Analysing Quality of Service in UMTS

Dilpreet Kaur, Pankaj Rakheja, Amanpreet Kaur

ITM University, School of Engineering & Tech, Dept. of EECE,
Gurgaon (Haryana), India

ABSTRACT

Analysis of the Quality of Service (QoS) in the UMTS (Universal Mobile Telecommunications System) network has been done using different parameters. UMTS is a universal telecommunication service which is more popularly known as 3G. It uses Wideband Code Division Multiple Access (WCDMA) techniques inculcating internet protocol, urban terrestrial and radio air interfaces. Thus, resources used here also allow lower generation services. It provides better speed, security, bandwidth utilization etc. Quality of Service is analyzed by changing the value of the precedence bit of the CBR application. The values of the precedence bits that have been taken are 0, 1, 4 and 6. The comparison has been done on the basis of throughput, average end to end delay etc.

Keywords: CBR, RNC, QoS, UMTS, UTRAN.

I. INTRODUCTION

UMTS[2] is the European vision of 3G. It is an upgrade from GSM via GPRS and EDGE. The standardization work for UMTS is carried out by Third Generation Partnership Project (3GPP) [3][2].It aims at providing global roaming. It also inculcates various multimedia services for voice, data and video at increased data rates of 384 kbps while moving and 2 Mbps when stationary at specific locations. It also has greater capacity with higher efficiency than first and second generation systems and it can also work in conjugation with Internet protocol. Higher bandwidth here enables a wide range of applications for both customers and business. For the consumer it provides video streaming, TV broadcast, video calls, video clips – news, music, sports, enhanced gaming, chat, location services etc and for business it provides high speed teleporting / VPN access, sales force automation ,video conferencing and real-time financial information. 3G services include CDMA and WCDMA. 3G Standard is created by ITU-T and is called as IMT-2000.

The UMTS network architecture can be divided into three main elements:

User Equipment (UE): The User Equipment or UE is the name given to what was previous termed the mobile, or cellphone. The new name was chosen because the considerably greater functionality that the UE could have. It could also be anything between a mobile phone used for talking to a data terminal attached to a computer with no voice capability.

Radio Network Subsystem (RNS): The RNS is the equivalent of the previous Base Station Subsystem or BSS in GSM. It provides and manages the air interface for the overall network.

Core Network: The core network provides all the central processing and management for the system. It is the equivalent of the GSM Network Switching Subsystem or NSS.

The core network is then the overall entity that interfaces to external networks including the public phone network and other cellular telecommunications networks.

Figure 1 shows the UMTS network architecture.

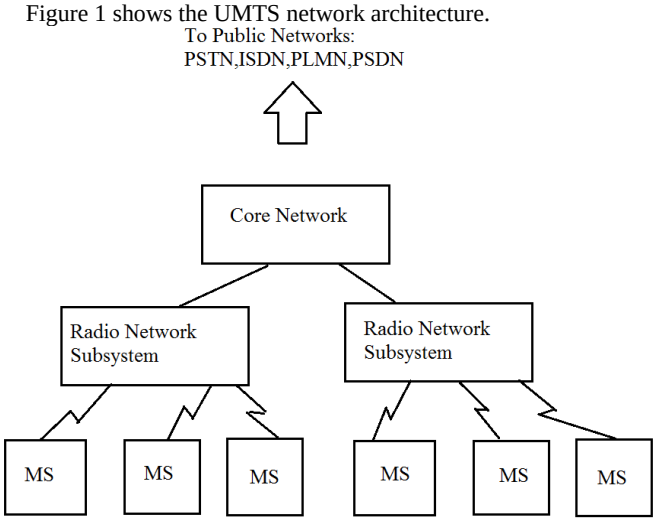

Figure 1: UMTS network architecture

A UMTS network consists of three interacting domains: Core Network (CN), UMTS Terrestrial Radio Access Network (UTRAN) and User Equipment (UE). The main function of the core network is to provide switching, routing and transit for user traffic. Core network also contains the databases and network management functions. The basic Core Network architecture for UMTS is based on GSM network with GPRS. All equipment has to be modified for UMTS operation and services. The UTRAN provides the air interface access method for User Equipment. Base Station is here referred as Node-B and control equipment for Node-B's are called Radio Network Controller (RNC).The Core Network is further divided in circuit switched and packet switched domains. Some of the circuit switched elements are Mobile Services Switching Centre (MSC), Visitor Location Register (VLR) and Gateway MSC. Packet switched elements include Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN). Some network elements, like EIR, HLR, VLR and AuC are shared by both domains.

II. OVERVIEW

In the field of computer networking and packet-switched telecommunication networks, the traffic engineering term Quality of Service (QoS) refers to resource reservation control mechanisms rather than the achieved service quality. Quality of Service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow.

A network or protocol that supports QoS may agree on a traffic contract with the application software and reserve capacity in the network nodes; for example during a session establishment phase.

During the session it may monitor the achieved level of performance, for example the data rate and delay, and dynamically control scheduling priorities in the network nodes. It may release the reserved capacity during a tear down phase.

Network services are considered end-to-end, this means from a Terminal Equipment to another Terminal Equipment. An end-to-end service may have a certain Quality of Service (QoS) which is provided for the user of a network service. It is the user that decides whether to realize a certain network QoS. A Bearer Service [6] with clearly defined characteristics and functionality is to be set up from the source to the destination.

A bearer service includes all aspects to enable the provision of a contracted QoS. These aspects are among others than the control signaling, user plane transport and QoS management functionality. Each bearer service on a specific layer offers its individual services using services provided by the layers as shown in figure 2.

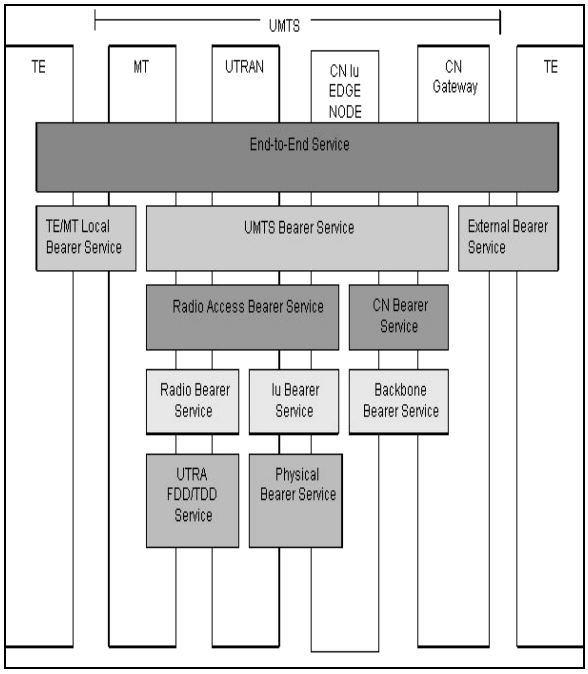

Figure 2: QoS architecture

The QoS architecture [6] shown in figure 2 have the following layers:

- **UMTS Bearer Service:** A Mobile Termination (MT) is used to connect a Terminal Equipment (TE) to the UMTS network. The traffic has to pass from one TE to another TE via different bearer services of the network. The UMTS bearer service provides the UMTS QoS as the UMTS operator offers services provided by UMTS bearer service.
- **End-to-End Service:** It uses the bearer services of the network on the application level. It is used by the TE and realization of this is done using a TE/MT Local Bearer Service, a UMTS Bearer Service, and an External Bearer Service.
- **Radio Bearer Service:** It makes use of UMTS Bearer Service possible over the cellular network topology taking into account various aspects such as mobility and mobile subscriber profiles.
- **Radio Access Bearer Service:** It deals with signalling flow along with the user data. It depends on the radio interface and mobility of mobile station.
- **Core Network Bearer Services:** It connects the UMTS Core Network (CN) lu Edge with the CN gateway to external network. It effectively controls and utilizes backbone network.
- **Lu Bearer Service:** It together with the physical bearer service provides the transport between UTRAN and CN. It also provides various bearer services for variety of QoS.
- **Backbone Network Service:** It covers layer1/layer2 functionality and is selected as per operator choice to fulfil basic QoS requirements of the core network bearer service .It is not specific to UMTS as it can also use existing standards.

There are four different QoS classes [2-4][6]:

- **Conversational class:** This class of service deals with the real time conversation which requires low end to delay.
- **Streaming class:** This class of service deals with the steady and continuous stream of data which is asymmetric and thus can withstand more delay and jitter than the conversational services.
- **Interactive class:** This class of service is used for applications where end user is online and at remote location.
- **Background class:** This class of service deals with data applications which do not require immediate action. Delay is also permissible.

Table 1 shows the functionality of these classes.

TABLE 1:
QoS CLASSES

S.No.	Traffic Class	Fundamental Characteristics	Finds applications in
1	Conversational Class	Preserves time relation, delay permissible and delay is stringent and low too	Voice communication
2	Streaming Class	Preserves time relation, delay permissible	Video streaming
3	Interactive Class	Payload content is preserved and follows request response pattern	Browsing web or internet
4	Background Class	Delay permissible and preserves payload content	Telemetry, Emails

Constant Bit Rate (CBR) is a term related to the quality of service. Constant bit rate is an encoding method that keeps the bit rate the same as opposed to VBR which varies the bit rate.

When referring to codec's, constant bit rate encoding means that the rate at which a codec's output data should be consumed is constant. CBR is useful for streaming multimedia content on limited capacity channels since it is the maximum bit rate that matters, not the average; so CBR would be used to take advantage of all of the capacity.

TABLE 2:
DESCRIPTION OF PRIORITY BITS

Bit	Traffic class	Description
0	routine	Used for transmitting routine application data such as e-mail etc
1	queues	Used for Priority wise transmission of data (Packets with higher priority will get forwarded first)
2	network	Used in networks as it tells us about the critical path ie which path to follow first; intended to be used within the network only
3	internet	It is used in internet usage reserved for gateway control originators
4	immediate	It is for immediate use applications where the sensitive data which needs to be attended first
5	Flash over ride	This is for video traffic
6	Flash	This is for higher class data traffic
7	Critical	This is for real time or VoIP traffic

The information regarding which type of QoS is being used is provided by precedence bit. It can be from value ranging from 0 to 7. The IP Precedence bits allow us to specify what traffic gets what class of service. IP precedence is a value that can allow certain traffic to gain priority over other types of traffic. Table 2 shows the details of each precedence bit.

III. WORK DONE

Scenario being made for UMTS network consisting of 12 user equipments, 1 radio network controller, a Serving GPRS Support Node, a Gateway GPRS Support Node and a Home Location Register. There is a wireless link between user equipments, network and radio control network and taken a wired connection between radio network controllers, Serving GPRS Support Node, Gateway GPRS Support Node, Home Location Register for ensuring reliability and security as wired connection have better performance in this respect as compared to wireless media. The application that is running between nodes is Constant Bit Rate. The Quality of Service is analysed by changing the value of the precedence bit of the CBR application. The values of the precedence bits that have been taken are 0, 1, 4 and 6. Figure 3 shows the scenario for analysing QoS in UMTS.

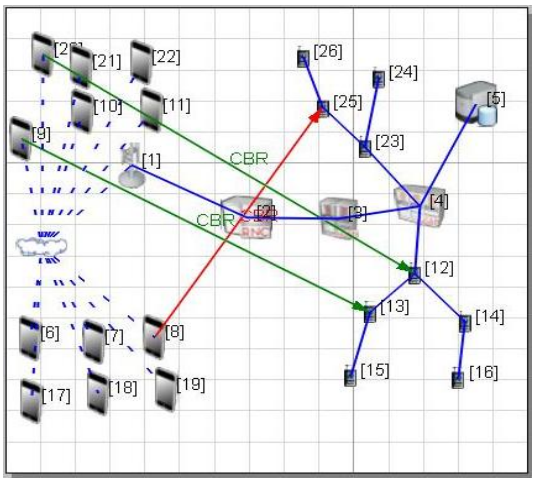

Figure 3: Scenario for analysing QoS in UMTS

IV. RESULTS

The parameters [5] throughput, average jitter and average end to end delay are defined as:

Throughput: Throughput is measurement of average rate of successful transmission of packets in a communication channel which is often measured in bits per second.

Average Jitter: The average variation in the packet arrival time is called Average jitter. Its often is in reference to clock source.

Average End-to-End Delay: End-to-End delay is the time taken for a packet to be transmitted across network from source to destination. It includes transmission delay, propagation delay and processing delay.

where transmission delay (or store-and-forward delay) is the amount of time required to push all of the packet's bits into the wire; propagation delay is the length of time taken for the quantity of interest to reach its destination and processing delay is the time it takes router to process the packet header.

Graphs of throughput, average jitter and average end to end delay for different precedence bits are shown below in figure 4, 5 and 6 respectively.

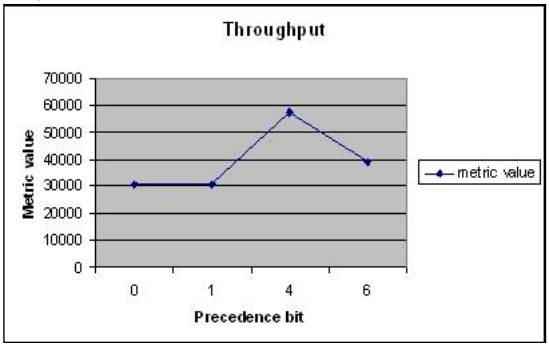

Figure 4: Throughput for different precedence bits

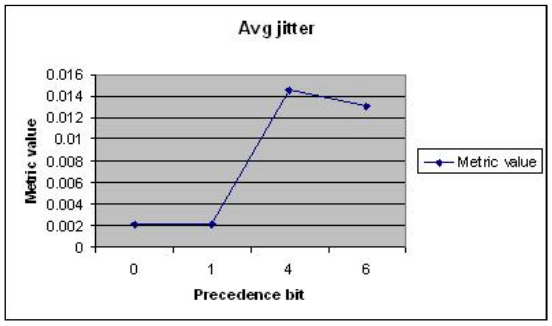

Figure 5: Average jitter for different precedence bits

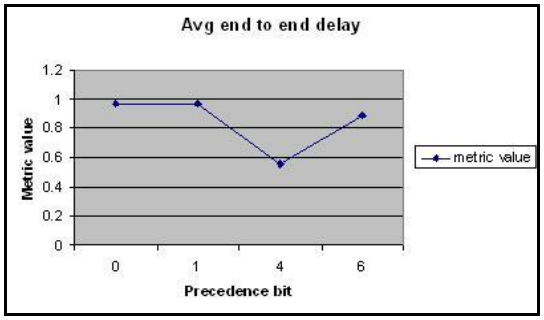

Figure 6: Average end to end delay for different precedence bits

V. CONCLUSION

Universal Mobile Telecommunications Service system is advancement over second generation system with enhanced data rates, capacity, security and much more .This paper gives an overview out of the UMTS system with its architecture and emphasizing to the Quality of Service in the UMTS network. UMTS is considered as evolution step from 2G to advance. The introduction of new WCDMA based air interface imposed new requirements for UMTS Radio Access Network.

The Quality of Service was analysed by changing the value of the precedence bit of the CBR application. The values of the precedence bits that have been taken are 0, 1, 4 and 6. It was found that maximum throughput was achieved with precedence bit 4. The minimum average end-to-end delay was also achieved with precedence bit 4.

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