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Framework for Element Management System and Performance Analysis

Amulya V
Dept of Information Science & Engineering
B.M.S College of Engineering
Bangalore, India
amulyav777@gmail.com

Dr. Jayarekha P
Dept of Information Science & Engineering
B.M.S College of Engineering
Bangalore, India
jayarekha.ise@bmsce.ac.in

***Abstract*—**A Network Management System (NMS) is a combination of hardware and software used to monitor and administer computer networks. As any organization becomes increasingly dependent on networking services, keeping those network services running is as difficult as maintaining the entire business. All the Network Elements (NE) in a network are managed by Framework for Element Management System (FEMS) and hence it is recognized under the bottom most layer of NMS known as Element Management layer.

There are certain common functionalities among different NEs like creating and deleting a NE and these common functionalities are implemented in FEMS. Along with the Common functionalities, FEMS also allows user-defined functions to be implemented for any NE.

In this paper we are considering the working of FEMS and the different application servers that can be used for the design of FEMS like Borland application server and Jboss application server. This paper also analyses the performance of a network of any organization which uses FEMS**.**

Keywords*—Framework for Element Management System (FEMS), Network Elements (NEs), Network Management System (NMS), Element Management System (EMS), Borland application server, Jboss application server.*

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I. INTRODUCTION

Different NEs of different networks has some of the common functionalities (example include creating and deleting of NEs). FEMS provides a generic framework with these common functionalities where, user can use FEMS as an instant tool to implement the NEs of their choice in to the required network.

Figure 1 shows the four logical layers of NMS [10][13][14][15]. The following are the description of each of the layers of the NMS.

A. Business management

Business management includes the functions related to business aspects, analyzes trends and quality issues, for example to provide a basis for billing and other financial reports. Business management is the act of getting people together to accomplish desired goals and objectives. Branches of management include financial management, marketing management, human resource management, strategic management and many more. Business management is the culmination of activities carried out in the running of a business. These activities include organizing, planning, directing, monitoring, staffing and coordinating. The above activities are meant to get people together to accomplish desired goals and objectives of a business using available resources efficiently and effectively.

Management in business and organizations is the function that coordinates the efforts of people to accomplish goals and objectives using available resources efficiently and effectively. Management comprises planning, organizing, staffing, leading or directing, and controlling an organization or initiative to accomplish a goal. Resourcing encompasses the deployment and manipulation of human resources, financial resources, technological resources, and natural resources.

Since organizations can be viewed as systems, management can also be defined as human action, including design, to facilitate the production of useful outcomes from a system. This view opens the opportunity to 'manage' oneself, a prerequisite to attempting to manage others.

Business management is also defined as the management of a division of trade that includes the manufacture or sale of products or services. This type of management is included in every single type of business one might imagine from a simple hot dog stand to a giant amusement park. Business management requires skills in managing employees, financial services, human resources, production, and even taxes and other business services. Business management is a common major at many universities because the degree applies well in the real world.

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B. Service management

Service management is integrated into supply chain management [17], as the intersection between the actual sales and the customer. The aim of high performance service management is to optimize the service-intensive supply chains, which are usually more complex than the typical finished-goods supply chain. Most service-intensive supply chains require larger inventories and tighter integration with field service and third parties. They also must accommodate inconsistent and uncertain demand by establishing more advanced information and product flows. Moreover, all processes must be coordinated across numerous service locations with large numbers of parts and multiple levels in the supply chain.

Among typical manufacturers, post-sale services (maintenance, repair and parts) comprise less than 20 percent of revenue. But among the most innovative companies in Service, those same activities often generate more than 50 percent of the profits.

Service management handles services in the network such as definition, administration and charging of services.

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C. *Network management*

Network management distributes network resources, performs tasks of configuration, control and supervision of the network.

Functions that are performed as part of network management accordingly include controlling, planning, allocating, deploying, coordinating, and monitoring the resources of a network, network planning, frequency allocation, predetermined traffic routing to support load balancing, cryptographic key distribution, authorization, configuration management, fault management, security management, performance management, bandwidth management, Route analytics and accounting management.

Data for network management is collected through several mechanisms, including agents installed on infrastructure, synthetic monitoring that simulates transactions, logs of activity, sniffers and real user monitoring. In the past network management mainly consisted of monitoring whether devices were up or down; today performance management has become a crucial part of the IT team's role which brings about a host of challenges—especially for global organizations[18].

D. *Element management*

Element management handles individual NE including, alarm management, handling of information, backup, logging, and maintenance of hardware and software. Element Management is concerned with managing network elements on the network element management layer (NEL) of the TMN (Telecommunications Management Network). An Element Management System (EMS) manages one or more of a specific type of telecommunications network elements (NE).

Element Management Manages functions and capabilities within each NE but do not manage the traffic between different NEs in the network.

It provides foundation to implement TMN layered operations support systems (OSS) architectures for better operability and meeting stringent QoS requirements.

OSS Interoperability between EMS and NMS has reached great heights with the introduction of CORBA (Common Object Request Broker Architecture) [5].

A server appliance is a computing entity that delivers predefined services through an application-specific interface with no accessible operating software to each of the NE. In order to develop a true server appliance, the end-user must be shielded from managing the solution as a general purpose server.

An Element Manager routinely audits the operational condition of core elements, including CPUs, power supplies and disk drives. In the event of hardware or software malfunctions, crashes, runtime errors and system boot failure, the Element Manager phones home and automatically generates a maintenance request. The use of standards-based mechanisms such as SNMP and Syslog ensures full integration with today's network management systems and provides a unified view of system-wide functionality. The Element Manager uniquely manages the software as an image and not just a collection of software parts.

An Element Manager also includes update services that automate the process and management of delivering updates, patches and other upgrades to server appliances deployed in field, including the operating system and all related applications. The update service provides a secure phone home point for delivering encrypted manifests and patches in the field.

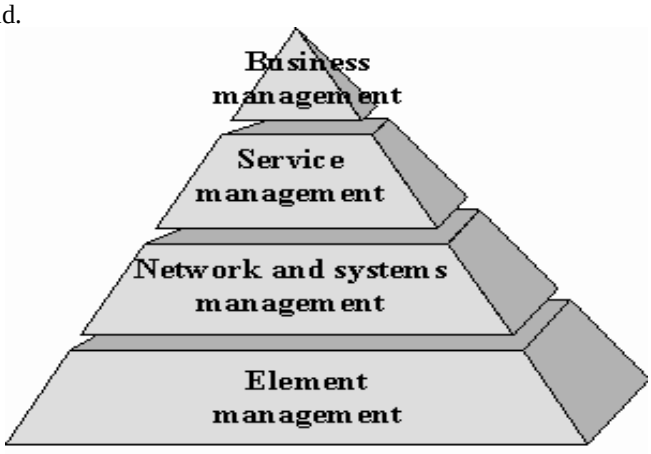

Figure 1. Layers of Network Management System .

II. COMPARISON OF NMS WITH EMS

An EMS is a carrier class management solution. It is capable of scaling as the network grows, maintaining high performance levels as the number of network events increase, and providing simplified integration with third-party systems. It meets the service provider's expectations for integrated operational support systems.

NMS provide an integrated system for sharing device information across management applications, automation of device management tasks, visibility into the health and capability of the network. It also involves in the identification and localization of network trouble. By using common centralized systems and network-inventory knowledge, an NMS delivers a unique platform of cross-functional management capabilities that reduces network administration overhead.

This paper mainly considers the bottom most layer of the Network Management Layer which is known as Element Management Layer.

EMS for diverse devices, that span technologies, have large amount of common functionally. The EMS provides a framework for developing management support for new and existing Network Elements. The platform provides the ability to register managed object classes, actions, rules, screens with embedded bindings and rules that will enable the support of a new Network Element. It provides functionality in its components common to EMS functions, as well as extensions that cover certain aspects of Network Management functionality as expected in specific network domains.

EMS captures this commonality into a single software framework with well-defined mechanisms to customize this functionality. More importantly, EMS provides a well-defined, documented and efficient way of adding device specific

functionality on the platform. This effort of customizing canned functionality and adding device specific functionality is termed as productization.

III. EMS FUNCTIONAL OVERVIEW

Devices in a network, referred to as NEs, need management for correct and efficient functioning. This management of NEs is divided into five functional groups viz., **F**ault, **C**onfiguration, **A**ccounting, **P**erformance and **S**ecurity (commonly referred to as FCAPS) [1][10][11][12]. Broadly, the FCAPS for an EMS are described as under. The Figure 2 shows where different functional groups are implemented in the EMS.

A. Configuration management

Configuration management [3][10][11][12] encompasses the process of setting up the resources in the NEs of the network to provide customer services. The first step here, typically, is to add the NE to management domain and establish management connection with it. Subsequent activities involve configuring parameters pertaining to equipment provisioning (NE wide parameters like IP address, timing source etc.), sub-component provisioning (say card provisioning) and service related configuration (like cross-connects etc.).

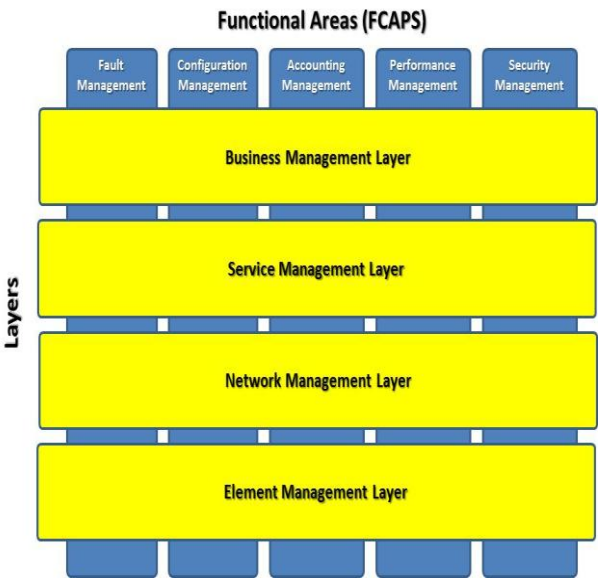

Figure 2. Functional areas of element Management System .

EMS provides a framework, to elegantly input this NE information model through a set of well defined XML files. This facilitates localization and easy introduction of NE specifics/idiosyncrasies.

One of the key functionality of the EMSs is to provide configuration data validation. Any NE has finite number of valid states (state here implies a particular configuration of the NE). It is in these valid states that specific services can run on that network element. Some knowledge of which configurations are valid is present on the NE. But in some NEs the valid state knowledge is either minimally available or not available on the NE. EMSs provide a significant value add by replicating the NE "valid state knowledge" and by providing additional "valid state knowledge".

EMS provides mechanisms for both replicating the validation rules from the NE and supplementing it with additional validation rules.

An important aspect of EMS is that user view of the configuration information is, typically, different from the way the information is exposed from the management interface of the device. EMS provides the ability to define both user views and NE view of the information and provide a mapping between them.

EMS provides transactional, logging, canceling and tracing capabilities to the actions defined (named and sequenced) for a specific device. The platform also provides some pre-defined actions like Creation of the NE etc. Various NEs use different communication protocols for management communication with the EMS.

B. Fault management

Fault Management [2][10][11][12] comprises collecting, synchronizing, processing, storing, displaying, forwarding and acting on fault events coming from the NEs managed by the EMS.

EMS processes the events in the following ways:

Make the event information human readable and meaningful to the operator.

Filter the events on the basis of any of the event attributes or source of the event.

Reassign severities and classify events into predetermined buckets.

Convert diverse event formats from different NEs to a single, standards compliant (X.731/X.733) format.

Provide analyses like threshold, correlation, parent child association, bouncing port detection etc.

In terms of display, EMSs provide a single alarm browser that shows all the alarms in a tabular fashion. This display is filterable and sort-able by the user. User may also manage an alarm say, acknowledge, clear, assign etc, from the browser. A filter based alarm-forwarding functionality, using one or more protocols, is available from the EMS.

C. Accounting management

Accounting [4][10][11][12] data enables the measurement of the use of the network services and the determination of costs to the service provider and charges to the customer for such use. This involves generation and collection of the usage data at the NEs and the processing and delivery of the usage data to downstream applications, such as billing. EMS, typically, provides the functionality of transporting this data from the NE, translating it to a standard format (say, AMA or BAF) and then storing and forwarding it to NB systems.

D. Performance management

Performance Management [5][10][11][12] evaluates and reports upon the effectiveness of the NEs for the support of services and the quality of the services. This involves, periodic collection of bulk performance data from NEs. EMS after collecting this data from the NEs can translate them in a standard format and forward this data to higher-level systems. This data in the EMS can be used to generate per NE reports aggregated over time.

In NEs, that do not support bulk statistics collection user-initiated polling of certain performance measures on the NEs is supported by EMSs.

EMS provides FTP mechanism for transfer of such bulk performance data from the NE and provides a similar mechanism to ship this data to North Bound systems.

E. Security management

Security Management [6][1][11][12] encompasses features that protects management access to the NEs and underlying resources, the EMS itself and its data and management data transmitted across public networks. EMS provides a comprehensive username-password and IP address based authentication. The password is always exchanged and stored in an encrypted form.

These functions of FCAPS are bundled as software components and are placed on a framework known as FEMS. So, FEMS if implemented on any network can provide the effective management of the NE and in turn the network as a whole.

IV. Application Servers

- in The need for the software in FEMS is
  - To automate each component functionality
- The reasons for the need of Application servers in FEMS are
  - Each functionality can be modeled as a separate component
  - Such component level modularization naturally fits into J2EE component architecture
  - Easily/freely available J2EE application servers are available off the self
  - Gives way to Rapid development
  - Flexibility to scale throughput in future

- Application server selection
  - Borland (Proprietary) [9]
  - Jboss (FOSS) [7][8]
- Architecture decisions
  - Multi Container
    - Restricted to Borland Enterprise Server
    - Good preference in JRE 4,5
  - Single Container
    - Possible across all Application Servers
    - Makes use of improved performance in JRE6, 7
- Operating System selections
  - Unix flavors preferred for their reliability/robustness
  - Proprietary Solaris vs. Open standards of RHEL can be used.

There are many application servers that can be used for the implementation of FEMS and the well-known are Borland application server and the Jboss application server. Still preferable is Jboss as it is a open source product.

V. PERFORMANCE ANALYSIS

As per the experimentation and results, FEMS when used in an organization for element management can provide Operation Administration and Maintenance (OAM) of NEs and in turn network as a whole. This OAM increases the entire network performance of the organization.

When FEMS is not used in any organization, the organization may have to maintain each NE individually which is not cost effective. FEMS on the other hand is a single tool which once implemented in the organization can provide the service of FCAPS and OAM to each and every NE in the network and also network as a whole.

The OAM services provided by FEMS are as follows.

- Operation deals with keeping the NE and in turn network (and the services that the network provides) up and running smoothly. It includes monitoring the network to spot problems as soon as possible, ideally before users are affected.
- Administration deals with keeping track of resources in the NE and how effectively they are utilized. It includes all the "housekeeping" that is necessary to keep the entire network under control.
- Maintenance is concerned with performing repairs and upgrades—for example, when equipment or component in the NE or NE itself must be replaced, when a router needs a patch for an operating system image, when a new switch is added to a network. Maintenance also involves corrective and preventive measures to make the managed network run "better", such as adjusting device configuration parameters.
- Provisioning is concerned with configuring resources in the network to support a given service. For example, this might include setting up the network so that a new customer can receive voice service. FEMS can also provide the configuration to the new customer and in turn provide accounting to the organization.

VI. PERFORMANCE ANALYSIS

FEMS is a platform on top of which various products are developed. These products are mainly related to operations and maintenance of various network types. The products which are built on FEMS effectively handle individual NEs like cells, Remote Network Connections, Radio Network Controllers etc.

Thus effective management as well as usage of different network types and specifically NEs with in the network can be achieved by the FEMS.

The main functional objects of NMS which are so called FCAPS are taken care by the FEMS.

The FEMS which is currently used for managing the NEs of 3G networks, when added with the advanced features of JAVA such as JAVA 8, can be useful in managing the 4G networks.

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