



中国移动
China Mobile

Considerations on Deployment and Technical Development of FTTR

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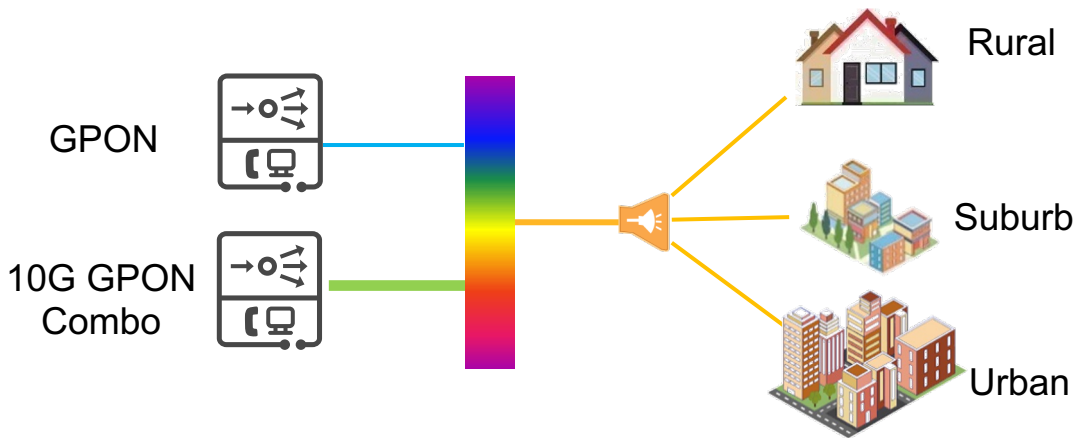
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China Mobile own a number of fixed broadband users over 280 million. To progress Gigabit speeding up and guaranteed QoE, it is essential to promote the development of Gigabit optical access network

Optical access networks GPON and 10G GPON

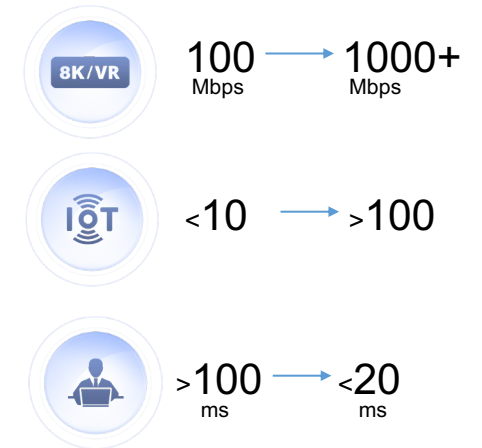


Fast development of Gigabit FTTH

50 million+
Gigabit users → 46%
Market share

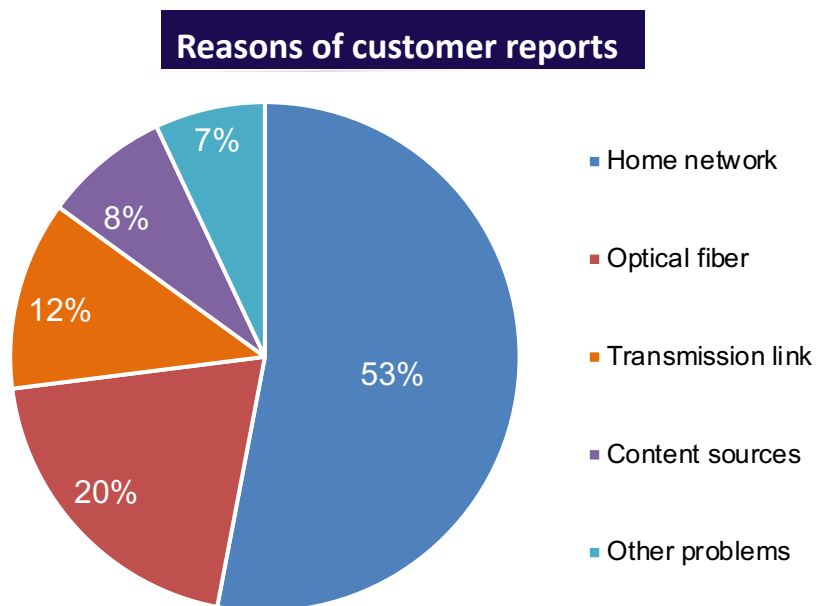
280 million+
Broadband users → 47%
Proportion nationwide

Differential experience driven by new services



- ❑ **Challenges:** Issues impacting on customers QoE mostly caused in the last 100 meters
- ❑ **Requirements:** To build end-to-end Gigabit optical network reaching rooms, through extending optical access network ability with Cooperative Wi-Fi networking

Challenge to end-to-end fixed broadband network :
issues within the last 100 meters



According to the reason distribution of operator's customer reports: 53% of the reports are related with the quality of home networks, source from CAICT

Requirements of FTTR



Extending optical access network from FTTH to FTTR

- Carrier optical network enables Gigabit coverage reaching rooms

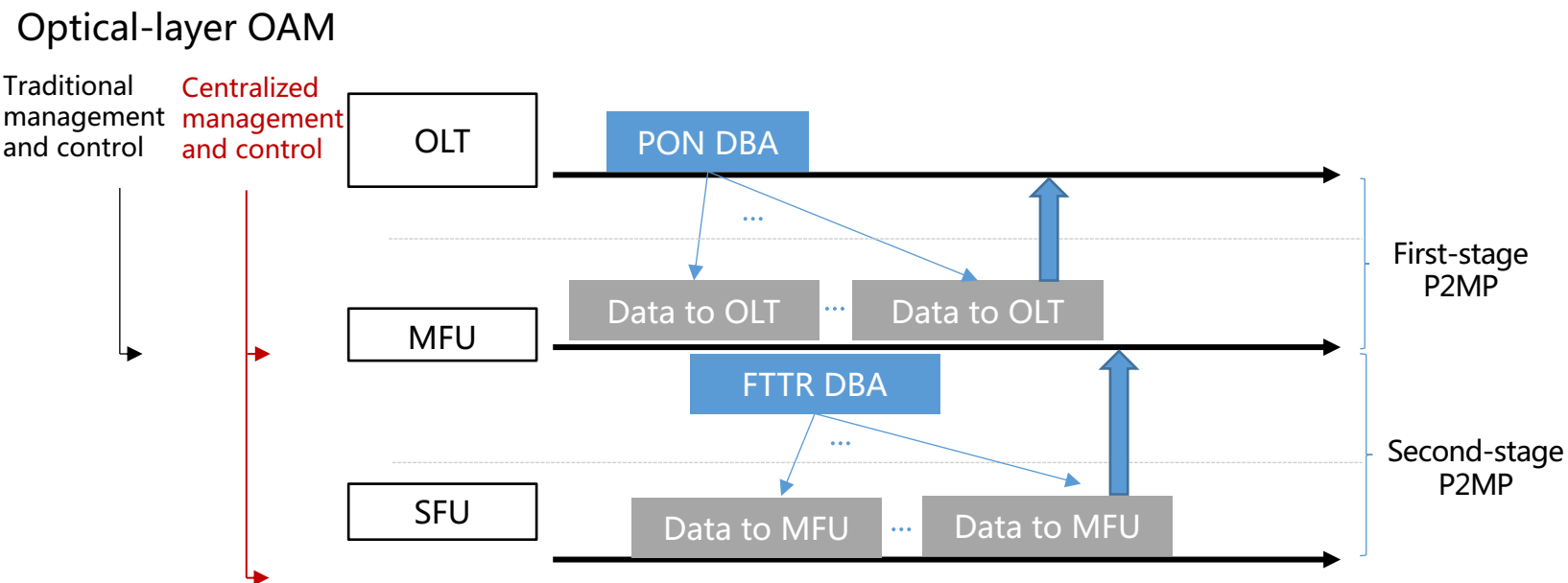


Multiple node Wi-Fi Cooperative networking

- Improve Wi-Fi experience
- Support fast roaming

Considerations on FTTR system

- Cooperation of Cascaded P2MP to build end-to-end Gigabit optical network
- Assume FTTR as the extension of PON, extensive management system in the PON could be utilized for FTTR



Cascaded P2MP Network

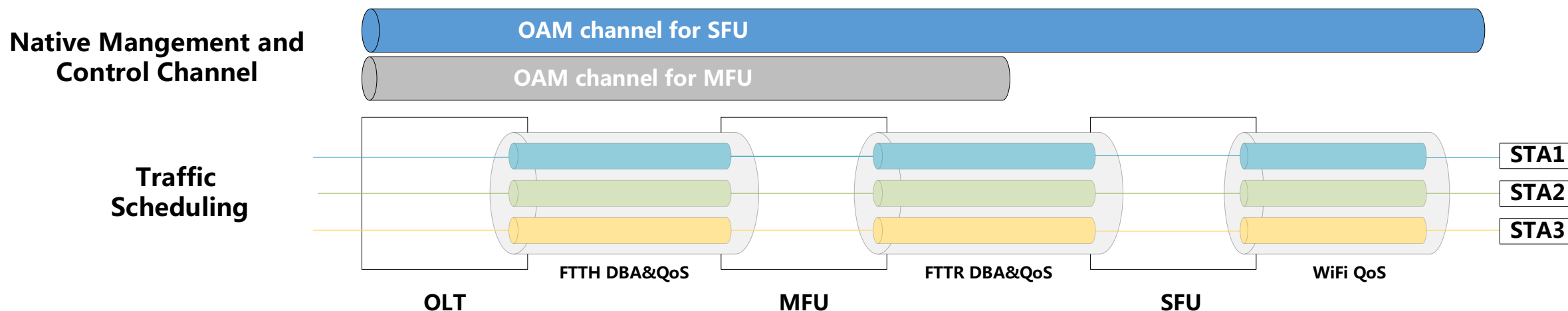
- Cooperation of Cascaded P2MP to build end-to-end Gigabit optical network
- The DBAs can be separated but run Cooperatively, and the traffic could be scheduled more efficiently

Centralized management

- Assume FTTR as the extension of PON, extensive management system in the PON could be utilized for FTTR
- Laying the foundation for Cooperative networking of PON and FTTR

Considerations on optical-layer OAM for FTTR

- ❑ Optical-layer OAM deriving from PON interface and G.FIN interface could present fundamental and optical-native management capability
- ❑ It should be advantageous to use OMCI to manage SFU, so that management visibility could increase from OLT and it additionally helps to build end-to-end gigabit optical network



01

Requirements of optical-layer OAM

- ❑ The basic management ability on FTTR established immediately once fiber is connected between OLT and MFU
- ❑ Centralized management, control, and scheduling for cascaded P2MP network
- ❑ Independent management channel isolated from data channel

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Implementation of optical-layer OAM

- ❑ Based on OMCI or OMCI extension
- ❑ OLT supports managing SFU directly, thus simplify IOP between OLT and FTTR, benefits deployment
- ❑ OLT supports managing MFU, especially G.FIN interface

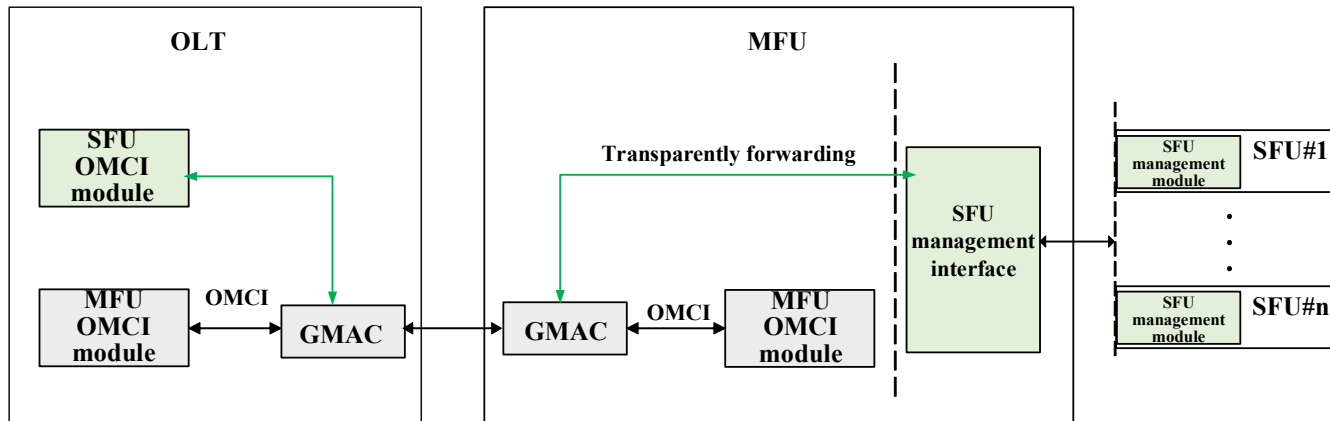
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Managed objects of optical-layer OAM

- ❑ G.FIN interface
- ❑ MFU
- ❑ SFU
- ❑ PON interface

- ❑ Prototype with optical-layer OAM was demonstrated in 2022, and relevant standard project has been setup in CCSA
- ❑ Propose to accelerate the progress of optical-layer OAM scheme analysis and standardization

Optical layer OAM implementation reference



Technical scheme of FTTR optical-layer OAM :

- ❑ **OLT directly manage SFU** : Based on OMCI extension
 - Adding SFU information into message
 - MFU transparently forwarding the message between OLT and SFU
- ❑ **OLT through MFU discover SFU** : Based on OMCI extension
 - Adding ME to describe SFUs connected to MFU

Technical research progress

- In 2022, CMCC working together with Huawei, ZTE, Fiberhome completed prototype test
- Field trial completed in 4 provinces, the optical-layer OAM scheme and interface functions perfectly demonstrated
- FTTR optical-Layer OAM scheme and technical research published in JOCN 2023, OFC 2023

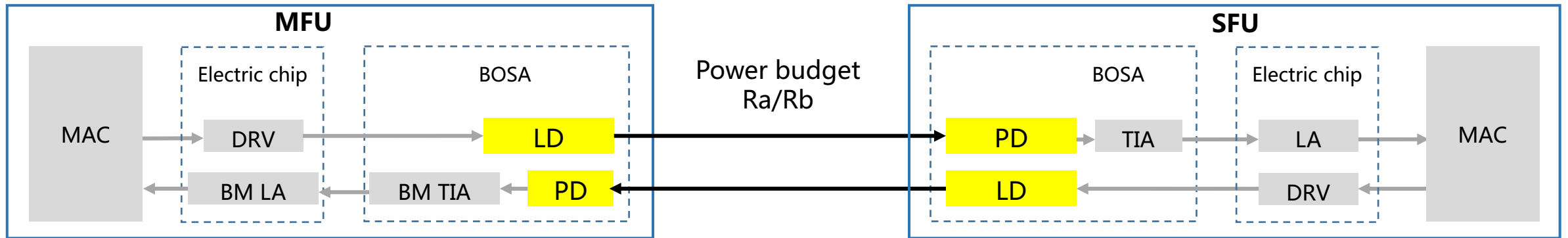
Future work

- Progress analysis and standardization of optical-layer OAM scheme
- Optical-layer OAM support managing combo FTTR, to handle the work mode switching

[1] Dechao Zhang, Jinglong Zhu, et al., Fiber-to-the-Room (FTTR): A Key Technology for F5G and Beyond, vol.15 issue.9, JOCN 2023.

[2] Jinglong Zhu, Junwei Li, et al., First Field Trial of FTTR Based on Native Management and Control Architecture for 5G Small Cell Backhaul, OFC 2023, Paper W2A.13

- ❑ For Ra class, the transceiver scheme and relevant parameters need to be redesigned to cost down. For Rb class, the industrial chain of GPON and 10G GPON can be reused
- ❑ The transceiver scheme and parameters of 2.5G is relatively easy to specify, while 10G Ra/Rb still need further discussion



2.5G Ra

- LD : DFB
emission power -4~0dBm
- PD : PIN , lower cost

- ❑ **Cost down further relative to GPON Transceiver**

2.5G Rb

- LD : DFB
- PD : upstream APD、downstream PIN

- ❑ **Reuse GPON class B+ industrial chain**

10G Ra

- LD : DFB
- PD : downstream PIN , upstream undefined

- ❑ **possibly based on 2.5G optics to overclock**

10G Rb

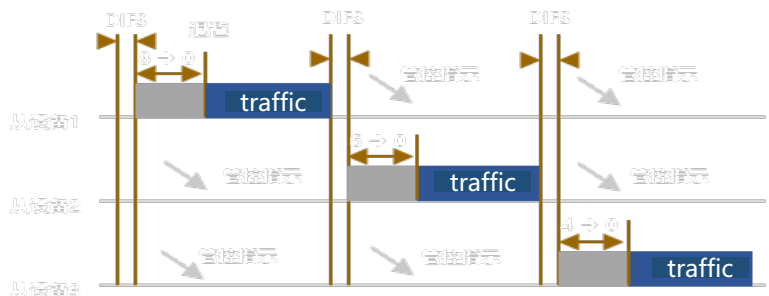
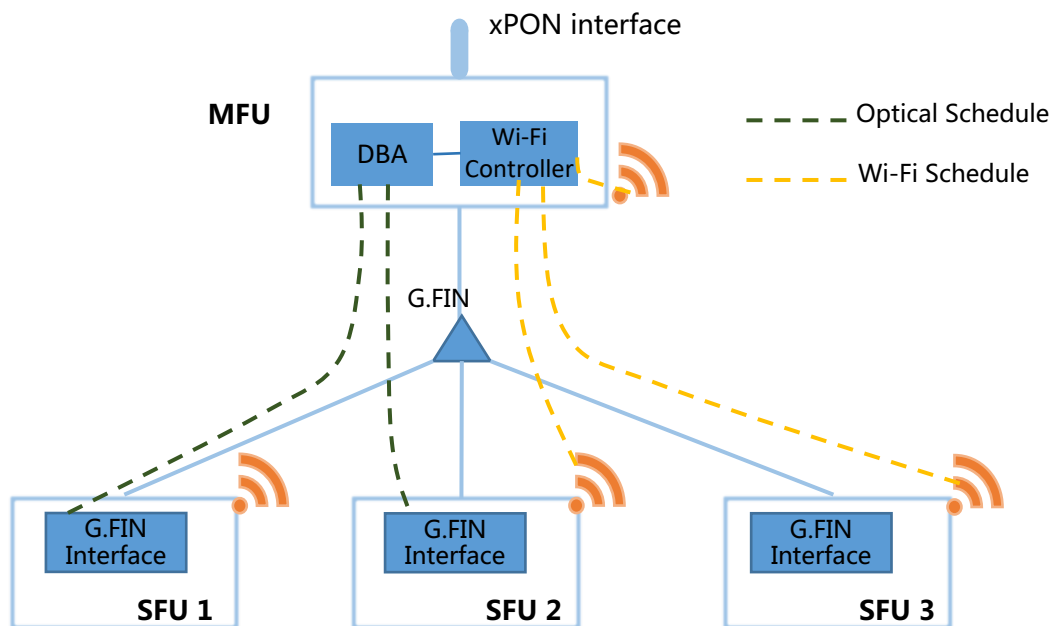
- LD : DFB
- PD : upstream APD、downstream undefined

- ❑ **Reuse XG(S)-PON industrial chain**

Challenge: to achieve power budget with trade-off between component performance and cost

New protocols support Gigabit Wi-Fi experience

FTTR DLL-layer need to support optical link and Wi-Fi cooperative scheduling to ensure Gigabit Wi-Fi experience by a centralized control architecture



Requirements of FTTR DLL-layer



End-to-end optical-layer centralized management and control

- Based on optical-layer OAM, to realize Gigabit optical network ability extension from PON to FTTR



MFU as a controller to centralized schedule Wi-Fi traffic of each SFU

- Support centralized optical link and Wi-Fi scheduling, to guarantee Gigabit Wi-Fi connected in order

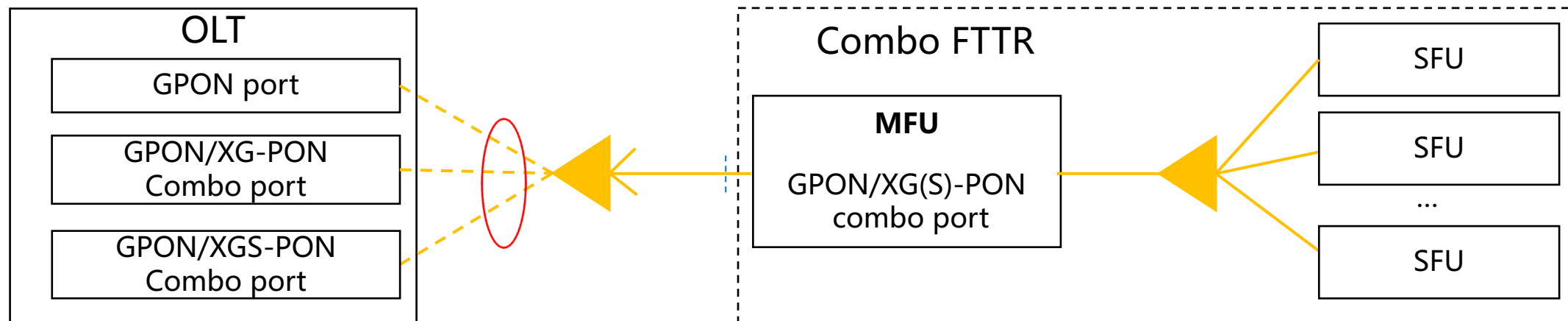


Simplifying the DBA mechanism for SFU

- With small splitter ratio, simplified DBA can reduce latency

Considerations on Deployment—Combo FTTR Solution

From CMCC perspective, FTTR needs to support access to either GPON OLT or XG(S)-PON OLT, and guarantee non-awareness to users when OLT upgrading, which is called Combo FTTR



Access to either GPON or XG(S)-PON

- Both GPON and XG(S)-PON port could develop Gigabit broadband service
- Areas deployed by either GPON or XG(S)-PON OLT can develop FTTR

To Guarantee user experience

- Combo FTTR can adapt OLT upgrade from GPON to XG(S)-PON, Guarantee the user experience
- One-generation FTTR device can support two-generations PON, protecting FTTR device investment

To provide promised Gigabit bandwidth

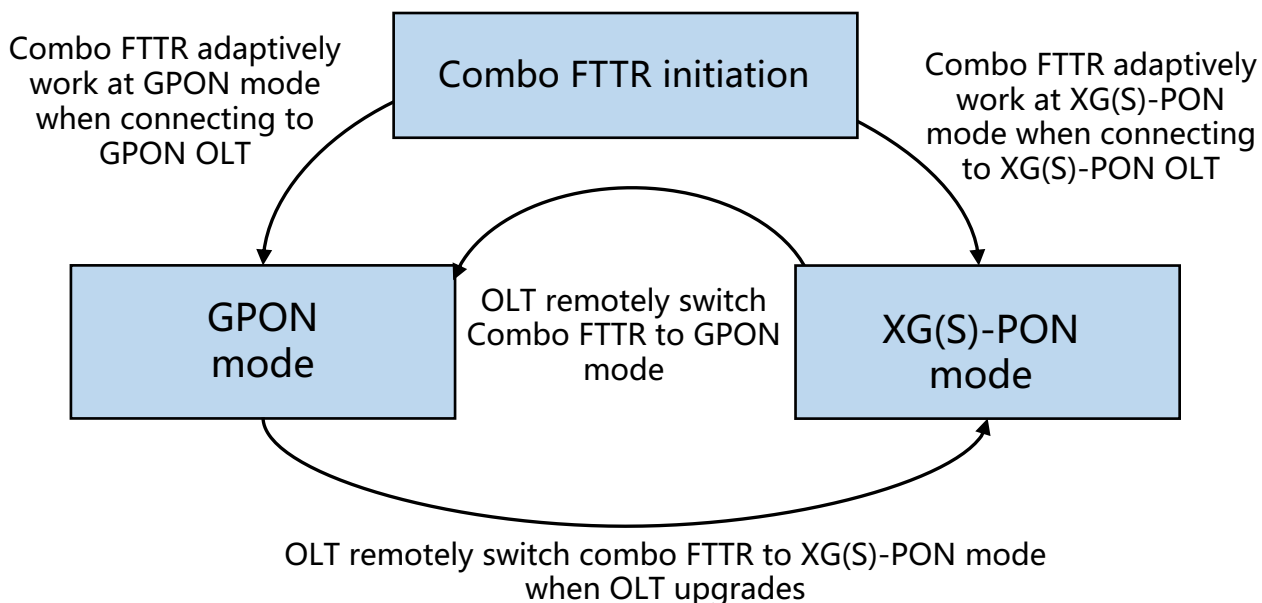
- Combo FTTR can switch working mode according to the service SLA and link load, when OLT is also combo

Considerations on Deployment—Combo FTTR Solution

- ❑ Combo FTTR working mode can be remotely managed based on optical-layer OAM and support adjustment on demand according to service SLA requirements and Link load
- ❑ The industrial chain of Combo FTTR is already mature, which can share industrial chain of Combo OLT、GPON and 10G PON BOSA

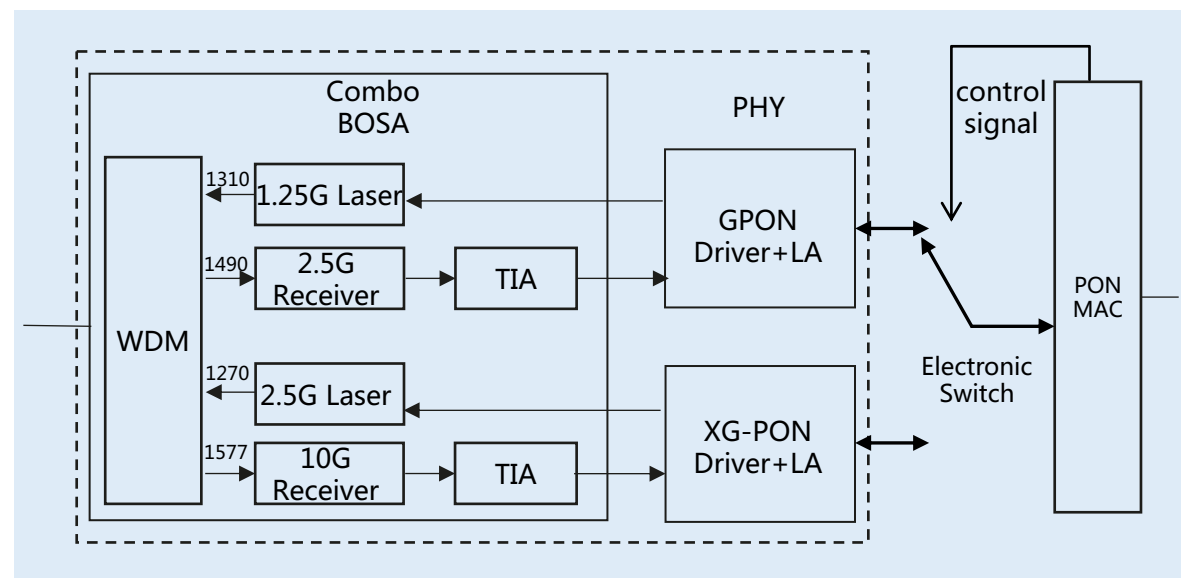
The controllable working mode of Combo FTTR

- Combo FTTR adaptively selecting work mode when first online
- Then based on optical-layer OAM, OLT can remotely switch combo FTTR work mode according to service SLA requirements and Link load



PHY solution of Combo FTTR

- Combo optical components : GPON BOSA and 10G PON BOSA combined via internal WDM
- Adding a electronic switch, to ensure only one-branch signal can enter PON MAC each time



- **Deploying FTTR as a further extension to user side of optical network to realize Gigabit seamless coverage, and together pushing forward FTTR technical development and standardization.**
- **Cooperative PON+FTTR can realize end-to-end network slicing, and possible to become the technical architecture of gigabit optical network**



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