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Functional Architecture of a Service Level Management System

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Abstract – **The goal of the proposed work is to introduce the functional architecture of Service Level Management system. The system should be implemented in an enterprise that delivers a wide range of IT – services. The architecture includes the main functional blocks, the interfaces between them and the interfaces to external functions as well. The internal structure of each functional block will be modelled and the information structure for the interactions will be presented as well. The work includes also recommendations for feasible and effective tools and platform for the implementation of the proposed functional architecture.**

Keywords **– Service Level Management (SLM), Quality of Services (QoS), Information Technology Infrastructure Library (ITIL).**

I. Introduction

Increasingly, the relationship between IT (Information Technology) departments and their internal customers is that of client–supplier, based on the mechanisms of marketing and competition. IT departments are losing their internal company monopoly and have to compete with services offered on external markets. In this scenario a consistent customer focus of the IT management is of pivotal significance [1; 4; 10]. IT departments are facing the challenge of emerging from a technology-oriented applications developer and infrastructure operator to a client-oriented IT service provider.

Reference models help to reduce the costs and risks inherent in the transformation of organizational processes [2; 3]. This explains IT management's increasing interest in reference models for service oriented IT processes. Within the framework of change mentioned above they ensure systematic structuring of customer focused IT management processes at reduced cost and risk [11]. Within the last few years the IT Infrastructure Library (ITIL) has developed into a de facto standard for IT service management [14]. This is corroborated by the rapid increase in membership of the IT Service Management Forum, which is an interest group enhancing and propagating the ITIL principles [9]. Also the large number of practice-oriented ITIL conferences, publications and training opportunities [7; 8; 9; 14] indicate the growing relevance of ITIL. Recent studies substantiate that the ITIL holds a position of high relevance as well as being utilized extensively in the everyday running of German companies [12]. In spite of its relevance, its wide distribution and a large number of publications, a critical analysis of the ITIL reference model from a formal point of view is lacking. On the one hand existing literature is content to simply describe the areas of IT management as documented in the ITIL [3; 6; 8; 9; 11] and on the other it makes suppositions about the general usefulness of the ITIL in practice [7; 13]. The authors know of only a few publications on ITIL in scientific journals [11; 14]. This results in uncertainty in the execution of ITIL projects and misunderstandings regarding the attainable advantages of adapting ITIL.

In the present work we introduce the full concept of a Service Level Management System that should be built according to the ITIL standards, requirements and principals. We will start with the global Service Level Management Concept, presented earlier. Then we will make our proposal for the architecture of the SLM – System and describe its main activities. A deeper look of a measurement tool located at the customer premises will be presented.

II. The SLM Concept

An important advantage of the proposed SLM concept [16] is that it provides tight integration across all solutions, permitting them to work together to benefit from - and build upon - the specific capabilities of each (Figure 1).

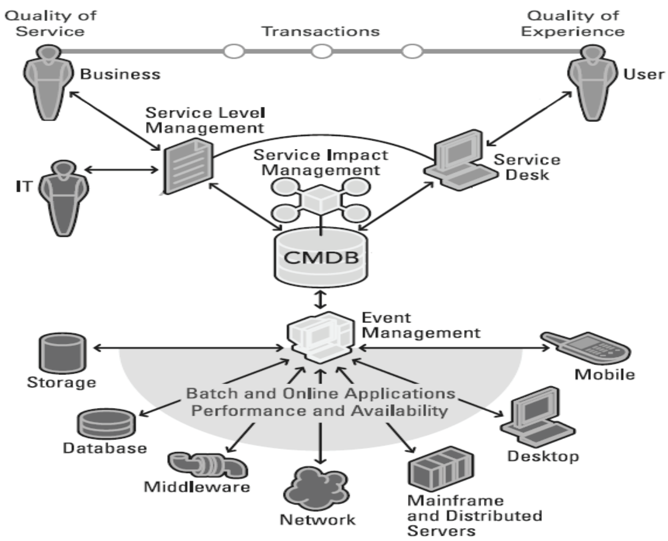

Figure 1. The proposed Service Level Management concept [16]

In the table below the synergies between the Standard Management elements and the functions of the proposed SLM concept are shown.

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Standard Management Elements	Proposed SLM Functions
Incident and Problem Management	▪ Tracks help desk response and resolution times and compares them with SLA (Service Level Agreement) commitments. ▪ Generates alerts and notifications to the support staff when support SLA's are in danger of being missed. ▪ Provides the help desk with service impact information to assist in determining incident priorities and to facilitate root cause analysis.
Change and Configuration Management	▪ Tracks SLA availability targets to ensure that change tasks and requests are performed in order and on time.
Service Impact and Event Management	▪ Delivers business – aware infor-mation about the real-time state of services.
Capacity Management and Provisioning	▪ Enables the analysis and predic-tive modeling of potential IT configu-ration changes and their effect on ser-vice levels.
Asset Management and Discovery	▪ Measures availability targets for specific assets and ser-vices, and shows the latest calculated availability metrics for the specified items in the CMDB (Common Management Data-base) to help ensure that critical business assets or services maintain committed levels of availability.
Infrastructure and Application Management	▪ Uses infrastructure and application data for service level measuring of both infrastructure and applications.

III. Proposed Functional Architecture of a Service Level Management System

The proposed functional Architecture of a Service Level Management System is shown on fig. 2.

The following section introduces the main elements of the system and their functionality. The system is named NOC (Network Operation Centre). It is build upon the proposed SLM concept and the proposed measurement tool, both described above.

1) ***What's Up Gold MSP Edition***, monitoring system provided by IPSwitch, with managed services based platform allows monitoring of multiple customers and helping one of the most important processes of the remote management.

It has a distributed architecture with a clustered Central servers and remote probe servers located at customer premises. The remote probe is polling all customer devices through ICMP (Internet Control Message Protocol), SNMP (Simple Network Management Protocol), WMI (Windows Management Instrumentation), Syslog etc. respectively all events and alarms are sent to the Central server in the NOC, through secure SSL (Secure Sockets Layer) connection where it triggers the Incident Management procedure. Depending on alarm priority the event can automatically open a trouble ticket in the Incident tracking system – Cerberus, as well as send notifications through different medias e-mail, sms, pager etc.

More than 150 customizable reports are available for the MSP (Managed Services Provider) and Customer so different statistical data, SLA, and problem areas are easily tracked and identified.

Monitoring system looks for different attributes in the network and sends notifications and alarms when disrupted:

- Availability
- Performance (CPU, Memory, Interface)
- Environment (Temperature, Humidity – depending on sensors)
- User experience (delay, jitter, packets loss)

2) ***Cerberus,*** An Incident tracking system located at the NOC, has the purpose of register all incidents related to supported customers and keep track of updates and progress on the incident management process. It provides flexible web access for NOC engineers and customer IT personnel as well as notification through e-mails. The system helps identifying different SLA KPI's (Key Performance Indicator) like MTTF (Mean Time To Failure), MTTR (Mean Time To Restore) and etc.

Key features of the system ensuring the Incident and Problem Management Processes are:

- Technical escalation
- Administrative escalation
- Multiple queues
- Role Based Account access
- Notifications

3) ***Rancid*** is an open source tool for automatic configuration collection from Cisco based devices.

Located at the NOC the application is configured to login to fetch device configurations 4 times per 24 hours over secure SSH (Secure Shell) connection. It then differs and keeps the configurations in a "configuration tree" where it's easy accessed by NOC engineers through web access. Every change is registered with information of the user account performed the change.

The tool ensures Configuration and Change management processes and is also very useful in recovering lost configurations.

4) ***Share-point Portal***, is the corporate server where customer information is stored in a secure way. Access is controlled by the embedded RMS (Remote Monitoring System) and is only allowed for authorized personnel. Specific information like customer assets, inventory, technical documentation etc. is available at any stage of the Managed services process. It helps all procedures including Configuration and Change Management, Capacity planning, Security management.

IV. Remote Monitoring Probe

The distributed Probe-Central architecture is very useful for large networks where access to parts of the network is difficult due to topology restrictions, overlapping address spaces, non-routable addresses and etc.

It's also very useful measurement tool, the SNMP polling would allow measuring different types of utilization, like

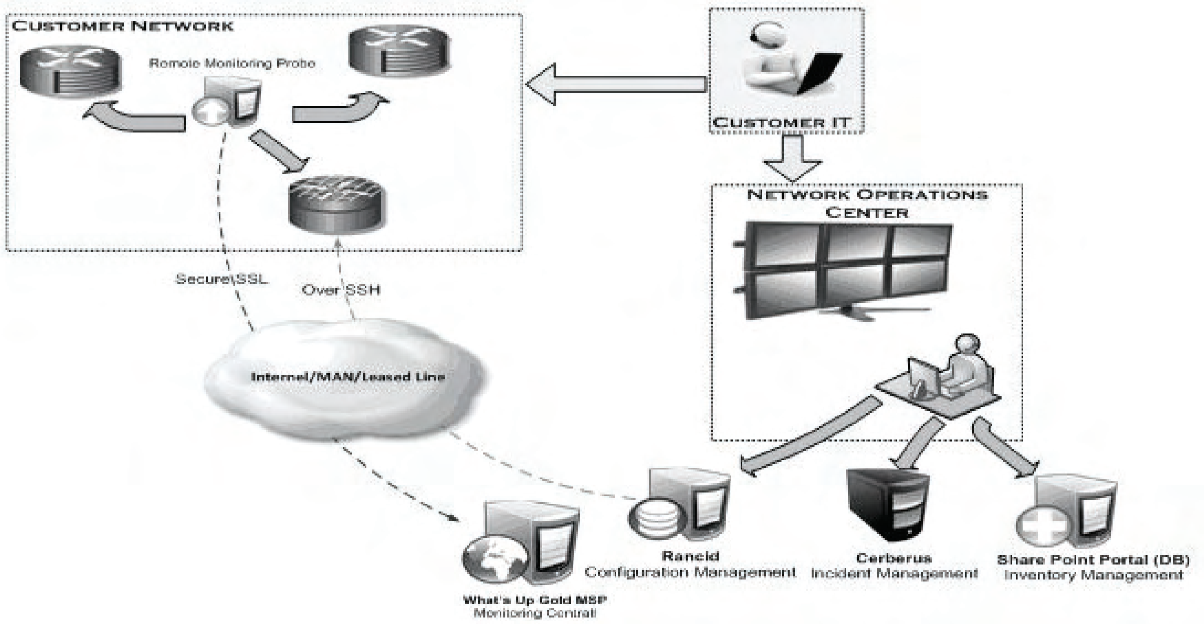


Figure 2. Functional Architecture of a Service Level Management System

bandwidth consumption with maximum, minimum, average and current values. Keeping these values in a SQL database would allow statistical data for a long period and consequent capacity analysis and planning, an important part of the ITIL process run in the NOC (Capacity Planning).

In this section an overview of the Remote Monitoring Probe function will be presented. This function is the most significant function in the customer premises. It has the goal to provide the measurement procedures near to the customers, according the customer network architecture and functionality. After the measurements are taken, the information shouldbe transferred over secure SSH channels through Internet to the Network Operation Centre.

In previous work [15] we proposed an appropriate sampling strategy and the structure of the measurement tool for completing the measurements.

A. Main Usages of Internet Measurements

The main usages of Internet measurements are Internet topology measurement, workload measurement, performance monitoring and routing measurement.

All of the mentioned above measurements can be performed in two ways – passive and active measurements.

The IETF's IPPM (IP Performance Metrics) has developed series of standards called Requests For Comments (RFC) on network performance measurements. The standard metrics for measurements are as listed below:

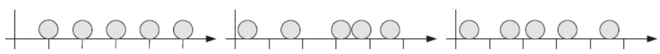
- Metric for Measuring Connectivity;
- A One-way Delay Metric;
- A One-way Packet Loss Metric;
- A Round-trip Delay Metric;
- One-way Loss Pattern Sample Metric;
- IP Packet Delay Variation Metric.

B. Sampling Techniques

In this chapter, three conventional sampling techniques, i.e., systematic sampling, random sampling and stratified sampling, and their characteristics are introduced.

Then a new sampling technique called "adaptive sampling" is presented.

Figure 3 illustrates these three sampling techniques.



a) systematic sampling b) random sampling c) stratified sampling

Figure 3. Sampling techniques

Systematic sampling generates sampling traffic according to a deterministic function. Random sampling employs a random distribution function to determine when a sample should be generated. Typically the samples are generated according to a Poisson process. With random sampling, an unbiased estimate of the QoS metric can be achieved. However, the entirely random nature of the sampling process may also cause the undesirable effect that sampling intervals are not uniformly distributed, and therefore the network may not be sampled for a rather long time. Stratified random sampling combines the fixed time interval used in systematic sampling with random sampling.

The proposed sampling method for the measurements inside the Remote Monitoring Probe Function is called adaptive sampling. In conventional sampling, the sample selection procedure does not depend on the observations made during the sampling, so that the entire samples may be selected prior to the start of the sampling process. In adaptive sampling, the procedure for selecting samples may depend on the values of the variable of interest observed during the

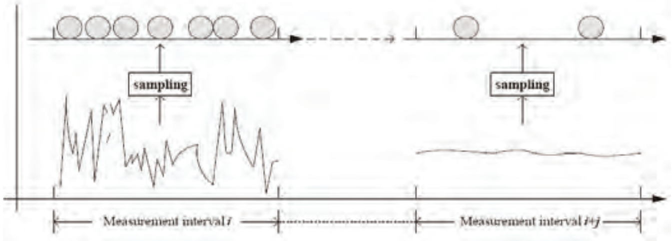


Figure 4. Example of adaptive sampling

sampling process. The primary purpose of adaptive sampling design is to take advantage of population characteristics to obtain more precise estimates, for a given sample size or cost, than is possible with conventional designs. Figure 4 shows the adaptive sampling in two measurement intervals.

Architecture of the Measurement Tool - MT System

MT should consists of two kinds of systems: (a) Control System (CS) and (b) Measurement System (MS). Fig. 5 describes the architecture of MT.

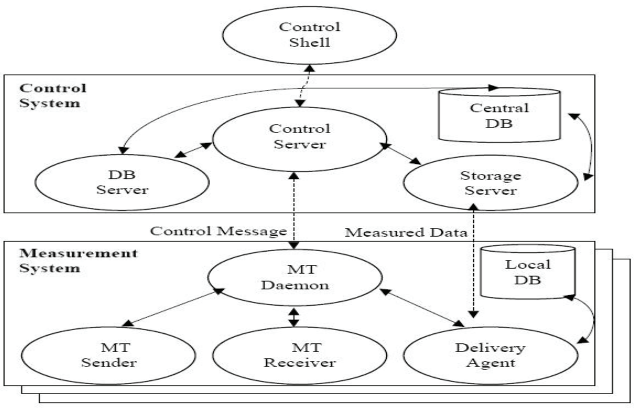


Figure 5. Architecture of the proposed MT

Control System (CS): CS, main system of MT, receives commands sent from Control Shell (CSH), with which operator controls and manages AMT.

Measurement System (MS): MS has four processes: (a) MT Daemon (MTD), (b) MT Sender (MTS), (c) MT Receiver (MTR) and (d) Delivery Agent (DA).

Procedure of Measurement

Step 1. Initialization of MTD for measurement
Step 2. Fork of measurement processes
Step 3. Establishment of control channel
Step 4. Confirmation about readiness from MTD
Step 5. Start of measurement
Step 6. Start of actual measurement
Step 7. Injection of measurement packets
Step 8. Storing of measurement records

In order to implement the proposed measurement tool into the Customer Network some changes and additions should be made. The changes and the additions concern not only the architecture of the measurement tool, but the measurement procedure too.

First: the MS should be located at the routing equipment of the customer network; second: an interface to the CS for transfer over customer LAN should be developed; third: a new interface in the Control Shell that supports SSL connection to the Network Operation Centre should be developed as well.

New procedure step – filtering and sending the information to the NOC should be also performed.

V. Conclusion

In this paper a full architecture of a Service Level Monitoring system is introduced. The main functionality of the system is defined. A closer look to the measurement tool and some of its functions are described as well. The future work in this direction will include the realization of the mentioned above necessary functions and interfaces in order to fulfill the whole functionality of the measurement process at the customer premises.

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