer designed service flow
- Combination of network service

Requirement:

- Isolated network
- O/E cable, East to west, O&M
- Guaranteed QoS

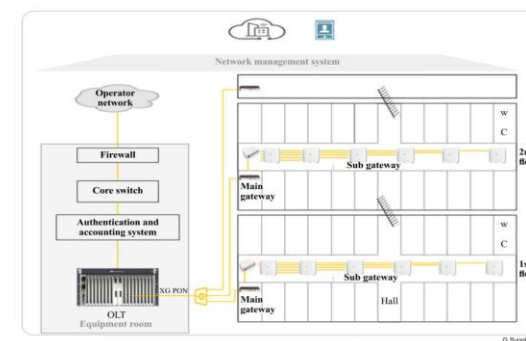
④ School

Service:

- Wi-Fi full coverage
- Dense connection

Requirement:

- Different modes of authentication
- Multicast, isolated network,
- O&M, network control

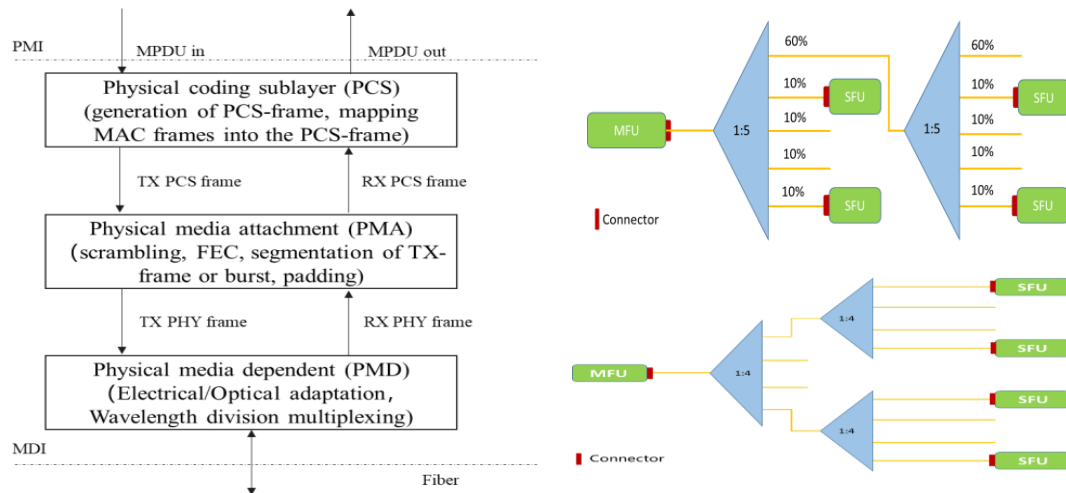


G Suppl.78(22)

Source: ITU-T SG15 Q3, G.suppl.78, Use case and requirements of fibre-to-the-room for small business applications, published in 2022

G.fin transceiver design

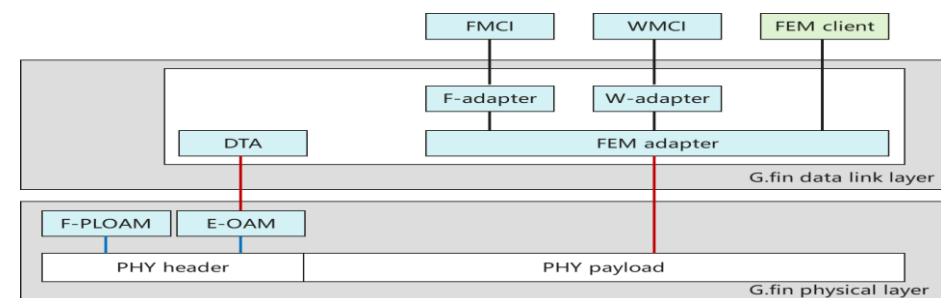
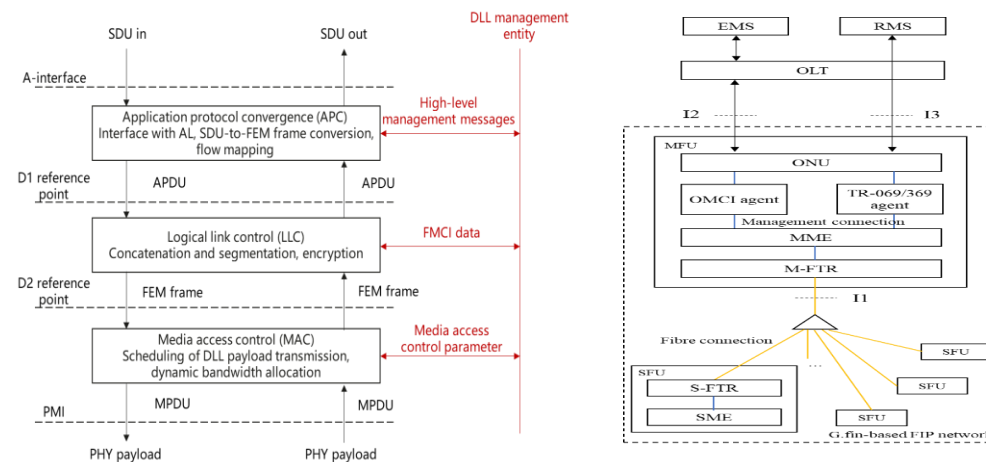
PHY: symmetric rate, optimized link budget, flexible splitting



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

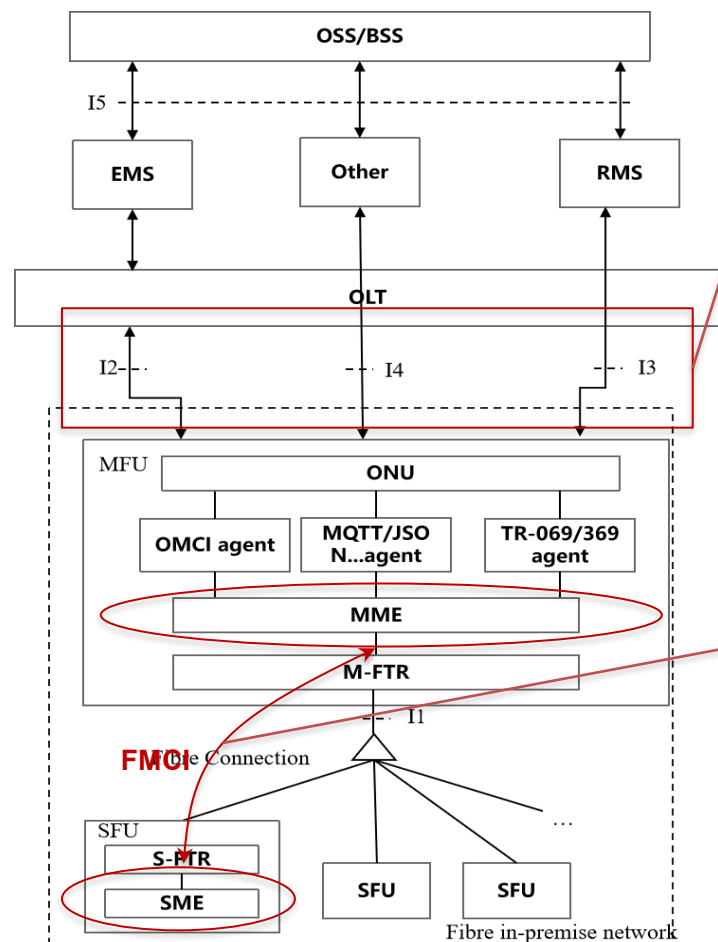
Source: ITU-T G.9941, High speed fibre-based in-premises transceivers - physical layer specification, 2024

DLL: TDMA, F/WMCI dynamic control, OLT enabled management



Source: ITU-T G.9942, High speed fibre-based in-premises transceivers - Data link layer, 2024

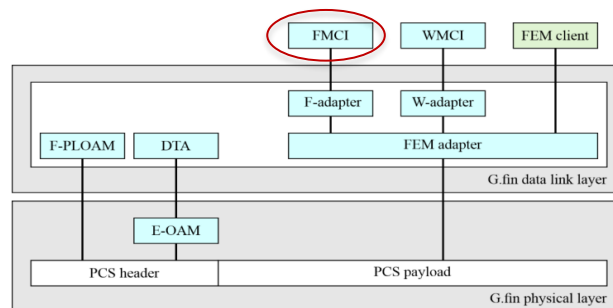
Management of G.fin



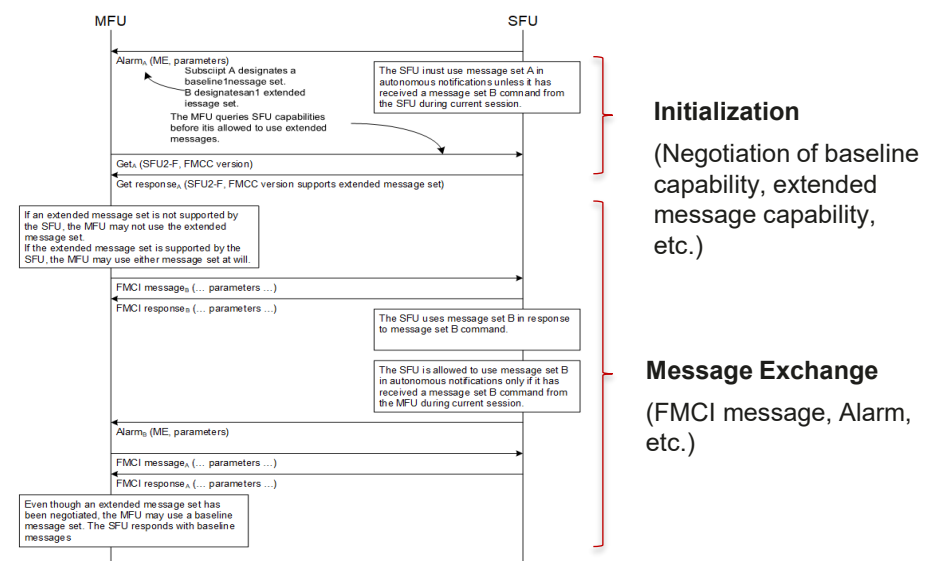
● Management for G.fin system:

1. Option 1: I2 through enhanced OMCI
2. Option 2: I3 through RMS based on IP protocol (TR-069/369)
3. Option 3: I4 proprietary solutions of service providers

● Management within G.fin system (G.9943 FMCI):

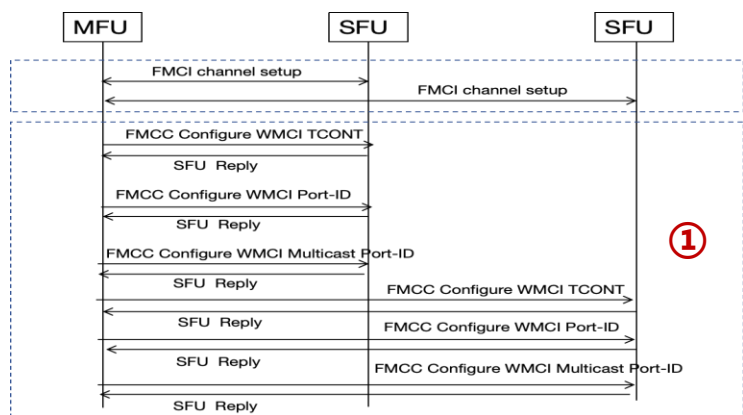
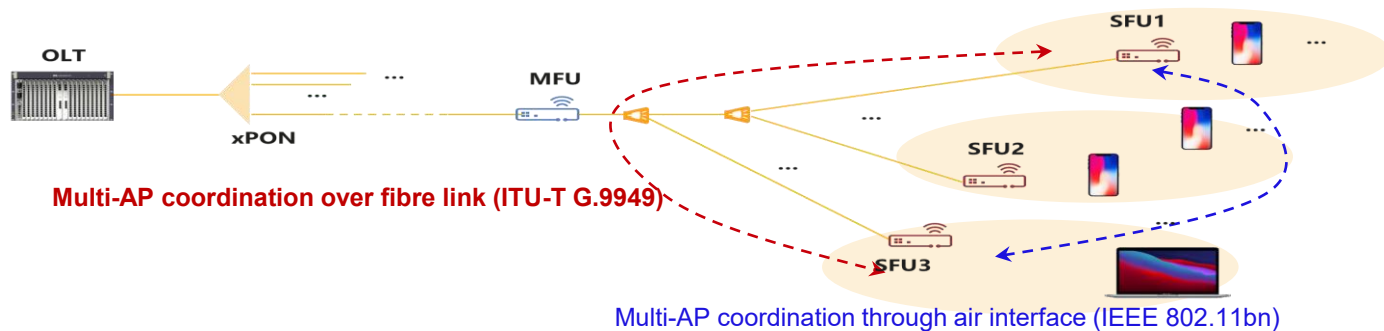


Byte number	Size	Use
1..2	2	Transaction correlation identifier
3	1	Message type
4	1	Device identifier
5..8	4	Managed entity identifier
9..40	32	Message contents
41..48	8	FMCI trailer



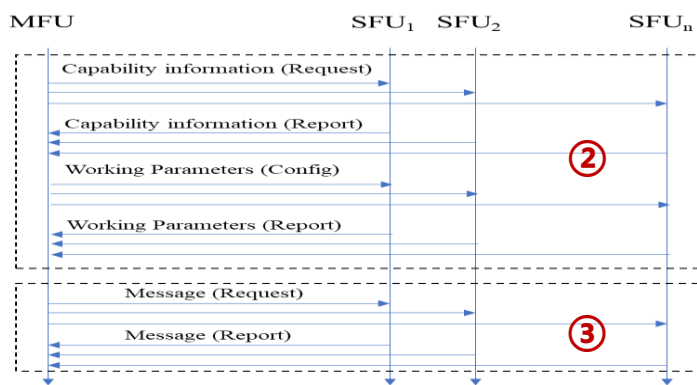
Source: ITU-T SG15 Q3, G.9943, High speed fibre-based in-premises transceivers – network management , consented in 2025

Fibre & WLAN coordination of G.fin



① WMCi channel setup

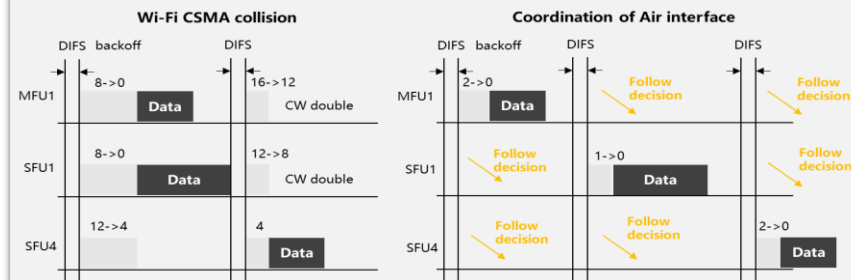
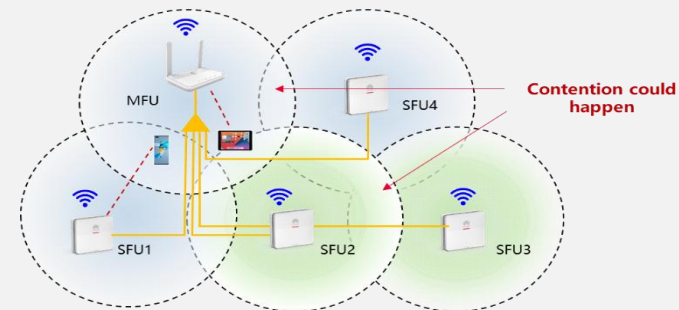
- Establishment via FMCI:
 - FEM Port-ID or multicast FEM Port-ID
 - T-CONT for low latency guarantee
- NOTE: Assign Alloc-ID via F-PLOAM



② Initialization

- Initialization: Capability exchange + working parameter exchange (version, WLAN status, security mode etc.)

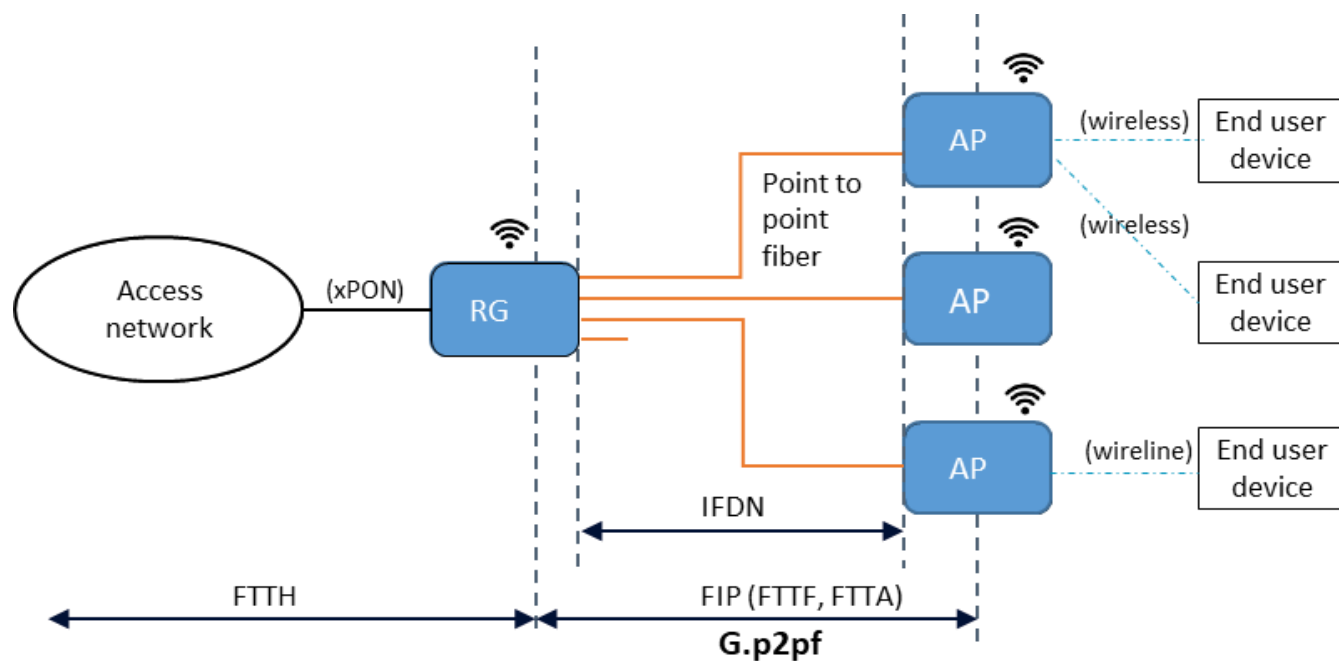
An example of coordinated Wi-Fi Tx in time domain



③ Synchronization

- Coordinated Wi-Fi transmission in time domain
- Power management
- Coordinated spatial reuse (Co-SR)
- Coordinated roaming

G.p2pf Architecture/topology



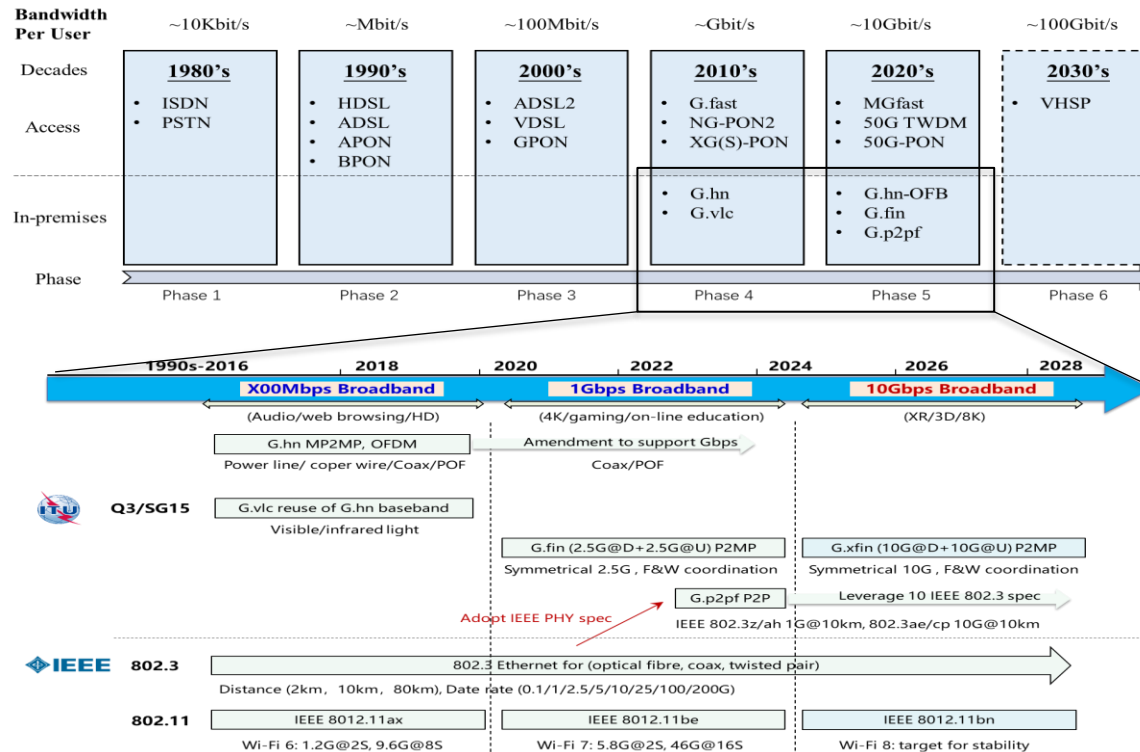
Description

- Optical Ethernet connections are used for connecting RG and repeaters
- Two types of connectivity:
 - ① RG/Repeaters are connected directly to the fibre infrastructure (IFDN) using devices with optical outputs
 - ② RG/Repeaters are connected to external optical/electrical converters using Ethernet. In this case, an external switch is needed on the RG side

Source: G.9930, Point-to-point fibre in the premises, 2024

Roadmap of in-premises technologies in ITU-T

Broadband access & in-premises network technologies evolution



● Gigabit phase:

1. G.hn (G.996x series) over copper or POF
2. G.fin (G.994x series) over single mode silicon fibre
3. G.p2pf (G.9930) by using optical ethernet

● 10 Gigabit phase:

1. G.Xfin (new recommendations on-going)
2. G.p2pf (G.9930) by using optical ethernet
3. G.hn-OFB

● Next generation (towards 2030):

1. Wi-Fi fronthaul technologies based on fibre
2. ~25G/50G Gigabit over fibre for in-premises

Source: ITU-T SG15 WP1, Technical paper, Broadband access & in-premises network (BAIN), agreed in 2025 March plenary

Q3/15 and AI

Efforts as part of ION-2030: strategic framework developed by ITU-T Study Group 15 to guide the evolution of International Optical Networks

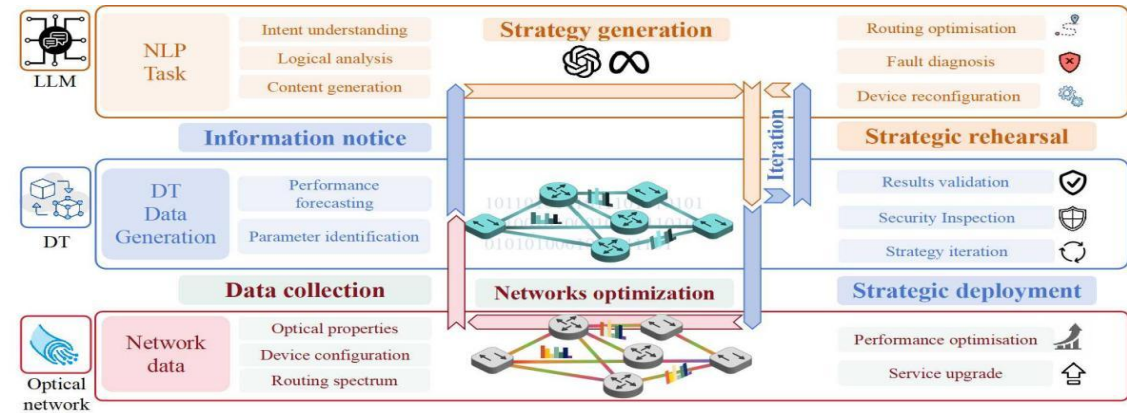
- Agentic AI as a service; Quality on demand; Self-optimizing network
- Home network is entry of broadband network, performing the direct network offering to end users and occupy the best position to facilitate AI service and function deployment

Why study AI in a network-driven group?

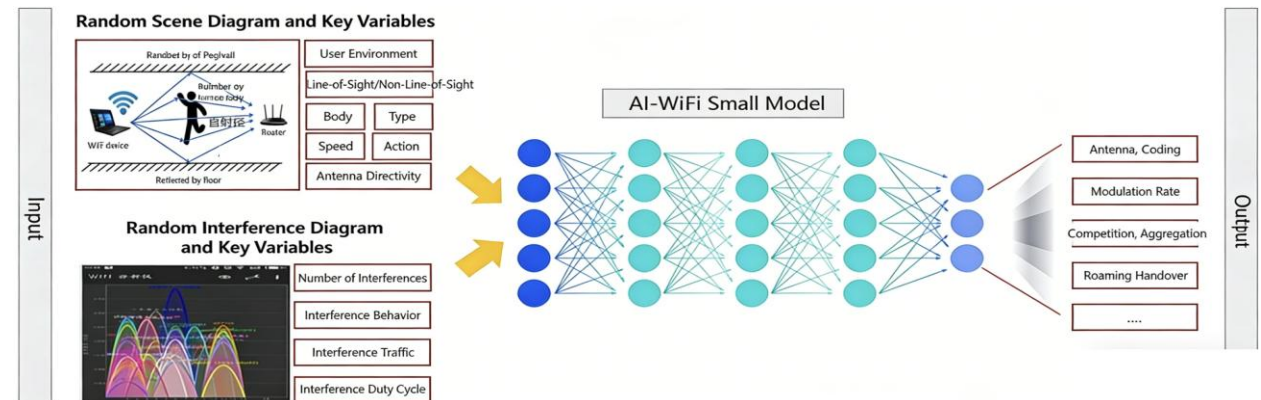
- **Q3/15 defined a clear scope on the efforts in AI, based on two assumptions:**
 - **Assumption 1:** Artificial Intelligence adds a new set of requirements on in-premises networks
 - AI may make use of data coming from the networks (e.g., QoS information)
 - AI may configure/manage the networks to optimize the behavior (e.g., prioritization, optimization)
 - **Assumption 2:** Artificial Intelligence provides a new mechanism to address some challenges that were previously addressed analytically
 - AI may be used for congestion-avoidance algorithms (e.g., DTA)
 - AI may be used to solve system-wide optimizations (e.g, coordination between systems for access to the medium)
- **Two main efforts ongoing:**
 - Coordination of fibre in premises networks and WLAN networks (WMCI)
 - aiHome project: “AI-enhanced home network”,

Q3/15 and AI: AI Home

- Analysis of interactions between AI and Network infrastructure
- Use-case based approach:
 - Collect use cases
 - Analyze impact on the network
 - Analyze data needed from the network
 - Proposal of interaction (OAM update)
 - Impacts different Recommendations
- To be agreed in the coming months
- Use cases under analysis (so far):
 - NAS security in Fiber In Premises
 - AI 3D Video
 - AI 3D health care
 - AI Wi-Fi distribution
 - ...



Interaction with network layer. **Source:** ITU-T SG15 Q3, G.Suppl.aiHome draft



Example of AI Wi-Fi optimization. **Source:** ITU-T SG15 Q3, G.Suppl.aiHome draft

To conclude for fibre in-premises network

- **Target for providing guaranteed user experience**
- **Applications are wide, including home & SME, potentially extended to verticals in the future**
- **Protocol design adapts to the characteristics of in-premises (home & SME)**
- **Foundation of 2.5G recommendations are completed in ITU-T**
- **Fibre & Wi-Fi coordination is the current hotspot technology to be addressed**
- **10G FTTR is on the way and match to the deployment of 50GPON & Wi-Fi 8**
- **AI-enabled fibre in-premises network brings new values to customers**

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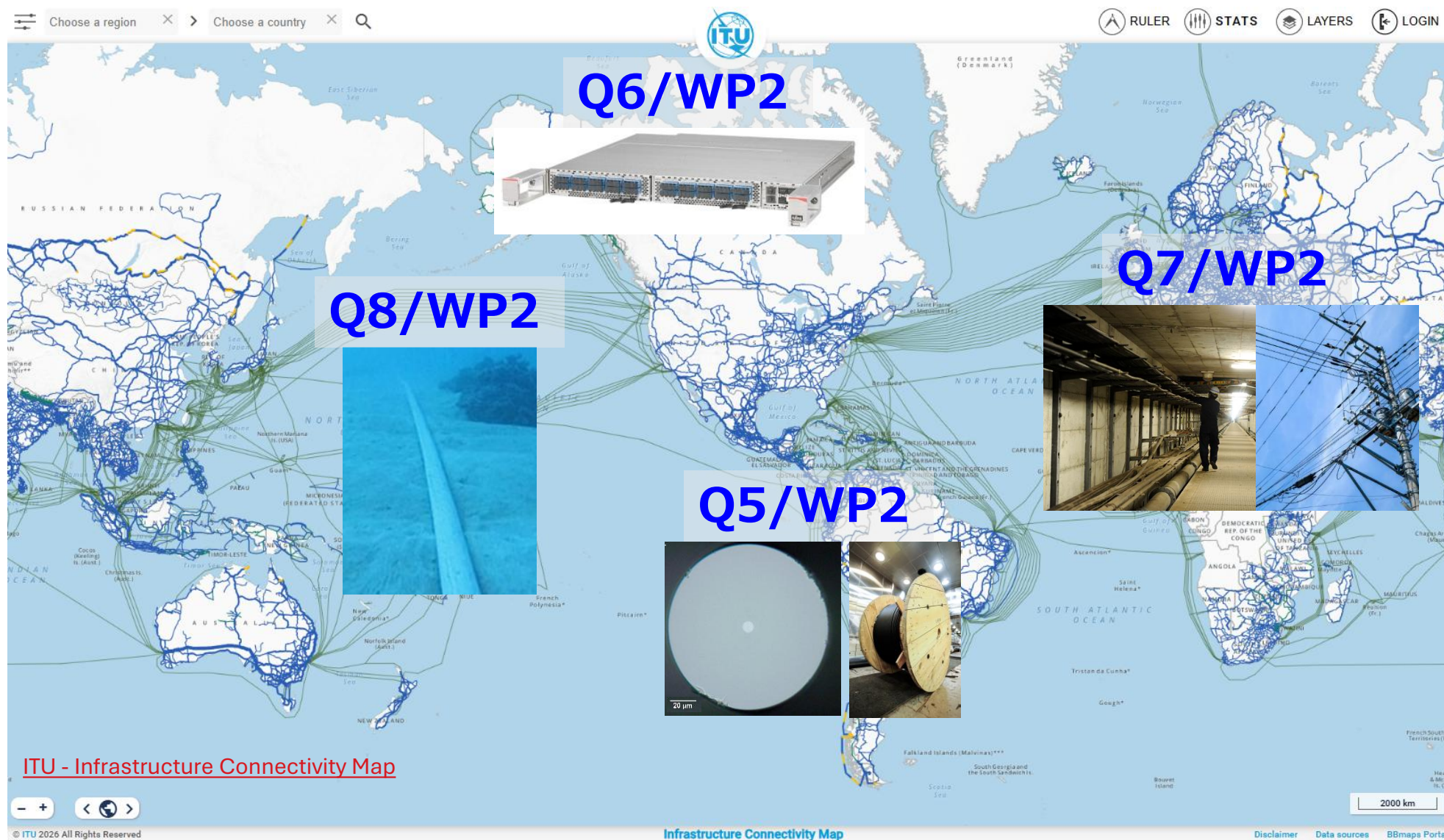
The future of optical networking
and communications

Recent activities in WP2

Kazuhide Nakajima

Rapporteur ITU-T SG15 Q5

WP2/SG15



Summary of major topics in Q5

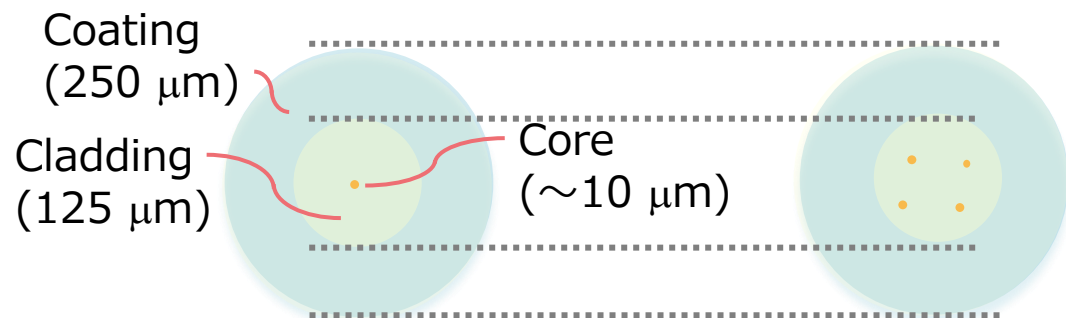
New Recommendations for Weakly-coupled Multi-core fiber (WC-MCF) Technology

- G.smmcf, G.csmcf, and G.650.2

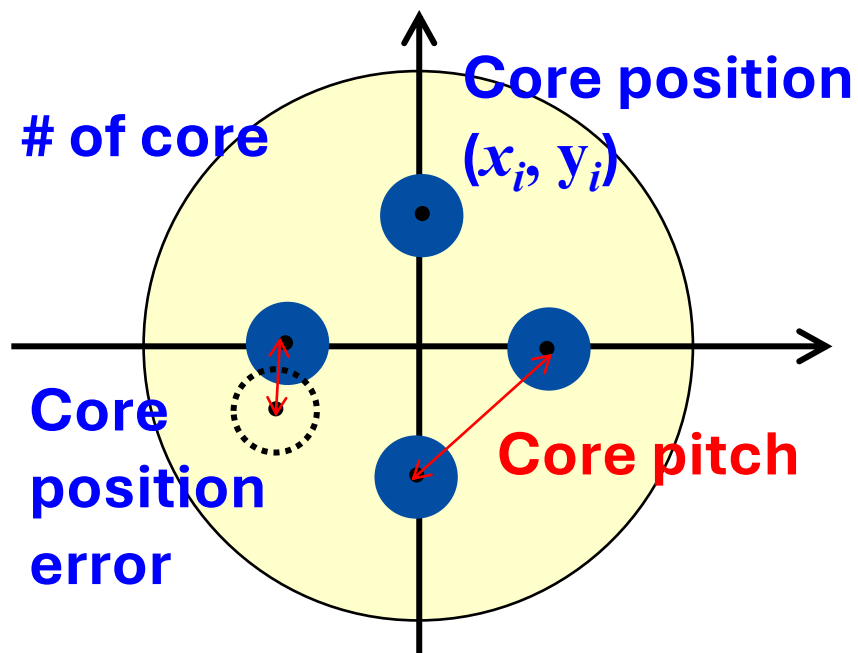
Examples of other active work items

- Introducing the coating diameter specification into Recommendations G.65x
- National experiences for cable deployment, New L.Suppl.ne
- Refinement of existing L.100-series cable Recommendations

WC-MCF Technologies

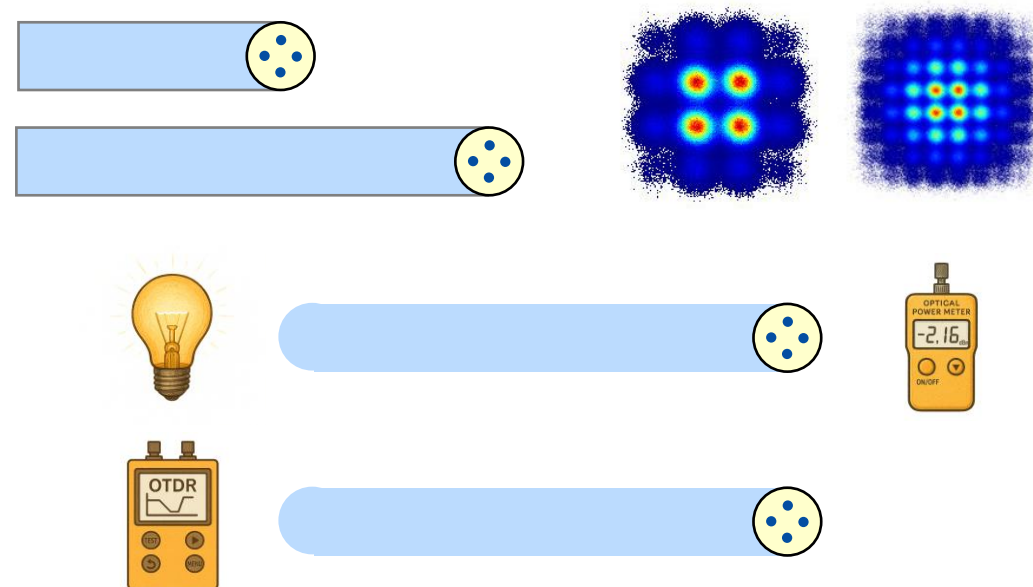


◆ Geometry

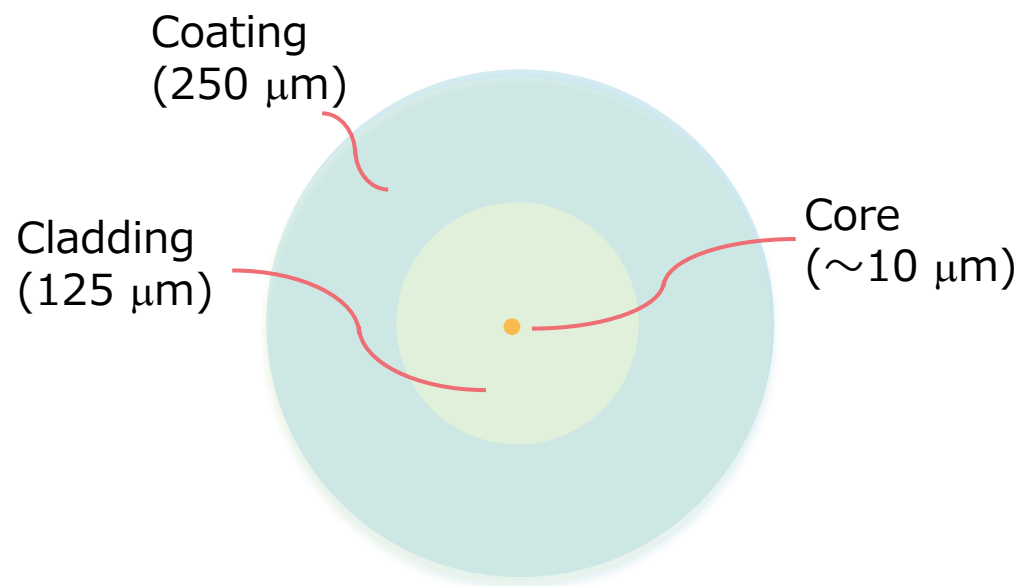


- ◆ Standard cladding diameter
- ◆ Compatibility to G.652 & G.654
- ◆ 2-core for submarine
- ◆ 4-core for submarine and DC

◆ Inter-core cross-talk (ICXT)



Coating Diameter

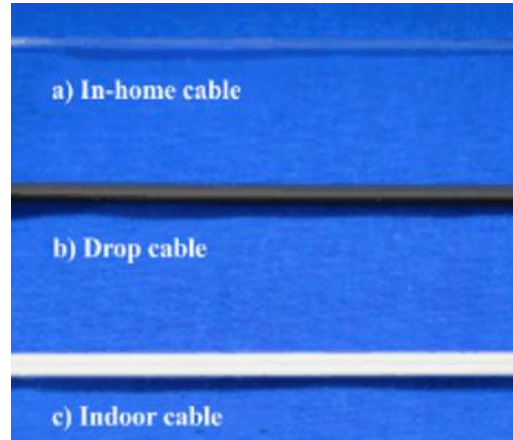


Cutoff wavelength	✓	✓
Chromatic dispersion	✓	✓
Mode-field diameter	✓	✓
Attenuation	✓	✓
PMD coefficient	✓	✓
Cladding diameter	✓	✓
Core concentricity error	✓	✓
Cladding non-circularity	✓	✓
Coating diameter		✓
Proof stress	✓	✓

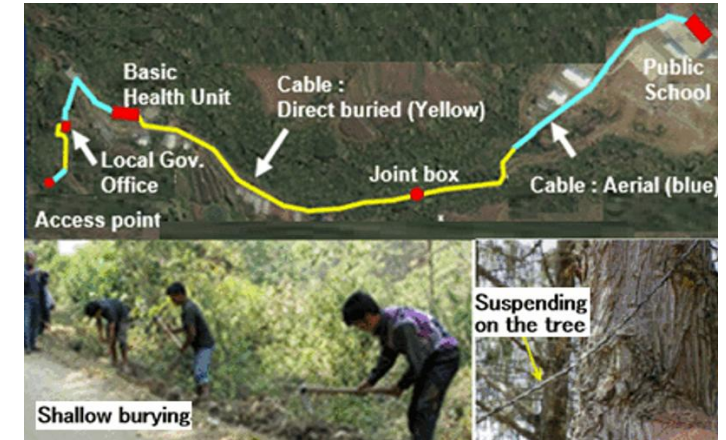
New L.Suppl.ne



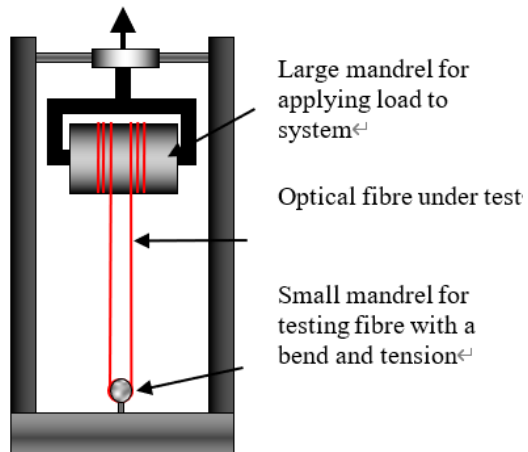
Low friction indoor in Japan



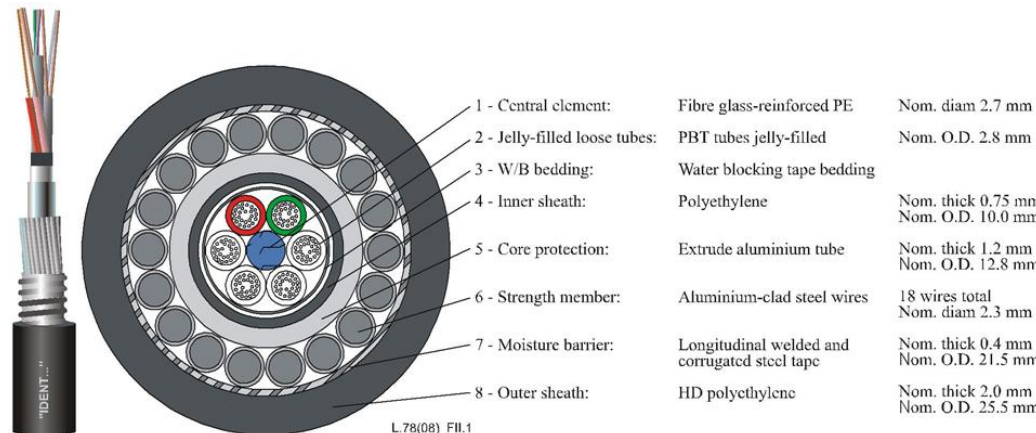
In-home example



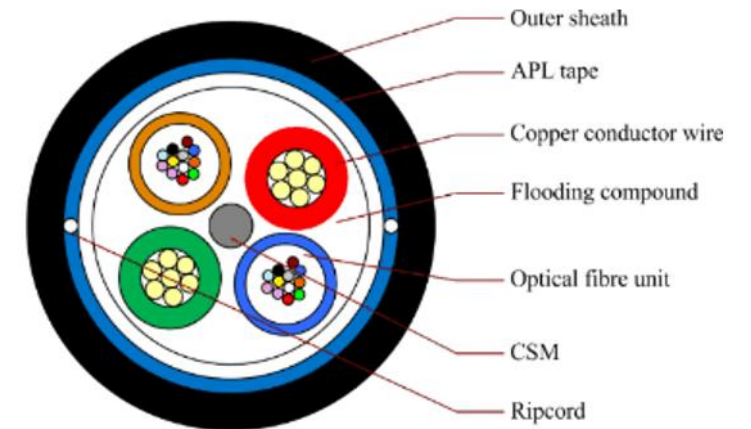
Direct surface in Bhutan



Indoor test in US



Sewer duct in Italy



Hybrid in China

L.100-series

Rec. #	Application Space
L.100	Duct and Tunnel
L.101	Directly Buried
L.102	Aerial
L.103	Indoor
L.104	Small Count Indoor
L.105	Drop
L.107	Sewer Duct
L.108	Microduct
L.109	Optical/Metallic Hybrid
L.109.1	Type II Optical/Metallic Hybrid
L.110	Direct Surface
L.111	In-home

L.ocwp1	Aerial with lower voltage power line
L.ocwp2	Aerial with higher voltage power line

Summary of major topics in Q6

Examples of **recently consented** work items (next slides)

- G.691, G.Sup39, G.641, G.672, TR.ION-aiDC

Examples of other active work items

- 800G DWDM applications in G.698.2.
- TR.fsc (feed-forward sensing in optical communication networks).
- 200G applications (“grey interfaces”) in G.959.1 and G.695.
- Self-tuning applications into G.698.4

New Recommendation G.681 (ex G.dfos)

- Distributed fiber optics sensing (DFOS) optical interface requirements for terrestrial optical transmission systems
- Two categories of DFOS system architectures are defined, where sensing and data channels share the same fiber: **back-scattering** type and **feed-forward** type
- Examples of covered aspects include wavelength plan, optical parameters, and impact of interference.
- Work in progress to extend the sensing distance to 80 km+

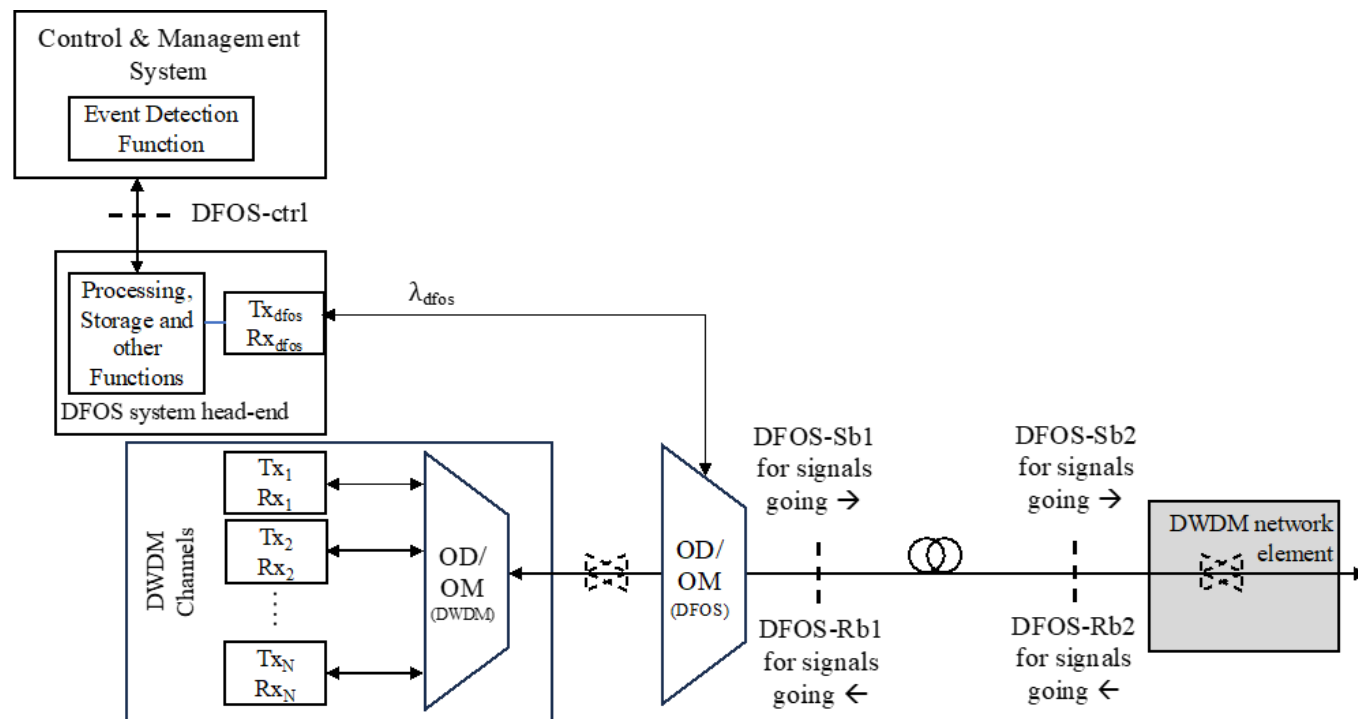


Figure 6-1 – Reference diagram of back-scattering type sensing. Out-of-band sensing wavelength, bi-directional DWDM transmission

Supplement G.Sup39

- Optical system design and engineering guidelines
- Non-exhaustive list of covered topics:
 - Methodologies used in the development of optical interface specifications
 - Spectral bands
 - Line codes and modulation formats
 - Statistical optical transmission systems design methodologies
 - Forward error correction techniques
- Recently added
 - Point to multi-Point (PtMP) configurations
 - Probabilistic Constellation Shaping (PCS)
 - Pulse Amplitude Modulation (PAM4)
 - Optical layer reliability and availability

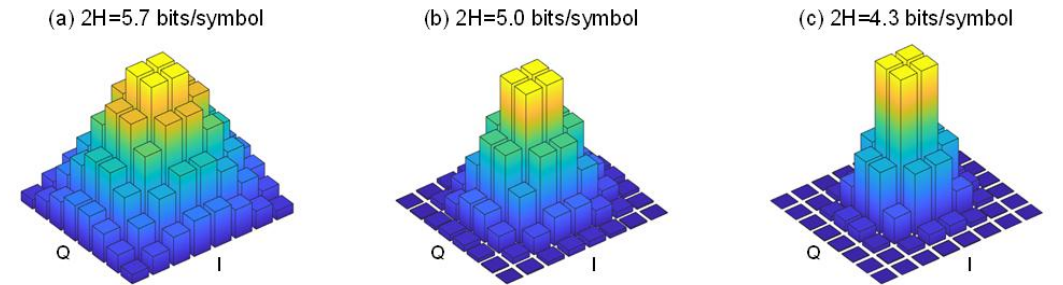


Figure 7-42 – Exemplary constellation distribution diagrams of PCS-64-QAM with entropies of (a) 5.7 bits, (b) 5.0 bits, and (c) 4.3 bits per complex symbol ([b-Liu2])

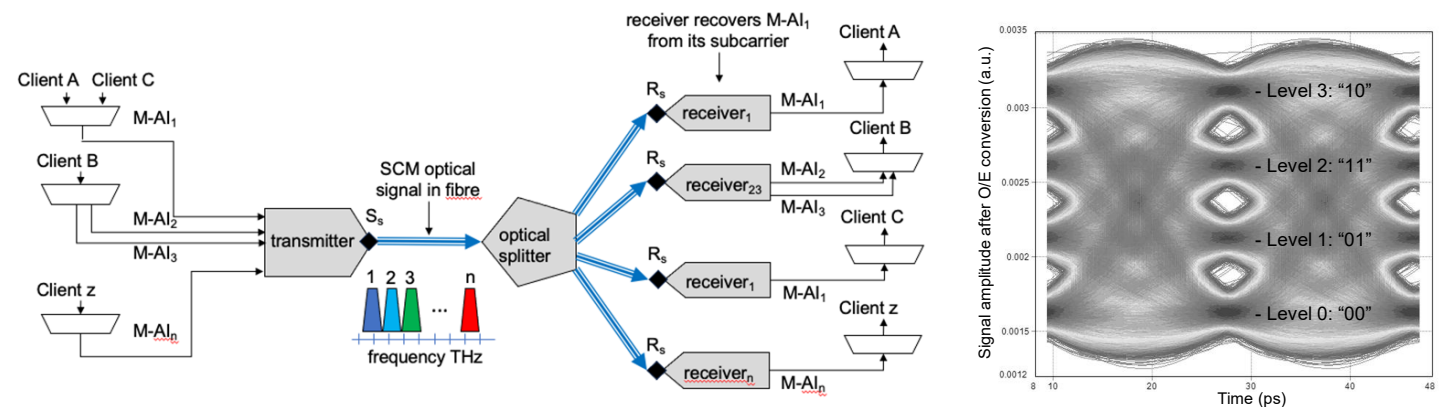
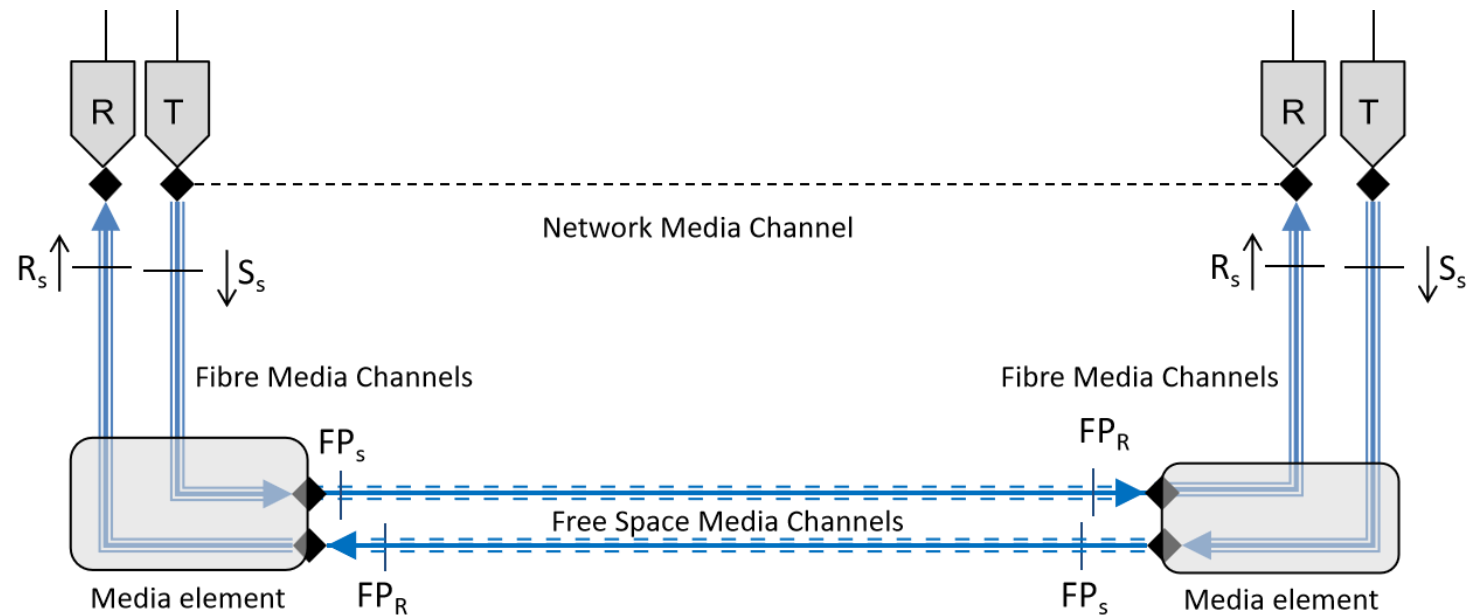


Figure 7-21 – Model of SCM in PtMP

Figure 7-10 – An exemplary PAM4 eye diagram generated by an EML at 112 Gb/s

New Recommendation G.641 (ex G.fso)

- Optical infrastructures are not only fiber infrastructures!
- G.fso provides physical layer parameters and values for channel interfaces in **free-space optics** (FSO) systems
- Transparent fiber-space interface **with optical amplification but no re-timing**
- It targets **terrestrial mobile backhaul** applications
- Possible upgrades: FEC-based applications, multi-channel systems



Recommendation G.672

- Description of **multi-degree ROADM**, used in DWDM optical networks to enhance network scalability and to support enhanced service provisioning and resilience features.
- Both **fixed and flexible DWDM grid** applications.
- New examples of ROADM configurations recently added, to reflect the evolution of optical networks
- Multi-granular ROADMs with band switching will be added soon

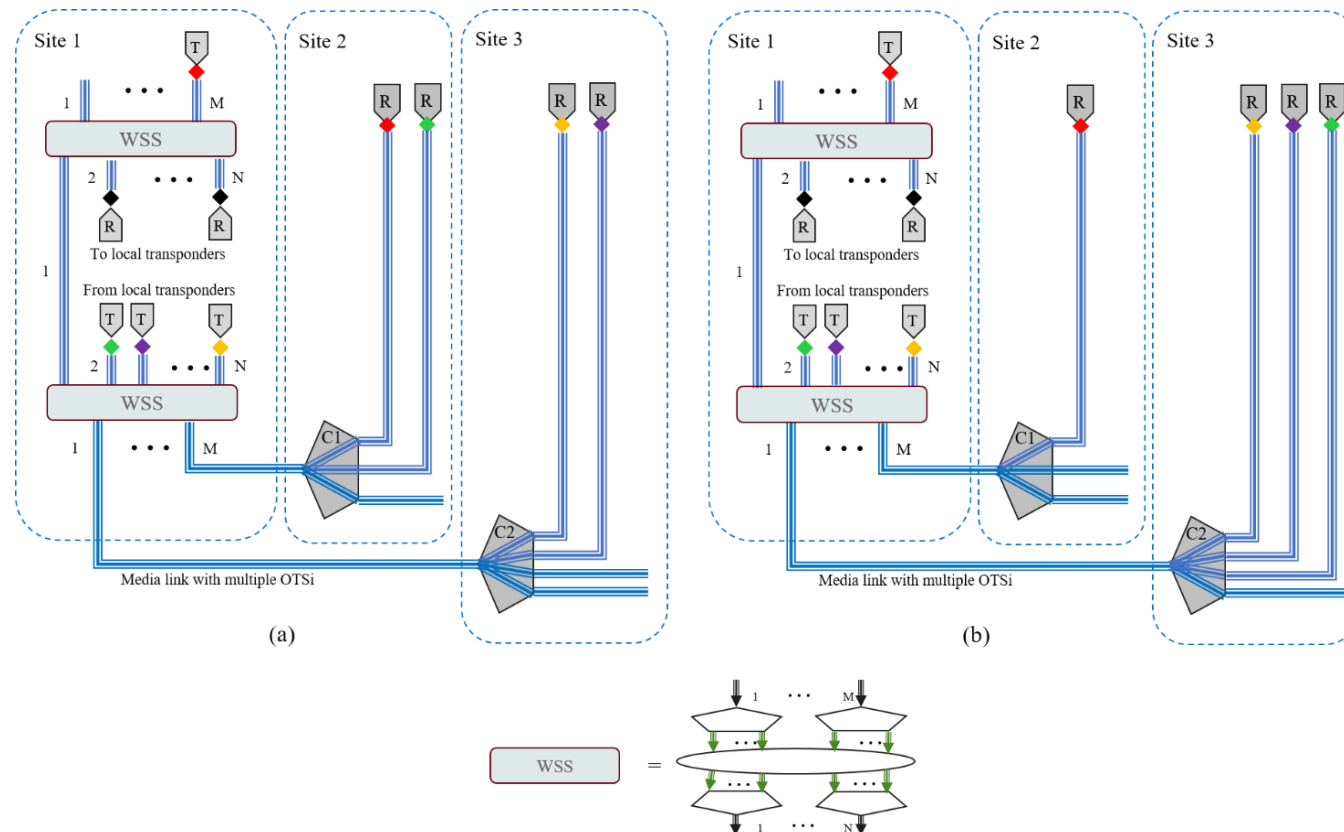


Figure III.5 - Optical one-hop connection and resource sharing features of metro aggregation ring network based on R-(LADD&WADD) in Appendix II.4.

New Technical Report TR.ION-aiDC

- That is “Optical technologies in ION-2030 for data centers optimized for AI”
- Overview of current DCI and DCN architectures and their issues in scaling in energy efficiency, capacity and computational power, due to the introduction of AI
- Optical technologies to face these open issues, including, but not limited to, OCS, optical transceivers for DCI and optical transceivers for DCN
- Requirements and developments requested to these technologies to meet the growth of traffic and computational power due to AI
- Impact of other relevant aspects (DCA, control and management, monitoring, security, ...) on optical technologies

Coming Soon

Summary of major topics in Q7

New Recommendation L.405: **Pre-connectorized cabling components**

- Optical cabling components with factory-installed optical connectors are newly created in 2025. This Recommendation describes applications and general requirements for preconnectorised cabling components.

Enhancement of **maintenance-related Recs.** and utilization of **DFOS technology**

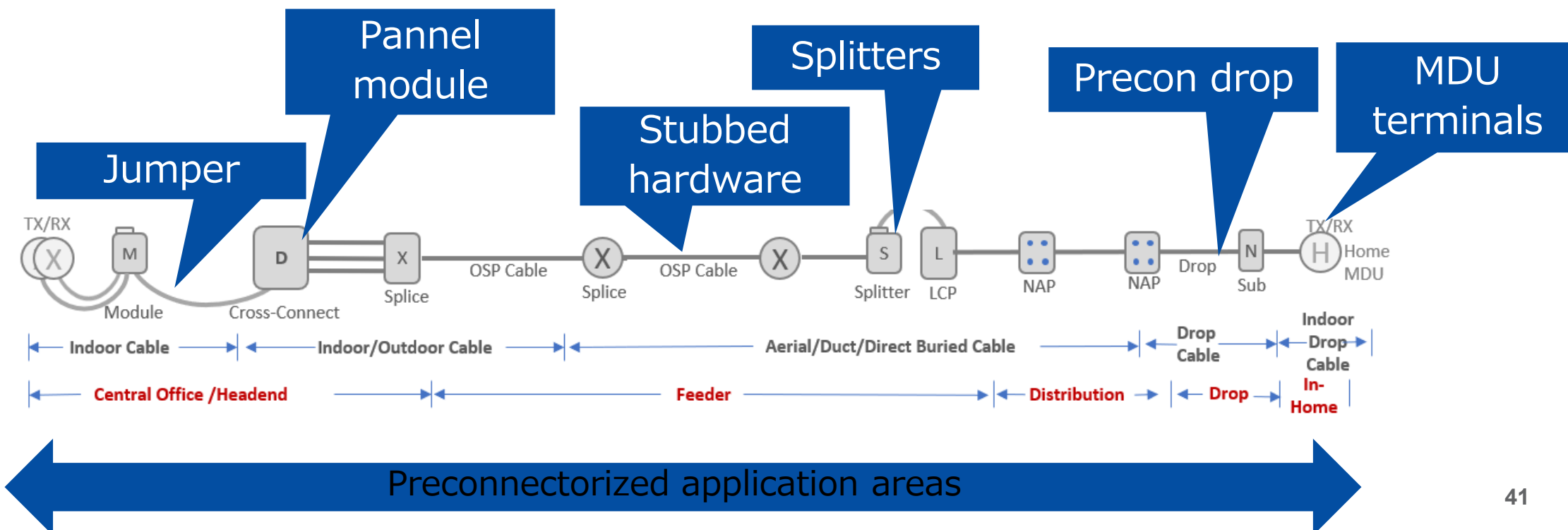
- In the revision of L.391 “Monitoring systems for outside plant facilities”, freezing is added to the category of disaster, and DOFS technologies have added as a disaster monitoring method.
- Similarly, the revision work of L.302 “Optical fibre outside plant maintenance support, monitoring and testing system” has started to catch up with current technology trends, including the possibility of using DFOS technology for

Optical network infrastructures sharing

- In the new L.nis “Practical considerations for network infrastructures sharing”, network infrastructure sharing is describing as an effective way to accelerate construction of telecommunication networks with low cost.

Details of L.405 (ex L.pcc)

Preconnectorised components include housings, modules, closures, cable assemblies and terminals, which are factory terminated with connectors. Homogenization of field connectivity and fast / skill-less construction can be expected.



Details of maintenance related Recs.

ITU-T L.300-series are updating and enhancing

L.300-399: Maintenance and operation

DFOS is a keyword for network maintenance

L.300-329: Optical fibre cable maintenance

L.302: DFOS will be considered as a network monitoring method in 2027.

L.316: DFOS introduced for a cable identification method in 2022.

L.330-349: Infrastructure maintenance

Maintenance Recs. are recently enhancing

L.340 & L.341: Maintenance methods for underground & overhead facilities have been updated in 2023 & 2025.

L.mct (L.342?): Maintenance methods for conduits will be newly published in 2027.

L.350-379: Operation support and infrastructure management

L.360 & L.361: Advanced ID tag technologies (image recognition and optical ID) are introduced in the revision works.

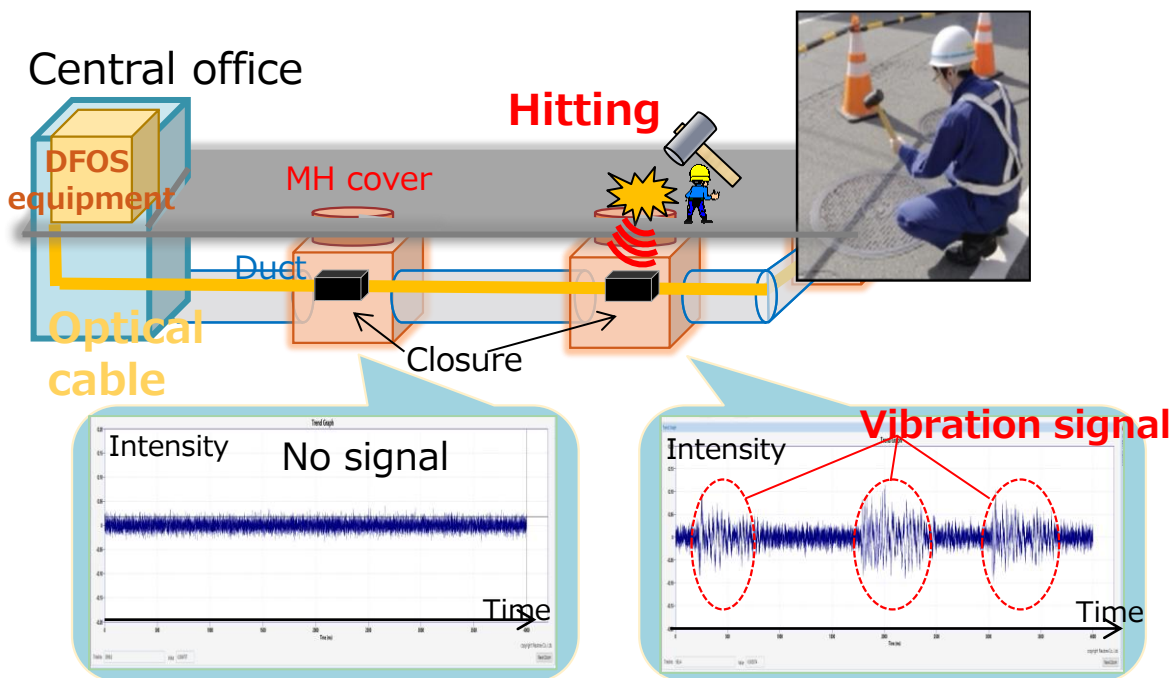
L.380-399: Disaster management

L.391: DFOS has introduced for a disaster monitoring method

Actual use of DFOS technology is steadily progressing

L.316: Cable identification for the construction and maintenance of optical fibre cable networks by optical sensing techniques

Published in 2022 ➡ introduced DFOS for a cable identification



Cable route identification with DFOS

L.391: Monitoring systems for outside plant facilities

Revised in 2025 ➡ added DFOS for a disaster monitoring

A method for grasping various network damage situations is expected as a future DFOS application.



Flood



Fallen trees

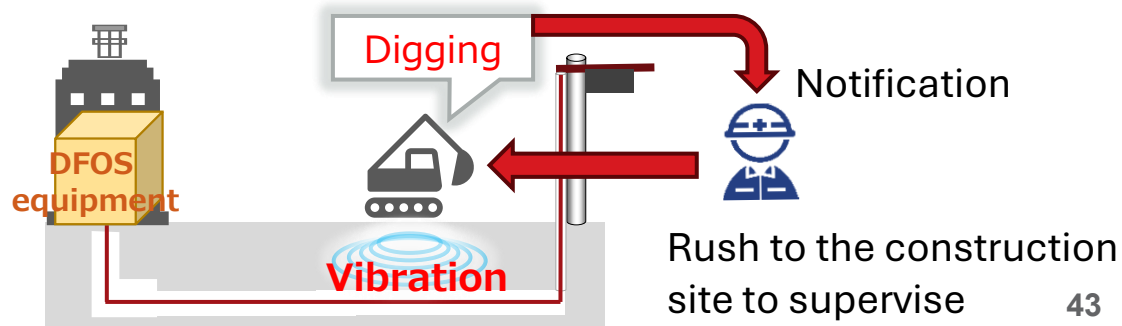


Snow damage

L.302: Monitoring systems for outside plant facilities

Under revision ➡ considering DFOS for a network monitoring

“Digging” detection is a possible application of DFOS.



Summary of major topics in Q8

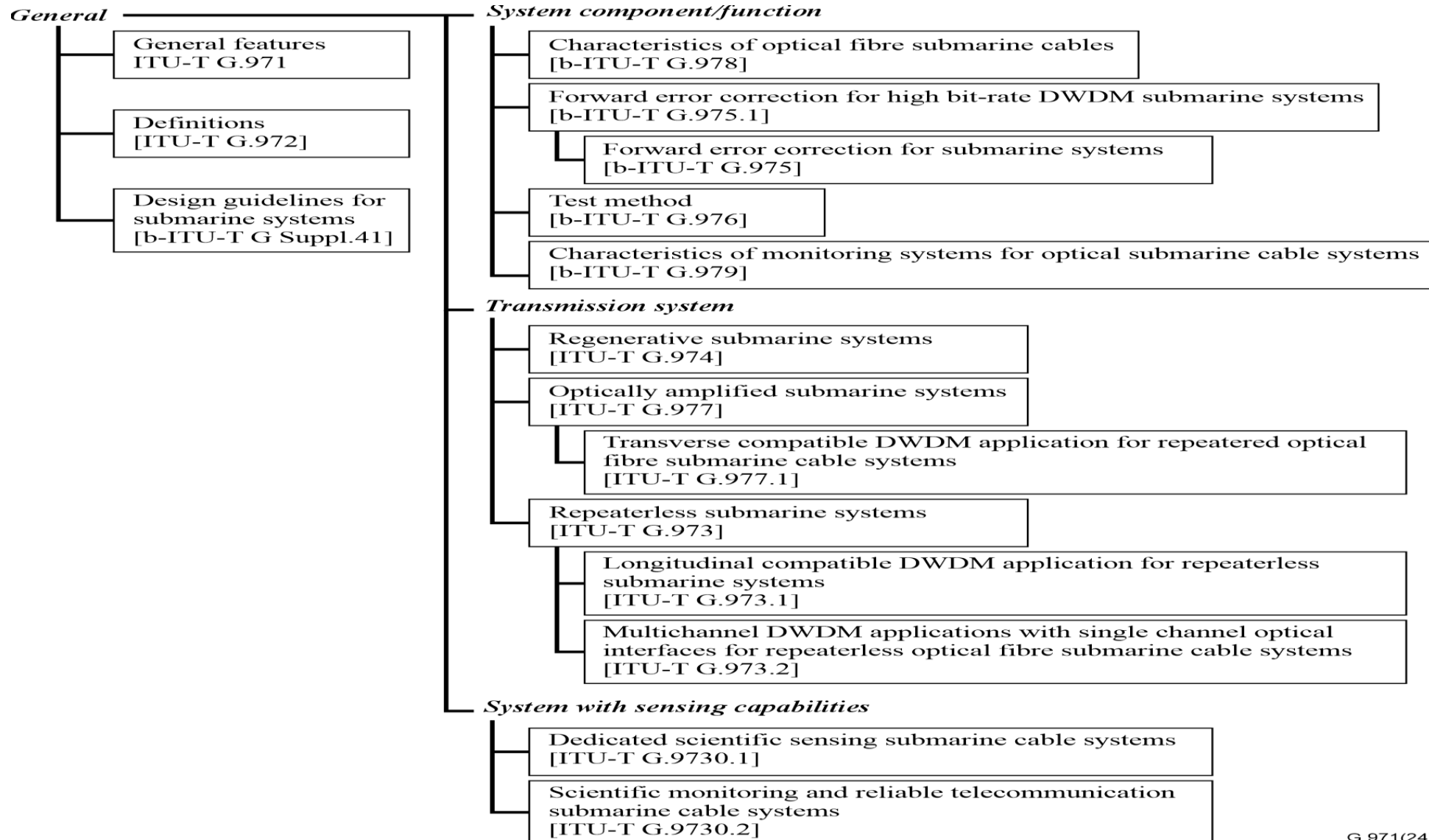
New Recommendations for Ocean Scientific Monitoring consented:

- G.9730.1 “**Dedicated scientific sensing** submarine cable system”
- G.9730.2 “**Scientific monitoring and reliable telecommunications** submarine cable systems”, SMART cables

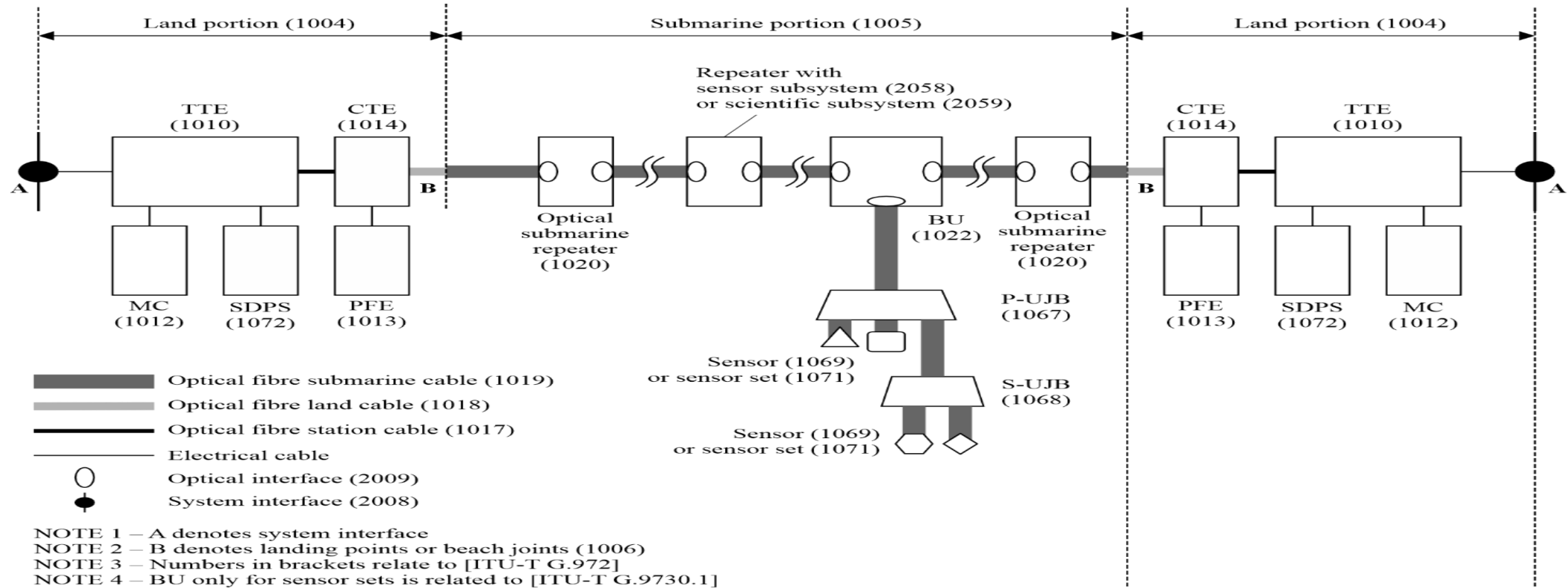
Restructuring and Revision of existing Recommendations under Q8 according to introduction scientific sensing capabilities

- Revision of G.971, G.972, G.976, G.978 and G.sup41.
- Start the study of New Recommendation [G.9730](#) "General features of optical fibre submarine cable systems with sensing capabilities".

Restructuring of Q8 Recommendations



Introduction of scientific sensing functions



G.971(24)_F01c

Sensor set: A group of co-located sensors consisting of at least one temperature sensor, one pressure sensor, and three accelerometers (each sensing one axis)

SDPS: Sensors Data Processing and Storage

UJB: Underwater Junction Box

Summary

- ◆ **Multi-core fiber standards are being developed with IEC SC86A, SC86B, and SC86C**
- ◆ **Network sensing technology is being studied intensively in both terrestrial and submarine as well as in the maintenance of outside plants**
- ◆ **Hollow-core fiber is becoming another emerging technology**

OFC

The future of optical networking
and communications

Transport networks and AI

Tom Huber, Nokia USA
Vice Chair, ITU-T SG15
Chair, ITU-T SG15 WP3

What are some characteristics of a transport network?

Convergence

- A network operated to carry multiple service networks efficiently

Efficiency

- A network that typically includes layer 1 or layer 0 switching, reducing total cost by switching as close to the media as possible (aka “router bypass”)

Distances

- Transport network encompasses both metro and long haul

What does any of that have to do with AI???

Using AI to operate transport networks

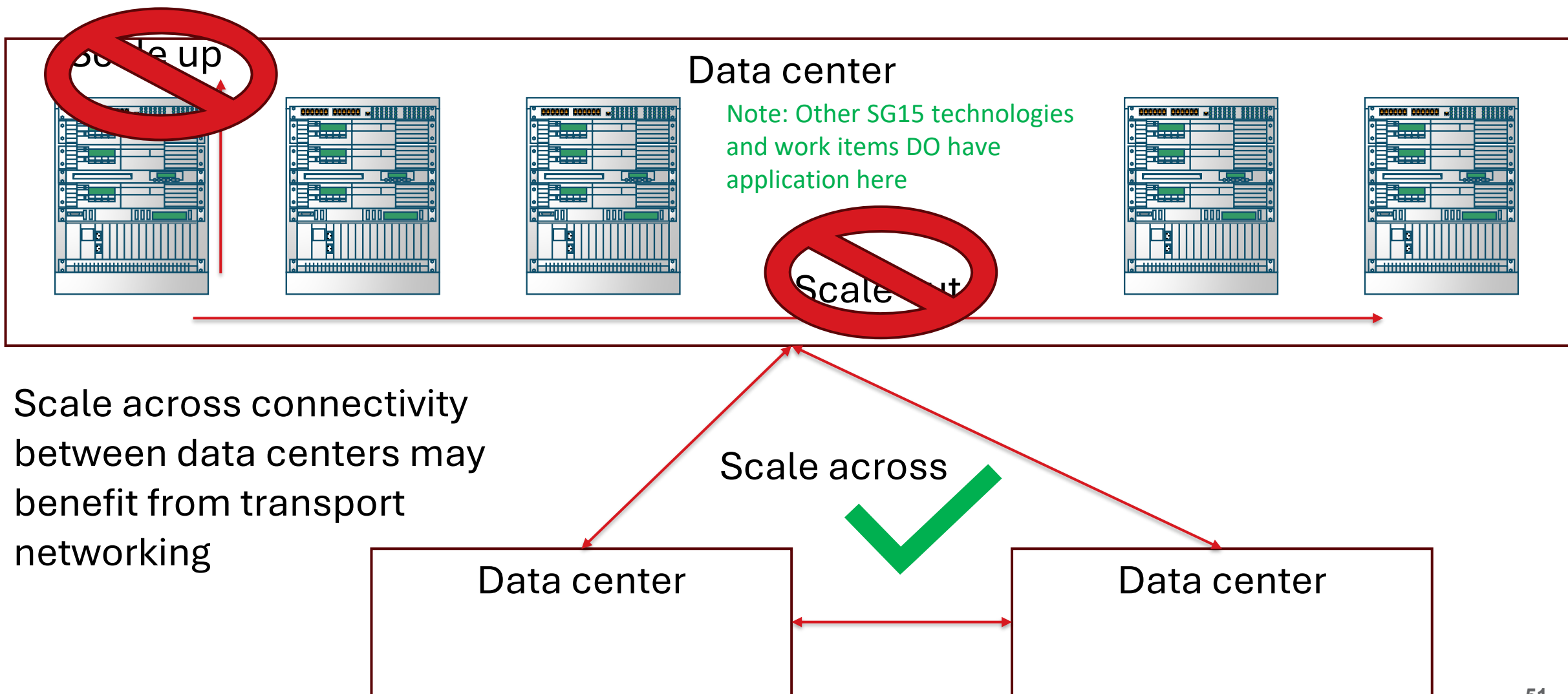
AI can be (and is!) used for:

- Predictive maintenance and analytics
- Intelligent automation and self-healing
- Optimized traffic configuration
- Optimized network synchronization configuration (e.g., timing reference selection, holdover management, ...)
- Enhanced network security

Related work:

- Q14/15 YANG models provide the data for AI to use
- Q14/15 work on digital twins and enhanced network operations
- Q13/15 work on sync in data centers

Transport network applications in DC connectivity



Related work in Q11/15 and Q12/15 – B1T OTN

Updates to G.709.1, G.709.6, G.798.4, G.872

- New FlexO path layer optimized for Ethernet clients, based on FlexO frame format and Ethernet-to-FlexO-xe client mappings
- New FlexO-xo section layer to support the new path layer, with minimally higher bit rate than FlexO-xe
- Strong FEC to support distances of ~1000 km
- Bit rates ~1.2T and ~1.6T
- Frame formats may be approved in 2H26 (Q11/15 meets this month)
- FEC and DSP aspects under study, with consideration of work being done in other SDOs (e.g., OIF)
- Architecture updates related to the new path and section layers

Technical Report on ION-2030 (led by Q12/15)

GSTR-ION-2030, Technical Report on international optical networks towards 2030 and beyond, highlights AI as a key trend for enhancing network operations

- AI-native optical networks
- Digital twins
- Use of ROADMs/OCSs in data center networks
- Energy efficiency

ITU Publications

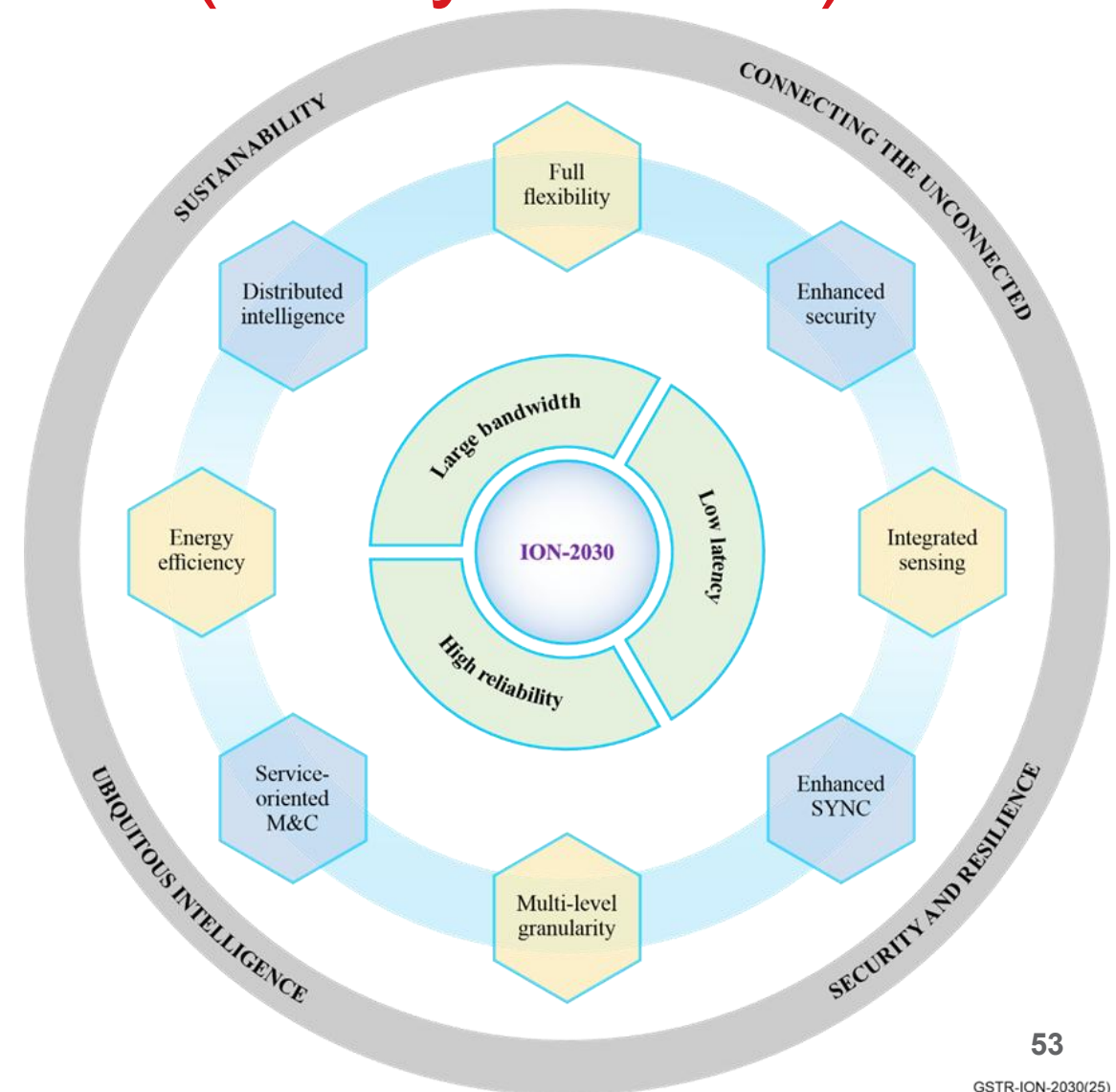
International Telecommunication Union
Standardization Sector

ITU-T Technical Report

(10/2025)

GSTR-ION-2030

Technical Report on international optical networks towards 2030 and beyond



ION-2030 for AI & AI for ION-2030

- Sustainability
- Connecting the unconnected
- Security and resilience
- Ubiquitous intelligence

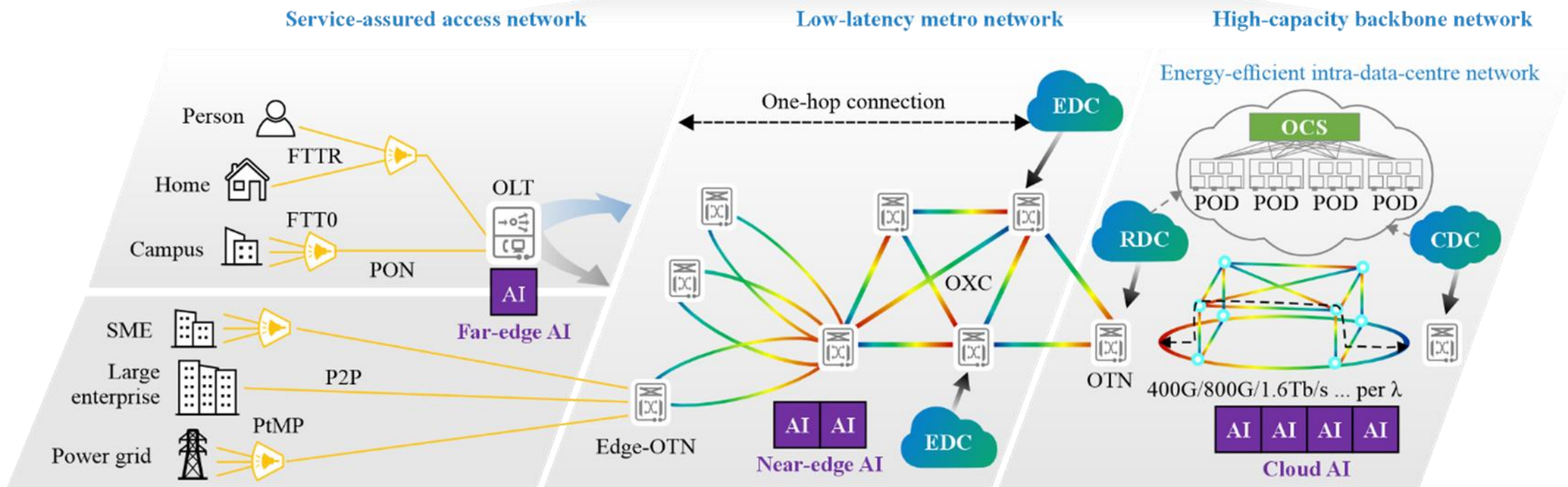
ION-2030 for AI:

Large bandwidth and coverage

Low latency and jitter

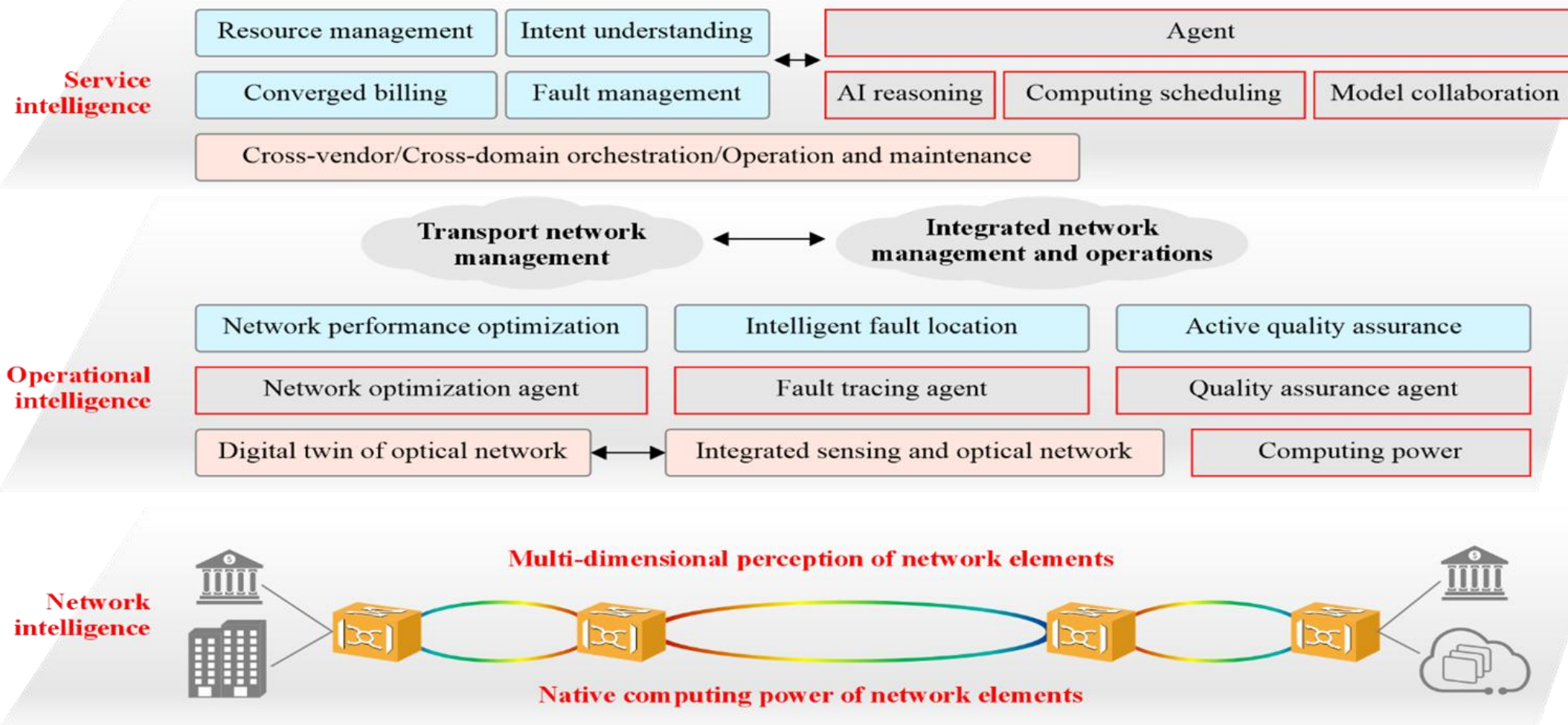
High availability and resilience

AI for ION-2030: E2E guarantee of QoS and QoE with automation, optimization, and protection



GSTR-ION-2030(25)

ION-2030 AI Native architecture



Other related work in Q12/15 and Q14/15

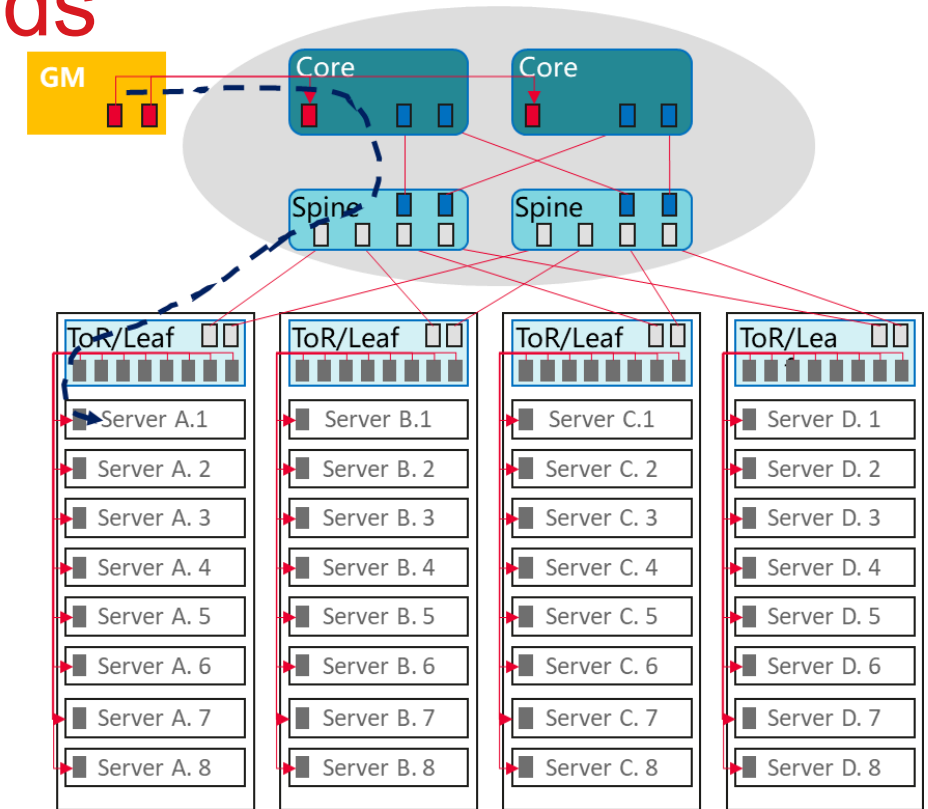
Active work on GSTR.ENO, *Technical report on enhanced network operations for transport networks*

Potential additional work items related to AI, data centers, and OCS are under discussion

Network synchronization and time distribution performance: application to AI Clouds

Enhanced Synchronization enables:

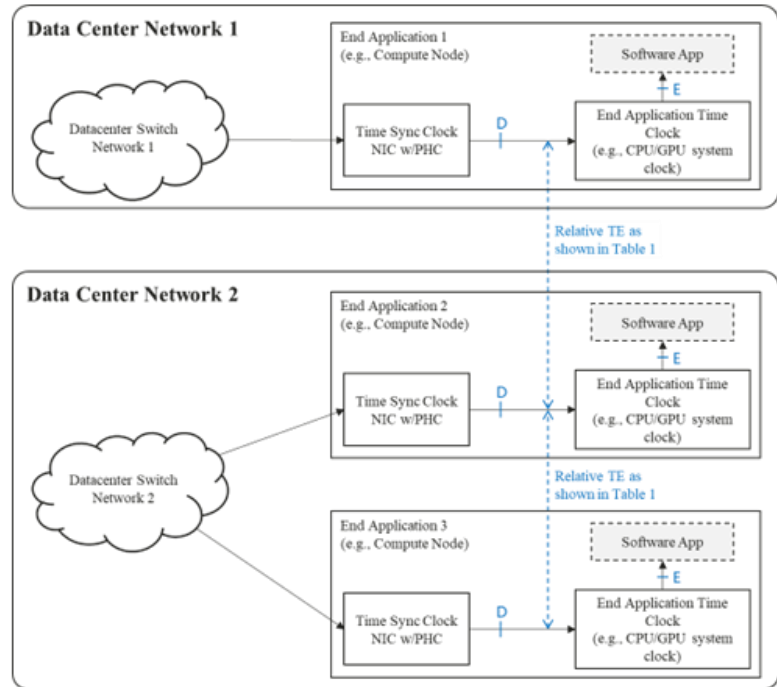
- Consistent operation between distributed data centres, minimizing latency.
- Event logging; Diagnosis and analysis of problems
- Regulatory requirements (financial)
- Support telecom networks requirements
- **Improvements of the overall performance of Artificial Intelligence and Machine Learning (AI/ML), including reduction in power consumption**



Synchronization is an enabler to effective AI operation and to advanced network performance monitoring

How Q13/15 is addressing these needs

Analysis of Requirements and solutions in G Suppl.92



Accuracy Class at Time Sync Clock	rTE between Time Sync Clocks	Typical applications
1	5μsec	Distributed databases
2	1μsec	High-Frequency Telemetry, Applications profiling via multi-node performance analysis tools
3	200nsec	Congestion control based on one way delay Time synchronized collective communication

Table 1 - From ITU-T G Suppl.92
(modified as per WD13-17 (March 2026))

ITU Publications
Recommendations

International Telecommunication Union
Standardization Sector

Supplement
ITU-T G Suppl. 92 (10/2025)

SERIES G: Transmission systems and media, digital systems and networks

Supplements to ITU-T G-series Recommendations

Synchronization for data centres

CAUTION!
PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

Continuation of the work for an optimized multicast PTP profile (G.FTS-Lite) and new clocks

Work done in cooperation with other relevant groups (IEEE P3335, IEEE P1588.1, OCP Time Appliances Project (TAP))

Thank you !



Questions?