A MANAGEMENT FRAMEWORK FOR INTERNET SERVICES

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***Abstract*—The Internet has become extremely popular as a distributed environment for delivering services to users. However, with the wide use of the Internet as a commercial service delivery vehicle to end customers, the current service management functions that exist in the Internet are somewhat inadequate. Internet management has traditionally been network element oriented, i.e., focusing on managing the state and connectivity of the physical network. Service management which supports improved quality of service is required—an evolution similar to that faced by the telecommunications industries.**

Although Internet management is facing similar issues to that of telecommunication service management, a critical issue for Internet management is to provide a distributed and scalable management solution for managing a large range of heterogeneous services to large number of end users.

This paper examines the issues of Internet services management and compares it with the service management approaches taken by the telecommunication industry. The paper suggests that the approaches taken in telecommunication industry offer a very sound framework for defining Internet service management.

***Keywords*—Internet, Service Management, Quality of Services**

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1 INTRODUCTION

The Internet has been extremely popular as a basic infrastructure for providing world-wide distributed services to end customers. Many technologies have been developed which can be used to provide different Internet services. But so far, many of the services are provided in an ad hoc manner and lack a generic management strategy.

Due to the rapid development of the Internet and the fast growth in demand for fast access, reliable services, better performance, etc., service management issues are becoming increasingly important. Similar to the development of telecommunication network and service management, early development of Internet management has focused on the network management is slowly moving to the services management and customer management.

Unlike the telecommunication network, the Internet is a totally open and distributed environment which allows different types of service providers to provide different types of services on the network. It also allows the users to access all possible services available on the network. Most services are un-managed or managed by the service providers in a non-standard and proprietary manner. The lack of an overall business and technology framework for Internet service management has become the major setback on the development of further Internet services.

Although service management has not yet been regarded as a crucial issue in the Internet community, it has already received serious attention in other service provisioning industries such as telecommunication. Much work has been carried out to provide a management framework and technologies for telecommunication networks and services (e.g., ITU-T's Telecommunication Management Network (TMN [3]), Consortium of Telecommunication Information Network Architecture (TINA-C [2]) and Network Management Forum (NMF [1])).

Although Internet services have special characteristics, when compared with telecommunication services, it is our view that the service management technologies developed for telecommunications by different standards bodies can be used as the basic framework for the management of Internet services.

This paper examines the issues of Internet services management and compares it with the standard network and service management framework (TMN, GR2869) adopted by the telecommunication industry.

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2 INTERNET SERVICES

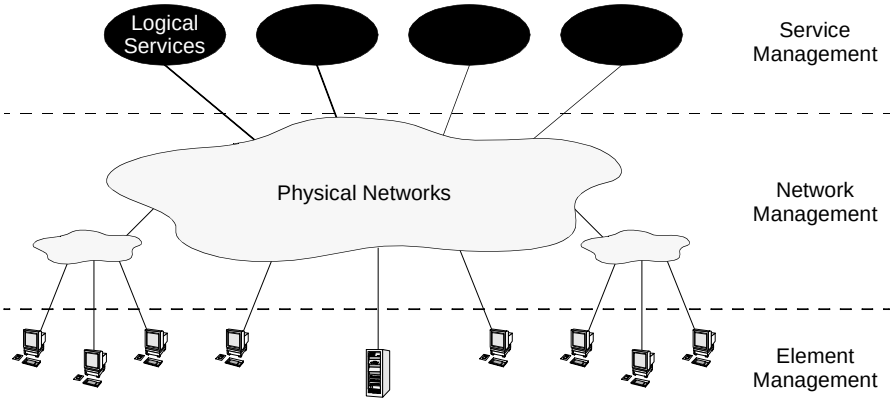

Figure 1: Internet Services

As with other telecom and data networks, the Internet contains two major components:

- physical equipment which constitutes the physical network; and
- (logical) services which are provided by service provider on top of the physical network.

In general, a service is anything that a service provider determines that customers will wish to purchase and that the service provider is willing to supply. A service normally has its own technical definition and interface and is characterised by its scope and features. So far, there are many Internet services are available. Example of such services include general information retrieval, job seeking, airline booking, electronic commerce, and different financial services, etc. Most services are provided and managed in ad hoc manner.

The following describes how Internet services compare to telecom services:

- There is no standard definition and specification of Internet services. Different service providers have their own definition of services and with their own way to charge for the service provided to customers.
- There are no agreements between service providers and service users with regards to the quality of services provided.
- Internet can be used to provide a much wider range of services than that provided by the telecommunications industry. It ranges from data, voice and multi-media and it covers different domains from health, retail and finance.
- Anyone can become a service provider in North America due to Telecom Act 1996.
- The Internet has an open architecture and open protocols which make the management of services provided in this environment more difficult.
- It growth is much quicker than any other type of telecom services.
- The un-managed status of the services makes it more complex, and hence more difficult, to inform user of the availability of existing and new services.

3 INTERNET MANAGEMENT

A layered management model can be applied to Internet management. There are four major layers are of particular interest:

- element management layer (EML)
- network management layer (NML)
- service management layer (SML)
- business management layer (BML)

The element management layer is focused on the management of individual Internet devices in the network. The management function is aimed at the status of the devices, the load of the devices, the fault of the devices, etc. Based on the element management layer, the network management layer manages the network. This includes the connections between different network elements, the status of the network, the overall performance of the network, the behaviour of network traffic, etc. Both the element management layer and the network management layer are focused on the management of the network infrastructure. Such infrastructure is used as the foundation for providing services to customers.

Different technologies are applied to provide management functions for different layers. Simple Network Management Protocol (SNMP [7]) and Desktop Management Interface (DMI) are often used for managing network elements, such as workstations, PCs, printers, routers, etc. These technologies allow Agents to collect raw element data and forward the collected data to management stations (sometimes also referred to as Managers) to be processed and presented to users.

SNMP can also be used to manage networks. Based on the raw data collected, a management application can be developed to analyse the raw data and to perform certain network management functions and to present to users and operators the network view of these data.

There are also other management protocols which can be used for developing network management applications, especially in the area of security, performance and fault management of networks and elements.

Due to the heterogeneity of the Internet and its applications and the wide acceptance and popularity of Web based technology, a Web Based enterprise management architecture (WEBM) is proposed by a number of companies, including BMS Software, Cisco, Compaq, Intel and Microsoft [8]. This proposal aims at consolidating the management functionality provided by SNMP in the heterogeneous environment. It focuses on the following issues:

- the ability for applications to be able to accept data from different resources
- creation of a standard front end user interface to allow shared data between different management applications and to carry out management tasks (mostly at the EML and NML)
- creation of a common transport mechanism between managed networks and management applications

In addition to WEBM, other efforts have also been made in Internet management. Java Management API [4] is one of the examples. It is developed in order for the easy development of Internet network management applications.

All the above mentioned technologies are aimed at managing networks and network elements. Compared with network management, less consideration has been given for Internet service management.

Even though most of the focus has been directed towards EML and NML, most data networks providers recognize the need for service management applications. The quality and speed to market of these SML applications will determine profits, acquisition of new customers, retention of existing customer base and proliferation of branding. Most data providers, however, are not focusing on BML. Research and development of SML and BML capability then represents a green field opportunity and is the subject of the balance of this paper.

4 INTERNET SERVICE MANAGEMENT

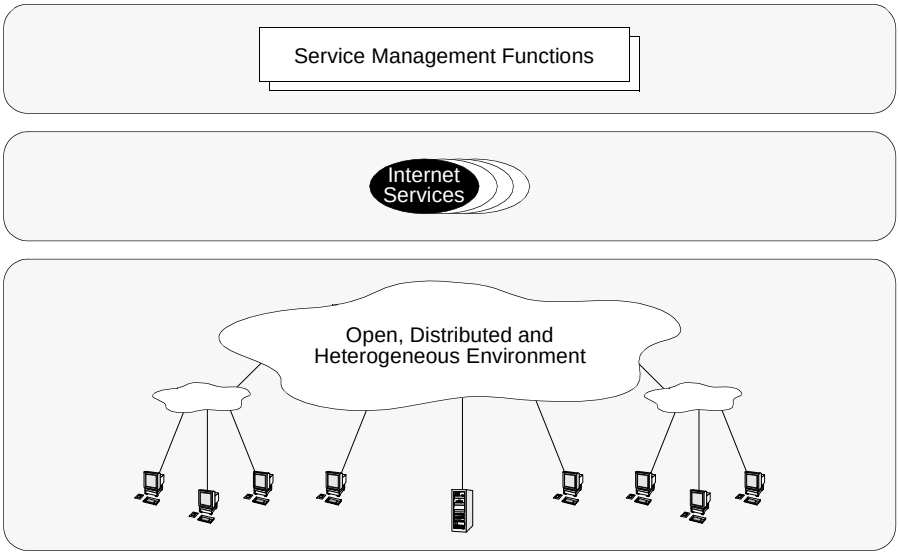

Figure 2: Internet Service Management

There are some service management programs which have been made available recently for managing web sites. Current data service management applications, while few in numbers, exhibit some severe limitations such as:

- they do not consider other services besides those which are Web-based
- they provide limited functionality that is usually related to contents and links checking
- they do not have performance monitoring
- they do not have a mechanism for customer trouble ticket administration
- the end-to-end Internet service management is poor, for instance, service fault localization is a major problem

This indicates the needs for Internet service management and shows that more effort is required to achieve a standard Internet service management strategy to manage all types of Internet services as well as non-Internet-based services such as voice services.

Furthermore, Telecommunication service providers are offering more Internet-type of services in addition to its traditional voice and data services. This convergence is leading to the diversification and integration of technology used to support these services. There is a need to define the management framework for Internet services and to investigate the relationships between different management functions and technology used in manage different domains.

Internet service management requires the well-defined FCAPS (fault, configuration, accounting, performance and security) functions. First, it is extremely heterogeneous in terms of type of services, and secondly, it requires a scalable delivery mechanism to deploy and manage services to a large number of customers in a widely distributed environment.

Because the Internet is extremely heterogeneous network and the requirement for a scalable delivery mechanism to deploy and manage services to a large number of customers, FCAPS as applied to data communication, and specifically the Internet, require a particularly complex set of definitions.

5 FUNCTIONS OF INTERNET SERVICE MANAGEMENT

FCAPS functions defined by TMN can be applied to Internet service management. Service management functionality is closely related to the network management and element management functionality. For example, the availability of a service is often related to the status of the network elements involved in providing the service and the status of the network connections. The quality of the service often depends on the performance of the network elements and the traffic on the network.

5.1 FAULT MANAGEMENT

Fault management at the service management level focuses on different issues from fault management at network and element level. In network and element management, fault management is responsible for the detection of any abnormal behaviour from network devices and connections which may cause device failure or broken connections. This information is collected by local management agents and passed to management applications. Fault management applications can be developed to help operators or network administrators to determine the cause of a fault and in some cases to trigger automatic recovery system.

5.2 CONFIGURATION MANAGEMENT

At the network management level, configuration management deals with the change of status of network devices and networks. At the service management level, configuration management is more customer oriented. It can be used to configure the service features and to maintain the relationships between services and network topology. Each service is finally implemented on a set of network elements and portion of a network. The performance of different parts of the network and network elements may affect the overall performance of the service. Such information is also useful to identify affected services in case of network and element failure.

5.3 SECURITY MANAGEMENT

Security issue is an important issue in Internet management. Some efforts have been made to increase the Internet security at the network management level, such as SSL and shttp, etc. Security is crucial in electronic

commerce and financial services. Security management at network level together with other existing access security can directly benefit the Internet service management.

It is interesting to note that the work on Internet security and HTTP can be used for providing security management at the service level without needing to build a special security mechanism. Another example is the Web based technology, including Web and Java based interface technology and WEBM platform, will offer help in building service management applications.

5.4 PERFORMANCE MANAGEMENT

Service performance is directly related to the network and network element performance, but measures different parameters. Network performance is measured by the parameters that are meaningful to the network providers and are used for the purposes of system design, configuration, operation and maintenance. Network performance is defined independently of the performance of the services carried over the network.

A network provider is concerned with the efficiency and effectiveness of the network, in providing services to customers. Therefore from a network provider's point of view, network performance is best measured by parameters such as down time, mean down time, recover time, etc.

Network performance usually determines the quality of service, but does not necessary provide information which is meaningful to service users. The relationship between the parameters of network performance and that of service quality are not a simple one-to-one relationship.

Performance management at service level is responsible for the following two tasks:

- to select suitable network elements for providing a service, based on network performance data and statistics. For example, to improve the performance by avoiding heavy loaded devices and a congested path if possible
- to provide customers with meaningful performance information to improve customer satisfaction

It is required to have integration between the NML and the SML so that network performance parameters can be used to produce quality of service parameters.

5.5 ACCOUNTING MANAGEMENT

Account management in Internet deals with two different aspects. One is the financial transaction between service users and service providers. Examples of such services including Internet shopping, where customers order goods from Internet and make payment through Internet. The account management in this case is a local issue of the goods suppliers. It is the supplier's own responsibility to make sure the goods being ordered are paid properly. However, the account management of Internet needs to provide the necessary electronic payment function to support these commercial transactions.

The other aspect of account management is to manage the usage of Internet itself. The Internet service providers require the infrastructure not only to manage the usage of the network capacity, but also to manage the usage of service. This requires the technology to support a flexible charging mechanism and tariff policy. As accounting and pricing management is the strongest area of competition and has the most dynamic business environment, it requires technology to support this dynamic nature and the de-coupling of business rules and application logic.

Another important issue in account management arises from the situation that many Internet service providers may require other Internet service providers in an offering of services. This requires inter-working between the different providers and increase the complexity of the account management.

6 INTEGRATED SERVICE MANAGEMENT

In telecommunication service management, each of the management functions listed in the previous sections is an important area by itself, however, the industry require more integrated management solutions. From telecommunication vendors' point of view, the provisioning of integrated service management is essential to their business success.

Integrated service management is still a new issue in the telecommunication service management industry [1]. However, the lessons and experiences learned by the telecommunication industry provide important research and development results to the Internet industry to develop the integrated Internet service management. The next section provides a view of customer-driven service management, which are based on

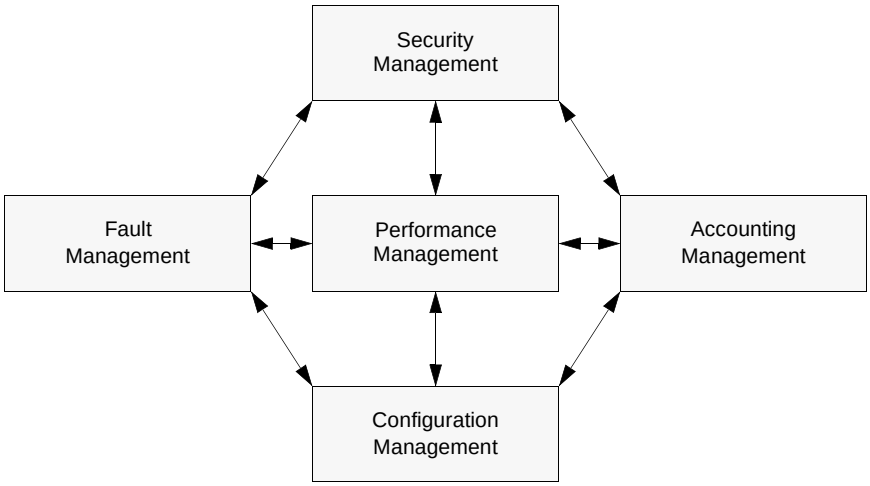

Figure 3: Integrated Service Management

an integrated view of services, functionality and applications. Since performance is a key concern, it is used to exemplify the power of applying telecommunication modalities to the data communication world.

Another important issue in service management is to provide an integrated service management. Integration is defined here as between telecommunication and data networks at the level of OAMP functionality, applications and services.

Service performance management deals with the following important issues:

- how to reach a set of agreements between the service provider and customer with regard to the services performance
- how to measure the performance of a service
- how to handle a performance problem
- how to interface with the customer about performance issues

Currently, there is no standard solution to performance management of Internet service. However, there is much research and standards work in the telecommunication service performance management area. The strategy and the results can be adapted and applied to the performance management of Internet services.

6.1 CUSTOMER REQUIREMENTS

A very important aspect of service management, including performance management, is the interface to customers. In performance management, the main interface to the customers is through a performance report.

Example of customer requirements within the scope of performance reporting include:

- tracking delivered service level quality against service level agreement
- linking the performance monitoring and reporting to other service management processes, such as billing and trouble ticketing management
- determining where service capability needs to be increased or modified
- reporting at regular intervals

6.2 SERVICE LEVEL AGREEMENT

Service Level Agreement (SLA) is an important concept in telecommunication service management. An SLA is an agreement between a service provider and a customer with respect to a service provided. It contains a set of technical, administrative and management parameters that the service provider can report against. These include the nature and the feature of the service, the scope and the expected behaviour of the service and the parameters of quality of services. Typically, an SLA includes statements about:

- system and service availability
- time to identify the cause of a customer reported problem
- time to repair a customer reported fault
- provisioning-related time

An SLA may also includes expected actions in case of the performance of the service which does not meet the specified level in the SLA.

Since the SLA is a contract between a service provider and a customer. It does not only play an role in the performance management, it also acts as an integration point among different management functions. SLA management include the management of all functions. For example, the performance degradation may result to a fault and the bad performance of the service may result in compensation when the customer is billed.

6.3 SERVICES PERFORMANCE MEASUREMENT

Performance management is not an isolated issue by itself. In many cases, it is related to other issues, such as trouble ticketing, fault handling, SLA management, etc.

6.3.1 AVAILABILITY MEASUREMENT

Availability is the key parameter that users are interested in. Availability measurements vary widely and are usually specific to certain type of services.

6.3.2 QOS MEASUREMENT

Quality of Service (QoS) is a collective metric of service performance which directly influences the degree of user satisfaction with a service. In contains the following aspects:

- service support and service operability performance
- service availability and service integrity performance

There are some performance parameters which can be used to measure the quality of service in the Internet. Each service normally has three different stages: access, user information transfer and disengagement. Each stage can be measured by the following three common parameters: the speed, the accuracy and the dependability. Some Internet services may not have clear boundary between these stages or do not have an explicit disengagement stage, but can still be measured using the same parameters.

For example, the access stage can be measure by:

- the access speed—average delay
- the access accuracy—the probability of incorrect access
- the access dependability—denial of access.

The user information transfer can be measured by

- the speed—the user information transfer delay and its rate
- the accuracy—the probability of user information error, the requirement of extra user information, or the incompleteness of user information delivery
- the dependability—the probability of lost user information

The disengagement can be measured by the delay of the disengagement and probability of denial of the disengagement.

6.4 MAJOR PERFORMANCE FUNCTIONS

Current Web based management technologies, such as WEBM and Java Management API, can be used as the basic framework for developing service management applications including performance management. However, more coordinated and integrated service management development is required to avoid the duplicated effort for implementing common functionality required for the performance management in individual applications. In order to provide effective performance management, the following common functions are identified:

- Collection Functions
- Storage Functions
- Reporting Functions

6.4.1 COLLECTION FUNCTIONS

These functions are required for the collection of performance monitoring data. Direct service performance monitoring function can be implemented to collect such data. It is also possible that some service

performance data can be collected based on the raw network and network element performance data. The collection functions should support the following capabilities:

- assign and change the interval used for the performance data collection according to customer requirement
- suspend and resume performance monitoring data collection when required by customer
- reset performance monitoring data when required
- set the schedule for performance data collection

6.4.2 STORAGE FUNCTIONS

The performance data can be reported to customer when it is collected. However, in come cases, a customer may require the performance data to be reported at a certain time of a day or with a particular frequency. This requires the service provider to provide temporary storage to store the collected performance information. In some cases, the history of the service performance data may be required by either the service provider or the customer or both for management purposes. In this case, persistent storage is required for the history performance data. Customer and service provider may reach an agreement of how long the history data should be stored.

6.4.3 REPORTING FUNCTIONS

The reporting functions are used by a service provider to inform its customers about service performance on a periodic basis. Different customers may have different requirements for the reports. For example:

- the type of information interested by the customer
- the ability to filter out irrelevant information
- the preferred period for the current performance report and for the historical information
- the way the report being generated, whether or not to use electronic form and if so which form

7 TOWARDS AN INTERNET SERVICE MANAGEMENT ARCHITECTURE

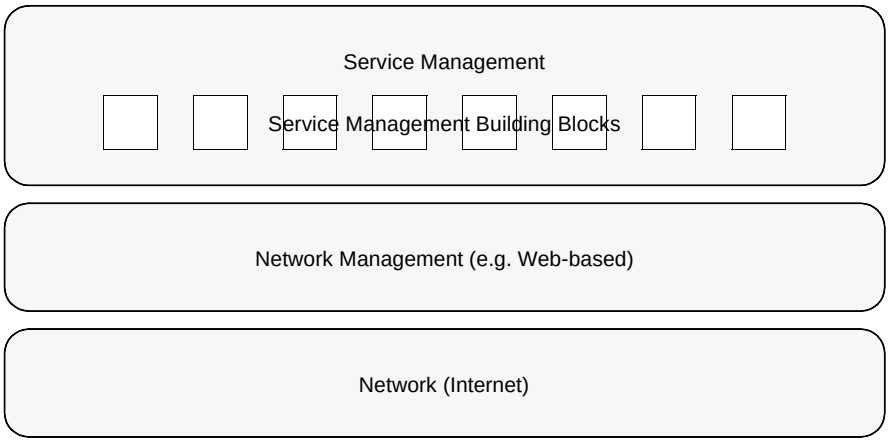

Figure 4: An Internet Service Management Architecture

The proposed Web-Based Enterprise Management Architecture can be used as the basic Internet management infrastructure, the Web and Java based interface technologies can be used to develop service management applications. Based on this architecture, a set of service management building blocks discussed in this paper are required to support different functions. However, Network Management Forum [1] has defined a set of common business processes for telecom service management and defined the mapping between them and the network infrastructure. Similar approaches can be used to define the Internet service management framework. Internet service management functions can be built as building blocks on top of the existing Web based management infrastructure. Similar to the performance management discussed above, a set of management functions can be identified for other management areas as well. This set of management functions can be developed as building blocks which provide the basic support for building a service

management layer. Based on the functionality supported by this service management layer, specific service management applications can be built to meet the special requirements for different service providers.

8 SUMMARY

This paper has briefly described a framework in which to understand the management of integrated telecommunication and data network services. It has demonstrated the applicability of the TMN concepts to Internet management, stressing service management as a key differentiator for service providers to capture a new market that is growing exponentially. Finally, this paper proposes, for further study, the adaption of business process modelling and methodologies currently defined in the NMF.

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