Title*: PoC#23:Health Management of Data Center Optical Modules

from **Source***: China Unicom
Contact:

input for **Committee***: ENI

Contribution **For***:		
	Decision	X
	Discussion	
	Information	

Submission date*: 2024-05-20

Meeting & Allocation: ENI#30
Relevant WI(s), or deliverable(s):

Decision/action requested: Please approve

ABSTRACT: *This contribution proposes to start a PoC project on Health Management of Data Center Optical Modules*

PoC Project Details

1.1 PoC Project

PoC Number (assigned by ETSI): #**23**
PoC Project Name: Health Management of Data Center Optical Modules
PoC Project Host: China Unicom
Short Description: This PoC aims to demonstrate the proposed artificial intelligence/machine learning (AI/ML) algorithm for solving the challenges of data center optical module operation and maintenance. The main type of data center optical network failure is gradual change. Through dynamic monitoring and perception of optical module parameters, multidimensional parameter analysis is carried out to predict the health of the data center network, early warning of risks, and active operation and maintenance.

This PoC is purposed to demonstrate the use case [#] discussed in GS ENI 001 [1], and report on suitability of ENI Reference Architecture described in GS ENI 005 [2] for this PoC. In order to demonstrate the rationality of the implementation of automatic closed-loop technology scheme in this PoC, more new functional requirements will be proposed to GS ENI 002.

1.2 PoC Team Members

Table 1.1

	Organization name	ISG ENI participant (yes/no)	Contact (Email)	PoC Point of Contact (see note 1)	Role (see note 2)	PoC Components
1	China Unicom	No	Yakun Hu, huyk13@chinaunicom.cn;	X	Network Service Provider	-Storyline/ Implementation of the baseline architecture -Implementation of deployment in an experimental network -Testbed logistic and setup
2	China Telecom	Yes	Yu Zeng, zengyu@chinatelecom.cn		Network Service Provider	-Participation in project discussions
3	ZTE Corporation	Yes	Liya Yuan yuan.liya@zte.com.cn		Others	- Help with the test of algorithm
4	Caict	Yes	Zhiruo Liu liuzhiruo@caict.ac.cn		Others	-Participation in project discussions
5						

NOTE 1: Identify the PoC Point of Contact with an X.
NOTE 2: The Role will be network operator/service provider, infrastructure provider, application provider or other as given in the Definitions of ETSI Classes of membership.

All the PoC Team members listed above declare that the information in this proposal is conformant to their plans at this date and commit to inform ETSI timely in case of changes in the PoC Team, scope or timeline.

1.3 PoC Project Scope

1.3.1 PoC Goals

The PoC will demonstrate the use case [#XX:Health Management of Data Center Optical Modules]. In particular, the proposed mechanisms are compliant with its initial context configuration, triggering conditions, operational flow, and post-conditions, as defined in GS ENI 001.

This PoC will demonstrate various requirements that are identified in GS ENI 002, including General requirements, Service orchestration and management, Data collection and analysis, Data learning, model training and iterative optimization, etc.

This PoC intends to test and validate functional blocks of ENI Reference Architecture that are identified in GS ENI 005 and report on the suitability of ENI Reference Architecture.

The main goals of this PoC is to demonstrate the benefits of assessing the health of optical modules in large-scale data centers, and to demonstrate how the ENI system supports the classification and assessment of optical module health in a test bench environment.. The detailed goals include:

- **PoC Project Goal #1:**Classification and evaluation of the health status of optical modules. Demonstrate the use of machine learning algorithms to determine the level of health of data center optical modules and predict their operational status for a period of time in the future. Determine whether to trigger the warning mechanism based on the health status of the optical module.
- **PoC Project Goal #2:** Automated closed-loop management. Simulate the data center network architecture of the system to achieve a full closed-loop process from reporting the performance of optical modules to network management, health classification and prediction, and feedback on optical module health operation and maintenance decisions to network management. It is hoped to significantly improve the digital capabilities and operational efficiency of operators.

1.3.2 PoC Topics

PoC Topics identified in this clause need to be taken for the PoC Topic List identified by ISG ENI and publicly available. PoC Teams addressing these topics commit to submit the expected contributions in a timely manner.

PoC Topic Description	Related WI	Expected Contribution	Target Date
Infrastructure Management -> Health Management of Data Center Optical Modules	ENI-005 (GS ENI 005 system architecture) –Stable draft ENI-008 (GS ENI 001 Use Cases) –Stable draft	1. Predicting the future health of optical modules based on performance data. 2. Functional blocks for this PoC. 3. Feasibility of using AI/ML algorithm for performance data prediction 4. Report on the suitability of ENI Reference Architecture for this PoC	02/06/2025

Table 1.2

1.4 PoC Project Stages/Milestones

Table 1.4

PoC Milestone	Stages/Milestone description	Target Date	Additional Info
P.S	PoC project submission	06/2024	
P.TP.1	PoC user story finalization	08/2024	Finalization of the high-level description of the two scenarios described In Section 2.
P.TP.1	PoC Test Plan 1	011/2024	Initial algorithm testbed up and running
P.D1	PoC Demo 1	1/2025	Webinar demo at an ENI plenary meeting.
P.C1	PoC Expected Contribution 1	TBD	Contributions to ENI requirements.
P.C2	PoC Expected Contribution 2	TBD	Contributions to ENI reference architecture.
P.R	PoC Report	03/2025	PoC-Project-End Feedback
P.E	PoC Project End	06/2025	Presented to ISG ENI for information

1.5 Additional Details

The dates for the demos are tentative and will be confirmed. More demos may be provided, if the PoC team finds the right venue.

2 PoC Technical Details

2.1 PoC Overview

Currently, with cloud computing, big models The implementation and application of emerging technologies such as AIGC require higher data transmission rates and lower latency for new data centers, further increasing the number and performance of high-speed optical modules. The optical module, as the key to data center transmission, provides a guarantee for stable and reliable data transmission in the data center. Traditional operation and maintenance methods can no longer meet the management needs of data centers for optical modules, so it is necessary to research intelligent operation and maintenance technologies for optical modules in data centers.

At present, the operation and maintenance of the optical module in the data center is due to feedback to the operation and maintenance personnel after business interruption for further maintenance. The network management system did not make judgments and predictions on the operating status of the optical module. However, this model cannot meet the customer experience needs of "zero fault" perception, nor can it achieve ENI's vision of "better customer experience and improved service quality".

In order to solve the problem of existing data center optical module operation and maintenance, this PoC and ENI propose a more intelligent optical module health management, namely Health Management of Data Center Optical Modules (s)..

PoC is used to demonstrate the intelligent operation and maintenance process of optical modules in data centers.As shown in Fig 1, this PoC consists of two scenarios:

- The first scenario demonstrates that AI/ML based technology can determine the degree of health of data center optical modules, and Implementing network congestion prediction and prevention, particularly demonstrating the implementation process of analyzing and predicting the traffic of each link in the IP network, and predicting the operational status of the optical module for a period of time in the future. Determine whether to trigger the warning mechanism based on the health status of the optical module..

- The second scenario demonstrates the functionality of the system in data center networking, achieving a full closed-loop process from reporting performance of optical modules to network management, health classification and prediction, and feedback on health operation and maintenance decisions of optical modules to network management, significantly improving customer experience.

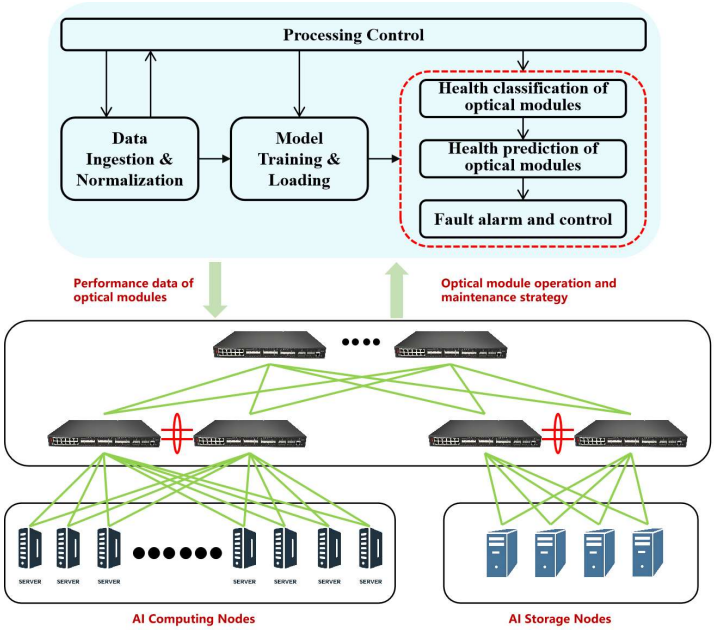

Figure 1 Scenario of this PoC

2.2 PoC Architecture

The diagram represented below shows the framework of the PoC mapping to the ENI reference architecture.

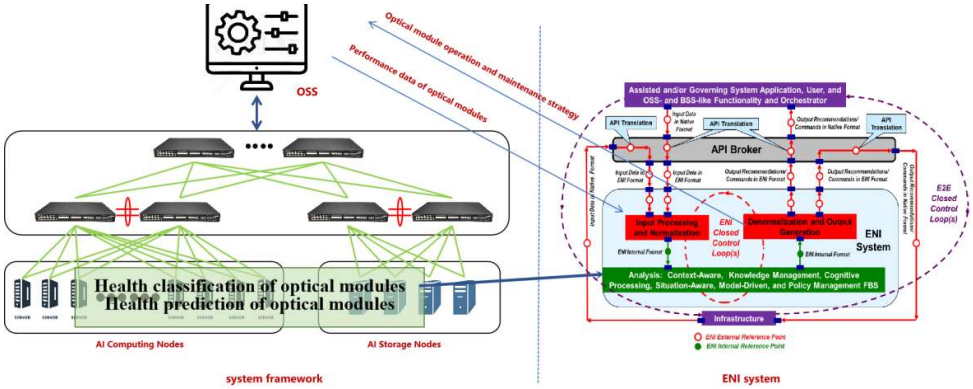

Figure 2: PoC architecture mapped to ENI reference

In order to achieve these two scenarios, the framework consists of the flowing stages:

1. The first stage is data ingestion and processing, mapping to the data ingestion and normalization functional blocks of the ENI system. At this stage, the Operations Support System (OSS) and Business Support System (BSS) collect performance data of optical modules (such as temperature, voltage, flow, etc.), network resource data (such as network topology, link and service latency, jitter, packet loss rate, etc.), and business status data from data center network computing nodes, storage nodes, and switches. Finally, statistical feature extraction algorithms and normalization algorithms were used to convert these data into a universal format for further processing by other FBs.

2. The second stage is model training and loading, mapping to the cognitive framework, knowledge management, and context aware management FB of the ENI system. At this stage, the training dataset is input into machine learning algorithms such as convolutional neural networks and recurrent neural networks to generate models for classifying and predicting the health of optical modules, and to develop warning reporting

strategies. After the model training is completed, the model will be loaded into the functional entity to prepare for work. At this stage, we will obtain two models: classification and prediction.

3. The third stage is process control, which maps to the cognitive framework, knowledge management, and context aware management FB of the ENI system. At this stage, some policy adjustments may be proposed. Based on the collected data (network performance and operator intent information), the optical module health classification and prediction model can be retrained.

4. The fourth stage is inference and output, which maps to the knowledge management, denormalization, and output generation of the ENI system. At this stage, preprocessed data and well-trained modules were implemented to complete uninterrupted health assessment and prediction of the optical module. Once abnormal trends or faults are detected, optimization strategies will be automatically generated through fault warning and control algorithms, and optimization strategies will be issued to data center operations personnel.

Based on the above stages, the optical module health prediction system provides an intelligent operation and maintenance solution that can be applied to optical modules in data center networks..

2.3 PoC Success Criteria

All goals are met when the described functionality is proved to be available.

References

[1] RGS/ENI-008 (GS ENI 001), “Experiential Networked Intelligence (ENI); ENI use cases”, v4.0.2 (stable draft), Sec 5.5.4.
[2] DGS/ENI-005 (GS ENI 005), “Experiential Networked Intelligence (ENI); System Architecture”, v4.0.3 (stable draft).