Design and Implementation of Lower Layers of Q3 Interface in Telecommunication Management Network

G.Farahani

Islamic Azad University Parand Branch, Computer and IT Department, Tehran, Iran
e-mail: farahani.gh@piau.ac.ir

Abstract

This paper presents a new method to design and implement lower layers of Q3 interface at internet mode profile and client-server in Telecommunication Management Network (TMN). Regards to functional and procedural requirements of internet mode profile, we develop software to implement and test lower layers with consideration of multithreading and critical section techniques to communicate between server and clients.

Because of growing up internet in worldwide and accessibility of it at most switch centers, internet mode profile against connection oriented mode profile and connectionless profile, will use as a world method for information interchange, which it includes TMN. In this paper Q3 interface in TMN has been implemented and tested in laboratory.

In this implementation, client computers simulate telecommunication switchs and control switch substitutes with server computer that makes a required instructions to control telecommunication switches. Test environment which made for program, simulate a functions that interchange between network element and operating system. In our implementation we found Q3 interface in comparison to ordinary telecommunication has an approximately 26.6% performance improvement of instruction interchange in TMN.

Keywords

Telecommunication Management Network, Q3 interface, TCP/IP protocol

1. Introduction

Variety of telecommunication networks and systems, causes different private interfaces in the networks, therefore management of each private network requires different interfaces for operation of protocols in the networks. To clarify the duty scope of each part, we should use management architecture with standard connection interface. Therefore standard institute ITU-T declared first standard for Telecommunication Management Network (TMN) in 1985. TMN in the concept is a discrete network, which has connection at different points. These connections are shown in figure 1 (ITU-T, M3010, 1996). According to figure 1, connection points are between telecommunication network and TMN at switches and transmission systems. The protocols which implement internet profile with required recommendation for implementation of those protocols are shown in Figure 2 (ITU-T, M3020, 2000). Internet profile is acceptable method which these days, utilizes for implementation of management information transmission network.

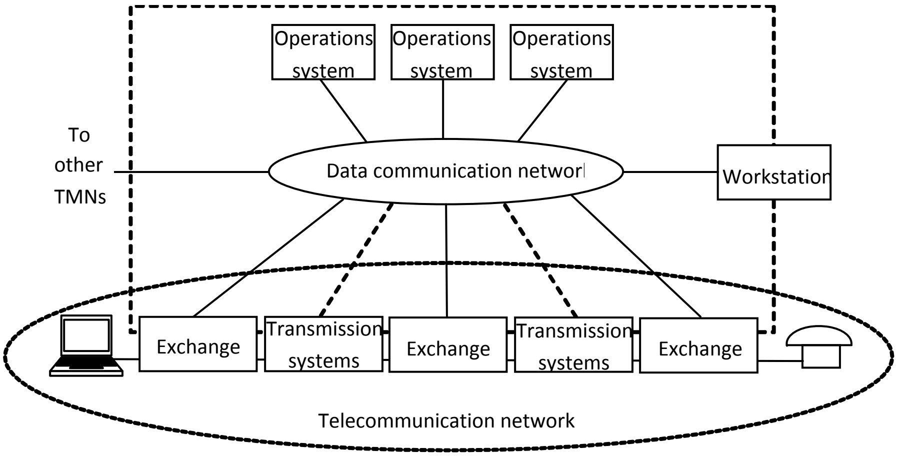

Figure 1: Relation between TMN and telecommunication network

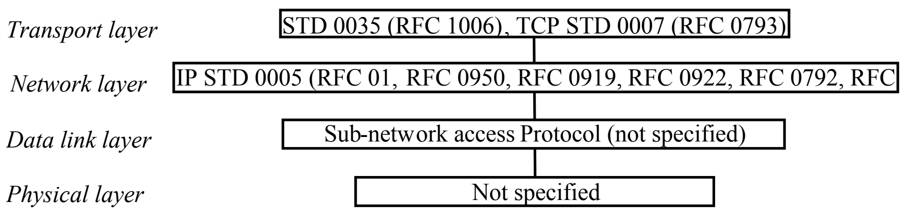

Figure 2: Internet profile protocols

Most producers of telecommunication equipment which are using other profiles except internet to manage information interchange, for compatibility with data transmission systems in the base of TCP/IP, currently are substituting their profiles with internet mode profile. In this paper we will simulate telecommunication switches which are implemented in Iranian Telecommunication Research Center (ITRC). In other countries especially European and American coutries, implementation according to their requirement has been carried out.

Now, studies on the other functionalities of telecommunication management network are carrying out which with association of Q3 interface program, we would be able to configure our network in the optimal condition (ITU-T, M.3000, 1995).

2. Telecommunication Management Network

In TMN there are three different architectures. We describe architectures briefly.

2.1. Functional architecture of TMN

In this architecture, five types of different functional architecture have been defined which in implementations of TMN, we don't require all of the functional blocks. Figure 3 shows different types of functional blocks of TMN.

In functional architecture of TMN we use references points to describe functional blocks. As a result, we have five set of reference points. Three of these reference points (Q, F and X) are defined completely with TMN recommendation but two other reference points (M and G reference points) are located at outside of TMN environment. In figure 4 reference points and their functional blocks are shown. At continuation, we will describe functional blocks of TMN briefly.

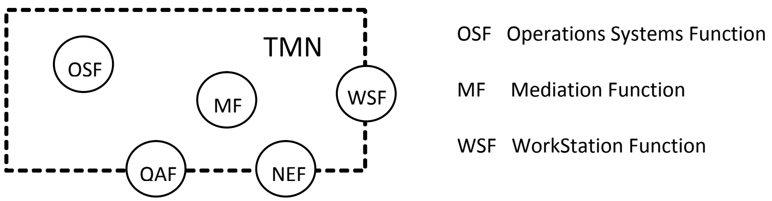

Figure 3: Functional Blocks of TMN

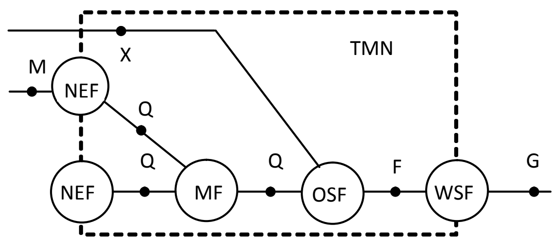

Figure 4: Different reference points in TMN

2.1.1. Network Element Function

A telecommunication network is made with switches and transmission systems. In TMN, these switches and transmission systems are examples of network elements.

2.1.2. Operation System Function

This function block is used for management operation initialization and receiving reports. An OSF will connect to NEF via Q3 reference point.

At primary standard in 1988, recommendation M.30 defined three reference points named Q1, Q2 and Q3 which reference point Q3 was used to interchange management information via management protocol of application layer and two other reference points defined for management information which should exchange via lower layers management protocol (e. g. data link layer) but after practical using of these two points, it was cleared that we can not make a difference between reference points. Therefore these two reference points replaced with reference point Qx. Generally services at reference point Q3 will consider as a Common Management Information Service (CMIS).

If require, it is possible TMN includes several OSF which in this condition OSFs communicated together via Q3 reference points and if OSFs are in the different environments of TMN, relation between them will carry out from X reference point.

2.1.3. Work Station Function

This function will prepare interpretation of management information for user.

2.1.4. Q Adaptor Function

It will use for connection of blocks that are not compatible with reference points of TMN.

2.1.5. Mediation Function

This block will operate on the transmitted information from NEF or QAF to OSF and will use to connect one or more NEF or QAF to OSF. The main duty of MF is storing and filtering management information and conversion of local format of information to the standard form (Lakshmi, 1999).

2.2. Information Architecture of TMN

This architecture describes the structure of information interchange between manager and agent which this information will use for management of information resources. In figure 5, common structure of relationship between manager, agent and information resources has been shown (Lakshmi, 1999).

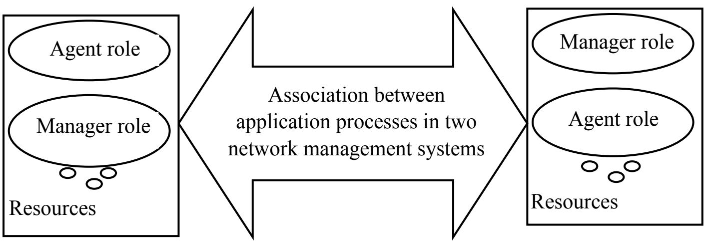

Figure 5: Common schematic of information architecture

2.3. Physical Architecture of TMN

Physical architecture of TMN will declare how we can implement functional block of TMN with physical equipments. Structural blocks usually will implement functional blocks of their names. Table 1 shows how to implement functional blocks in structural block (Lakshmi, 1999).

	WSF	OSF	QAF	MF	NEF
NE	O*	O	O	O	M
MD	O	O	O	M	
QA			M		
OS	O	M	O	O	
WS	M				
DCN					

O: Optional; M: Mandatory; O*: May exist if OSF and MF exist

Table 1: Relation between functional blocks and structural blocks

3. Q3 Interface

In TMN, there are four different communication types which are shown in table 2.

Application	TMN interface
Between OS and NE, MD and NE Between OS and OS in a TMN environment	Q3
Between OS and OS in different TMN environment	X
Between MD and NE	Qx
Between WS and OS or WS and MD	F

Table 2: TMN interfaces

As shown in Table 2, Q3 interface includes all states which systems will enter in TMN environment. Although Q3 interface will use for interaction between function of different systems but type of interchanged management information in each different states that listed in front of Q3 in the table 2 is different because of logical layering or considered abstraction level. According to requirements of Q3 interface, three application classes are defined as below:

1. Interactive Class: In this class we deal with information that are received unexpectedly and should answer rapidly.

2. File-oriented Class: This class will use for applications that information are as management file.

3. Directory Class: This class will use to map application entity and its address for connection establishment.

3.1. Upper layers of Q3 interface

In this section necessary concepts for protocol requirements of upper layers will introduce, that upon to function supported with these layers, different services have been defined (ITU-T, Q.812, 1997).

3.1.1. Functional Unit

Functional unit is a method for services grouping in the designed sets. Upon to type of services and with using functional units, information interchange may perform.

3.1.1.1. Application Service Element (ASE)

It is a block which carries out specified function of application layer. Some of ASEs might be used in different applications. When several ASEs used at application layer, it is necessary to have coordination between them which in this situation we need a coordination unit that includes functions to organize between ASEs.

ASE includes Association Control Service Element (ACSE), Remote Operation Service Element (ROSE), Common Management Information Service Element (CMISE) and System Management Application Service Element (SMASE).

3.1.1.2. ACSE Functional Unit

ACSE will use at connection-oriented services and it use to establish and release the connection. This functional unit has four services which are A-Associate, A-Release, A-Abort and A-P-Abort. A-Associate service for connection establishment, A-Release service for gracefully disconnection, A-Abort service for suddenly disconnection by user of ACSE and A-P-Abort will use to suddenly disconnection by ACSE. Simply, ACSE services only have a task of connection and disconnection while data transmission will carry out with services of other three entities.

3.1.1.3. ROSE Functional Unit

After establishment of connection, management information should be send to destination with remote operation protocols and destination will send a response to source with these protocols. These requests and receiving related response will carry out in format of four services in ROSE functional unit that are RO-INVOKE, RO-RESULT, RO-ERROR and RO-REJECT.

RO-INVOKE service will use for sending initial request, RO-RESULT service will use to send positive response to request from side of receiver, RO-ERROR service will utilize for sending negative response to the request and RO-REJECT service employ to reject each of the three services mentioned before.

3.1.1.4. CMISE Functional Unit

This functional unit uses for common management information transmission between OS and NE. With use of services and protocols of this unit, all of the common management information will transfer to ROSE unit and will send as a request or response.

3.1.1.5. SMASE Functional Unit

This unit doesn’t have obvious protocol and standard for implementation. It includes several system management functions which will use for more clearance and transparency of information and parameters of CMISE. Therefore SMASE with CMISE will deliver complete information to ROSE (ITU-T, Q.812, 1997).

3.2. TCP protocol in Q3 interface

TCP is a connection-oriented protocol which has little limitations for its lower layers to transmit secure data stream. Table 3 shows schematic of network layers at TCP protocol.

User or Upper layers
TCP
IP
Connected Network

Table 3: Schematic of network layers at TCP/IP protocol

From point of view of protocol's architecture, TCP layer will sit over IP, that IP layer will able TCP layer to send and receive information with fragments of different length (ITU-T, Q.811, 1997).

Internet Protocol will utilize to fragment TCP packets in source and adhesive them in destination and also data transmission and delivery between several networks and gateways. IP will transfer information between several networks according to priority and security. For implementation of TCP over IP, parameters such as reliability, data stream control, multiplexing, communication, priority and security should be considered (Thomas, 1996).

3.2.1. TCP/User Interface

After brief understanding of TCP protocol and functional units of application layer at internet mode profile, we will review interface between user and TCP. Because of each system has a different facility, therefore in implementation of TCP different interfaces for connection between TCP and user will be utilized, such that TCP could connect to application layer at Q3 interface and performs instructions of ACSE functional unit and return its answer. However, in all implementation of TCP, a minimum simple set of services should implement that are Open, Send, Receive¸ Close, Status, and Abort. Task of necessary services is as bellow:

Open service for connection establishment, Send service for sending of information, Receive service to receive information, Close service to graceful disconnection, Status service for monitoring of connection status (includes external socket, local connection name, receiving window, sending window, connection status, number of buffers which are waited to receive ACK, number of unknown buffers for urgent receiving, priority, security, fragmentation and data transmission time) and Abort for abruptly disconnection (Forouzan, 2009).

4. Comparison OSI and TCP/IP model

In table 4, network layers of two OSI and TCP/IP reference models are shown.

TCP/IP	OSI
Application	Application (Layer7)
	Presentation (Layer6)
	Session (Layer5)
Transport	Transport (Layer4)
Internet	Network (Layer3)
Subnet	Data Link (Layer2)
	Physical (Layer1)

Table 4: Comparison between OSI and TCP/IP reference models

At TCP model, session layer doesn't exist and related works to session layer carry out by transport layer. At TCP, presentation layer doesn't exist and related works to presentation layer carry out by application layer. Application layer exists in both reference model but their services are different. Transport layer at TCP/IP model, provide two standard protocol which named TCP and UDP.

At OSI model, network layer is like other OSI layers, that provides both connection-oriented and connectionless services while at TCP/IP model, internet layer is connectionless merely. At OSI model, Connectionless Network Protocol (CLNP) model is similar with IP protocol in performance and only their difference is variable address length at CLNP protocol while IP has a fix address length 32 bit (Pouffary, 1997).

Transport layer at TCP/IP doesn't have any limitation on the lower layers of TCP/IP but host must be able to connect to the network and send data with use of IP packet protocols. Because is not defined a standard protocol for sub network, this protocol will change from one host to other host and from one network to other network.

5. Implementation

Regards to client-server property which exits in TCP/IP protocol and because of using TCP/IP at lower layers of Q3 interface in our implementation, implemented software has a client-server property. On the other hand TCP/IP connection is connection-oriented, therefore if client connect to the server, fraction of server time will waste to receive information from client, even if client send it's information with short time gap. Therefore if server is answering or listening to the client, other requests should be in the queue till connection between first client and server released and another request answered. To prevent occurrence of problems like this, we have used multithreading property in the software (Duffy 2008). Multithreading has a property that will divide the time between different threads and upon to number of clients which have request for connection simultaneously with server, time will assign to them. In fact, Multithreading is combination of codes with special stacks which work as multitask. Thread is a best solution for queue of consecutive packets at management works such that manager will not wait to get a packet from network element and each time server receive a packet, it will process it and will send a suitable management answer. To create relation between application programs and TCP/IP protocol, we use a socket programming which each socket will get arguments and will return one or more results and will use as an end point for connection establishment in TCP/IP.

Implementation software of client-server, test program for send/receive functions, connection/disconnection and all of the function in TCP/IP protocol are written with C++ software on windows (Schildt, 2004). With respect to receiving information from application layer, connection establishment, connection release, clean and unaccepted data sending and different states of TCP are implemented (Petzold, 1998).

5.1. Proposed Algorithm

Regarding to three different approaches for transaction of information between threads named Semaphore, Deadlock and Critical Section, we have used Critical Section approach, it means if there is shared resource between threads and one thread use a shared resource, another thread doesn't have an ability of using shared resource till first thread finish its work with the shared resource. Proposed implemented algorithm for lower layers of Q3 interface is shown in figure 6. For implementation of our algorithm in the TMN, we used a processor core 7i with processor speed 3.2 GHz and bus speed 2400 MHz for server which simulate control center in TMN.

For 20 clients in the simulated TMN, we utilized processor Celeron dual core with processor speed 2.2 GHz and bus speed 800 MHz. Each instruction for ordinary approach in switching ordinary telecommunication networks with different protocols was 86 bit in average while when we use Q3 interface with proposed algorithm each instruction need 64 bit. Our management network was implemented in laboratory with RS232 network and maximum bit rate 11520 bps. Results of our implementation are shown in figure 7. Our proposed method with Q3 interface implementation has overcome to ordinary method in approximately 300 points in average with 26.6% performance improvement that performance was calculated as relative improvement of bit per second for each number of instructions per second.

6. Conclusions and the Future

Regarding to requirement of telecommunication networks to use worldwide protocols such as TCP/IP to manage and control whole telecommunication equipments such as switches with central processor, implementation of lower layers of Q3 interface is essential step. In this paper lower layers implementation was described. These layers were simulated and implemented on laboratory in simulated environment. We reached to 26.6% improvement in average for our proposed algorithm with Q3 interface in comparison to ordinary method in TMN to manage all telecommunication switches. Practical test of Q3 interface in TMN could be at continuation of our works.

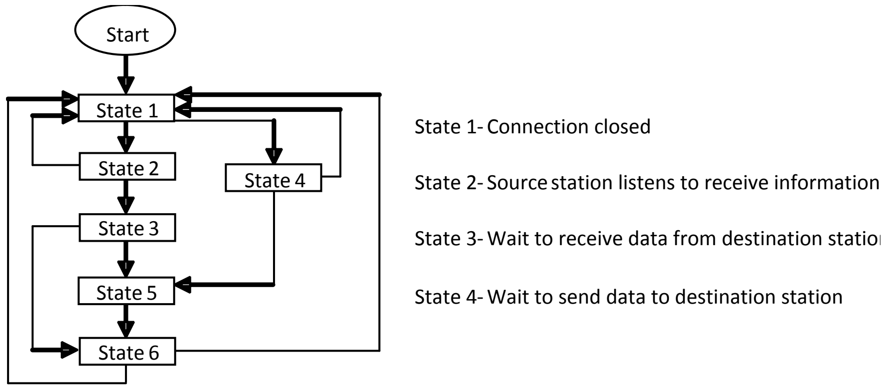

Figure 6: Proposed algorithm for connection between client and server

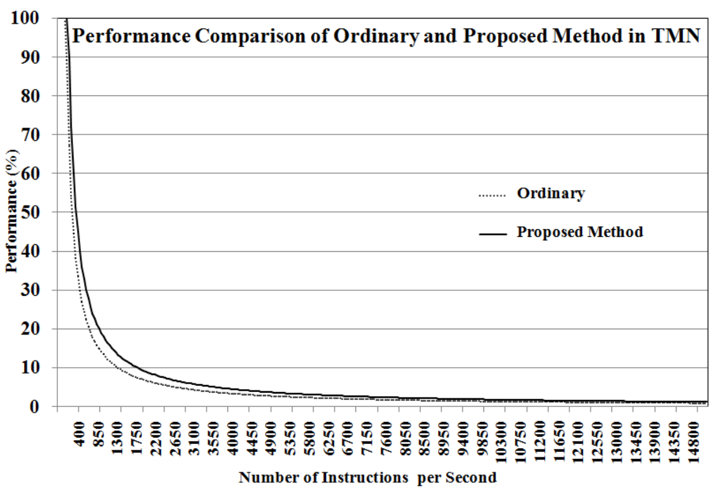

Figure 7: Comparison performance between ordinary and proposed method with Q3 interface in TMN

7. References

Duffy, J. (2008), *Concurrent Programming on Windows*, Addison-Wesley, ISBN: 9780321434821.

Forouzan, B. (2009), *TCP/IP Protocol Suite*, Mcgraw-Hill, 4th edition, ISBN: 9780073376042.

ITU-T, M.3000 (1995), “Maintenance Telecommunications Management Network: Overview of TMN Recommunications”.

ITU-T, M3010 (1996), “Principles for a Telecommunications Management Network”.

ITU-T, M3020 (2000), “TMN Interface Specification Methodology”.

ITU-T, Q.811 (1997), "Lower Layer Protocol Profiles for the Q3 and X Interfaces".

ITU-T, Q.812 (1997), "Upper Layer Protocol Profiles for the Q3 and X Interfaces".

Lakshmi, G. R. (1999), *Fundamental of Telecommunication Network Management*, IEEE press, New York, ISBN: 9780780334663.

Petzold, C. (1998), *Programming Windows*, Microsoft Press, ISBN: 9781572319950.

Pouffary Y. (1997), *ISO Transport Service on top of TCP (ITOT)*, RFC2126, Digital Equipment Corporation.

RFC791 (1981), "Internet Protocol", Information Sciences Institute University of Southern California.

Schildt H. (2004), *The Art of C++*, McGraw-Hill/Osborne, ISBN: 978-0072255126.

Thomas, S. A. (1996), *Ipng and the TCP/IP protocols*, John Wiley & Sons Inc, ISBN: 9780471130888.