

Consideration on optical management for network maintenance

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Background

- The 802.3dj task force has discussed optical AN and optical LT for sometime, recognizing the need and benefit of automatic management of optical PMDs with the new development of technology and use cases.
- Since 2023, the rapid development of large language models promote the booming construction of AI infrastructure globally. Multiple telecom operators and cloud service providers, including China Mobile, all have began construction AI Data Center with the scale over 10,000 GPU cards. Meanwhile in 2024, China Mobile is also planning other large scale AI clusters.
- High reliability is a crucial requirement for AI clusters. Automated and intelligent management of optical modules and network could contribute to enhancing the reliability of AI clusters.
- Here we share our view on the necessity of OAN and OLT to support link awareness and network management in the AI cluster as well as telecom network.

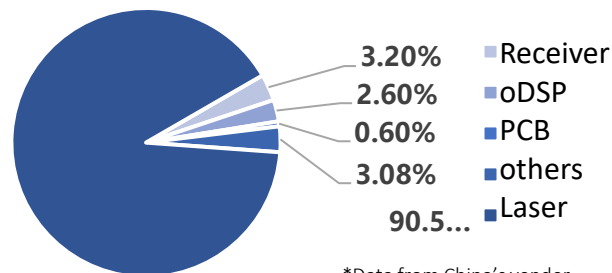
Automated management and intelligent networking

- The large bandwidth required to move data within AI clusters, necessitates the use of the most advanced interconnect technology such as 200G/L optical interfaces.
 - A big series of optical PHY types are being defined
 - Two FEC modes used by optical modules that have the same MDI, DRn vs DRn-2 and FR4-500 vs FR4
 - With the large amount of optical modules deployed, it is anticipated that interop abruption occurs due to mis-use or shortage of correct module types
- The Optical AN method proposed in [brown 3dj 03a 2405](#) and [brown 3dj 04a 2405](#) would allow automate deployment of the optical modules and reduced engineering intervene
 - Automated configuration of FEC modes
 - Plug-and-play without having to hold the knowledge of all the module types, cost down on workers
 - Eases supply management, use DRn-2 in place of DRn
 - Expedites link up process
 - Reduces link-fault alert ratio

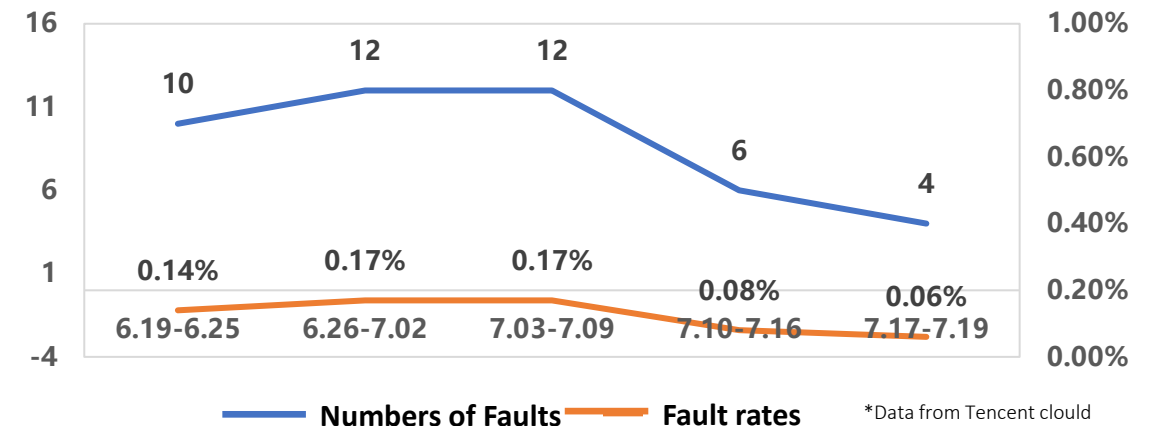
Reliability of AI/ML network

- A top priority of AI network is reliability. Depending on the training algorithm and network design, failure of one optical link could require re-do of hours of precedence work.
- A recent survey performed by Tencent Cloud pointed out optical link down, i.e. optical module failure, being a major source of network failure. Optical link faults occur with a failure rate of approximately 0.1% to 0.2%, that is close to [one link-down alert per week](#).
- For larger models using more computing resources and bigger network, the risk of optical link failure grows along.
- Current network management has been quite manual and costly:
 - LOS /Link failure reported, engineer sent in, fiber cleaned/module unplug-and-plugged multiple times, then the link miraculously become up again or the module discarded and changed.
- What is needed next to improve the reliability of the AI network
 - Automated adjustment of Link performance, adapting to changed operation conditions.
 - Prediction of failure, allowing “prepared” training interruption
 - Remote management of link

Fault proportion of different components



Failure rate of AI network with thousands of ports



Optical layer awareness and management for high reliability

- Modern optical modules are capable of monitoring various performance factors, such as OMA level, laser efficiency, and etc. Some status data depicts component aging. Some status data are being shared to its host switch for network management. However, such information has only been used locally, with the link partner kept blind from the other side, making it difficult to locate link failures or optimize link performance.
- With the broadcasting function supported by OAN ([brown 3dj 02 2401](#) and [brown 3dj 03 2403](#)) and the expandable features of OLT , it is possible to extend the monitor and diagnostic to both ends of the link and the media in between.
 - Support of FEC modes and Ethernet rates could be shared.
 - Optical loss in both direction can be shared.
 - Warning of aging or other defects could be synchronized.
- These measures could facilitate better management of the network and build up its reliability.

Telecom network also benefits from OAN and OLT

- 800GBASE-FR4 and 800GBASE-LR4 are used in Metro access and Metro aggregation network. FR and LR PMDs are also used in front-haul network. Manual maintenance in these use cases are costly and sometimes impossible. The difficulties described in the contribution from Ulf [parkholm_3dj_01_2403](#) is very much echoed here.
- China shows huge geographic diversity in population, economics, natural resources and infrastructure. These also affects our network:
- Some links has better condition than others, e.g. newer fibers, newly spliced connectors, better-managed service plant
 - Essentially lower power budget required
 - Power is valuable in many places
- Automatically “down-grade” the optical module could allow for saving in both energy and OPEX
 - Bypassing convolutional inter-leaver
 - Even OMA adjustment as proposed in [ghiasi_3dj_01a_2405](#)
- Automatic parameter re-adjustment after change occurred in link condition can only be facilitated by further expanding and exploiting the adopted OLT baseline in [ghiasi_3dj_01a_2405](#).

Summary

- In this contribution, we identify the potential of OAN and OLT in facilitating automated and intelligent management of the new AI clusters of CMCC
- The OAN and OLT function could also brings benefit to telecom network, providing new ways of cost down in the over all networking expenses.