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Performance Management in Network Management System

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Abstract: ***Telecommunication networks are becoming more and more complex, as a result telecommunication operators are facing big operational problems to monitor or manage the performance of the system. Telecommunication Management Network (TMN) is the framework developed by International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) for managing telecommunications networks and services. Performance Management (PM) is one of the five core management functionalities identified by ITU-T. A Network Management System (NMS) falls under the Network Management Layer of the TMN. This paper provides the foundation for understanding PM principles and PM operation workflow. Architecture for a PM System in NMS is proposed and the challenges in the implementation of PM System and methodologies to overcome these challenges are observed.***

Keywords: Telecommunication Management Network (TMN), Element Management System (EMS), Network Management System (NMS), Performance Management (PM), Key Performance Indicator (KPI)

1. Introduction

TMN is the framework developed by the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) for managing telecommunications networks and services [1]. Based on TMN reference model, management systems can be categorized into the following layers to perform specific functions and have a specific scope:

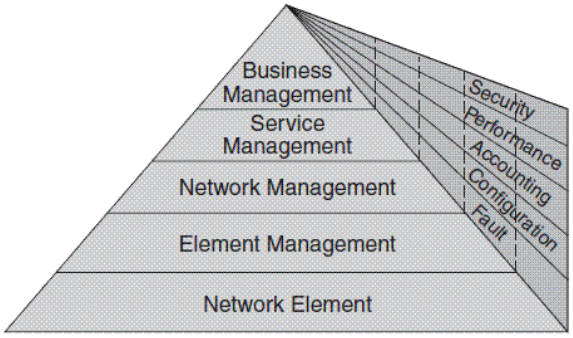

Figure 1: Different Layers of TMN reference model

Figure 1 shows the five different layers of the TMN reference model. The Business Management Layer (BML) is responsible for the implementation of policies and strategies within the organization that owns and operates the services and possibly the network itself. The Service Management Layer (SML) is responsible for the customer contractual aspects that include service complaint handling, order handling and invoicing, of services that are being provided to customers or available to potential new customers. The Network Management Layer (NML) takes care of coordination of activities of a network which involves managing relationships and dependencies between network elements that are required to maintain end-to-end connectivity of the network. The Element Management Layer (EML) is responsible for functions related to either a single or a small number of network elements located in a small geographical area. The Network Element Layer (NEL) represents telecommunication equipment (or groups/parts of telecommunication equipment) and supports equipment or any item or groups of items considered belonging to the telecommunications environment that performs Network Element Functions.

Network Element (NE) is a facility or equipment used to provide telecommunications service to the user. Element Management System (EMS) consists of systems and applications that are concerned with managing NEs. Network Management System (NMS) as the name signifies is used to manage a network. It offers full end-to-end visibility and control over both traditional and virtualized networks.

ITU-T has categorized management into five broad management functional areas namely: Fault, Configuration, Accounting, Performance and Security (FCAPS) [2]. A subset of the concepts of FCAPS management introduced in the TMN would be performed at each TMN layer [3].Fault management deals with detecting, isolating, fixing and recording errors that occur inside the network. Configuration management has to do with maintaining accurate information on the configuration of the network (hardware and software) and controlling parameters that relate to its normal operation. Accounting management relates to user management and administration, as well as with accounting and billing for the use of the resources and services. Performance management attempts to maximize the network performance. It is strongly related to QoS provisioning and to parameters like resource utilization, delay, jitter and packet loss. Security management deals with ensuring security and safety in the network [4].

2. Basic Concepts of Performance Management

PM involves evaluation and reporting the behavior and effectiveness of network elements by gathering statistical information, maintaining and examining historical logs, determining system performance and altering the system modes of operation [5]. The primary function of an ideal performance management system is to optimize the use of

the network and applications so as to provide a consistent and predictable level of service [6]. PM includes measurement of network and application traffic in order to provide a consistent and predictable level of service at a given instance and across a defined period of time. With the goal of improving the performance and traffic management PM involves monitoring of network, applications and service activity and design and configuration adjustments. Network performance may deteriorate because of external or internal problems which may result in faults that affect the service performance, reliability, availability and ultimately the customer experience. Performance management enables you to detect the deteriorating tendency in advance and proactively solve the potential threats so that faults can be prevented [7]. According to 3rd Generation Partnership Project Technical Specification 32.401 (3GPP TS 32.401), data is required to be produced by the NEs to support the following areas of performance evaluation [8]:

- Traffic levels within the network, including the level of both the user traffic and the signaling traffic.
- Verification of the network configuration.
- Resource access measurements.
- Quality of Service (e.g. delays during call set-up, packet throughput, etc) and
- Resource availability (e.g. the recording of begin and end times of service unavailability)

A Key Performance Indicator (KPI) is a quantifiable metric of the performance of essential operations and/or processes in an organization [6]. KPIs are helpful in identifying the strategic value drivers in PM analysis and also helpful to check whether all individuals at various levels of network are using consistent strategies to achieve the shared goals. During KPI definition it is very important to have a clear understanding of the metrics that will be measured and frequency of the measurement, complexity of the metric and the benchmark that should be used.

3. Architecture for PM System

The architecture of PM System is as shown in figure 2 and it has the following layers:

- Data Collection and Parsing Layer
- Data Storage and Management Layer
- Application Layer
- Presentation Layer (User Interface)

3.1 Data Collection and Parsing Layer

Data is collected from NEs using a network specific protocol. The protocol can be a standard management protocol like SNMP, FTP as shown in the mediation agent of figure 2, or it can be a proprietary protocol that is specific to the company implementing the NE. Using a standard protocol will provide flexibility so that the data collection agent that is implemented for the protocol can be reused for data collection from another NE that supports same protocol. From the NE to the EMS, the results of the measurement jobs can be forwarded in three different ways:

1) The result reports that are generated by the measurement jobs executing in NE is scheduled and sent to the EMS as soon as they are available in the form of notifications.
2) The EMS can retrieve the reports that are stored in the NE whenever required. Using a bulk transfer mechanism (i.e., file based) such as FTP.
3) In addition to generate regular scheduled result reports, measurements may be sent based on operator-defined thresholds. The thresholds are set when instantiating the measurements, and performance alarms are generated when the threshold value is crossed.

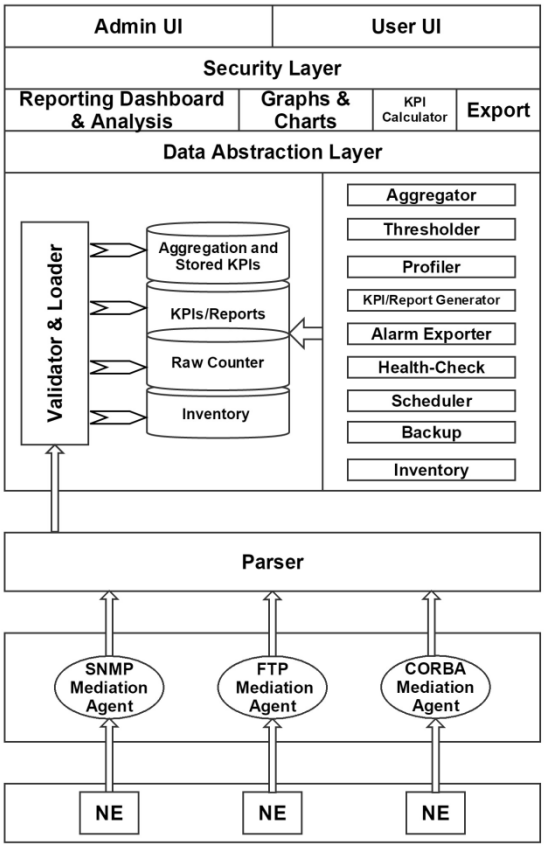

Figure 2: Architecture for PM System

The collected data is stored in input files and these files are renamed to unified file name. The corrupted files should be identified and discarded. Correct files should be sent to the parser. Processed files can be stored as they might be needed for future data re-load purpose.

3.2 Data Storage and Management Layer

In this layer a data warehouse based on standard DBMS which is optimized for VLDB distributed data storage is used. A validation and loading component is used for loading the parsed data to the data store and validating the data gaps and data re-loads. The storage in data warehouse should be scalable for network growth and ensure a secure data storage. It should be flexible for future customization and enhancements and support embedded programming language for data access and modifications.

3.3 Application Layer

The actual processing of the collected and stored data is performed here. This layer should provide multi-threaded access to DB for parallel concurrent processing for data aggregation, events generation, correlation and profiling, report generation. This layer is also responsible for storing and sharing of generated KPIs and reports. It should include

modules to check threshold actions (i.e., alarms, notifications etc) and perform automatic health-check reporting.

3.4 Presentation Layer

This layer should take care of providing a web-based user interface. It involves a security layer to ensure that the generated PM results which are available in the form of dashboards and real-time graphs, charts. It should also provide the option to export results to .csv, .xml, .pdf file formats. This layer can provide two user interfaces: Administrative UI for all system components and User UI for all PM result review. The data abstraction layer hides the complexities of the aggregation, reporting, scheduling, health-check mechanisms of application layer and present the results of PM system in a simplified manner to the user of the system.

4. Challenges of Performance Management

The first big challenge is the efficient administration i.e, collection, storage, processing and aggregation of massive volume of performance measurements data that is collected over a period of time to ensure that the relational database used for storing this collected data remains healthy; its size is under control with acceptable responsiveness of the user interface and reports.
The second big challenge is the handling of performance measurements that don't have a unified structure or content. Performance measurements differ for each NE type, as different proprietary protocols and data structures are used by manufacturers in their devices to gauge performance.

4.1 Handling Massive Network Performance Data

Multiple pollers, threads and probes can be used for network data collection. Flexible aggregation rules using Round-Robin Database Structures can be used for aggregation of records ,Periodic exporting of records can be done to flat files e.g. comma separated value files (CSV file) after the expiry of predefined retention period. Permanent deletion of records can be done from database automatically after a user predefined retention period. Pollers can be used to proactively poll or collect performance data in a scheduled base, KPI directly from a device. A Performance Monitoring application can be threaded and different processes can be split up to allow multiple CPUs to work on a single process [7]. While collecting performance measurements, threading is very useful. Multiple threads can be used to perform data collection job concurrently and therefore it can be completed quickly. A probe is a program for collecting data about network activity. In large distributed network architectures, probes give the mechanism required to accumulate data essential for building network history and trends. The amount of data that can be kept in any database, especially for large networks is limited. Hence after a user predefined time limit (say 1 week) raw data needs to be aggregated.

4.2 Handling performance measurements that don't have a unified structure or content.

This can be done by having a conversion module in the data collection and parsing layer. The collector provides the collected data to the converter which in turn converts into a standard format that is understood by the NMS to which the PM system is part of. Thus before saving the data in the database, it is converted into standard format with proper structure.

5. Conclusion

This paper attempted to provide the foundation for understanding PM principles and PM operation workflow and proposed architecture for PM System in NMS. The challenges that lie during the implementation of the PM System were analyzed and methods to overcome these challenges were proposed.

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