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A YANG Data Model for WDM management in Front-Haul NBI

Abstract

This document introduces an architecture of semi-active fronthaul WDM system and explains how the semi-active devices can be managed by a transmission controller. This document also specifies a YANG data model for the WDM devices in front-haul scenario, which is defined in G.owdm. The model is expected to be used in the Northbound of controller.

Status of This Memo

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1. Introduction

In the 5G era, great change of the basic wireless network architecture from RRU-BBU to AAU-DU-CU brings the change of 5G transport network from fronthaul-backhaul to fronthaul-middlehaul-backhaul network. Moreover, to avoid excessive transmission bandwidth requirement, the CPRI interface evolves to eCPRI interface.

Contemporaneously, the Centralized, Collaborative, Cloud and Clean Radio Access Network architecture (C-RAN) have been actively deployed instead of the previous D-RAN architecture by several operators. For example, the medium-scale C-RAN centralized with 10 base stations will become the main scenario for 5G network, according to the statistics of different provinces in China. It is noted that the transmission distance will be increased from a few hundred meters for D-RAN to up to 10km for C-RAN (typically 5~10km). As the degree of centralization increases and the distance from AAU to DU becomes longer, the complexity of control and operation and maintenance will greatly increased.

The traditional front-haul solutions will not meet the requirements of C-RAN, such as the traditional fibre direct connection solution which requires 12 fibres for six duplex modules of one base station and occupies large fiber resources for medium and large scale C-RAN. However, if using WDM technology, a basic fronthaul requirement of a 5G base station with 12-channels can be satisfied by one fiber. A lot of fiber resource would be saved.

For 5G C-RAN front-haul network, several front-haul transport schemes based on WDM technology have been proposed to solve the lack

of fiber core, including passive WDM, active WDM, and semi-active WDM.

The passive WDM system is composed of WDM optical modules and a pair of passive de/multiplexer at both AAU and DU sides, which has the advantages of low cost, flexible deployment, etc. However, the passive equipments cannot support on-line management. The potential fault points should be manually processed one by one, including optical modules, WDM de/multiplexer, branch fibers between optical modules and WDM de/multiplexer, trunk fibers between a pair of WDM de/multiplexer. This result in long fault detection and service disruption time.

The active WDM scheme is composed of a pair of active WDM equipments at both AAU and DU sides and can perform powerful OAM functions, but the system cost is sharply increased and the deployment of the active equipment at AAU side is limited by power supply.

The semi-active WDM solution with a passive AAU side and active DU side not only greatly reduces the pressure of optical fiber resources, but also has the advantages in cost (compared with the active solution), management and protection of the front-haul network (compared with the passive solution). It helps operators to build 5G fronthaul networks with low cost, high bandwidth and fast deployment. A centralized transmission controller could manage all the semi-active WDM systems in a large zone.

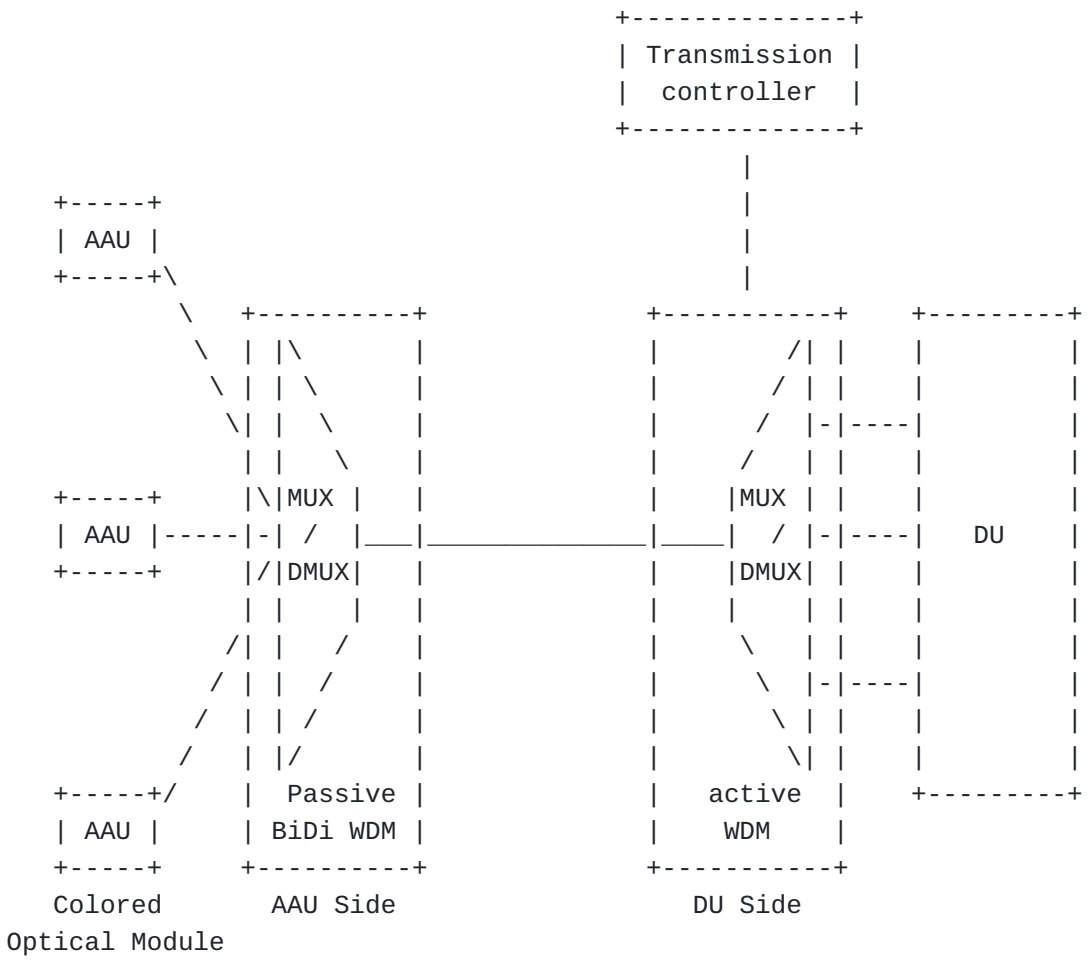

Figure 1: Figure 1:Semi-active WDM solution

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Architecture for Semi-active Front-haul WDM

The semi-active WDM system is composed by a passive AAU side with colored optical modules and passive BiDi WDM like MUX/DEMUX, and an active DU side with active WDM equipment and modules. The active WDM equipment should be composed by passive BiDi WDM, microprocessor unit and OAM modulation/demodulation unit. There are some mangement challenges of semi-active WDM system that need to be resolved. Since the the AAU and DU are both wireless devices and could not be managed by transmission controller, the management of optical

modules at AAU/DU side is difficult and special. Because of the passive AAU side, the management of passive AAU side have to be done through the active DU side.

One of workable solutions is introduced below. An OAM channel in the semi-active WDM solution could be implemented by service signal overhead or pilot tone with the low modulation depth of the optical channel signal. The OAM channel is used to transmit management and control information between the AAU side and the DU side. The active WDM equipment could send management requests to the AAU and manage the optical modules within the AAU, including query and configuration. The optical modules within the AAU can receive management requests from the active WDM equipment and then send the OAM information of AAU and the optical modules to the active WDM equipment automatically or at regular time intervals once the optical modules are powered on, including the wavelength, driving voltage, driving current, launch power of the transmitter, transceiver optical receive power, etc. The WDM optical modules can add the OAM information with the service signals and transport together in the same optical channel. The detection unit in the active WDM equipment can demodulate the OAM information, obtain the transmission performance of AAU and modules, and then report it to the transmission controller.

The centralized transmission controller for the semi-active WDM systems could display of the network topology, equipment, and module information, and support fault monitoring of the fronthaul network. Fig.2 shows the link failure monitoring functions. These failures could be monitored at branch fibers between optical modules and WDM de/multiplexer in AAU side as 1 and 2, branch fibers between optical modules and WDM de/multiplexer in DU side as 4 and 5, fiber link as 3, modules as 6 illustrated in Figure 2.

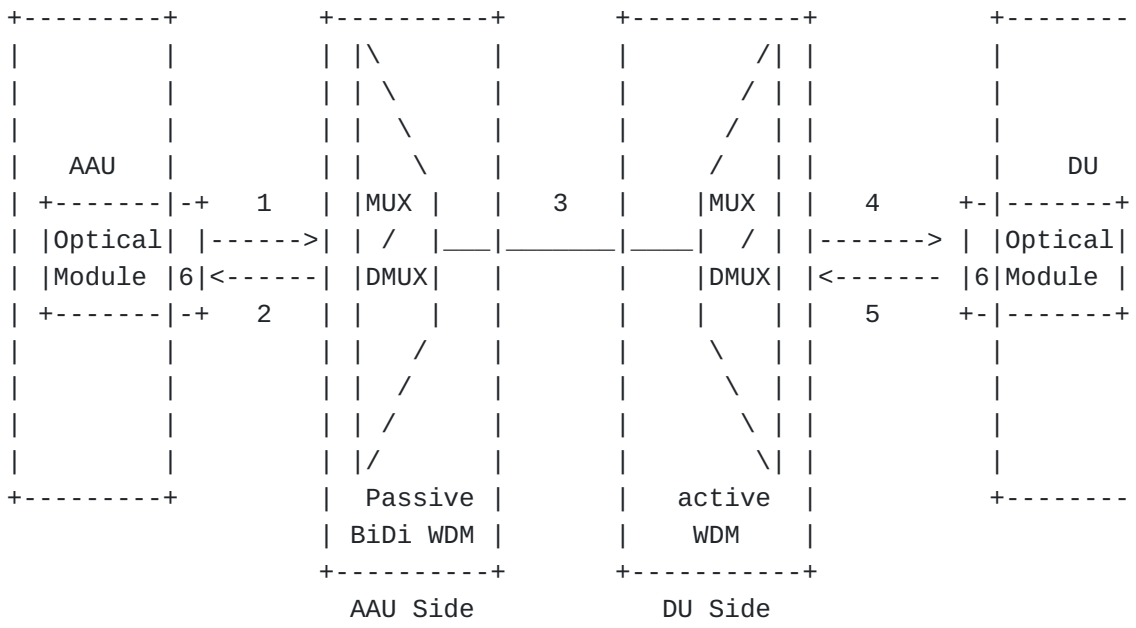

Figure 2: Figure 2: Illustration of potential failures analysis

There is also a requirement for protection in the semi-active WDM solution. By introducing a splitter and a switch between the remote and local part as figure 3, the semi-active WDM system is of OLP protection like capability.

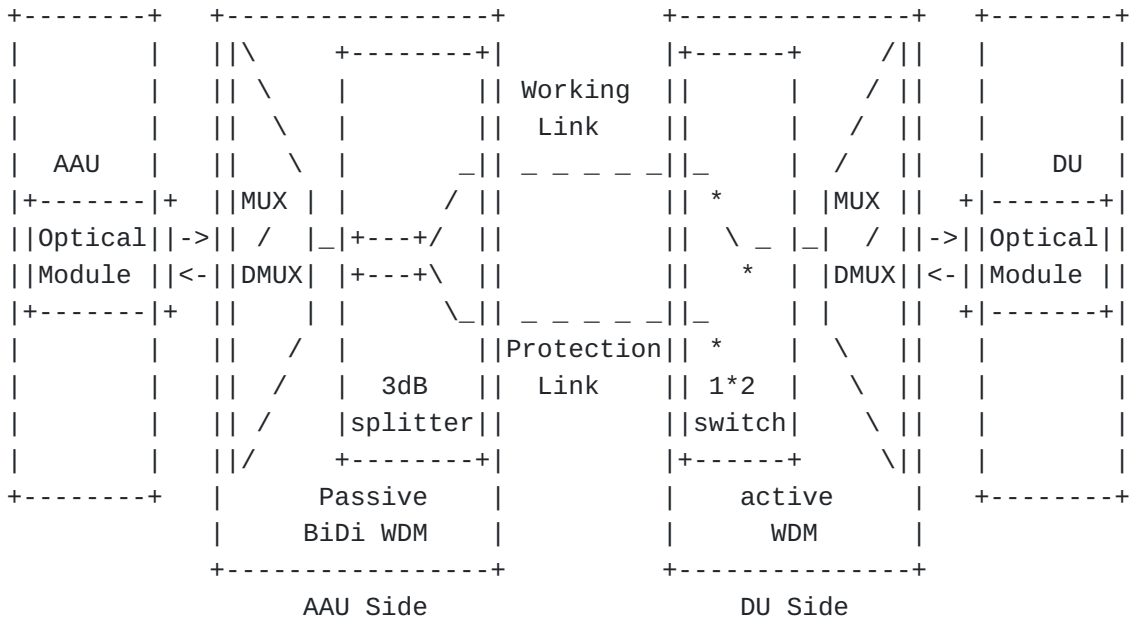

Figure 3: Figure 3: Protection of semi-active WDM system

3. Model Relationship

In the semi-active WDM solution, transmission controller is preferred to manage WDM equipments and the optical models on AAU and DU. Though there are some data models have been defined for the WDM management, consider that the AAU and DU are both wireless devices, some extensions are needed for the transmission controller to manage them.

For a full-lifecycle management, the traditional NMS function and SDN control plane are both required, includes tunnel, topology, inventory, alarm and performance management.

For daily maintenance, e.g. fault location, there is a requirement of viewing the whole signal flow. So the tunnel and topology model are necessary in the semi-active WDM system management. The WDM related models existing, like RFC9094, draft-ietf-ccamp-wson-tunnel-model and draft-ietf-ccamp-flexgrid-yang etc. are all considered useable in semi-active WDM system management.

It is suggested that the solution and data model in draft-yg3bp-ccamp-optical-inventory-yang can be used for inventory management. The inventory model is in the first I-D draft version state, let's keep tracing on this model.

Solution and data model in RFC8632 should be used for alarm management. We will do more research on whether is there special requirements of semi-active system on alarm management.

For the performance management, e.g. OAM and loop-back operations, is also required for the semi-active WDM system management. The draft-ietf-teas-actn-pm-telemetry-autonomics defines a generic performance management framework. And the draft-zheng-ccamp-client-pm-yang defines an Ethernet over OTN service level performance monitoring. We consider that both of these two models can be used in the semi-active WDM management model in the future.

4. YANG Tree

We will provide some augmentations on the existing tunnel, topology, inventory, alarm and performance models based on our further investigation.

5. YANG Code for Front-haul WDM

We will provide some augmentations on the existing tunnel, topology, inventory, alarm and performance models based on our further investigation.

6. Security Considerations

TBD

7. IANA Considerations

This document does not have any requirement on IANA allocation.

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