Improving Efficiency of Network Service Quality of the United Nations Economic Commission for Africa (UNECA)

Wendwosen Abebe
United Nations Economic Commission for Africa, Addis Ababa, Ethiopia
wondlej@gmail.com

Abrehet Mohammed Omer
Department of Computer Science and IT, Addis Ababa Science and Technology University, Ethiopia
Abrehet@gmail.com

Abstract

Service quality is a concept that has aroused considerable interest and debate in the research literature because of the difficulties in both defining and measuring it with no overall consensus emerging on either. Client satisfaction and service quality are often treated together as functions of customer's perceptions and expectations and research has shown that high service quality contributes significantly to profitability. Service quality is required to be first evaluated and monitored in order to improve the quality in a service organization. The purpose of this paper is to identify the major Network Services problems at the United Nations Economic Commission for Africa (UNECA) regarding it performance and clients dissatisfactions following the degradation of the service. Quality of Service in computer networking refers to a broad collection of networking technologies and techniques to provide guarantees on the ability of a network to deliver predictable results. To evaluate clients' dissatisfaction on the network service, clients' satisfaction survey is undergone and then based on the result from the survey with respect to the industry service target, various technical experiments were done to address the existing network performance based problems.

Finally, technical solutions are given for each problem identified and recommendations are also made.

Keywords: Service Quality; Computer Network; UNECA;

1. Introduction

IT Service providing section like ITSS (Information and Technology Service Section) at the UNECA (United Nations Economic commission for Africa) is realizing the significance of customer-centered philosophies and is turning to quality management approaches to help managing its service addressability and client's satisfaction. Among several IT services, this paper will try to show the concept of network service quality and will also try to identify the major problems that created client dissatisfactions and demonstrate technical factors that lead to network performance degradation.

IT Service quality is a concept that has aroused considerable interest and debate in the research literature because of the difficulties in both defining it and measuring it with no overall consensus emerging on either. Different literature defines IT service quality as to what is meant by service quality. One that is commonly used defines IT service quality as the extent to which a service meets clients' needs or expectations.

Service quality can thus be measured as the difference between customer expectations of service and perceived service. If expectations are greater than performance, then perceived quality is less than satisfactory and hence customer dissatisfaction occurs.

The aim of this research is to identify the frequent problems occurring at UNECA IT service due to the performance degradation on the IT services mainly the network performance issue and provide a better quality IT service which exceeds the expectation of its clients and which assures the business continuity of the organization. It appears that IT service quality is not a new concept; however, measuring service quality technically is still a developing and a challenging issue. Both from the technical point of view and in business practice, it is well established that measurement of a network performance is an important procedure for improving the quality of IT service. Thus, there has been an abundance of

research on the issue of network performance measurement, which have contributed to the development of a solid research foundation.

Many modern networking applications can benefit from improved Quality of Service (QoS) supported across multiple administrative domains. Provisioning of end to end advanced transport services requires methods for verifying the established Service Level Agreements (SLAs) between the service provider and its customers. Even in a well-engineered network, however, occasional equipment fault or mis-configuration can cause severe service performance degradation.

One outcome of the previous steps may be the need to procure new hardware such as routers and hubs. These network components are also not easy to configure. For instance, current routers require users to specify numerous interdependent configuration variables. Mistakes in router configuration are the most common reason for network outages [1]. Beyond its technicalities, the following factors can affect performance of a network.

- Disturbance in communication media,
- Mismatch in protocols,
- Power failure,
- Server failure,
- Congestion in networks,
- Repetitive demand of same data packets,
- Virus or spyware or malware attacks.

A network monitoring and diagnosis system periodically records values of network performance metrics in order to measure network performance, identify performance anomalies, and determine root causes for the problems, preferably before customers' performance is affected. These monitoring and diagnostic capabilities are critical to today's computer networks, since their effectiveness determines the quality of the network service delivered to customers.

The most important performance metrics that are monitored include connectivity, delay, packet loss rate, and available bandwidth.

i. Network connectivity is probably the most important metric for a network monitoring and diagnosis system, since the top priority of a network service is to guarantee that any pair of end nodes can communicate with each other. Due to its importance, all network layers, starting from the physical layer, provide mechanisms to automatically monitor network connectivity.

ii. Network delay is perhaps the most widely used performance metric in today's network applications. It is monitored mainly at the end-to-end level using ping. Network delay can be used to directly evaluate network path performance, especially for small data transmissions.

iii. Packet loss rate refers to the probability that a packet gets dropped on a network path. It is mainly monitored at router interfaces using SNMP packet statistics. For ISPs (Internet Service Providers), since packet loss rate is a key marketing metric, a lot of monitoring and diagnostic effort is devoted to reducing packet loss. For applications, however, packet loss rate does not always significantly affect the performance of data transmissions. For example, single packet loss has a very limited impact on bulk data transmissions that use state-of-art TCP protocols.

iv. Available bandwidth is another important performance metric, which directly captures data transmission speed. Although network delay can be used to evaluate the performance of a network path for small data transmissions, the available bandwidth metric is needed for larger data transmissions. However, available bandwidth is much less popular than the delay metric due to its high measurement overhead. People instead use the link load metric, which can be more easily measured to capture available bandwidth information.

These performance degradation indicators and others (such as the performance of the network signaling on the end nodes, compression, encryption, concurrency, and so on) all affect the effective performance of a network. In some cases, the network may not work at all; in others cases, it could be slow or unusable. And because applications run over these networks, application performance suffers.

2. Background

(UNECA was established in 1958 by the United Nations Economic and Social Council to encourage economic cooperation among its member states (the nations of the African continent) following a recommendation of the United Nations General Assembly.

It is one of five regional commissions and has 53 member states corresponding to the 53 member states of the United Nations that lie within the continent of Africa.

The UNECA network infrastructure is constructed based on the CISCO proposed hierarchal network layers which are the core, distribution, and access layers. Having a hierarchal network can benefit the organization in terms of enhancing the performance, maintainability, manageability, redundancy, scalability, and security of the network services.

UNECA/ITSS is technically organized into four major units in order to provide its services to its clients as follows:

- CSU: Customer Support Unit
- NSU: Network Service Unit
- VCU and Telecom: Video conference and Telecom unit
- BSU: Business Solutions Service Unit

The UNECA network infrastructure is also equipped with one big data center and two firewalls one at the interfaces with the public network and one with the sub regional offices.

Although SNMP is most commonly associated with gathering network statistics and configurations, it is extensible to even non-network devices as well. SNMP was originally developed as a communications framework between all kinds of networked devices and servers. Thus, any device with a network connection can potentially receive and respond to SNMP requests or send its own traps.

Nowhere is this more valuable than with the environmental sensors used in many data centers today. These environmental sensors regularly check the temperature, humidity, and (in the case of accidental flooding) water level present in the data center room. The installation and use of these sensors is critical to ensuring that expensive IT investment doesn't melt down if data center air conditioning stops functioning.

With the right tools and protocol like SNMP in place, an alert could have notified administrators immediately when temperature conditions in the data center started their deviation. Consolidating SNMP's data into a unified network management solution enables the real time alerting of problems directly to network administrators.

3. Experiments

The purpose of the experimentation was to identify the major factors that caused the degradations on the performance of the network services at UNECA. These experiments mainly focus on the main factors that can affect the network performance like:

- Bandwidth of the network infrastructure
- Availability of the network services and devices
- Packet loss or drop and
- Delay

However; many other scenarios are considered that can strengthen the above four or tend to consider others incidents happened during the experiment. The experiments were classified into four steps based on their nature of monitoring procedure and expected output and the experimentation for the network traffic collection have been done from the UNECA data center for two weeks which went from 12 Nov, 2012 to 24 Nov, 2012. The methodology of this research is experimental research method and the experiment setups are selected to address the problems through analysis of the information fetched. This method relies on controlled methods, random assignment and the manipulation of variables to test a hypothesis. SNMP works at the application layer of the Internet Protocol Suite.

The experimentation is done on both the internal LAN of UNECA and remotely on three sub regional offices in Rabat, Kigali, and Niamey to test the CITRIX remote connectivity, reliability, and speed of the network services using their perspective tools and protocol.

Experiment one was undergone to analyze connectivity and availability of both the Internet and

the bandwidth utilization of the services. MRTG was the appropriate tool to fetch information and will display the results calculating the inbound and out bound of the data transmission in the UNECA local area network.

The Purpose of experiment two was to evaluate the WAN services mainly

- CITIRIX (Remote connectivity): This service is available mainly to SRO (Sub Regional Office) employees at Rabat, Niamey, and Kigali and some of the UN staff members in Addis Ababa through the WAN. On the CITRIX remote service, several applications are uploaded which enable the employees to use them and to easily access their workstations remotely.
- Lotus Notes (mail routing and replication)
- Intranet service
- Voice (IP Telephoning), etc.

Therefore, the evaluation of these services was done using the MRTG monitoring tool. The WAN connectivity with the SRO is arranged in such a way that all services are provided from the UNECA using VSAT connectivity.

The third experiments tried to show the actual connectivity and availability status of the network devices at each node of switches, routers, hubs, and other network devices and display the results in pictorial checking each node's connectivity status for the last 24 hours. The Hp Openview Network Node Manager helps to trace the failed or disconnected devices with respect to their cabling status.

Finally the last experiment analyzed the connectivity and availability status of all servers and server applications using the proposed Hp Openview Operation Manager (Hp Openview OM) and Big Brother (BB) tools.

The Hp Openview-OM monitors network infrastructure and consolidates and correlates fault and performance events to help identify the causes of network performance incidents. The tool has an active software component, known as an agent, that is installed on the various hosts monitored. Hp Openview-OM tools can monitor server applications and log files run scheduled tests of various kinds.

The Big Brother bandwidth monitoring tool provides: connectivity via ping, http servers up and running, disk space usage, uptime and CPU usage, essential processes are still running, system-generated messages and warnings. Big Brother is a loosely-coupled distributed set of tools for monitoring and displaying the current status of an entire network and notifying the admin if need be. It came about as the result of automating the day to day tasks encountered while actively administering the network systems.

4. Proposed Solutions

On the first experiment that we have done, the following solutions and recommendations are suggested based on thorough discussion with experts and by merging the experiences of similar works from various literatures.

The result shows that the root problem is on the Internet provider side the LAN infrastructure of the UNECA at every three network hierarchal layer (core layer, distribution and access layer) should be fiber cable. This will help to utilize the available connectivity of 200/200 MB.

- The use of fiber optic cables helps to eliminate network downtime caused by a single point of failure. All networks need redundancy for enhanced reliability. Network reliability is achieved through reliable equipment and network designs that are tolerant to failures and faults. Therefore, replacing all the existing UTP cat 5 cables to fiber optic cables is very important.
- Load balancing should be performed and should carefully studied the highest capacity is required of the inbound and out bound service. This effect has a cost issue which UNECA is paying unnecessary amount to the service provider for which it never used.
- Proper monitoring techniques should be implemented with the ISP and other alternatives like VSAT should be placed as a backup [2]. Because this will help the UNECA to have an up to date status of the Internet connectivity with ethio telecom so that either it could notify to its clients for any requisition

activities or use backups as a temporary solution until it recovers.

For the experiment two, we have observed that the allocated VSAT connectivity speed is too slow for all SROs to get all the network services from UNECA and all offices are fully dependent on the UNECA network infrastructure. The regional offices should start using local Internet connectivity at least with a capacity of approximately 10Mbps rather than depending on the VSAT. Moreover; instead of using VSAT connectivity, it is better to use the public Internet connectivity with secured virtualized VPN (Virtual Private Network) and then we have proposed the network diagram as shown in Figure 1 with the SROs at high level and all the necessary security precautions should be taken. The benefit of the proposed network will be

- Better connectivity speed with the UNECA and they can manage their own network by themselves.
- VSAT connectivity is too expensive and the bandwidth size is limited and therefore, using the secured public network will minimize the operation cost with a maximum bandwidth.
- The organization can only use the VSAT as a backup network.

To mitigate the problem identified during experiment three, we recommend the use of redundant cabling system and replacing all the UTP cables to fiber optics. What is the benefit of having these two? If we look at redundant cables in nature, like the network of the veins within a leaf, we may realize that redundancy creates flexibility. If a vital device is struck in a network without redundancy, it would mean all nodes which it previously fed into would be effectively annihilated from the network. A redundant network overcomes this problem by spreading out the risk. Redundant cables work by creating multiple data paths within a network, between any and all locations. If a hub, switch, or router suddenly fails, another pathway will be available to maintain the communication flow. Fiber optic cable is quickly becoming the industry standard in computer networking, telecommunications, and even home audio equipment. Fiber optic cable offers many advantages over other types of cables used to transmit audio, video and voice data.

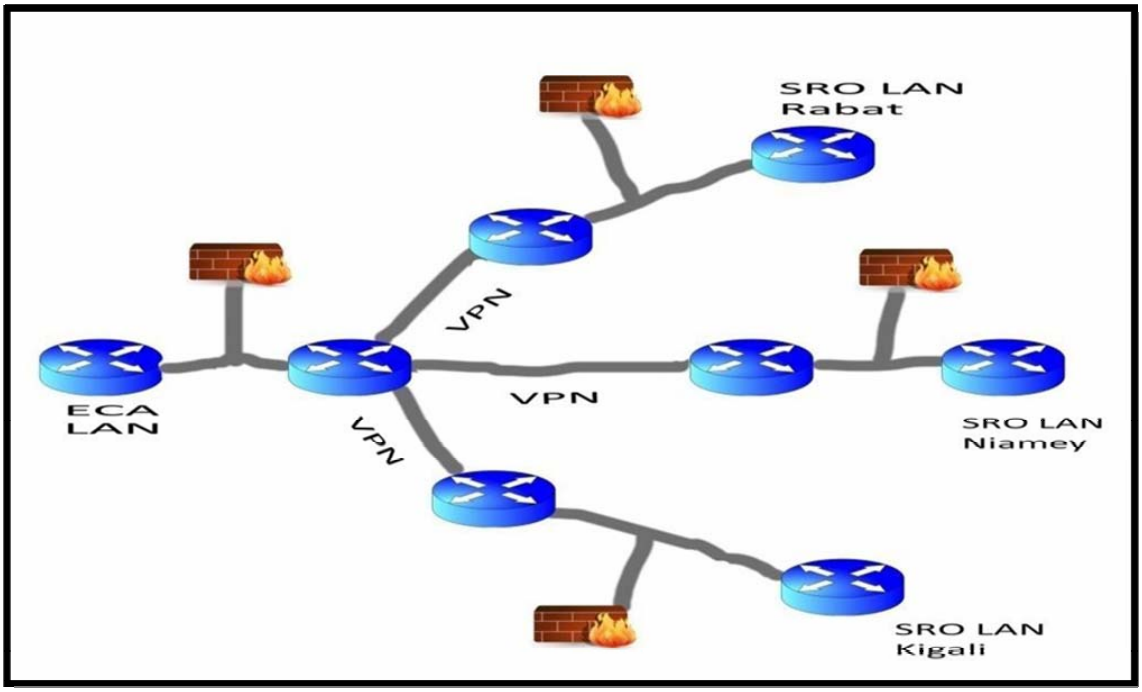

Figure 1: Proposed network diagram of connectivity between ECA and SROs

From the last experiment, we have observed that some servers frequently fail. When a server fails, the first thing we need to ask is: "What are the symptoms of the crash?" and "Has anything on the server changed recently?" To address these problems, we suggest the use of server redundancy and server virtualization so that all servers can function up and running at all times and the system administrators

should closely monitor the servers and server applications even if they are virtualized and redundant.

5. Validity of the Solutions

Validation has been done with three domain experts at the organization after solutions and recommendations have been made that were adopted from literature to check the acceptance and visibility from the UNECA perspective.

The proposed solutions adopted from literature and related works for the identified network problems during the research work should be validated by the domain experts at the UNECA. The validity checking with the decision makers has been done on interview based and undergone detailed discussion on each and every of the proposed solution during the experiments on the findings and problems identified during the survey analysis and the four experiments.

As we have seen on the validation interview, the three domain experts have commented their ideas based on their area specialties on each of the four experiments.

- On the issue of replacing UTP to fiber cables, the domain experts have agreed on the upgrade and replacement of the existing network cables. The 1GB cables which run from the core layer to the distribution layer should be upgraded to 10GB fiber cables to carry the current network traffic and in addition the existing UTP CAT 5 cables between the distribution layer and the access layer should be replaced by a redundant 1GB fiber cable. However, they have objected the recommendation to install a fiber cable between the access layer to the clients machines as UTP CAT 6 cable can bring the desired network performance. By doing this, it is possible to achieve the same performance as of the fiber optics.
- The network administrators we have interviewed expressed their concern on the importance of migration from the current VSAT to VPN connectivity with the sub regional offices as it is costing the organization a huge amount of money having all the possible limitations of VSAT service. Therefore, they have agreed with the recommendations on the use and implementation of a secured VPN connectivity with the SROs. If the organization can achieve this, the performance of the CITRIX service will be enhanced at the same time.
- The given solution and recommendations were also positively validated from their perspective on the implementation of an alert system when network devices and system failures occur so that proper investigation and maintenance could be performed.

6. Conclusions

Although there are challenges and constraints being faced during the early phase of this research, the literature review, the data survey to assess the client dissatisfaction on the network service, and the final experimentations to find the causes of the problems are done successfully.

More specifically, the following are recommended to the UNECA IT managers. First and foremost, speed of the Internet and proper utilization of the bandwidth is the critical determinant of the success of providing quality of network service. Since accessing the recourses of the UNECA became difficult for the SROs, proper attention should be given in shifting from the VSAT service to a secured VPN so that business can continue smoothly. Besides, the structure of the LAN of the UNECA should be revised in such a way it should incorporate redundant fiber cables and use of network and server virtualization.

Last but not least, the data center of the UNECA should also be organized to give proper disaster recovery alerts to the network administrators with proper ventilation, redundant power, and security.

In conclusion, all intended tasks have been completed successfully. In the first client satisfaction evaluation task, we did the data collection and data analysis. The purpose of the research was to identify the frequent problems occurring at UNECA IT service due to the performance degradation on the IT services, mainly the network performance issue and

provide a better quality IT service which exceeds the expectation of its clients and which assures the business continuity of the organization. The findings of this research are mostly useful to those IT managers in the organization who intend to standardize and provide quality network services with relatively low cost, time, and energy. The results indicated the most important and existing network problems at the UNECA and solutions were suggested carefully to mitigate the problems using literature and with expertise involvement.

References

[1] http://www.defcon1.org/citrix.html, last accessed on December 2012.

[2] H. Erik Hia, "Secure SNMP-Based Network Management in Low Bandwidth Networks", Virginia Polytechnic Institute and State University, 2001.