Unified and Automated Fault Management Platform for Optical Networks

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***Abstract*—A unified and automated fault management platform for heterogeneous optical networks is quite important for telecom operators to monitor and respond to various levels of network events. In this demo, we are demonstrating the details of the design, implementation and evaluation of the proposed HUBBLE platform while targeting to manage the underlying optical network of a telecom operator in real time. The proposed HUBBLE platform consists of three major building blocks i) a data collection layer that is integrated with the telecom operator infrastructure, (ii) data association and analysis layer that is used to measure the severity levels based on predefined alarm severity levels and constraints, and (iii) user interface layer that is on top of management and infrastructure layer which is used to demonstrate the faulty optical lines and is also integrated with fault management systems. Through the dashboard interface of the proposed HUBBLE platform, telecommunication operator's network optimization experts can easily detect the problems related to either fiber or DWDM link and can take appropriate actions.**

***Index Terms*—Automation, span loss, fault management, optical networks.**

I. Introduction

New value-added services added to the list of products and services offered by Network Service Providers (NSPs) leads to the growth of network usage. Therefore, tracking and monitoring the status of the underlying optical networks is essential to provide the seamless services to end-user. For this reason, NSPs start to make new investments on monitoring and network management tools. However, operational difficulties arise when the number of deployed optical equipments increase exponentially to provide wide coverage nationwide. Moreover, NSPs mostly provide their equipment from several vendor companies for reasons such as the fact that they do not want to depend on a single vendor inside their growing networks. At the same time, each vendor companies offer separate Network Management System (NMS) interfaces for the management of their own devices. Although these different interfaces are connected to a single fault management system, it is easier for NSPs to work with all topological views in a unified manner without using different interfaces. The quality status of fiber optical cables deployed for optical networks consisting of Dense Wavelength Division Multiplexing (DWDM) nodes, is an important factor for the continuity of the provided services.

A novel architecture that monitors streaming alarms/events in real time by capturing, processing and visualizing them is demonstrated in [1]. Automation works are also carried out for optical networks and the study in [2] is such an example. In this demonstration, we are presenting an automated system that analyzes the fiber optic cable span loss and DWDM node span loss dynamically, by monitoring streaming data from the network equipments of a NSPs's real-time network. In addition, for visualization purposes nodes, links and alarm severity levels are monitored on a map via the dashboard interface. The modules in the system are created with python, storage server is MySQL database and the faulty links are notified to the HP TeMIP [3] fault management software.

II. Demonstration of proposed HUBBLE platform

The basic components of the HUBBLE's system architecture as well as the demonstration workflow of optical network fault detection process using the network dataset is given in Fig. 1. Network data are collected from different vendor equipments using Simple Network management Protocol version 3 (SNMPv3), Transaction Language 1 (TL1) protocols or directly using commands with Secure Shell (SSH) depending on the nodes capability. The inventory server is used to maintain location and hardware information about the active equipments such as nodes in the NSPs's network and the inserted cards, card types as well as distance/track information of fiber optic cables between nodes.

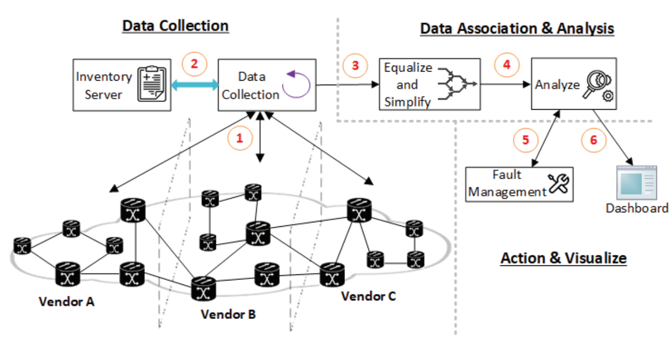


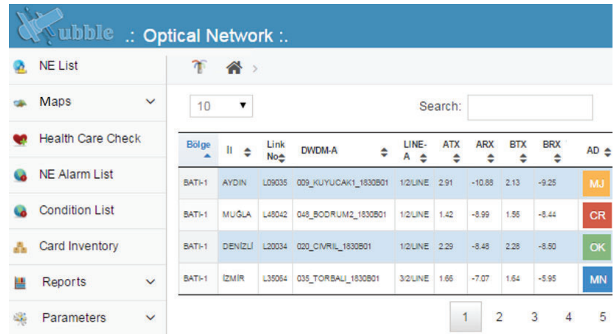
Fig. 1: High level architecture of the demonstration that collects and analyze data from different vendors.

There are mainly six steps followed inside HUBBLE's system architecture. In **Data Collection** module, marked as steps (1) and (2) in Fig. 1, data collection is done continuously and for all DWDM equipments of different models that belong to different vendors. The collected data in step-(1) is the information pertaining to the fiber optic signal quality levels which is held on the ports of the DWDM equipments momentarily. These values are kept inside the devices in both receive and transmit directions. In addition to the collected fiber measurement values, the fiber optic cable distance information is collected from the inventory server, given in step-(2).

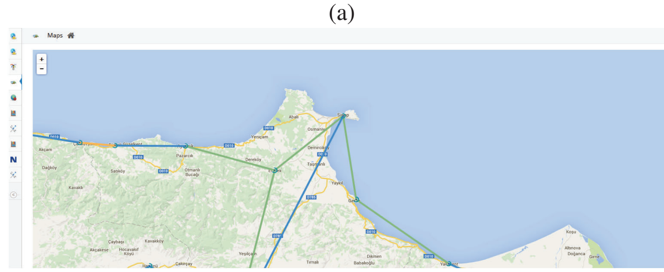
In **Data Association & Analysis** module marked as step-(3) and step-(4) in Fig. 1, the main responsibility is to consolidate the data collected from different sources under the same data format. Later this data is analyzed to conclude if there exists a problem inside optical network infrastructure. In the Equalize and Simplify module, the data collected in step (3) is converted into a single data format. Fiber measurement information are kept in different data formats for different vendor companies' devices such as Comma-separated values (CSV), Extensible Markup Language (XML) formats. First, these diverse data formats are simplified and normalized to a common format. Afterwards, the information from the inventory server and received data from the devices are joined together to analyze the same DWDM links. An important metric to measure the DWDM alarm severity is DWDM attenuation difference. This is the difference between DWDM attenuation differences from node A to B (AB) and from node B to A (BA). In step-(4), the measured Beginning of Life (BoL) and End Of Life (EoL) values of the fiber cables are checked if they fall within the same range with the values obtained after the previous calculation. For example, if Live Network Attenuation (LNA) value which the maximum value of DWDM attenuation difference AB or BA, is between BoL and EoL or DWDM attenuation difference is between 0 1.0 (dB), no alarm is generated and the fiber link is marked with green color. If it is between EoL and EoL+2 or DWDM attenuation difference is between 1.1 3.0 (dB), minor alarm severity is created with yellow color, if LNA is between EoL+2 and EoL+3 (dB) or DWDM attenuation difference is between 3.1 5.0 (dB), DWDM alarm severity is major and marked with orange color. Finally, if LNA is greater than EoL+3 (dB) or DWDM attenuation difference is greater than 5.1 (dB), DWDM alarm severity is critical and marked with red color on the map of the dashboard interface. Finally **Action & Visualize** module marked as steps (5) and (6) in Fig. 1 performs the interaction with the fault management system using TEMIP platform [3] for ticketing purposes and monitors the alarm severity levels on the HUBBLE's dashboard.

TABLE I: Nationwide statistics of utilized DWDM dataset monitored by the proposed system in Turkey.

# of cities	81
# of DWDM nodes	2,143
# of links	7,544
# of ports	15,088
# of faulty detected links	776
Total # of subscribers	44,500,000



(a)



(b)

Fig. 2: HUBBLE platform demonstration a) Dashboard of the platform b) Map view of the optical links with corresponding measured alarm levels.

A general nationwide statistics of the DWDM links that are used for failure detection by HUBBLE platform during our demonstration is given in Table I. The experimental setup demonstrates the detection of the problem related to either fiber or DWDM span status of the link where the location of the problem is also marked on map near real-time [4]. An example for the demonstration of near real-time DWDM link status updates with their corresponding measured and expected attenuation values are given in Fig. 2. During the demonstration, we show the dashboard view of the HUBBLE platform as given in Fig. 2 (a) which also includes the map view of the HUBBLE platform's underlying monitoring infrastructure data as shown in Fig. 2 (b).

III. Acknowledgements

This work was partially funded by Spanish MINECO grant TEC2017-88373-R (5G-REFINE) and by Generalitat de Catalunya grant 2017 SGR 1195.

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