

Supplement

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

Supplements to ITU-T G-series Recommendations

Use case and requirements of fibre-based in-premises networking for home application (FIP4H)

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Supplement 80 to ITU-T G-series Recommendations

Use case and requirements of fibre-based in-premises networking for home application (FIP4H)

Summary

Supplement 80 to the ITU-T G-series Recommendations describes the use cases, requirements and corresponding advantages of fibre-based in-premises networking technology (G.fin) for home application.

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Use case and requirements of fibre-based in-premises networking for home application (FIP4H)

1 Scope

This Supplement describes the use cases and requirements of fibre-based in-premises networking technology (G.fin) for home application. The corresponding advantages of the technology are also analysed.

2 References

- [ITU-T H.265] Recommendation ITU-T H.265 (2024), *High efficiency video coding*.
- [ITU-T H.266] Recommendation ITU-T H.266 (2023), *Versatile video coding*.
- [ITU-T GSTP-FTTR] Technical paper ITU-T GSTP-FTTR (2021), *Use cases and requirements of fibre-to-the-room (FTTR)*.
- [ETSI GR F5G 001] ETSI GR F5G 001 (2020), *Fifth Generation Fixed Network (F5G); F5G Generation Definition Release #1*.
- [ETSI GR F5G 020] ETSI GR F5G 020 (2024), *Fifth Generation Fixed Network (F5G); F5G Advanced Use Cases; Release 3*.
- [IEEE 802.11ad] IEEE 802.11ad (2012), *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band*.
- [IEEE 802.11aj] IEEE 802.11aj (2018), *IEEE Standard for Information Technology – Telecommunications and information exchange between systems Local and metropolitan area networks – Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput to Support Chinese Millimeter Wave Frequency Bands (60 GHz and 45 GHz)*.
- [IEEE 802.11ax] IEEE 802.11ax (2021), *IEEE Standard for Information Technology – Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks – Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN*.
- [IEEE 802.11ay] IEEE 802.11ay (2021), *IEEE Standard for Information Technology – Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks – Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Enhanced Throughput for Operation in License-exempt Bands above 45 GHz*.
- [IEEE 802.11be] IEEE 802.11be (2024), *IEEE Draft Standard for Information technology – Telecommunications and information exchange between systems Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Extremely High Throughput (EHT)*.

[IEEE 802.11bn]	IEEE 802.11bn (2024), <i>IEEE Draft Standard for Information Technology – Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks – Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications – Amendment: Enhancements for Ultra High Reliability.</i>
[IEEE 802.11k]	IEEE 802.11k (2008), <i>IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Radio Resource Measurement of Wireless LANs.</i>
[IEEE 802.11v]	IEEE 802.11v (2011), <i>IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications Amendment 8: IEEE 802.11 Wireless Network Management.</i>
[IEEE 802.11r]	IEEE 802.11r (2008), <i>IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Fast Basic Service Set (BSS) Transition.</i>
[3GPP TS 23.203]	3GPP TS 23.203 (2011), <i>3rd Generation Partnership Project: Technical Specification Group Services and System Aspects; Policy and charging control architecture.</i>
[Cloud VR WP]	White paper (2018), <i>Cloud VR Network Solution White Paper – Huawei</i> < https://www-file.huawei.com/-/media/corporate/pdf/ilab/2018/cloud_vr_network_solution_white_paper_2018_en_v1.pdf >

3 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

5G	5 th Generation
AP	Access Point
AR	Augmented Reality
CCTV	Closed-Circuit Television
E2E	End-to-End
eFBB	enhanced Fixed Broadband
F5G	Fifth Generation of Fixed network
FFC	Full-Fibre Connection
FIP4H	Fibre-based In-Premises network for Home application
GRE	Guaranteed Reliable Experience
HD	High Definition
IFDN	Indoor Fibre Distribution Network
IoT	Internet of Things
IP	Internet Protocol
LAN	Local Area Network
LED	Light Emitting Diode

MAC	Medium Access Control
MFU	Main Fibre Unit
MGFAST	Multi-Gigabit Fast
M-FTR	Transceiver of MFU
NAS	Network Attached Storage
O&M	Operation and Maintenance
OCR	Optical Character Recognition
OFDMA	Orthogonal Frequency-Division Multiple Access
OTT	Over The Top
P2MP	Point-to-Multipoint
PC	Personal Computer
PMD	Physical Medium Dependent
QAM	Quadrature Amplitude Modulation
QoE	Quality of Experience
QoS	Quality of Service
RGW	Residential Gateway
RTT	Round-Trip Time
S-FTR	Transceiver of SFU
SFU	Sub-Fibre Unit
STA	Station
TDMA	Time Division Multiple Access
TV	Television
VR	Virtual Reality
WFA	Wi-Fi Alliance
Wi-Fi	Wireless Fidelity
XG-PON	10G Passive Optical Network
XR	Extended Reality

4 Introduction

A technical paper on FIP4H use cases and requirements has been published to guide the development of G.fin technology in home application [ITU-T GSTP-FTTR]. This supplement further updates the use cases and corresponding network requirements for FIP in home applications for a G.fin network and analyses the advantages in detail.

5 Motivations for applying FIP technology in home applications

Fibre-based communication technology for home leverages the advantages of fibre communications, including the following.

- 1) Lightweight and long lifetime: optical fibre is made of glass with a diameter less than 10 μm in the core for single mode, resulting in extremely lightweight technology and a long-life cycle.
- 2) High-quality transmission for backhauling: fibre-based communications are able to provide a high throughput due to low attenuation in fibre transmission. With appropriate protocol design, it can integrate control/management functions, and support QoE-oriented service bearing over Wi-Fi-based transmission networks.
- 3) Low power consumption: low transmission power with low attenuation of the medium reduces the overall power consumption compared to copper-based technology.
- 4) Short distance fibre connection: compared to traditional access networks, fibre in-premises technology has new characteristics, including a simple PMD layer (e.g., lower splitting ratio, small optical budget), engaging with in-premises services (e.g., smart home, network attached storage (NAS), sensing), and a capability of fibre and wireless coordination.

6 Use cases and requirements of FIP4H

6.1 In-home Wi-Fi backhauling

6.1.1 Wi-Fi data backhauling

6.1.1.1 Description

Wi-Fi technology is widely utilized in home networks for the connection of end use devices, such as mobile phones, televisions, home appliances and so on.

To have a full home coverage of Wi-Fi signals and overcome the attenuation due to wall penetration, a Wi-Fi mesh solution called "EasyMesh" has been defined by the Wi-Fi Alliance (WFA). In this solution, multiple Wi-Fi access points (Aps) are formed as a LAN. In 2021, IEEE published the [IEEE 802.11ax] specification, used as a brand called "Wi-Fi 6" by WFA. With a channel bandwidth of 160 MHz and the support of eight data streams, the maximum transmission data rate can achieve up to 9.6 Gbit/s. For "Wi-Fi 7", new technology features are developed in [IEEE 802.11be], including a 320 MHz channel bandwidth, 4K QAM and multi-link operation. Next generation (recognized to be "Wi-Fi 8") [IEEE 802.11bn] mainly targets stable and reliable Wi-Fi networks. Multi-AP coordination is one of the core technologies.

To support such a network with high throughput, a backhaul link with enough transmission capacity is necessary. To match this, Figure 6-1 shows a typical application of a fibre-based network as backhauling for a Wi-Fi connection. To have full signal coverage, each room is assumed to have one Wi-Fi AP deployed, backhauled by a fibre link. The residential gateway can be the central node grouping the information towards and from the Internet connection.

With the evolution of new network services, such as high-definition video (8k), AR/VR or hologram in the future, the backhauling network needs to support a data rate up to 10 Gbit/s. The network should also support extremely low latency transmission to satisfy QoE requirements for cloud gaming, online education, etc. In addition, the access network is also evolving to the 10 Gbit/s era with the wide deployment of an XG(S)-PON system or MGFAST system.