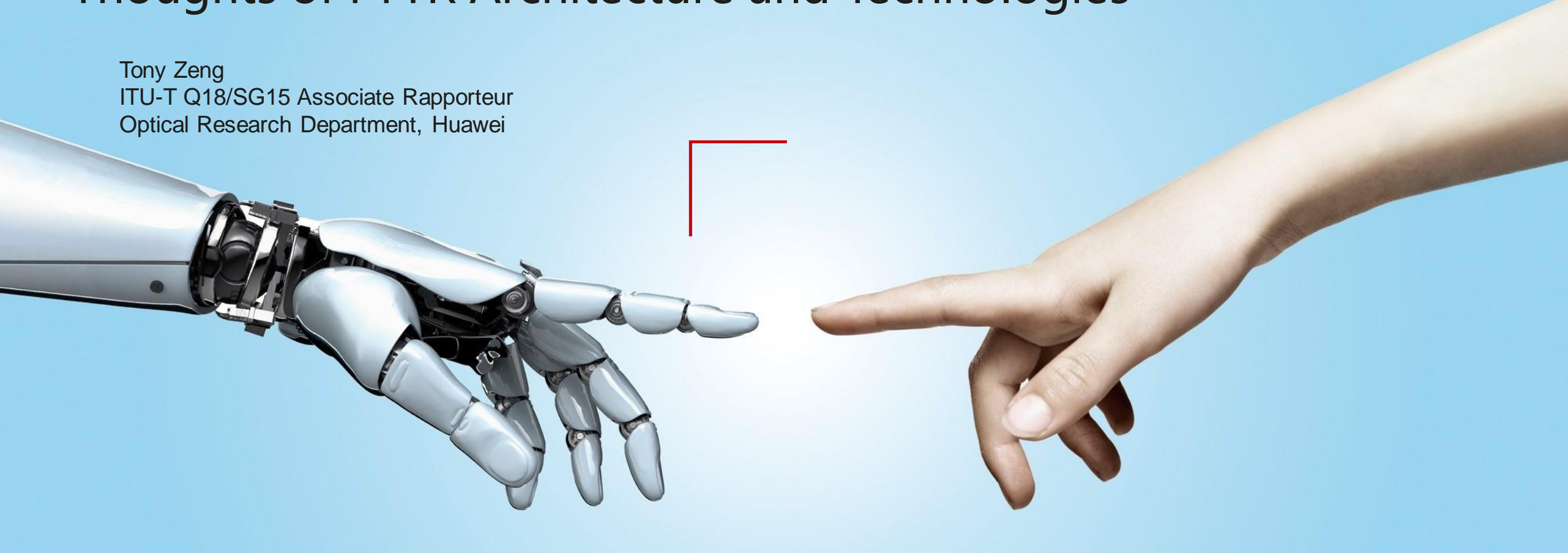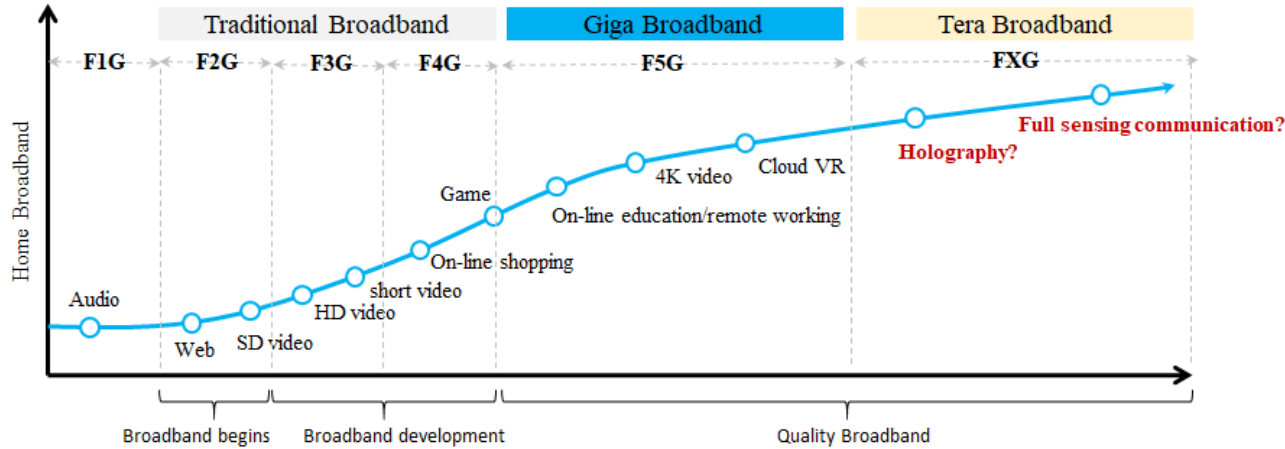# Thoughts of FTTR Architecture and Technologies

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Emerging Home Service Requires Giga Home Broadband

New applications are coming

As is (F4G)	To be (F5G)
Service: Web、HD video	**Service:** On-line gaming/ education, Live streaming/Could VR
Network: 100M, insensitive to PLR and latency	**Network:** Gigabit, Guaranteed QoS
Technology: G/EPON、Wi-Fi 5	**Technology:** 10GPON、FTTR、Wi-Fi 6

Network requirements for new services in HN

Type	Throughput	Latency	Jitter	Packer loss
On-Line Edu. Remote Wor.	5~20Mbps	≤60~150ms	≤100~200ms	≤1.0E-3
On-Line gam.	≥2Mbps	≤60	≤100	≤1.0E-1
4K IPTV Unic.	≥50Mbps	≤20ms	/	≤1.4E-4
8K IPTV Unic.	≥280Mbps	≤15ms	/	≤1.0E-5
4K IPTV Bro.	≥54Mbps	/	≤50ms	≤1.0E-5
8K IPTV Bro.	≥150Mbps	/	≤30ms	≤1.0E-6

Network requirement of Cloud VR

Level of Quality		Fair-experience Quality	Comfortable-experience Quality	Ideal-experience Quality
Strong interaction content resolution		4K	8K	8K/16K
Typical terminal resolution		4K	8K	8K/16K
Strong-interaction VR service	Bitrate	≥40Mbit/s	≥90Mbit/s	≥360Mbit/s (8K) / ≥440Mbit/s (16K)
	Bandwidth requirement	≥80Mbit/s	≥260Mbit/s	≥1Gbit/s (8K) / ≥1.5Gbit/s (16K)
	E2E Network RTT	<20ms	<15ms	<8ms

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Issues for Blocking Giga Home Broadband

Evolving Home Broadband Requirement

Past		Now

Past

Now

100Mbps

10X
On-line education /Video/Remote working/VR, etc.

>300Mbps

500ms

1/25
Latency Requirement

20ms

Broadband

1→3
Business model

QoS+ Networking+ Scenarios
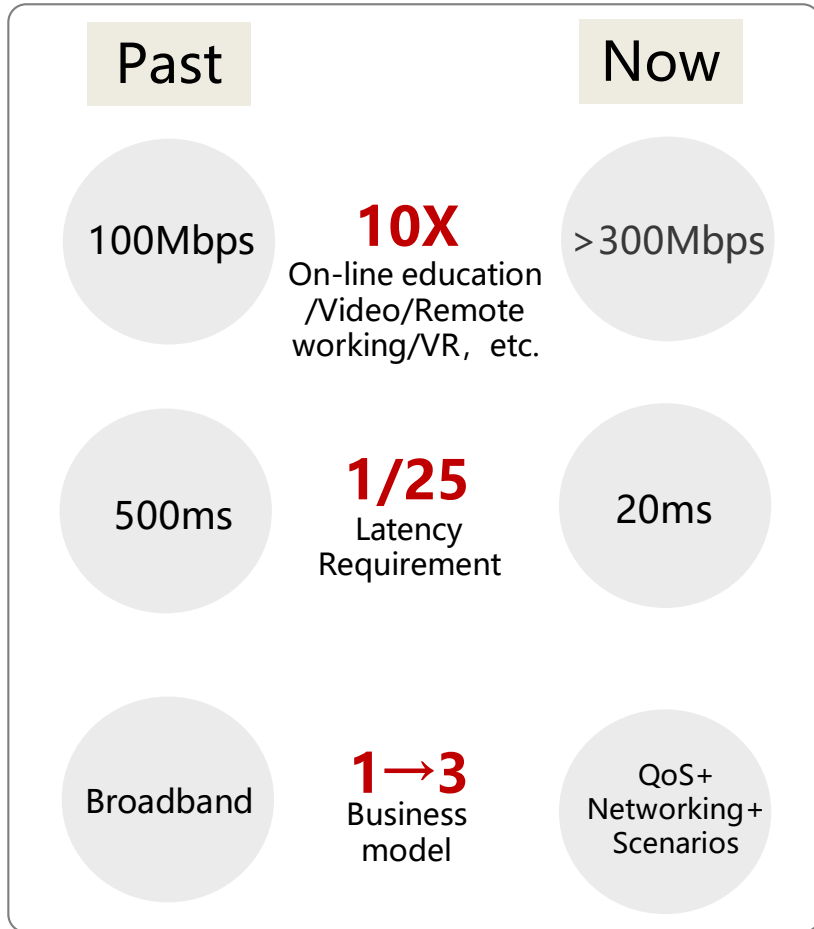
Bad Experience under Current Home Network

19%

Bad quality of on-line class

15%

Drop rate of remote working

3.6%

Low quality of IPTV
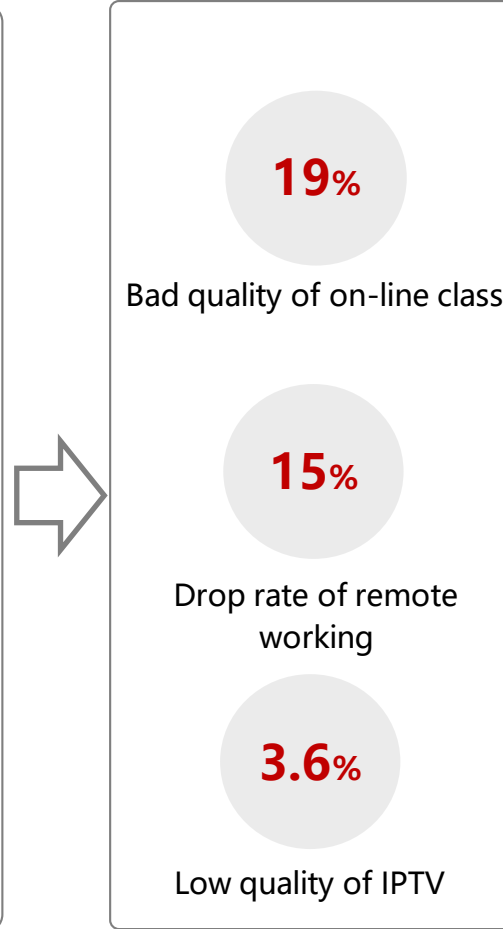
4 key factors affecting Giga Broadband experience

3 Management platform
Wi-Fi not manageable, hard to diagnostic

1 **100M FE ONT, Hard to accerlerate**

Ethernet ~100M

OLT   Fibre   ONT   **2** **Low Quality of CAT5/5e**   **4** **Not guaranteed broadband over Power line or Wi-Fi mesh**

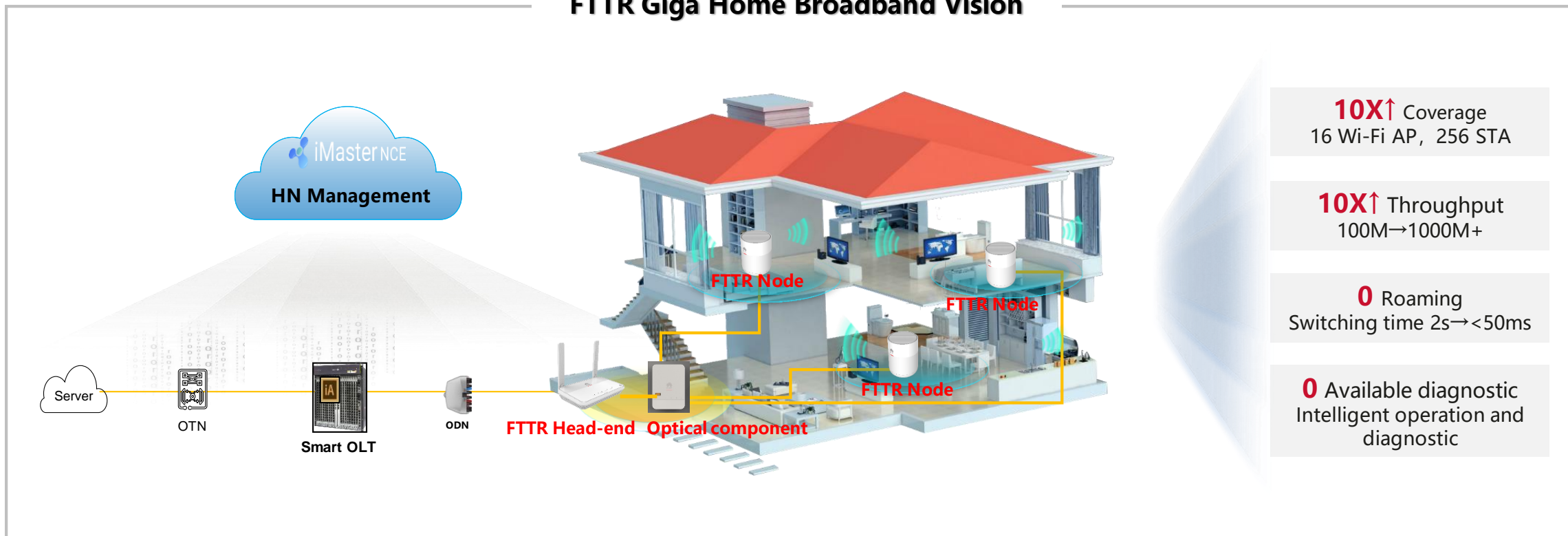Data rate loss

1000M~500M   ~100M   <50M

Access Rate   Rate for Room   Rate for End Device
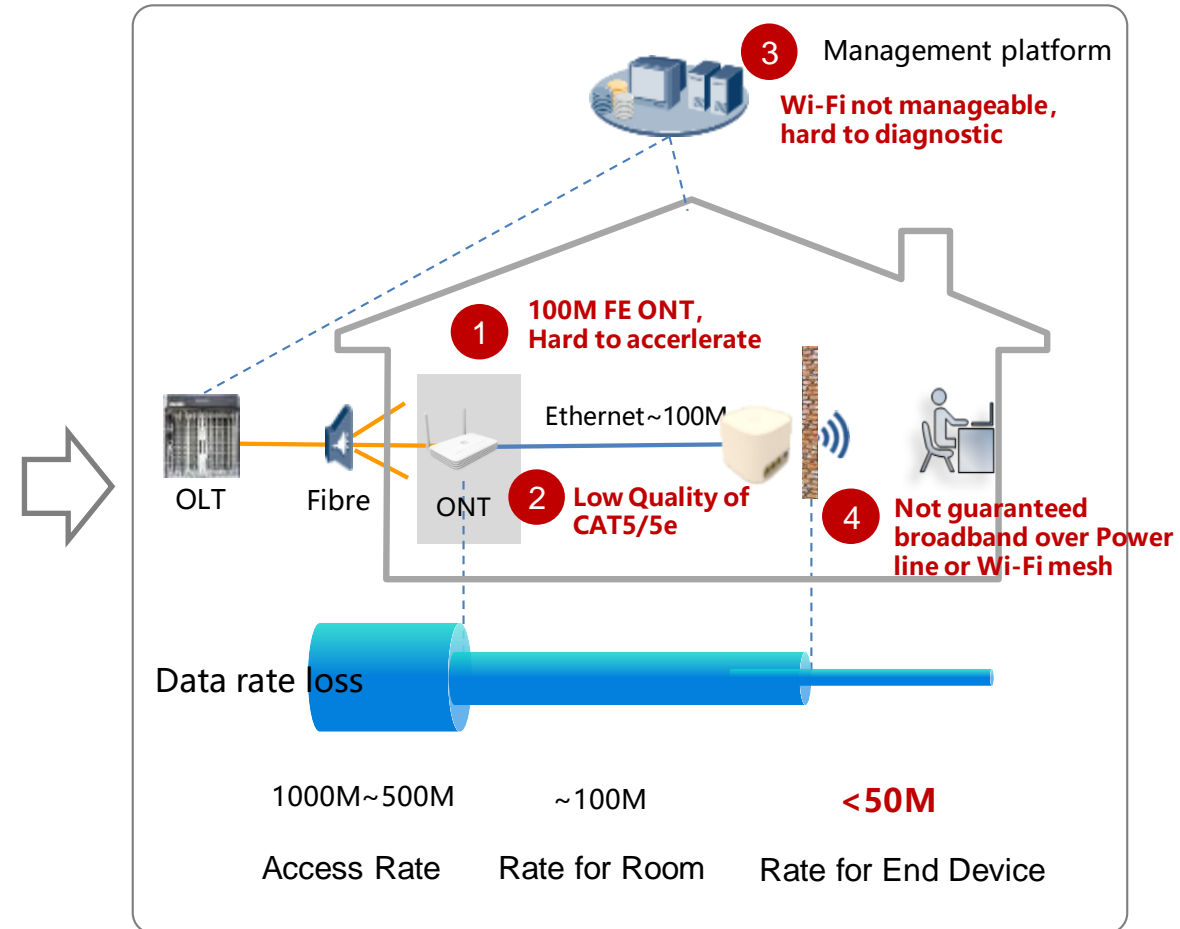
Take an example of FTTH in China, the optical Fibre is only to information box, access broadband is around 200M for 70% cases. However, the actual downloading average broadband is around 41Mbps (2020 Report of Broadband Development Alliance)

Fibre-to-The-Room(FTTR): Provide Stable Giga Home Broadband

FTTR Giga Home Broadband Vision

iMaster NCE
HN Management

Server
OTN
Smart OLT
ODN
FTTR Head-end   **Optical component**
FTTR Node
FTTR Node
FTTR Node

10X↑ Coverage
16 Wi-Fi AP，256 STA

10X↑ Throughput
100M→1000M+

0 Roaming
Switching time 2s→<50ms

0 Available diagnostic
Intelligent operation and diagnostic

Full Fibre Connection

- Fibre extends to Rooms
- Smart ODN

Giga Broadband Coverage

- Wi-Fi6 160 MHz
- Giga rate to STA

Wi-Fi Roaming

- Seamless roaming
- Switch time <X0ms

Intelligent operation

- Intelligent operation, devices visibility, easy diagnostic

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Difference between access and home over optical network

Network: From Access to Home
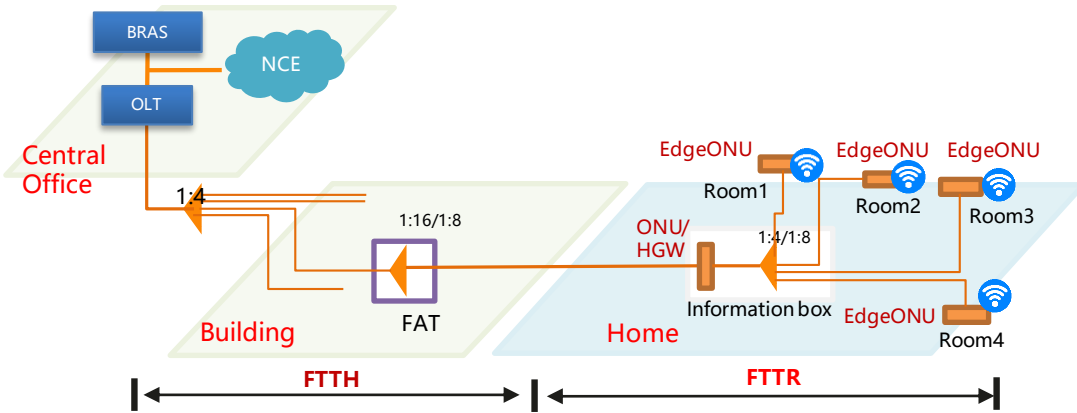
Connection： Service oriented
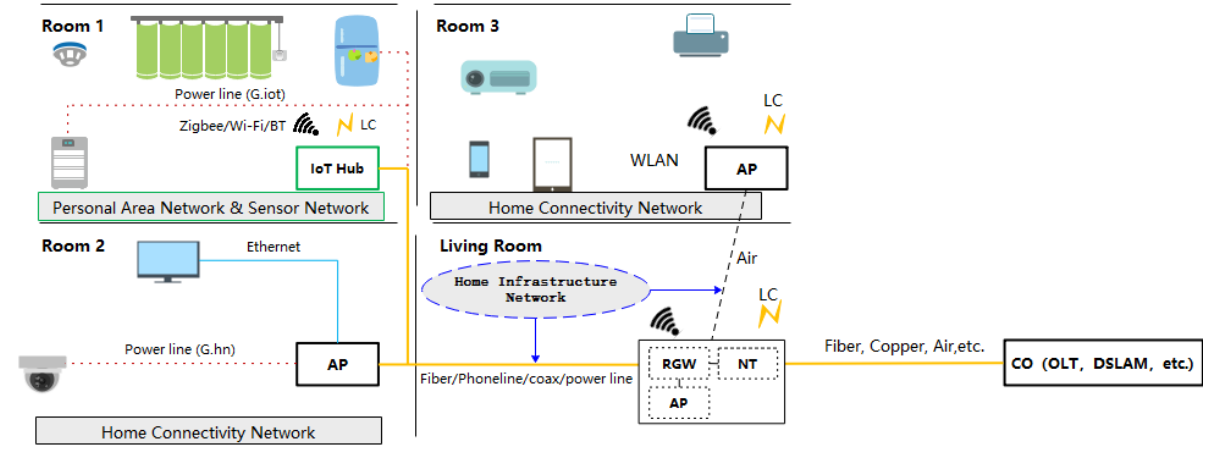
Change

1. **Small Loop length** (50-100m, 20-30dB channel gain), Transmission latency <0.1us@30m
2. Less nodes with **QoS requirements for nodes**: VR/Video/IoT

1. **Close to service**: Guaranteed QoE, from enough throughput to enough latency and packet loss rate
2. **Close to device:** Various device types and tech generations

New

1. **P2MP networking**: South-North streaming to East-West streaming: New opportunities on system design and protocol

1. **Low power devices**: IoT center-control low power mode
2. **One single network**：Optimized FTTR + Wi-Fi network

Evolution

1. **Industry/Verticals:** TSN design & other scenario oriented design
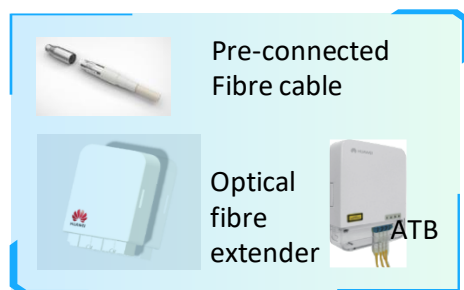2. Smart office/building/campus

Source： ITU-T SG15 Q18, FTTR use cases & network requirement, 2021

Use case & Network requirement of FTTR (1)

① High Quality Wi-Fi Backhualing
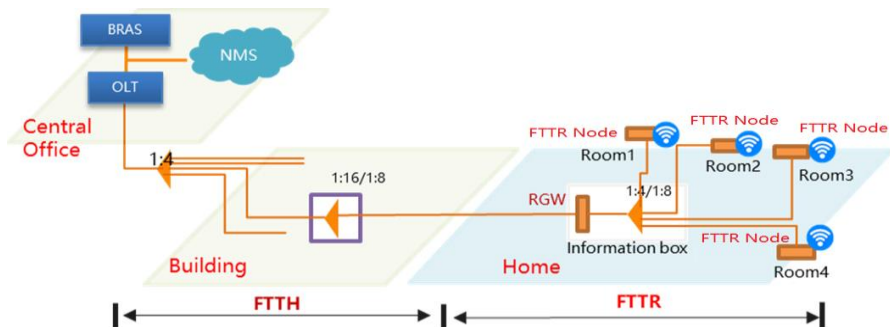
- Throughput   100Mbps   ➤   1Gbps   ➤   10Gbps
- Roaming   1s   ➤   10ms   ➤   <1ms

② Support of Extremely low latency

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

③ Low Complexity and Easy ODN

In-premises ODN   **Engineering Tool**

Pre-connectorized fibre,   fast fibre installation, high successful rate
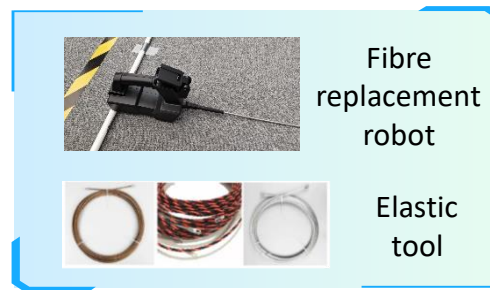
Source: ITU-T SG15 Q18, FTTR use cases & network requirement, 2021

④ FTTR Slicing
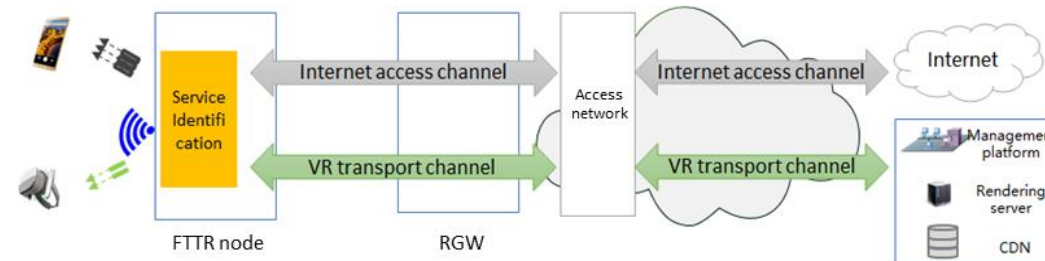
- Service type recognition, high priority channel
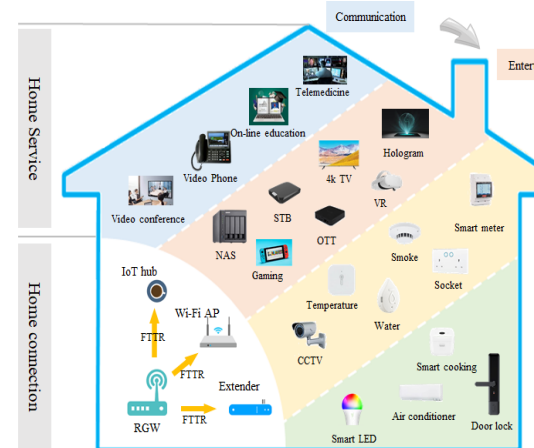- FTTR+Wi-Fi coordination & optimization

Use case & Network requirement of FTTR (2)

⑤ East-West Streaming

- **HN service:** Real-time security camera, IoT service, audio control, data storage

- **Network requirement:** East-West streaming, dynamic adjustment

- **FTTR architecture:** FTTR-head end routing

⑥ Support Various Device Types

- **Devices:** video, audio, IoT hub, AP, etc.

- **Network requirement:** low complexity, multiple rates/ modulations,

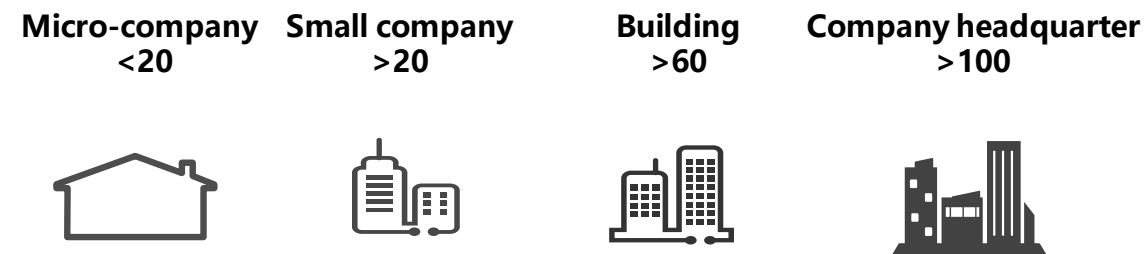- **Multiple generations:** FTTR 1.0/2.0/3.0

⑦ Enable Smart Home Connections
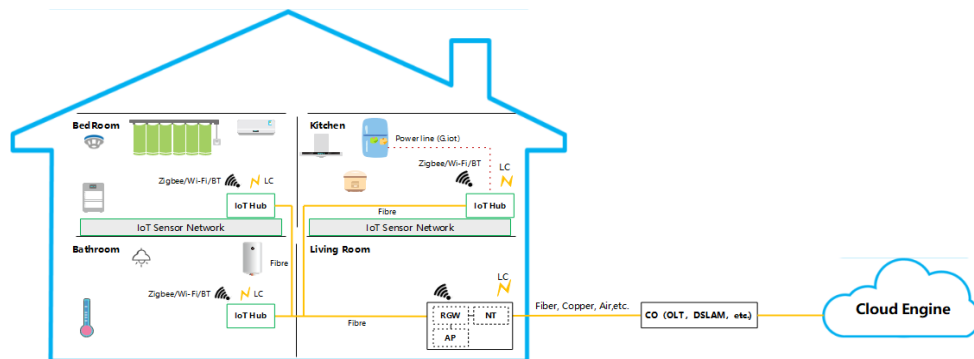
- Central control low power mode

**Source:** ITU-T SG15 Q18, FTTR use cases & network requirement, 2021

⑧ FTTR Applications

Micro-company <20	Small company >20	Building >60	Company headquarter >100

- **More connection:** Home -> small company -> building
- -> Headquarter

ITU-T Q18/SG15 In-premises Networking

- **Question Lead** (Huawei & Maxlinear)

- **Participants:** Huawei, Maxlinear, CAICT, NTT, Signify, PPC, China mobile, China Telecom, China Unicom, Devolo, Iberola, E.on, ISSI, Hisilicon, HHI, Futurewei, etc.

- **Project series:**
  - A. **G.hn series:** In-premises networking technology based on powerline/twisted pair/coax/POF
  - B. **G.vlc series:** visible light communication, based on G.hn PHY and ACO-OFDM PHY
  - C. **G.occ series:** Optical camera communication
  - D. **Smart grid:** PRIME, G3-PLC, G.hn applications in smart grid, G.iot
  - E. **HN Architecture:** TP, G.hetnet (Terminology of home network)
  - F. **FTTR (G.fin) series:** Fibre based in-premises networking:
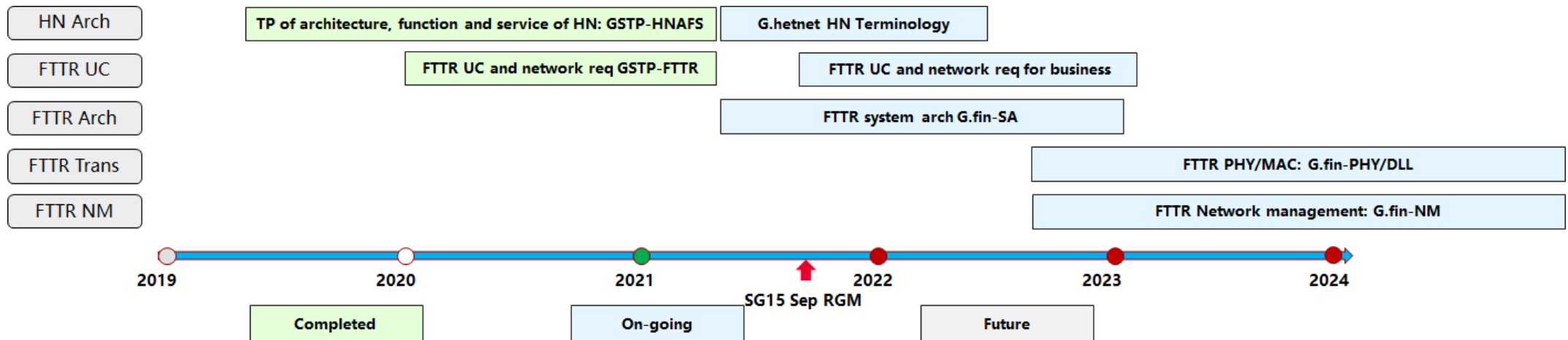
Thank you.

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Bring digital to every person, home and organization for a fully connected, intelligent world.

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