Considerations on Deployment and Technology Development of FTTR

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Outline



Overview



Progress on 50G PON and FTTR



Progress on AI+FTTR+RFID

Motivations from gigabit to 10-gigabit

- Gigabit optical broadband network is growing rapidly, with Gigabit users now accounting for 36.8%
- Driven by the industrial policy and development of AI, evlution from gigabit to 10-gigabit broadband with new architecture, services and experience is necessary

Infrasturcture upgradation driven by policy

10-gigabit field trials (2025)

168 field trials in total nationwide

Including factory, campus and residential areas

"AI+" Action (2025)

fostering new infrastructure, technologies, and industrial ecosystems

Growing of gigabit customers

670m

Broadband users

258m

Gigabit Subscribers

- Broadband users: 670 million
- Gigabit users: exceeds **258 million** (36.8% of total users)
- Number of 10G PON ports growing rapidly, up to 32.86 million in 2026 H1

Source: MIIT of PRC

Optical access network evolution driven by AI

AI for services

- AI services & UEs with AI

AI for connection

- Large scale connection to human and IoT or robots

AI for data stream

- AI training data, deterministic network

AI for maintenance

- AI intelligent maintenance, flexible network

Fibre in-premises are evolving beyond connectivity

- New services require optical access and in-premises networks to continuously enhance connectivity (low latency, high bandwidth) as well as capabilities beyond connectivity (edge computing, data services)

Special scenarios



Inspection & emergency support

Highly Reliable Connectivity
Remote automated control

Commercial



Exhibition halls, in-store guides, etc.

Highly Reliable Connectivity
Smooth interaction

Industrial



Autonomous robotic material handling

High reliability
low latency
Freeing human labor

Home



Smart home control enables intelligent services

Real-time training
Real-time inference
Indoor/outdoor general-purpose tasks

Token



AI computing interaction

Ultra-large uplink bandwidth
Massive uplink Token data

Connectivity Requirements

Multi-modal transmission

Traffic: uplink share will rise to 40%-50%, bandwidth demand raising

Ultra-low latency & ultra-high reliability

ToC: 50ms→10ms@99.99%
ToB: 5ms → 1ms@99.9999%

Dynamic networking

From static to dynamic networking

Requirements Beyond Connectivity

Computing services

Device side: 0.5-1 TFLOPS
Edge side: 100 TFLOPS

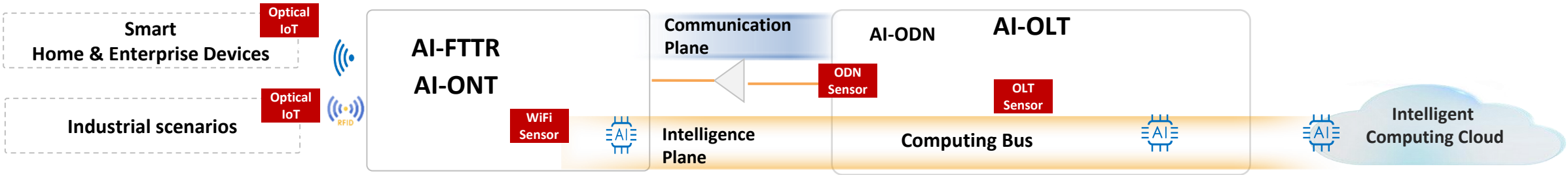
Data services

Multi-dimensional data
Secure communication

Technology Development of 50G PON and FTTR

- In the AI era, the PON and FTTR would evolve from communication-oriented to Token-operation-oriented system, reshaping the full workflow of transmission, computing and service delivery

AI-Native 50G PON+FTTR



Key Technologies @ Connectivity

- **Symmetric 50G PON** : Deploying PONs with three-generation coexistence and meeting the large uplink bandwidth demands of AI services
- **E2E Experience Assurance**: Driving 10G FTTR and Wi-Fi 7 getting mature, continuously upgrading the home and enterprise 10-gigabit connectivity foundation
- **Enhanced Deterministic Capability**: Combo PON are adaptable to the OLT, decreasing the deployment costs while equipping with new system capabilities

Key Technologies @ Beyond Connectivity

- **Communication-computing convergence**: The traditional communication-oriented OAN evolves into a converged communication-and-computing OAN
- enhancement on heterogeneous computing capability in PON and FTTR
- enhancement on perception capability
- enhancement on dynamic computing collaboration based on the terminal-edge-cloud computing collaboration
- **Integrated RFID over FTTR: C**onstructing a IoT enabled optical network with gigabit broadband and passive IoT capabilities

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Progress on 50G PON and FTTR



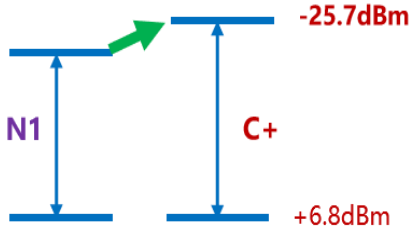
Progress on AI+FTTR+RFID

50G PON Technical Capability Requirements

- As the new generation 10-gigabit optical access system, architecture and capabilities of 50G PON need to be improved to satisfy integrated service access demands

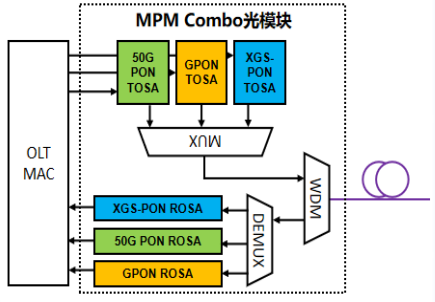
Power budget

- Compatible with ODN class C+32dB power budget
- Compensate new transmission effects such as dispersion



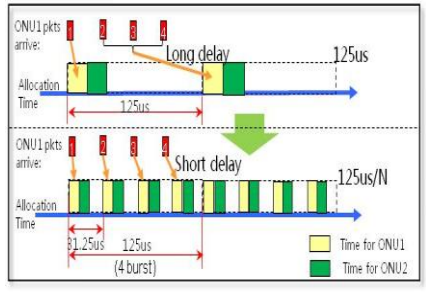
Coexistence

- 3-generation in same PON port via WDM
- ONU side support dual-mode Combo



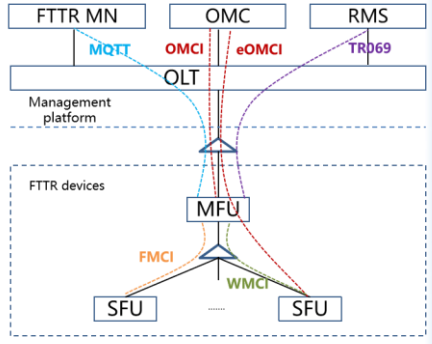
Low latency and slicing

- For industry PON services, support deterministic low latency
- guaranteed experi-ence using PON slicing



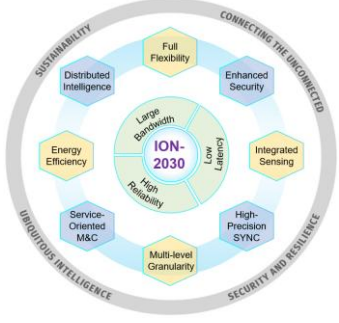
FTTR native management

- Centralized control with high efficiency
- OLT directly manage both MFU and SFU



Multi-dimension convergence

- Network combined with computility, intelligence and sensing
- establishing a foundational optical connectivity for IoT



50G PON Progress

- As 50G PON standards are completed, The 50G PON industry has made great progress, and already meet requirements of commercial deployment in 2026

ITU-T Standards

2016.2	2018.2	2021.4	2022.9	2024.3
ITU-T initiated the HSP study	50G PON ITU-T international standard project approved	First edition of the 50G PON standards G.9804 series published	Symmetric N1 standard G.9804.3 Amd.1 published, defining wavelengths for three-generation coexistence	symmetric C+ standard G.9804.3 Amd.2 published

Industry progress

Chips



Modules



Systems



Chip types

- ✓ OLT has largely adopted ASIC chips
- ✓ ONU main chips are evolving from FPGA to ASIC

FEC coding scheme

- ✓ standard LDPC (17280, 14592)
- ✓ Improve the BER limit to 2E-2

Optical module forms

- ✓ Mainstream vendors fully launched SFP, supports three generation coexistence

Power budget

- ✓ Asymmetric systems fully meet the C+ class requirements
- ✓ Symmetric systems have basically met the C+ class requirements

Multi-mode coexistence

- ✓ OLT side: support GPON/10G GPON/50G PON coexistence in same port
- ✓ ONU side: 10G/50G Combo released

New 10G capabilities

- ✓ Low latency capability: supporting 128 bursts per frame, latency <100us
- ✓ PON+FTTR native management and control
- ✓ Combo OLT and Combo ONU capabilities

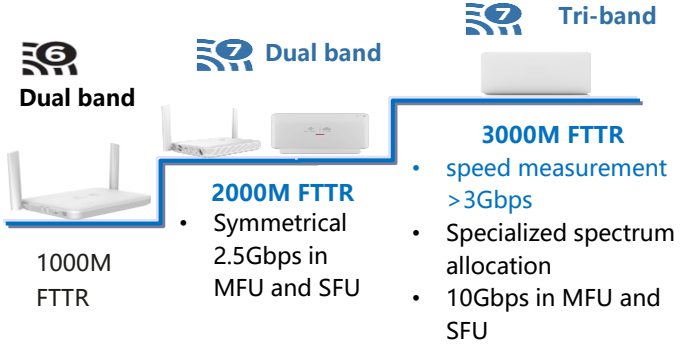
Tri-band Wi-Fi 7 technology and 10G FTTR physical layer

The 10G FTTR and tri-band (2.4G/5G LB/5G HB) Wi-Fi 7 technologies have achieved milestone results:

- The supply chain of tri-band Wi-Fi 7 is now mature, supporting rolling out 3000M broadband services
- The new Ra+ option supports direct connection and split ratio of up to 1:32 supporting both residential and enterprise scenario

Wi-Fi7: Tri-band MLO

Optical and Wi-Fi coordination: the connectivity foundation keeps upgrading



Key technologies

- Traffic identification and dynamic allocation
- Seamless band steering

Type	Protocol	Operating band	Channel width	Theoretical rate
Dual-band	Wi-Fi 6	5.2G	160MHz	2402Mbps
	Wi-Fi 7 MLO	2.4G+5.2G	40+160MHz	3570Mbps
Tri-band	Wi-Fi 7 MLO	5.2G+5.8G	160 + 80MHz	4323Mbps

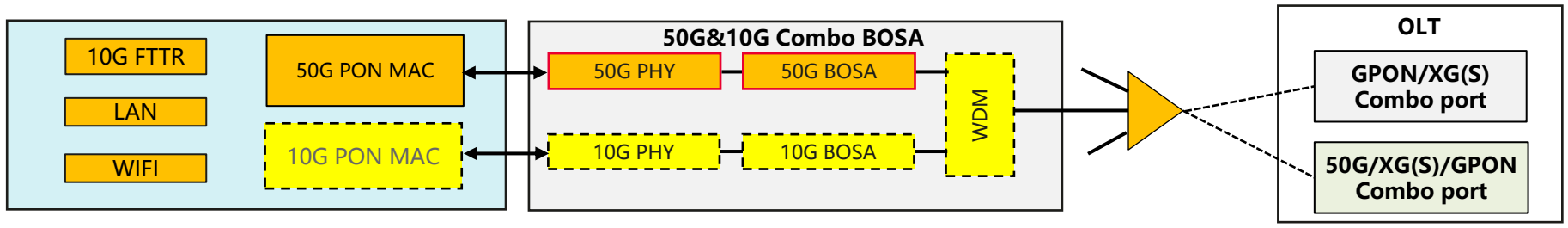
10G FTTR physical layer

- PHY metrics have reached consensus at CCSA
- Ra and Ra+: unified SFU specs enable low-cost, highly flexible deployment
- Optimizing the overload and sensitivity to support low-cost reception

Category	Item	Unit	Ra	Ra+
	Power budget	dB	0–18	0–21
MFU	TXmin	dBm	1	1
	TXmax		5	5
	Overload		2.5	2.5
	Sensitivity		-19.5	-22.5
SFU	TXmin		-1.5	-1.5
	TXmax		2.5	2.5
	Overload		5	5
	Sensitivity		-20	-20

PON cooperation based on combo OLT and combo ONU

- To trade off between the upgrade and cost, 50G PON terminal deployment can be carried out in advance appropriately by supporting adapting to both 10G PON and 50G PON OLT port flexibly
- The Combo OLT working together with Combo ONU/FTTR can enhance determinism, reliability and other capabilities, which is valuable for industrial PON scenario



FTTH scenario

Service scenario requirements:

- Deploying terminals ahead of demand enables on-demand OLT upgrades, helping reduce early deployment costs

Combo solution:

- Adopting 10G/50G PON Combo terminals to adapt to 10G PON and 50G PON OLT equipment flexibly
- Operating mode relies on optical-layer OAM remote management for on-demand, where the OLT can upgrade with user-transparent mode

Industrial PON scenario

Service scenario requirements: Industrial networks need enhanced capabilities: 100-μs deterministic low latency and 99.999% industrial-grade reliability

Combo solution:

- Dedicated Activation Wavelength: using the 10G channel as the registration window to optimize 50G PON max upstream latency and jitter
- Dual-channel protection switching: switching to the 10G channel rapidly and ensuring uninterrupted service when 50G channel fails

China mobile has jointly initiated ITU-T G.sup.PONcoop regarding the application scenarios and technical solutions above

Outline

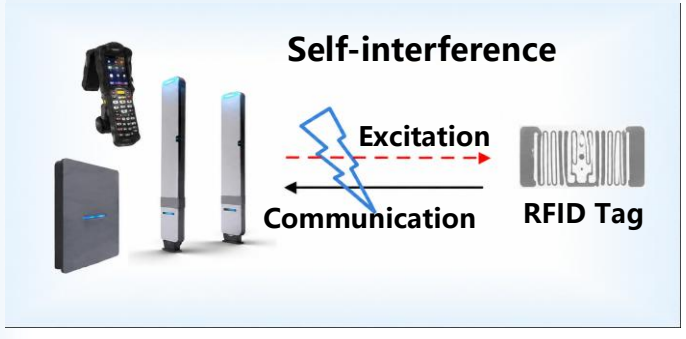
1 Overview

2 Progress on PON and FTTR

3 Progress on AI+FTTR+RFID

Technical requirements for AI+ Passive IoT Optical Networks

- Digital transformation of smart homes and enterprises is accelerating, and massive unconnected "dumb assets" are in urgent need of digital upgrading. The conventional RFID solution cannot adapt to rising ubiquitous intelligence demands, with four key challenges summarized below



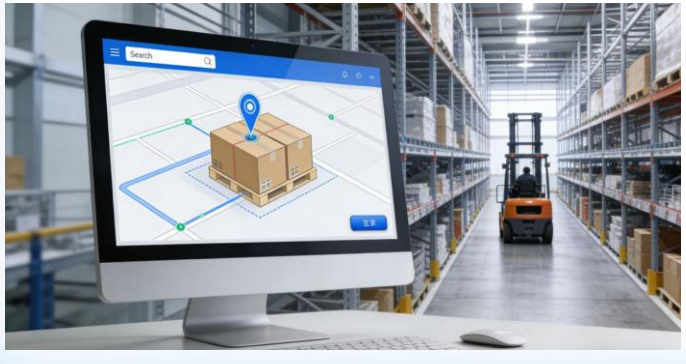
Coverage

Self-interference in integrated RFID readers between Tx/Rx limits coverage by a single device



Networking

Multi-device interference, Interference between RFID readers
Lack of coordination



Positioning

Conventional RFID lacks locating capability for passive tags

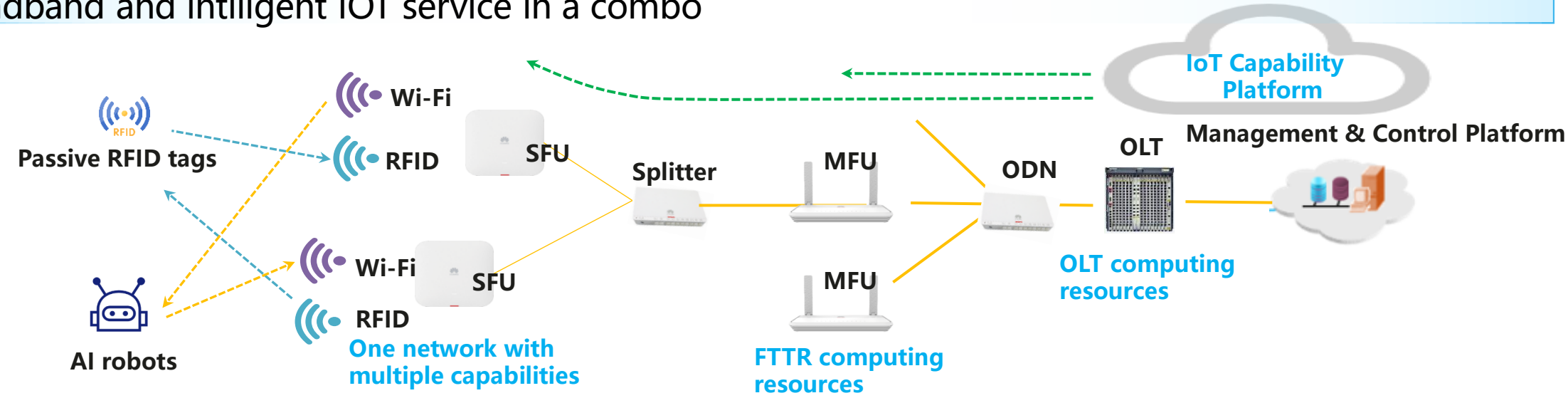


AI Analysis

Massive sensing data remain underutilized for analytics
Difficult to integrated with AI

Technical Architecture for AI+ Passive IoT Optical Networks

- We propose an optical network solution Integrated with AI+passive IoT targeting these challenges
- Integrated RFID and computing capabilities over PON+FTTR network provides both beyond-gigabit broadband and intlligent IOT service in a combo



Basic Capabilities with RFID

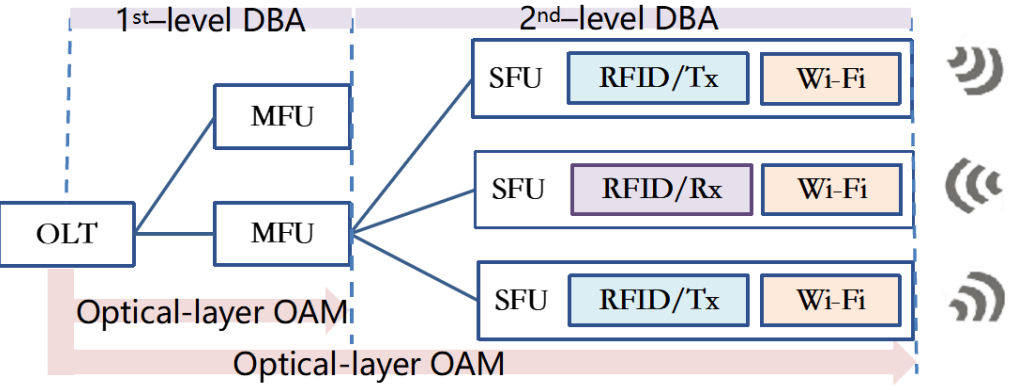
- Coverage enhanced
- Centralized Management
- RFID networking
- RFID+Wi-Fi coexist

Advanced Capabilities with AI

- Positioning
- AI application

Key Technology 1: Integrated RFID over FTTR

- Tx/Rx separation and optical-layer OAM enable centralized management and control of RFID network, in which FTTR provides low-latency control channel
- Native time synchronizationn shceme in TDMA network like PON and FTTR, could enable RFID beamforming for extended coverage





The RFID protocol requires the tag to respond within T_2 after a reader command

BLF (kbps)	Maximum transmission latency (us)
40	500
80	250
160	125
320	62.5
640	31.25

T_2 is determined by tag backscatter link frequency (BLF)

① Mgnt&Ctrl-Layer Protocols

- **PON + FTTR optical-layer OAM** enables centralized control for scheduling RFID network, **reducing interference and extending coverage**.

② Tx/Rx Separation

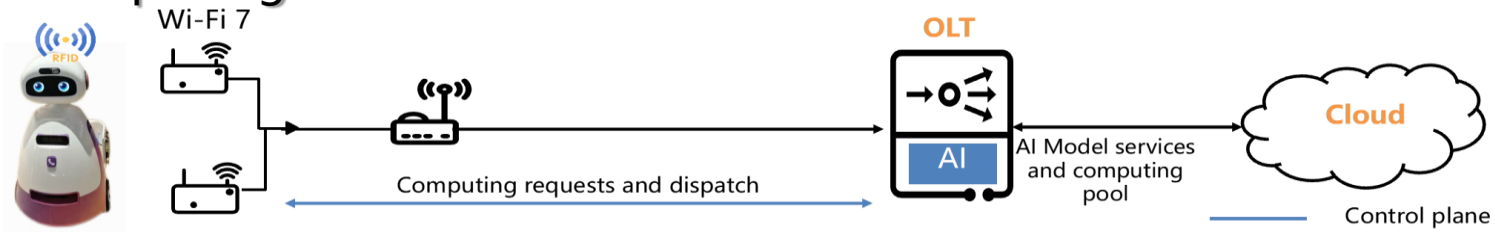
- Each SFU is assigned as transmitter or receiver but not simultaneously
- **Tx/Rx SFU separation** eliminates self-interference and effectively **extends the coverage**.

③ High-Precision T–F Synchroniza0tion

- Native time synchronizationn shceme in TDMA network like PON and FTTR, could enable RFID beamforming for extended coverage

Key Technology part 2： Integration with Embodied AI Introduces New Capabilities

- To further promote the value of RFID integrated optical networks, we attempt to break technical boundaries and deeply integrate with embodied AI, and heavy computing tasks are offloaded to edge computing node in the OLT



- Inventory Blind Spot Filling
- Key Monitoring

- Map Modeling
- Precise Positioning

- Intelligent Interaction
- Path Navigation

New Capabilities via FTTR+RFID + Embodied AI

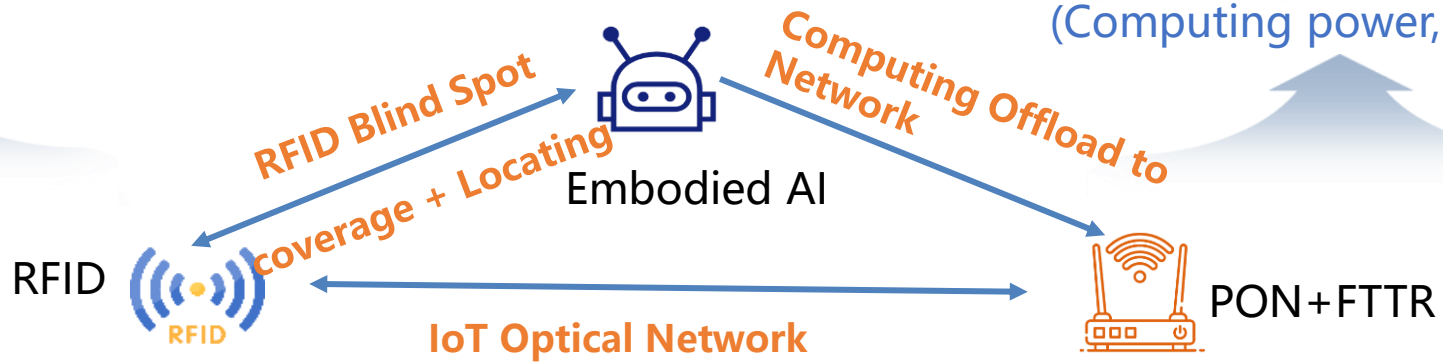
AI models deployed in Embodied AI side

RFID Model 1T、100ms | Map model 4T、100ms

AI models deployed in OLT side

Semantic Navigation 30T、1s | Intent Recognition 10T 、50ms | Voice explanation 10T 、1s | Intelligent inspection 190T、2s

New Requirements for Optical Networks (Computing power, Latency)



Field Trial: Senarioes enabled by AI+FTTR+RFID Network

- The capabilites, such as automated inventory, electronic geofencing, positioning and intelligent interaction, of AI+FTTR+RFID network has been validated through filed trials

FTTR+RFID





Application Demonstration at the CMCC Laboratory

- **Electronic Geofencing**
- **All day monitoring**
- **Gigabit coverage**





Deployment in a Factory Warehouse

- **Coverage area:** >1,000 m²
- **Items(Tags):** >2,000
- **Reduce inventory time:** 1 day → minutes
- **Reduce labor savings:** 1 person is enough

Integration with AI to enable new capabilities

AI+FTTR+RFID





Innovative Technology Trial at a Porcelain Museum

Existing Capabilities:

- One-click inventory
- Electronic geofencing
- All day monitoring
- Gigabit coverage

New Capabilities:

- Eliminate inventory blind-Spot
- Targeted item monitoring and localization
- Intelligent interaction
- Map construction and route navigation

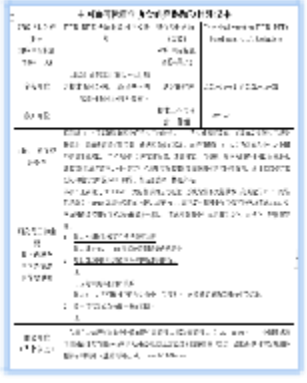
Technology & Industry Progress — Standardization

- Standardization projects across CCSA, ETSI and WAA are under development

CCSA



CCSA TC6 WG2



- Completed the study on “The Study of FTTR + RFID Passive IoT Technology”.
- Launched standardization project H-2025112012809.
- Establishing the foundation for Passive IoT Optical Network standards in enterprise and home scenarios.

ETSI



ETSI ISG F5G



- Leading and continuously developing WI 37, “RFID over FTTR Architecture”.
- Defining scenario requirements, system architecture, and functional interfaces for ISAC over 10G optical networks.

WAA



WAA WG C8



- Established the WG-C8 working group
- Launched project TF-C13
- Developing standards for experience, performance evaluation, security assessment, and system-platform technologies of Passive IoT Optical Networks

Summary

- As the technical basis of 10-gigabit optical broadband, 50G PON has basically reached class C+ power budget in symmetric system, further endeavours are required to keep improving the system performances and capabilities
- FTTR is critical for the 10-gigabit user experience, it is necessary to accelerate the technical research and standardization of 10G FTTR and coordinated management of FTTR, by collaborating with AI, sensing and IoT capabilities, to enhance 10-gagabit service capability

Thank you!