Benefits Of Element Management Systems In FTTP Networks

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Introduction

Fiber-to-the Premise (FTTP) deployments are finally taking off. Fueled by multi-billion dollar initiatives in the US and Asia, we see a lot of excitement worldwide with new deployment announcements appearing almost daily.

Fiber optics is often seen as the ultimate future-proof transport alternative because of its extended life expectancy and its capability of transporting virtually unlimited bandwidth. Add to this today's availability of hardened components and connectors, which have evolved to the point where signal loss is minimal and life expectancy is at an all-time high.

From an operations perspective, upgrading existing copper-based networks to fiber-optics promises savings of up to 50% (vs. connecting, disconnecting, and moving copper lines). In addition, FTTP networks are characterized by their very low bit error rates while carrying unprecedented high rates, creating opportunities for significantly higher efficiency, along with the introduction of new revenue-generating services.

The success of FTTP depends heavily on the strength of its supporting network management solution. In contrast to traditional access solutions, FTTP is commonly deployed for triple-play services, i.e., voice (IP and TDM), data, and video (IP and RF) over a *single* platform. That is, all services are aggregated at the CO, transported over a single fiber, and delivered at the premises via a single ONT, where they are again separated.

Notice that even though the resulting network infrastructure is much simpler than today's copper and coax loops, this consolidating architecture introduces several single points of failure, with the obvious risks. E.g., imagine the event of a fiber cut upstream in a PON driving up to 32 triple-play ONT's. This immediately affects all services to many subscribers, which greatly attenuates the impacts of such an outage. Each service is expected to offer the same -or better- service quality and guarantees vs. directly looped services over legacy twisted-pair copper.

It is therefore extremely critical that the supporting management solution is capable of instantaneously detecting and isolating service affecting faults.

In addition, applying common and familiar service models, regardless of the transporting formats (legacy vs. IP-based), can greatly simplify provisioning procedures.

This paper explores the management challenges and opportunities associated with FTTP networks and the strategic role of related Element Management Systems.

Challenges

FTTP networks introduce a new set of operational concepts and challenges, not present in traditional access networks. These include:

- Management and troubleshooting of fiber-optics related parameters, physical properties and behavior
- Simultaneous management and 'a-la-carte' provisioning of both legacy and IP-based service types
- Management of a mixture of QOS parameters and metrics related to all media types, being transported simultaneously

- Management and provisioning of SLA's of bundled triple-play services
- Correlating Layer-2 (ATM, Ethernet) and IP-layer faults to service quality
- Non-traditional access network topology (PON)
- Unprecedented high data rates (Gbps), which open up opportunities for new categories of services (e.g., IPTV, interactive TV, gaming, etc.)
- New troubleshooting tools and techniques

Intuitive management tools can help an operator effectively maintain the network. Designing such systems requires a good understanding of today's mode of operation, the new management domain, as well as the new breed of operators - an emerging trend of home builders getting involved in the deployment and management of FTTP networks (Greenfield service providers).

The Role of an EMS in FTTP Networks

An EMS typically consists of the following key functions (illustrated in Figure 1 below)

- Gateway to higher layer OSS and Network Elements – responsible for translating information models over respective interfaces
- EML server with FCAPS functions (Fault Configuration Accounting, Performance and Security Management)
- Multiple client management interfaces – this allows multiple Analysts and Customer Service Representatives to simultaneously provision and monitor the network
- Persistent Database – keeps an up-to-date state of the network and services

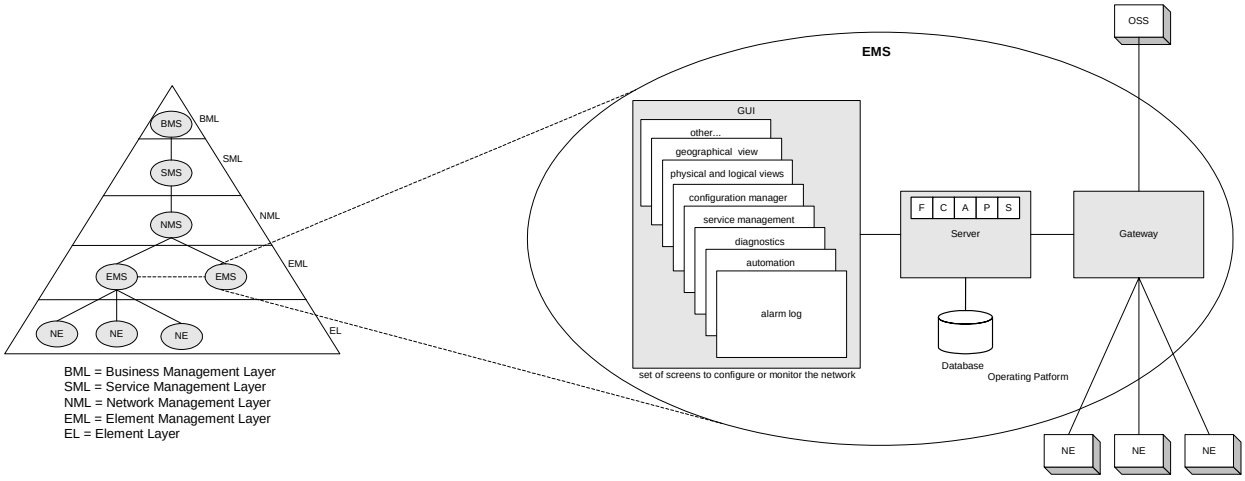


Figure 1: TMN Layering and EMS Components

In the figure above, the pyramid on the left represents the Telecommunications Management Network layering model, defined by the ITU-T, which is the reference model used for the design of network management systems.

On the right, details of an EMS are shown. The NE's represent individual OLT's in the central office or in the field, through which the EMS has control over the subtending elements in an FTTP network (i.e., the optical distribution network (ODN) and ONT's).

In general, the key benefits of an EMS are:

- Centralized management – this allows for a clear central point for the application of service profiles, policies and maintenance routines
- Significant reduction in manual (error-prone and time consuming) data entry and the associated paperwork via process automation, electronic interfaces, and the use of templates
- Simultaneous management of multiple network elements, scalable to large numbers
- OSS integration - the aggregating gateway allows for a single point from where provisioning and alarm/state information can be sent or received from OSS applications throughout the network
- Data persistence via a industry-grade database allows for the maintenance of all management data. This can be used to restore the state of network elements in the case of an outage.
- A real-time view of the state of the network elements – the EMS is designed to continuously and automatically resynchronize with the network elements, and represents their up-to-date states.
- Intuitive management through a set of comprehensive GUI's – Java-based graphical representation of the FTTP topology, state and services, together with intuitive navigation and data entry screens allow for quick focus via point-and-click operations
- Simultaneous management via multiple clients

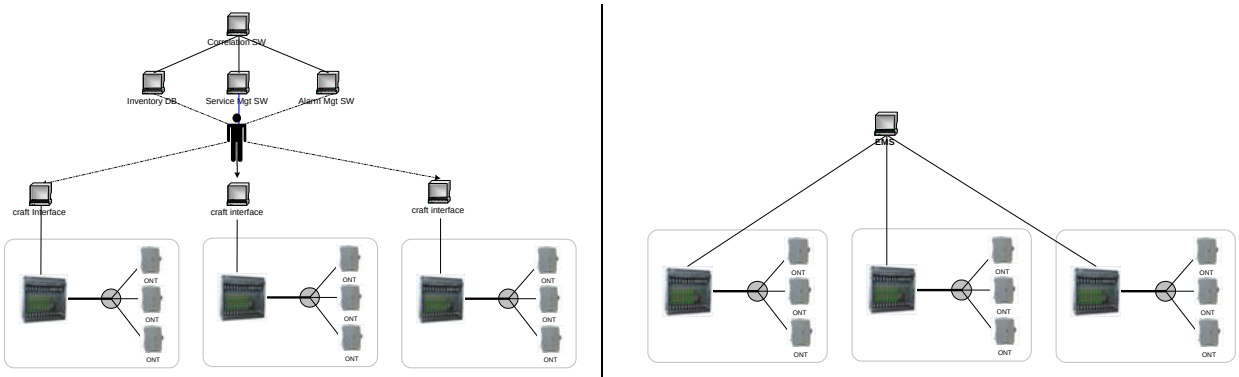
Because of its strategic location, an EMS has all the necessary data available for associating e.g., alarm/state information with the actual network topology. This allows for the design of a variety of very informative diagnostics tools and graphical representations that can accurately display the location and details of a given fault.

Larger incumbent operators generally understand the essence of an EMS in their OSS environment, and view this as the only viable management interface into their FTTP network.

However, new and upcoming operators are often tempted to manage their entire FTTP network via individual craft interface applications. This is often due to the lack of familiarity with the benefits of an EMS. This approach is clearly not sustainable, however, and does not scale with the growth of the network.

Figure 2 below shows the difference of these two approaches; notice how with the craft interface approach the number of manual interactions grows with the number of NE's and OSS applications.

Smaller operators may prefer some NML and SML functions integrated into their EMS. With this they can have a turn-key 'out-of-the-box' management solution that allows for full management of their access network. System vendors can accommodate these functions in different creative ways. The EMS shown in figure 2 optionally includes selected 'higher layer' configuration, provisioning and assurance functions, and hence does not require other management systems for operation.



Management via the Craft Interface

Management via an EMS

Figure 2: Management via Craft Interface vs. an EMS

Valuable Features of an FTTP EMS

Support of specific EMS features is often up to a vendor's discretion, and options vary widely. In addition to the basic core features (FCAPS, TMN compliance, navigation, etc.) there is a set of features that, when supported, largely enhance the capabilities and efficacy of day-to-day operations of an operator's FTTP network.

The following list is far from exhaustive, but can help make the right choices:

- Multi-service bundling utilities – a key objective of today's triple-play service offerings
- Subscriber SLA's – allow an operator to define system-wide service profiles or templates of parameters and verifiable metrics. These may include any combination of voice, video and data services, in any format
- Fine-granularity and flexibly scalable bandwidth
- Flexible import and export capabilities of configuration data and service templates
- Costumer Network Management (CNM) – allowing customers to monitor and modify service parameters online via web-enabled portals
- Automated provisioning – functions that enable the scheduling of ONT plug-and-play and subscriber activation
- Open Access – support multiple service providers independently and transparently
- Next-generation OSS interface technologies and information models (COBRA, XML)

- Service assurance – alarm reporting / monitoring / problem isolation and resolution
- Threshold Crossing Alerts – help indicate the onset of faulty conditions or trends
- Diagnostics tools – powerful diagnostics tools can significantly shorten the time it takes to identify a problem and isolate it to the correct root cause. The use of graphical tools is highly recommended.
- Statistics collection and browsing tools – essential for monitoring service quality, these tools provide the operator with real-time statistics collection and flexible browsing and export options. In addition, there can be options for setting up a 'study' of subscriber-specific statistics in order to observe a suspected problem area over a certain period.
- Management of Ethernet and IP concepts (e.g., VLAN, IGMP)
- ODN topology viewer – represents the topology together with key configuration and state information of the OND via graphical representation and point-and-click navigation
- Laser power management – the laser power state and/or temperature can be monitored and graphically displayed in real-time to help identify network quality and deterioration trends.
- TDMA operation – For a PON, efficient operation of the upstream bandwidth allocation scheme is essential. Protocol related alarms, state information and statistics help in monitoring its operation.
- Support of new customer "touch points", e.g., to enable ordering of a variety of services via the TV, in addition to the telephone and Internet.
- Inventory tracking tools - enable quick location of network inventory and assets
- Planning tools – allow for tracking of the physical plant inventory and calculate required vs. available system resources (fiber, splitters, etc.) through 'what-if' scenarios when deploying new networks
- J2EE architecture - for flexibility and extendibility
- Flexible operating platform options (Microsoft, Linux, Solaris) – provide options based on an operator's preference or existing environment
- Best-of-breed 3rd party software (e.g., Oracle Database, JBoss Application server, etc.)