Day 2: Technology Advancements and Opportunities in Broadband Access

Progress in standardization of wired backhauling in-premises communication technologies in ITU-T SG15

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ITU-T Rapporteur Q3/15

ITU-T SG15/Q3 experts group

- Study Group 15: Networks, Technologies and Infrastructures for **Transport**, **Access** and **Home**
- **Q3: Technologies for in-premises networking and related access applications**
- 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 visible light communication based on G.hn technology
    - Goal to produce Technical Papers on narrow beam OWC and channel adaptive OWC
  - **G.fin (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.9940 (**approved** in 12/2023), High speed fibre-based in-premises transceivers - system architecture
- G.9941 (**consented** in 12/2023), High speed fibre-based in-premises transceivers - physical layer specification
  - Under Last Call comment resolution process – Expected approval July 2024
- G.9942 (**consented** in 12/2023), High speed fibre-based in-premises transceivers – data link layer
  - Under Last Call comment resolution process – Expected approval July 2024
- G.9930 (**consented** in 12/2023), Point-to-Point fibre in the Premises
  - Under Last Call comment resolution process – Expected approval July 2024
- G.9960 (2023) AMD 1 (**approved** in 01/2024), Unified high-speed wireline-based home networking transceivers - System architecture and physical layer specification
- G.9961 (2023) AMD 1 (**approved** in 01/2024), Unified high-speed wireline-based home networking transceivers - Data link layer specification

Recently approved Technical Papers & Supplements

- **G Suppl.78** - Use case and requirements of fibre-to-the-room for small business applications (2023)
- **GSTP-OPHN** - Operation of G.hn technology over access and in-premises phone line medium (2022)
- **GSTP-OVHN** - Overview of the ITU-T G.hn technology (2021)
- **GSTP-HNAFS** - Architecture, functions, and services of home network (2021)
- **GSTP-FTTR** - Use cases and requirements of fibre-to-the-room (FTTR) (2021)

  - **All can be found at** https://www.itu.int/pub/T-TUT and https://www.itu.int/itu-t/recommendations/index.aspx?ser=G

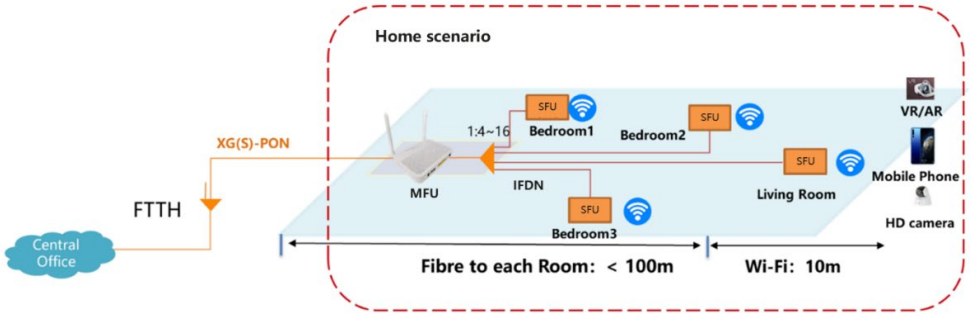
Future deliverable timeline - Recommendations

- **G.fin series: High speed fibre-based in-premises transceivers**
  - Physical layer (G.9941) and data link layer (G.9942) – for approval July 2024
  - Management layer – goal to consent July 2024
  - Wi-Fi coordination (G.wmci) – goal to consent in 2025
- **G.p2pf: Point-to-Point Fibre in the Premises (G.9930)** – for approval July 2024
- **G.hetnet: Terminology and overview of the architecture of a Heterogeneous Home Network** – goal to consent July 2024
- **G.uvs-XR: Technical requirements of AR/VR/MR service over in-premises networks** – goal to consent July 2024
- **G.fin-X series: High speed fibre-based in-premises transceivers (10G), PHY and DLL** – goal to consent in 2025
- **G.hn series:**
  - G.hn2: Evolution of unified high-speed wire-line based home networking transceivers
  - G.iot: System architecture, PHY layer and DLL for IoT Smart Home over PLC

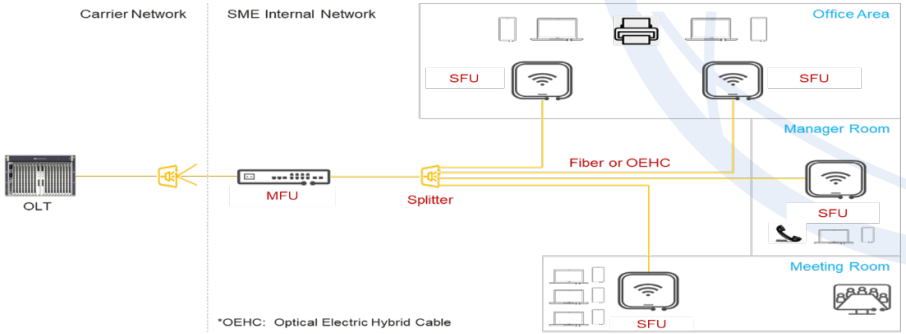
Future deliverable timeline – TPs & Supplements

- **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:**
  - coordinated management of access and fibre in-premises networks (G.suppl.CMAFP),
  - fibre to the grid use cases and network requirements (G.suppl.FTTGrid),
  - enhanced in-premises networking with computing functions (G.sup.Edge4Home),
  - use cases and requirements of fibre-to-the-room for residential applications (SUP-FTTR-4H),
  - digital twin network on in-premises networking (G.sup.TwinHome) – for agreement 2024 – 2026

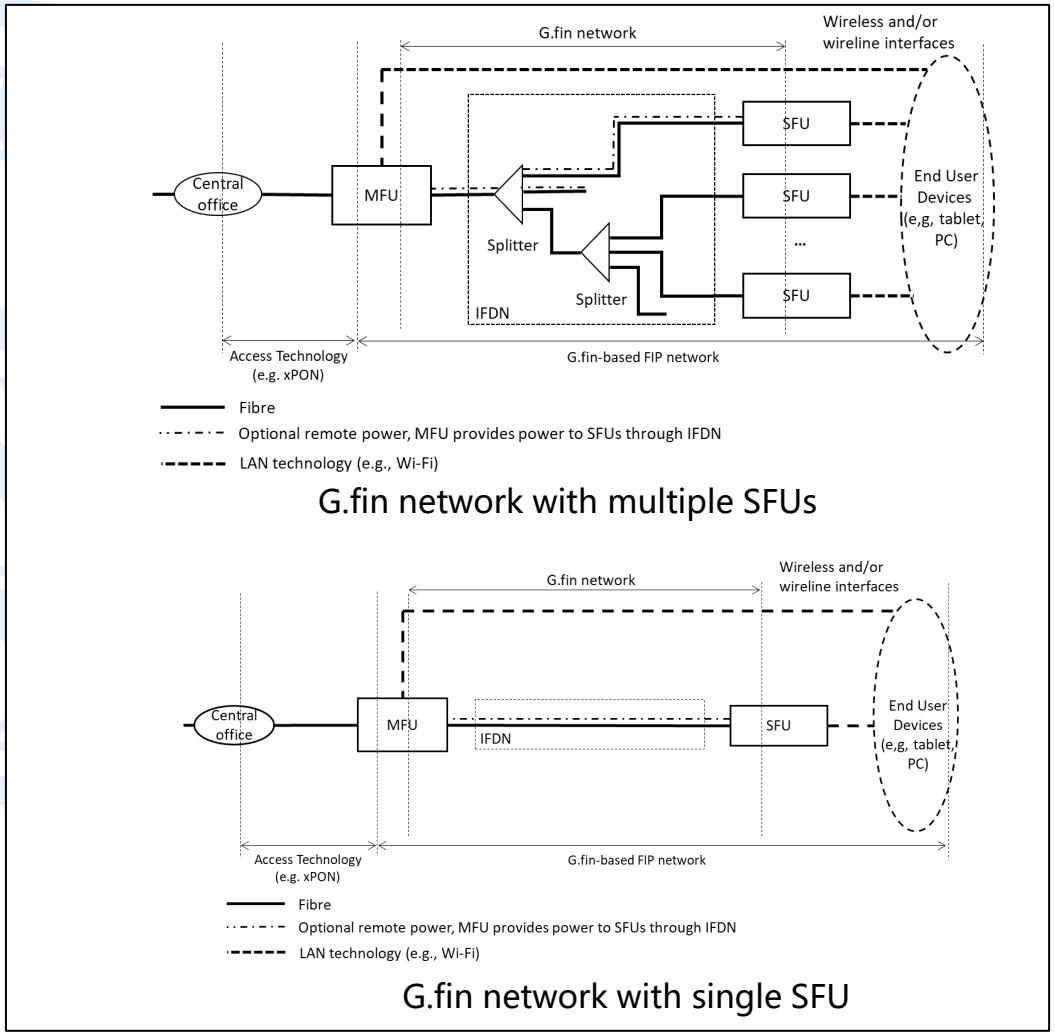
In-premises fibre networking for Gigabit Broadband



- **Home scenario**



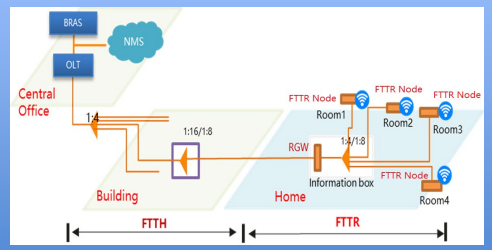
- **Business scenario**



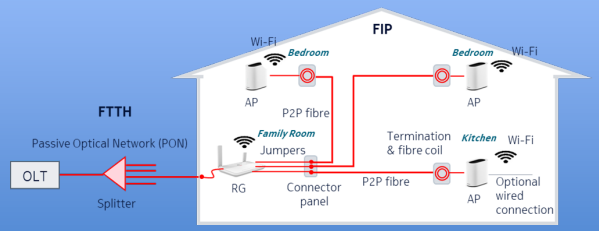
Source: *ITU-T G.9940, approved December 2023*

Use cases for Home environment

High Quality Wi-Fi backhauling

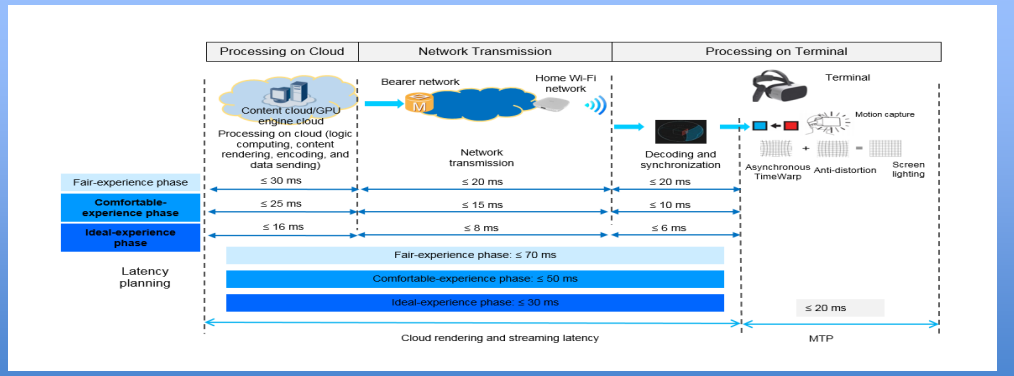


P2MP



Multi P2P

Support of extremely low latency



- In-premises backhauling network requirements: Stable networking, extremely low latency: sub-ms, jitter<1%

Low complexity/Easy installation ODN

Pre-connected Fibre cable

Optical fibre extender

ATB

In-premises ODN
Pre-connectorized fibre,

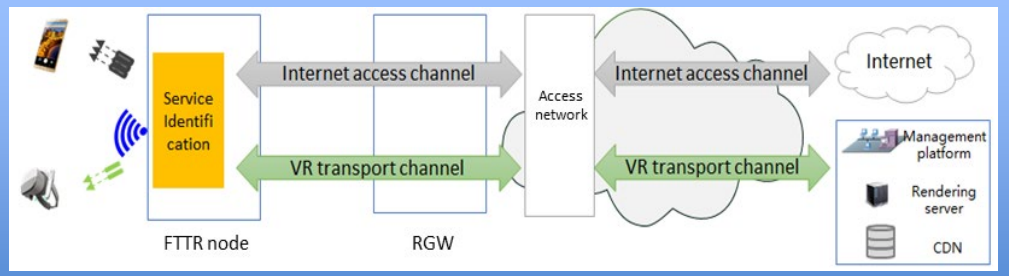
Fibre replacement robot

Elastic tool

Engineering Tool

Fast fibre installation, high success rate

FTTR Slicing/QoS



- Service type classification, Use of high priority channel for sensitive traffic
- FTTR+Wi-Fi coordination & optimization

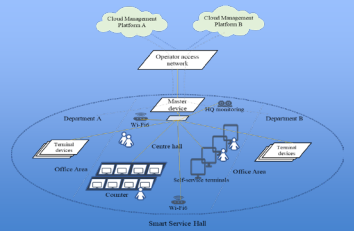
Sources: ITU-T GSTP-FTTR (2021) – Use cases & requirements of FTTR
ITU-T draft G.9930

Use cases for Small & Medium Enterprises

Live application

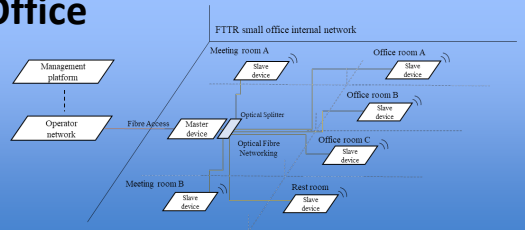
- Real-time 4K/8K video with dense links
- 10-20 ms E2E latency with stable data rate
- Multi-gigabit throughputs

Service hall



- Separated services
- Isolation of subnetworks
- Network slicing

Smart Office

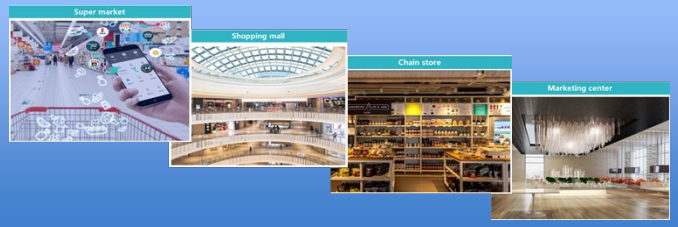


- Many simultaneous connections (32-128)
- Longer distances (1-2km length)
- Multi-gigabit aggregated throughputs

Schools

- Dense connections
- Per user Security/Authentication

Business buildings

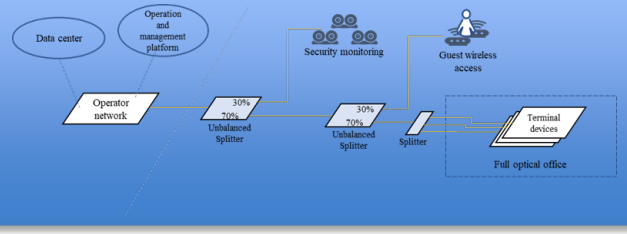


- Mobility – Fast roaming
- Dense connections
- Network isolation
- QoS-driven

Indoor leisure & entertainment

- Dense connections
- Gaming services
- Low latency connections

Workshop

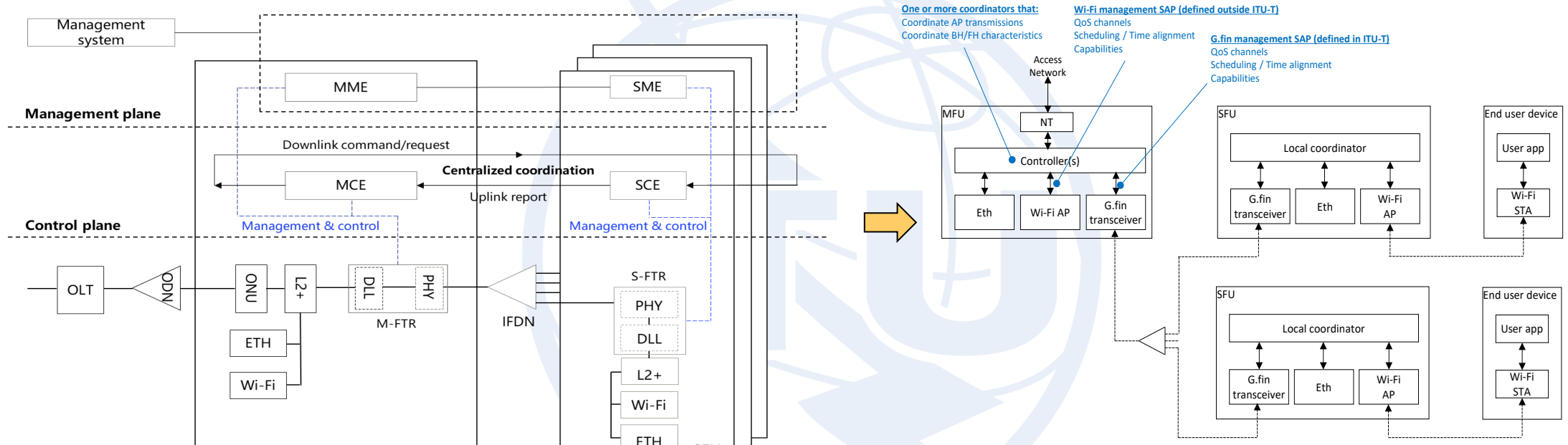


- Large coverages
- Asymmetrical connectivity
- Easy management

Smart community

- Community services
- HD surveillance
- QoS

G.fin architecture



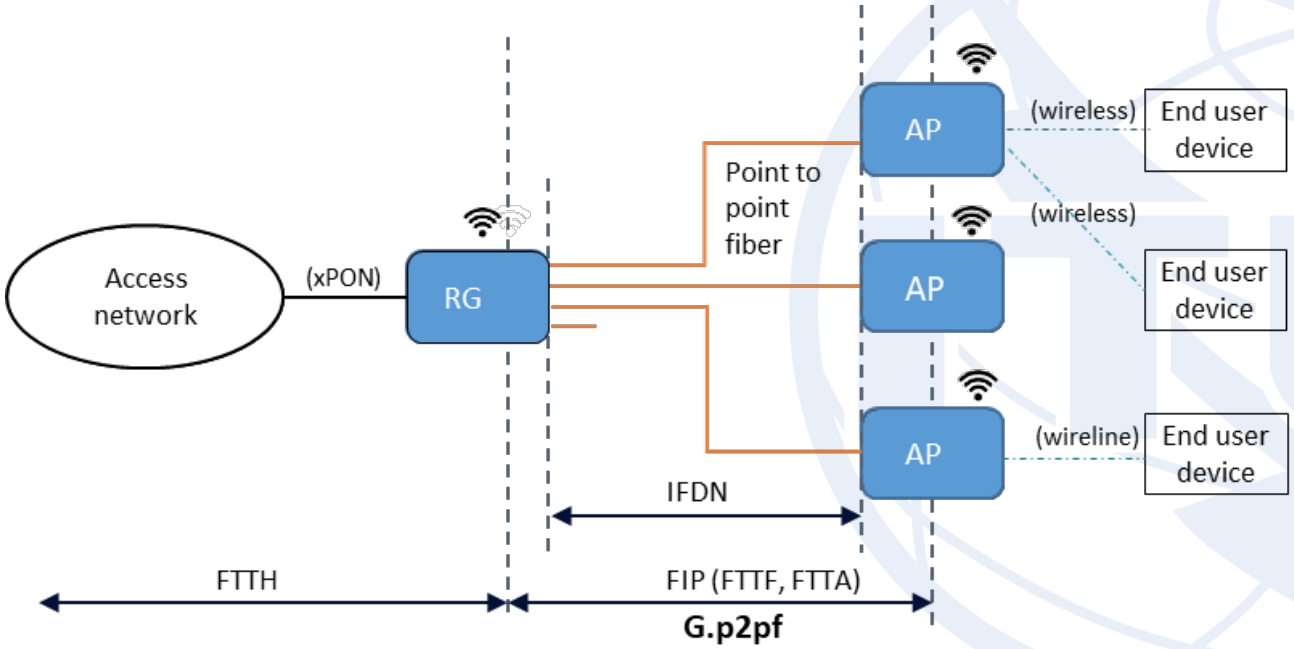
Functional framework of G.fin system

Source: *ITU-T SG15 Q3, G.wmci, new project initiated 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

G.p2pf Architecture



Description

- Optical Ethernet connections are used for connecting RG and repeaters
- Two types of connectivity:
  - RG/Repeaters are connected directly to each of the Fiber infrastructure (IFDN) (equipments with optical outputs)
  - RG/Repeaters are connected to an external optical/electrical converter through Ethernet. An external switch is needed in this case on the RG side

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

Possible Collaboration with Broadband Forum

- Data model development
  - Starting from use cases, define the necessary interfaces, statistics, and controls (TR-181)
- Fiber/Wi-Fi coordination
  - Develop coordination architectures and procedures
- Updates on BBF architectural documents
  - Align with the new architectures and terminologies defined in ITU-T (G.HetNet)
  - Incorporate to BBF catalog the new technologies defined in ITU-T (e.g. G.fin, G.p2pf)
- Deployability
  - Requirements on multi-vendor interoperability between connectivity devices (i.e. “MFU” and “SFU”)
  - Performance test plans/certification for in-premises fibre home networking

FTTR joint workshop in 2024

➢ **Multi-SDO (ITU, BBF, CCSA, ETSI) joint FTTR workshops, focusing on in-premises fibre networking**

1st WS (2021.6)
- Share UCs
- Identify tech. gaps

2nd WS (2022.6)
- Align tech. direction
- Common sense in data rate

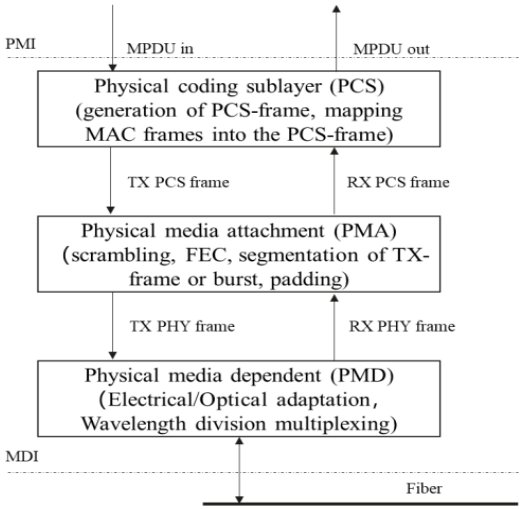
3rd WS (2023.6)
- Sync up arch. & tech. spec.
- Discuss future evolution

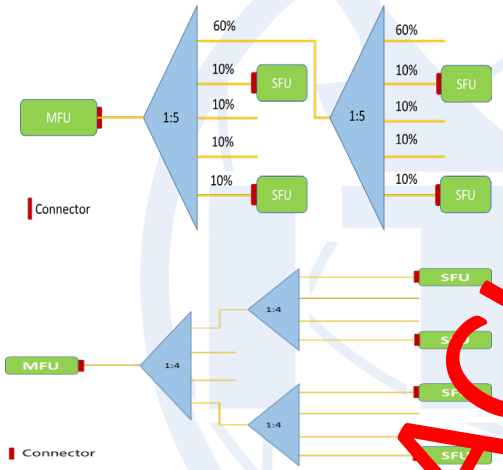
- **Potential topics:**
  - 1. FTTR standard progress
  - 2. Fibre infrastructure (e.g. fibre deployment, fibre components utilized in FTTR)
  - 3. QoE of network service in residential and business area
  - 4. Fibre and wireless coordination technology of FTTR
  - 5. Network management of FTTR
  - 6. FTTR deployment and development practice experience (e.g. policy, verticals)
  - 7. FTTR business cases from operator's point of view
  - 8. Extended applications over FTTR (e.g. Fibre sensing, VLC, narrow-beam OWC)
  - 9. Future views and research outcome for next generation of FTTR
- **Time：** June or July


ITU

G.fin transceiver design

PHY: symmetric rate, optimized link budget, flexible splitting



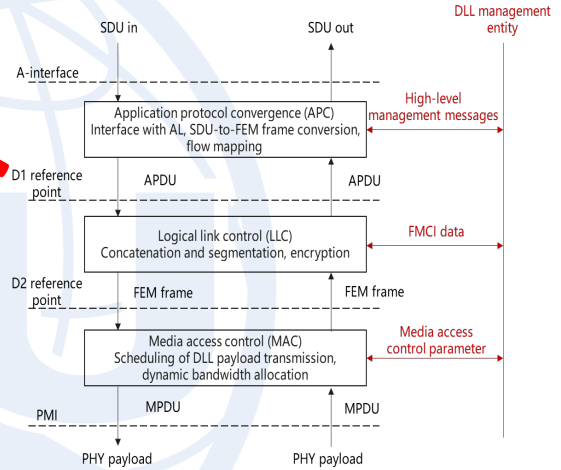


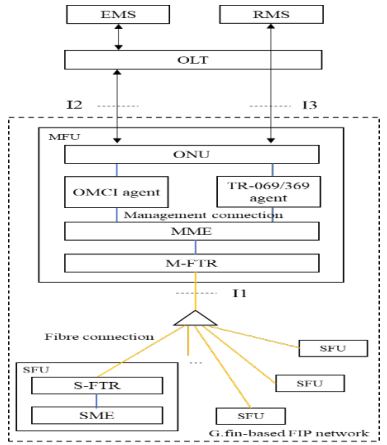
BACKUP

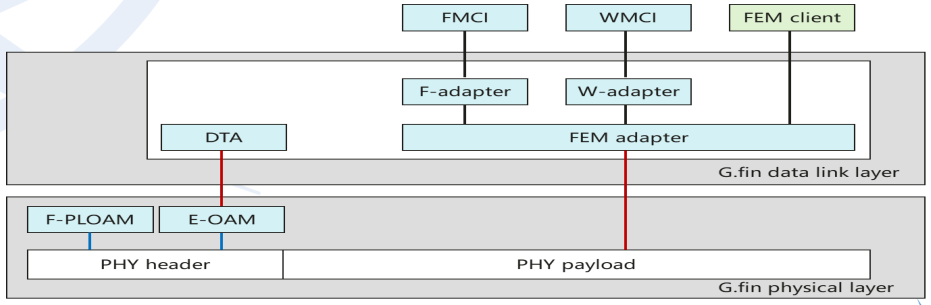
Optical link budget	Typical splitting ratio	Upstream/downstream wavelength set	
		2.5/2.5 Gbit/s	10/10 Gbit/s
0-18 dB (home)	1:8	Up: 1300-1320 nm Down: 1480-1500 nm	Left for further study
13-28 dB (SME)	1:32	Up: 1300-1320 nm Down: 1480-1500 nm	Option 1: Up: 1300-1320 nm Down: 1480-1500 nm Option 2: Up: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

Source: *ITU-T G.9941, consented in Nov plenary of 2023*

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







Source: *ITU-T G.9942, consented in Nov plenary of 2023*