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Enhancement in Quality of Services using Integrated Services in 4G Cellular Network

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Abstract-Mobile communication is considered as one of the most critical issues in the domain of cellular networks. A cellular network implements the appropriate network model to support packet data services at high speed. The core of the packet data service model is an important part of quality of service (QoS). In order to provide support to different QoS, multi-services configured in universal mobile telecommunication systems. This research work provides the enhancement of QoS, using integrated services in radio access 4G cellular network. To enhance integrated services, a resource reservation protocol is implemented at Radio Access Network (RAN) layer and deployed to enhance the QoS. The objective of this research work is to implement it on the architectural model for integrated services and QoS classes, mapping it into universal mobile telecommunication system (UMTS). Its ultimate benefit is to provide a wide range of 4G services to mobile users. Because it helps to run the fast multimedia services and error free Internet facilities with efficiency and consistency. Accordingly, it provides QoS at high speed. This research work also draws the comparative analysis between integrated services and differentiated services for each class of traffic problems as well.

Keywords-QoS, Integrated Services, RSVP, UMTS, 3G/4G

I. INTRODUCTION

QoS in a cellular network is controlled in principle by an Internet Protocol (IP) bearer service manager. This barrier services manager resides in a gateway node. It potentially exists in the mobile station in the 4G cellular network which was not in the early models. This manager can use any of the QoS control that exists in IP. QoS configuration is implemented at differentiated services, end to end node function, IP policy enforcement and integrated services level. The QoS is mandatory while the integrated services are optional. They provide IP signaling by using Resource Reservation Protocol (RSVP)by reserving bandwidth and meet QoS requirements as described in [i].

Ideally, General packet Radio Service (GPRS) supports the same QoS classes as Universal Mobile Telecommunication Systems (UMTS) (i.e. Conversational, Streaming, Interactive and Background) [ii]. When the mobile is attached to its GPRS, it registers its capabilities. This is the first step in assigning quality. In this way, mobile switching class mark is stored in the mobility management context. As long as mobile cellular is attached to GPRS, we get the radio and network capabilities. Radio access capability is further split into two parts, one for Global System of Mobile (GSM) and the other for UMTS. The GSM part contains multisport capabilities, technology types and power class. It is sent by Mobile Station(MS) to serve GPRS support node (SGSN) which is used by Base Station Subsystem (BSS) as addressed in [iii, vi, xv]. Support of QoS depends on QoS profiles as discussed in [iv, viii, ix, xvi] for the services request. Bit rates, error rates, delays and ordering requirements are included in a 13-octet. QoS information element is carried in the QoS profile.

In several scenarios, our focus on real time traffic utilization is effectively achieved by non-real time traffic transmission with the quality of service provisioning mechanism in 4G network.

They tell the architecture that how to configure RSVP in UMTS. These are the key entities which are involved in the QoS issues of any communication system. They are based on RSVP implementation, a comparative analysis of differentiated and integrated services which provide the results and conclusion. The upcoming section describes literature review regarding UMTS protocols and service.

II. LITERATURE REVIEW

In this section, we address the concepts of implementation in terms of volume, data transfer rate and new facility capabilities from Second Generation(2G) active networks towards 3G [6, 10]. In its starting phase, third generation (3G) offers fantasy bit rates up to 512 kbps in high flexibility localities, but now it has increased up to 4 Mbps in stationary user environments. Using Regularity between upstream and downstream data rates seems that we are using combined frequency division multiplexing spectrum. It also means that 3G/4G over UMTS and QoS classes is perfectly suitable for user requirements such as actual video telephony.

The research community addresses to keep attention only on UMTS as it is the core method in the IMT-2000 standardization structure that is capable to provide accurate 3G facilities to a broad range of European clients in the foreseeable future [vi-vii, xi-xii].

As per the theoretical focus, we can share the 3G/4G network into two layers. The first one is access layer and the second is non-access layer. The access layer not only covers the protocol treatment between the user modules but also the access network. The non-access layer contains the protocol treatment between the user modules and the core architecture of the network. The structural focus of UMTS network is categorized into three main units i.e. client hardware, remote access network and the core structure. Another object is that it not only adds access network in the core architecture of UMTS but also delivers a major external network. Functionality, it is the remote access method that is used in UMTS. The following Fig. describes the physical layout of UMTS cited in [v, xiii].

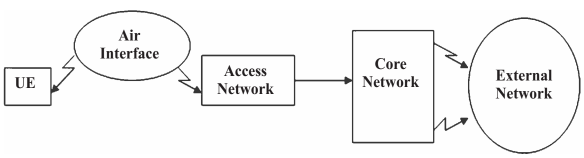

Fig. 1. UMTS Architecture borrowed from [v, xiii]

Firstly, we have a look to the air interface of the UMTS and later focus on the contents of UMTS.

It is cited in the literature that some of the access techniques can be used or are being used for radio access in different communication networks. Here, we address the specification of various technologies which are defined for the radio access but the widely agreed technology is the Direct Sequence-Wideband Code Division Multiple Access with Frequency Division Duplex (DS-WCDMA-FDD) [viii, ix, xiii]. The Time Division Duplex (TDD) is another technique used within the Wide-Band Code Multiple Access (WCDMA) [v].

WCDMA is the enhanced version of the access technique CDMA. The common difference is that the frequency band shared by the users is much wider than that in CDMA. The total band is of 5MHz with the effective band of 3.8MHz. The rest of the band is the guard band. This technique is used in WCDMA which spread spectrum in the channel for the broadcast signal. It creates much broader than the channel of the real information. The spread spectrum technique has many advantages that includes its resistance in radio interference and signal interference through multiple transmission signal branches. Majority spread spectrum methods are now available. For example, frequency-hopping spread spectrum (FHSS), direct sequence spread spectrum (DSSS), time hopping spread spectrum (THSS), and hybrid methods which are the merge of the first three. UMTS WCDMA use direct sequence spread spectrum [vi-vii, xiii, xv].

A. Duplexing Methods in WCDMA

Commonly, two duplexing methods are used in the WCDMA architecture, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD)[i]. FDD needs paired frequency bands for Downlink (DL) and Uplink(UL). The TDD method uses unpaired bands. Both duplexing methods have an overall similar performance. Although, some differences exist between them. Due to a clash between transmitted and received time slots, TDD does not delay high propagation in mobile station and base station system which makes TDD systems more suited for environments at low propagation delay. It means TDD operational mode can be assigned to smaller cells. With proper network planning, the distinctive advantages and disadvantages of both methods may work complementary [i, xi-xiii].

III. Experimental Setup

We have implemented this work by deploying the Network Simulator (NS-3) at transport layer and physical layer of Transmission Control Protocol over Internet Protocol (TCP/IP) model in order to accomplish the objectives of the study. This effort provides accuracy of high data rate, low jitter with least latency and high throughput through integrated and differentiated services. The results, shown in this research work provides efficient results than previous existing techniques.

Here is the protocol implementation architecture of transport layer in UMTS network interfaces.

A. Protocol Architecture of Transport Network

In UMTS, the practical architecture is the lowermost layer in transport, which facilitates the services to transportation and routing together. Over all, the user traffic and switches in UMTS are network interfaces. The below mention Fig. 2 describes the protocol architecture of transport layer network.

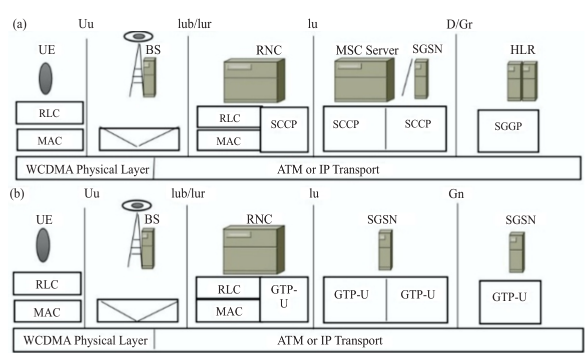

Fig. 2. Protocol architecture of transport layer

B. Physical Level Protocols in User Interface

The transport channel has used multiple types of information over the physical layer protocol. Physical layer is responsible for sending and receiving data bits and controlling the physical channels. It also provides bandwidth on demand. That's Why, it has a variable bit rate and manages the transportation arrangements over the transport stations. Security is also maintained by the physical channel by attaching a Cyclic Redundancy Check (CRC).

The most important performance among transport stations and physical stations for multiplexing is also done by the physical level procedures in the Uu interface. It is also a platform between the UE and BS.

1) Physical Layer Protocols in Other Interfaces

3GPP standardization bodies have selected two main procedure suites: first from wideband telecom system and the second is the Internetwork bit rate in transmission networks. Usage of IP or Asynchronous Transfer Mode(ATM)procedure in UMTS transport layer network requires additional convergence protocols. Pseudo noise in the core network (PSCN) domain relies on the use of these protocols.

C. Services in UMTS

The UMTS networks are the networks of services are compared with GSM or any other 2G networks. UMTS is capable for wide variety of services. The services, offer in the UMTS, include the normal voice services, video and audio conferencing, streaming services that include both the audio and video streaming and other services like the internet browsing and email. The circle of the services expands with the passage of time but it is hard to predict any limit for the services that will be the part of the UMTS. Due to the vastness of the services, they are offered by the 3G networks. QoS become much more important in direction to manage the system resources and to deliver satisfaction to the user of any particular service.

1) Quality of Service (QoS)

QoS can be described as a quality of the communication session. Clients' focus on the QoS calls success rate should be high with minimum delay and jitter when data is transferred with negligible loss of the data. These facilities are informal to meet in stable systems but are quite challengeable. The 2G networks are designed only for voice calls. Mostly, the time of voice traffic is restricted due to the limited scope of QoS. In UMTS, on one hand we have voice calls which impose the restriction on the delay and jitter in the network. While on other hand, we have packet data transaction which does not impose restriction on delay over minimum error rate. So, to cope with all these different restriction and to handle all these services in a single network with scarce resources the proper QoS management is required.

The quality of service can be implemented through various sets of parameters that will be discussed later. These parameters have different values for different services. The network allocates different resources for a certain call on the basis of these parameters.

2) UMTS QoS Carrier Design

Common objective of the UMTS packet bits is to deliver QoS bits of data distribution with suitable module through peer to peer services. These services are used to get the requirements to build and configure the design of QoS defined in 3GPP [ii]. The layered QoS architecture address the following key points:

I. QoS limitations linked with Traffic classes
ii. Locality of QoS utilities
iii. QoS Cooperation
iv. Network resources share data flow by multiplexing
v. A peer-to-peer information release model

The layered design of QoS allows the simultaneous growth of diverse working of network. It has been represented in Fig. 3.

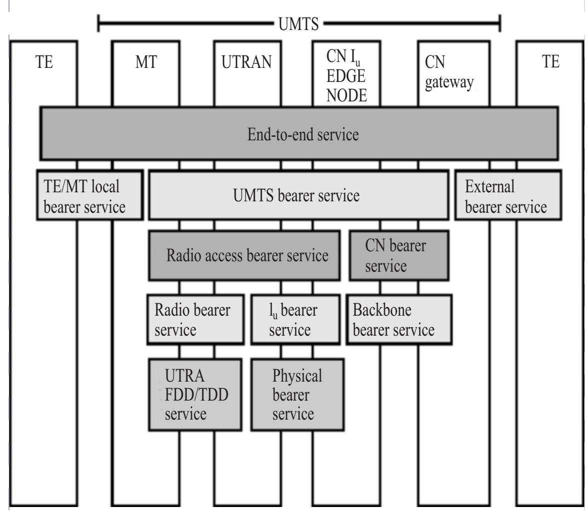

Fig. 3.UMTS QoS Design

In Fig. 3, we see that here are some layers each present its job and thus reducing the simplicity. The core network carrier facility explains that how a given system delivers the QoS by signaling procedures and organization purposes. When more than one network are involved, we have to go out of home network. The peer-to-peer carrier facilities are dependable but the combination of network services are involved in networks. The peer to peer carrier facilities are additionally distributed into three sections Terminal Equipment (TE) local carrier facility, the exterior local carrier facility, and the UMTS carrier facility.

The TE local carrier facility allocates the transmission with different modules or remote stations. All these modules are called Mobile Telecommunication (MT). Majority physical modules are responsible to manage the UMTS Remote Access Network (UTRAN) across the air interface and single or many connected end client modules. It is called terminal equipment. The UMTS carrier facility is maintained by a lower layer carrier facility with a radio carrier facility, Core Network (CN) carrier facility and back end facility. The Radio Access Barrier (RAB) delivers the information transmission between the system network and the remote terminal through the CN service. Responsibility for the link of the UMTS network by the further external network over gateway. The part of this facility is to control it efficiently and utilize the back end network in direction to deliver the slight UMTS carrier facility. The UMTS packet core network provision different back end carrier facilities for a diversity of QoS choices.

3) QoS Attributes

Providing QoS in UMTS is based on a properly selected bearer service, and for one call, the service has several functions. The characteristics of the bearer service set have specific parameters. These parameters are described in detail below:

i. Flow Class: Provides QoS configuration of classes in different classes based on UMTS, and various services. These classes are explained in the next section.
ii. High bit rate: This is the high number of bits that can provide a UMTS bearer within a certain time interval. This is important for the radio resource management and avoid wastage of the resources
iii. Assured bit rate: The average number of bits per second is equal to the call duration for the entire lifetime. At least, the sustained bit rate must be guaranteed by the network and the number of bits in given unit of time.
iv. Delay in transformation: This is the delay between the user and network data transmission and the maximum transfer delay is limited with respect to the type of service.
v. Traffic Handling Priority: This determines the relative significance to handle all the information units on the single carrier as parallel to other. This priority is primarily used for scheduling different types of interactive traffic.
vi. Retention or Allocation Priority: This is used to distinguish carrying rare resources that are allocated or reserved. It is a subscription attribute which can be negotiated by the mobile.
vii. Delivery order (y/n): This limitation determines the carrier order of SDUs that may remain the true sequence or not.
viii. Service Data Unit (SDU) maximum size: This parameter defines the type of specific service and the maximum size of the packet data unit. This is used for permission control and security.
ix. SDU information format: This parameter contains an exact format of the data unit. The application can list the exact size of the SDU, which means that error protection by the radio access bearer.
x. Error ratio of SDU: In SDU, the ratio of the total number of SDUs is lost or received. This parameter can be used by selecting the UTRAN protocol, error detection code algorithm and so on.
xi. Bit Error Ratio (BER) of residual: It defines the SDU as the bit error rate of the undetected transmission can also be used to select the protocol error detection technique.
xii. Erroneous delivery SDUs (y/n/-): it signifies whether erroneous SDUs should be provided or dropped, or delivered without considering error detection.
xiii. Statistics descriptor of source: (speech/unknown): This indicates whether the source should be allowed the use of statistical characteristics by using statistical multiplexing. Because it delivers voice discontinuous transmission characteristics.

Now keeping in view the above-mentioned parameters, in order to deliver an efficient QoS, we desire a guaranteed bit rate and the delay should be low. Further error ratios should also be small. In this way, the priority system can be implemented to differentiate non-real-time and real-time services.

D. UMTS QoS Classes

In UMTS, a method of providing QoS is based on the class of service. The services are offered by the network and these services are categorized into major four classes. The QoS parameters are defined for each class. This class is based on scheme to help the group services of the same type together. It defines the QoS for that class on which the basis of services are grouped.

The implementation of this class-based methodology is done with the help of User Equipment (UE). The UE may negotiate QoS parameters for the radio bearer. The negotiation process is always initiated by the UE application. They send the necessary resources to the network request. The network determines whether the requested resources should be provided or not. The requested resource can be granted reduced or rejected a request for a resource. UE may accept or reject the revised offer. Application requirements can be changed (UE initialization renegotiation).You can renegotiate these parameters if the state of the network resource changes the connection (Network (NW) starts to renegotiate).

In UMTS, QoS requirements can generally be divided into four categories as QoS classes of UMTS. They are Conversational Class, Streaming Class, Interactive Class, and Background Class.

On the demand side, the composition of each service of this class is somewhat similar in form of the requirements. In the following, we will discuss each class in detail along with the services offered in that class.

The detailed parameters are depicted in Table I. Each class has the parameters to display and negotiate the classes which remain unmarked.

TABLE I
PARAMETER REQUIREMENTS FOR UMTS CLASSES

Traffic class	Conversati-onal class	Streaming Class	Interactive Class	Background class
Maximum bit rate	X	X	X	X
Delivery order	X	X	X	X
Maximum SDU size	X	X	X	X
SDU format information	X	X		
Delivery of erroneous SDUs	X	X	X	X
Residual bit error rate	X	X	X	X
SDU error rate	X	X	X	X
Transfer delay	X	X		
Guaranteed bit rate	X	X		
Traffic handling priority		X		
Allocation/ retention priority	X	X	X	X

The Table drawn above shows the required QoS parameters for each class of service. It guaranteed the provisioning of QoS.

1) QOS Handling in UMTS

This all related to the simple perception of the quality of services phenomenon. Now, we will discuss the handling of the QoS in various network components of UMTS such as radio access network and the core network.

2) QoS Handling in Radio Access Network

In UMTS, the radio access network is particularly referred to UTRAN. In the previous Section, we have discussed the UTRAN in detail and we know that it is used to establish the RAB between the user and the network. UTRAN is linked to both, the packet and circuit switched area of the core network. At a certain moment of time, it can handle one or several RABs. In order to implement QoS provisioning in the UTRAN, each established RAB is characterized by a certain set of parameters and these parameters are obtained by the UTRAN after the core system. The main task or the goal of UTRAN is launched and continue the RAB by those QoS levels. All the time, RAB remains recognized at the demand of core system. If the UTRAN has admitted the QoS levels, it becomes his responsibility to maintain those levels of the UTRAN. In parallel establishment of RABs, UTRAN also monitors the established RABs so that the QoS levels should not exceed. Smooth traffic flows and blocking prevention is fundamental. Low importance is thatNon Real Time (NRT) transportation can be delayed in approval of high importance Real Time (RT) services.

In general, the real time services impose strict transport delay obligations on UTRAN. For real-time services, the transport delay should be according to the 3GPP requirements less than 7ms and the jitter should be less than 10% of the transport delay. These requirements are relaxed for the non-real-time services where the transport interval extends to 25-30ms. Rigorous requirements for jitter, delay and loss rate show UTRAN transmission in a real-time application transport network. The transportation network must be given a very high priority and a firm commitment to the resources. The main features of the radio access network are the processing of QoS, control functions, radio access bearer control (RAC), radio resource allocation and radio management.

Talking about the transportation solution in the access network, first ATM was proposed by 3GPP but now release 4 and 5 IP are given as the transport solution for the UMTS. IP is becoming fast in online world of data, voice and grouping based signals and operations. Therefore, IP-based RAN is consistent backbone infrastructure which allows operational efficiency. Another important fact is that the 3G core network is based on IP. IP-based transport solutions face many challenges to meet the rigorous transport requirements of 3G RANs, especially the WCDMA UTRAN. QoSmeans tightly ending the zero packet loss rate and delay jitter control. Current IP networks are designed for data applications that do not delay. It also needs to improve IP-based transport solutions that provides QoS support, including latency, jitter and loss. In addition, reliability and safety as well as transmission signals must be supported in real time.

We identify main evaluation criteria of the resource reservation protocol (RRP) in cellular environment, mapping UMTS of QOS classes to Integrated Services and differentiated services. The comparison of differentiated services and integrated services with MPLS provides reliability and accuracy in transmission of real time networks.

E. QOS Provisioning Mechanism

Behind the 3GPP R5 announcement, the purpose of the 3G network is fully switched to IP address. In the previous rare decades, proving intellectual property is a concept of data transmission. It is described as "the best effort" which especially suited to the quality of connection.

In the mobile cellular networks, the users are consumed by engaging Connection-oriented service with the distinct amount and excellence features.

The first mechanism/approach for provisioning the Quality of Service is known as Over-Provisioning. This is a straight forward approach of carrying QoS to a network by making the unrestricted quantity of bandwidth which is accessible to the clients. This approach, no doubt, is highly expensive due to which, it cannot be implemented. As the cellular environment is highly dynamic, i.e. amount of available resources and a number of users continuously change. So, different QoS provisioning mechanisms have been developed and proposed [vi-vii, xi-xii].

Now in the next units, we will discuss the mechanisms that gives the guarantee of QoS over standard IP devised.

1) Resource Reservation Protocol – RSVP/IntServ Approach

Internet engineering task Force (IETF)defines this mechanism to enable the receiver to request the required QoS. Perhaps, it is the most complex procedure for QoS provision. Resource Reservation Protocol (RSVP) works over the transportation layer IP like Internet Control Message Protocol (ICMP) [xv, xviii]. RSVP has been developed to address network congestion. It allows routers to determine in advance whether they meet the requirements of the application process if they are available. In fact, RSVP is used to start integration services. An integrated service (Int Serv) has two options:

i. **Guaranteed Service (GS)**: This is a personal virtual circuit analog in integrated service status. This provides a steady state limit connector according to the rules of the traffic delay parameter. This also provides an upper limit constant flow of delay and loss. Audio and video applications are suitable with strict delay requirements [xv, xviii, xxiii-xxiv].

ii. **Best-effort service (BE)**: Internet services are offered at a similar level of service, delay, loss and jitter with the latest backup solutions without any limitation.

Controlled load (CL): This integrated service state is just like the definition in "best effort in no-load conditions". For a given process, we cannot guarantee to provide certainty about the end of the delay. The service of this class is designed for real-time applications and adaptive structure [xix].

In the case of bandwidth limitation delay, jitter-bound traffic and the transmitting side will be described as in Figure. 4. This information is sent to the recipient address in the RSVP PATH message. The establishment of each RSVP receiver along the receiver router PATH message always includes the state of the previous address in the PATH message. Finally, the PATH message reaches to the recipient.

To acquire resources, the receiver sends a RESV message transmission direction. The QoS includes a so-called path that defines the attributes of the original message in the path message.The type of the integrated service utilizes the request. The RESV message is also included in the definition data retention filter packet (transmission protocol and port number). All these definitions works together and form a so-called "stream descriptor" that is configured along the path of using each RSVP which enable router to identify resource reservations [vi-vii, xi-xii].

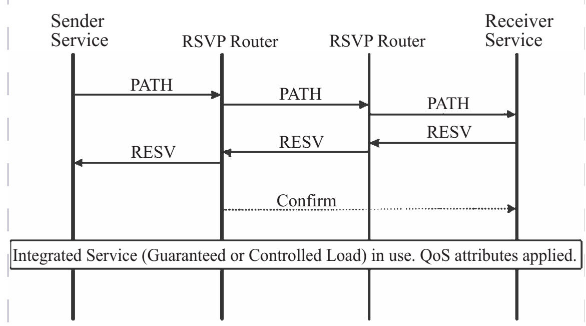

Fig. 4. RSVP Principle Diagram

When RESV message is received then use routing enables RSVP, Accept Control (AC) and allocates the necessary resources which are needed for the activation process to initiate the authentication request. If this resource is not allocated, the router will forward the address to recipient to show the error message. If all AC-related processes are successful, the RSVP is enable and router will send a RESV message to the router.

When the last router use the RESV message in RSVP, the router indicates that the service preparation is a route and sends an acknowledgment message to the receiver with the desired characteristics and QoS request. Router RSVP is closest to the last transmitter which has mentioned here, or common point of a multicast stream. In another words, we should adopt common points while using the multicasting technic.

The path between the sender and the receiver can contain both RSVP and non-RSVP capable routers. In this case, the non-RSVP router is transparent. Because we cannot guarantee that this environment of non-RSVP routers is dangerous to connect with resource reservations.

F. RSVP In Cellular Environment-Mobile RSVP

There are several problems, if you use the mobile communication network standard RSVP. For better understanding, we use the cellular network, which is characterized in R1, R2 and R3. They are connected through three routers of the Packet-Switched Public data Network (PSPDN), as per shown in below mention Fig. 5. R2 router is serving cell 1-4 and 5-7 taking R3 router. In the case of R1 and R2, the reservation base station 1 in the Mobile Station (MS) along the path indicates the bold line in the base station 1. When the MS 2 enters in the current cell, R2 is reserved and connected to the base station 2.Now it is moved under the base station 2 along a new path.

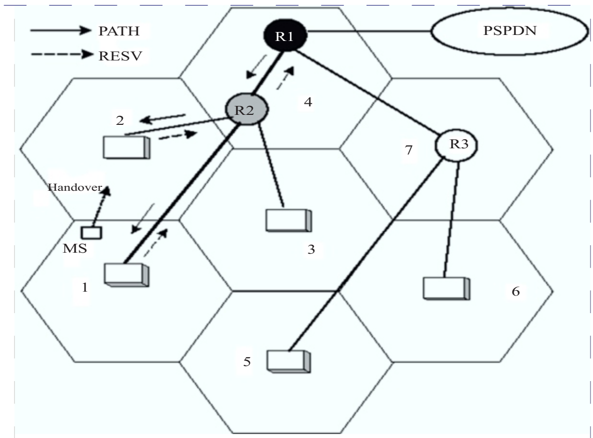

Fig. 5. Traditional RSVP in a mobile environment

The MS must wait for the host to receive RESV message because the MS can transmit the PATH message periodically. The data source awaits a new reservation, such as RSVP, which cannot be used to initiate the reservation request before receiving the PATH message. On the other hand, R2 continues to send packets along the previous path to cell 1.These packets are lost by the MS [i, iii, xii-xiii].

This difficulty is terminated or resolved by exchanging the RSVP so that MS can be handed over to a new cell. After that, the path message of R2 can be transmitted. Due to the resource reservation process, the associated delay remains very slow. Every packet loss can be too long. If the MS moves to a very high flow cell, the problem becomes particularly severe. Under these circumstances, the MS should renegotiate by the system or network to allocate the necessary resources, which will no longer lead to additional loss of delay and data packets. According to the quality of service requirement, the network can deny the reservation request. Thus, the guarantee of required quality is impossible.

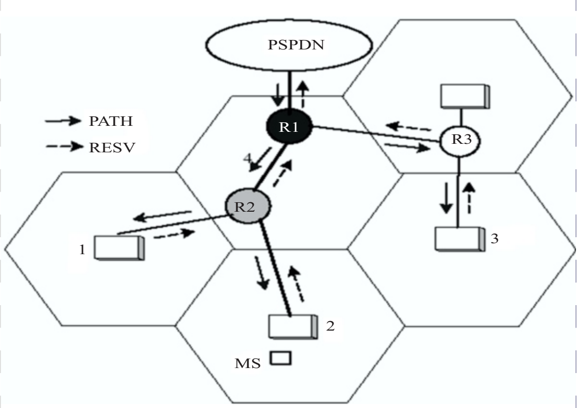

Fig. 6. Mobile-RSVP in a mobile environment

This problem addresses the use of mobile RSVP. MRSVP recommends that all MS-accessible nodes can be stored in a network database. All node resources are maintained by the MS, but it use only one resource. This can ultimately reduce delays. It is shown in Fig. 6. Because the MS 1, 2 and 3 can access the allocation of resources to the cell in three paths or routers. During the other two passive routing, the cell distribution of MS (2) is activated. The base station (2) from MS to RSVP in R2 to PSPDN is connected [i, xii, xii].

G. Disadvantages: This concept is simple but holds several disadvantages:

This information cannot be true around the roaming MS in the cells, so this idea is not widely practical. MS is expected to roam in a large number of cells. If each cell has a lot of MS, then system database must be extremely large. Because it will be too difficult to manage such database. It is proportional to the amount of state information flow. We can handle hundreds of thousands of core routers in the core IP network which requires the processing load of huge resource requirements. This method does not balance well by the amount of movements and creates routers extremely complex. This architecture is not compatible with short-term traffic flows such as the web, because the processing of RSVP is larger than all packets in the stream of ownership. RSVP is a smooth state method to continue public information for every stream. This needs big storage ability. The status is not timed out and the malicious user set the PATH message timer value. It is extremely important to take up network node memory resources.

1) Mapping UMTS QoS Classes to Integrated Services Classes

In order to guarantee QoS in UMTS, environment use Integrated Services/ RSVP approach. We need to consider the mapping between four classes of QoS of UMTS (i.e. Background, Interactive, Streaming and Conversational) and the Three Integrated Services Classes (Best Effort Service, Controlled Load and Guaranteed Service)

If we observe the requirements of Conversational UMTS class and Guaranteed Services (Integrated Services), we can conclude a perfect match as GS is designed for application services with high delay requirements [xvi, xx-xxi].

Interactive UMTS class is intended specifically for adaptive actual requests. The services belong to this class can tolerate higher delays as compared to conversational UMTS class. Although the Classifier (CL) Integrated Service class does not provide any delay guarantees due to its resource allocation policy. We still expect reception of packets at acceptable delays. Therefore, Integrated Services CL class may be configured the Stream of UMTS class.

The background class does not need to reserve any sort of resources in the network. So, we can map this class to the Best Effort class of Integrated Services.

As there is no knowledge of traffic characteristics regarding to the applications in Interactive class. So, we do not know how much resources should be reserved for data belong to this class. But, still, we may fix a maximum bit rate. Therefore, we propose signaling the traffic class by CL class of Integrated Services. The below mentioned table display the planning of Integrated Services classes to UMTS QoS classes [xxii].

TABLE II
PLANNING OF INTER SERVICES AND UMTS CLASSES

UMTS QoS Classes	Diff Serv's PHBs
Conversational Class	Expedited Forwarding
Streaming Class	Assured Forwarding-Gold Class
Interactive Class	Assured Forwarding-Bronze Class
Background Class	Best Effort

2) Differentiated Services

Firstly, classification of the packets and a relative simple mechanism allows the other processing in the network of classes. Each transparent resource reservation stream in RSVP Integrated Services is not a large network. Consequently, RSVP / Integrated Services are for practical methods.

Differentiated Services are applied in Layer 3. It uses its IP header over network layer. It is internal network protocol. It use IP version 4.0 "Service Type" field and 6.0 traffic type field of IP. But each field is modified. The following embodiment, shown in the utilization diagram of Differentiated Services in the IP header field 8 (referred to as DS field) shows the importance, priority bit description and T, D, R:

TABLE III
TOS AREA OF IP HEADING CONSUMED AS DS AREA

3 Bits Precedence	D 1	T 1	R 1	Unused 2

It also uses a six bit DS code point (DSCP). It ignores the remaining two bits unused or left.

TABLE IV
SIGNIFICANCE OF PRECEDENCE BITS IN DS FIELD

Precedence Bits	Significance
111	Network Controller
110	Internetwork Controller
101	Critical
100	Flash Overrule
011	Flashy
010	Direct/ Speedy
001	Precedence
000	Scheduled

TABLE V
SIGNIFICANCE OF T, D, AND R FIELDS IN DS FIELD

T-> Throughput D-> Delay R-> Reliability Bits	Meaning
000	Throughput, Normal Delay and Reliability
100	Low Interval
010	Extreme Throughput
001	Extreme Reliability

The two main components of Differentiated Services Architecture are the use of simple queue priority mechanisms for forwarding and the use of allocation policies and configuration rules at edge nodes.

Packets originate the sender domain when it enter in the Differentiated Services system. They are categorized over PHB (Per Hop Behavior) and then prepared at an edge device/router. The forwarding treatment for a group of packets is termed as PHB. They are more achievable DSCP and consistence PHBs. E.g. DSCP 000 000 is the default and gives the lowest priority of forwarding. It indicates the gathering of packets which are provided by the system on “Greatest Struggle”. Differentiated Services PHBs cover the following four arenas:

1- Best-effort services/default
2- Expedited Furthering (EF) for short interval, short latency and low-jitter facility (as described in RFC 2598)
3- Assured Forwarding (AF) four relative CoSs as defined in RFC 2597
4- Class selectors for backward compatibility with IP precedence methods

There are four main functions of Differentiated Services routers for the conditioning of the incoming packets in a Differentiated Services network as stated below:

i. **Classifier:** According to the rules, the contents of the packet header of the choice are based on the packet.
ii. **Marker:** Execution flags (pre-labeling and annotation DS code point process data packages are provided according to defined rules)
iii. **Shapper/Dropper:** Perform shape (packet delay traffic flow so that certainly defined flow templates follow to the process.)
iv. **Meter:** The time is selected by the metering device so the classification of the measurement process (e.g., ratio), measures the characteristics of the traffic stream.

H. ***Advantages:*** The main advantages of implementing Differentiated Services at IP level are

I. Additional Signaling controls the traffic in the Differentiated Services scheme. After all,QoS specific information is not included in the UMTS control plane protocol (e.g., Radio Access Network-Access Point (RANAP) and Gateway Tunneling Protocol(GTP) control plane, etc.).
ii. The complexity of all nodes will be configured according to the network resource allocation aggregate traffic in the edge/router.
iii. Promote interoperability with other networks such as differentiated Services, PLMN ISP, Intranet / Internet and UMTS.

1) Service Level Agreement: A key part of the differentiated services mechanism is Service Level

Agreements (SLAs). An SLA forwarding service is a facility contract under a client and facility provider network, which is used to designate a customer to receive. SLAs incorporate traffic rules. These rules include classifier rules that apply to classification rules, traffic profiles, billing, and customer traffic. The traffic profile is specified by the time attribute selected by the traffic classifier flows.

2) QoS Provisioning in UMTS using Differentiated Services

Differentiated Services, edge serving of wireless network controller, perimeter gateway router Serving GPRS support node, a gateway GPRS support node, and weighted indicated dictionary provide descriptive traffic regulation. Scheduling and priority description is discarded. DSCP marking and annotation-based traffic manage the policies. Flow meter carries out the contract. The packet delay contract is a consistent flow because the molding machine discards the incompatible packet dropper. IETF's Differentiated Services architecture on the road. [iv, viii, ix, xvi].

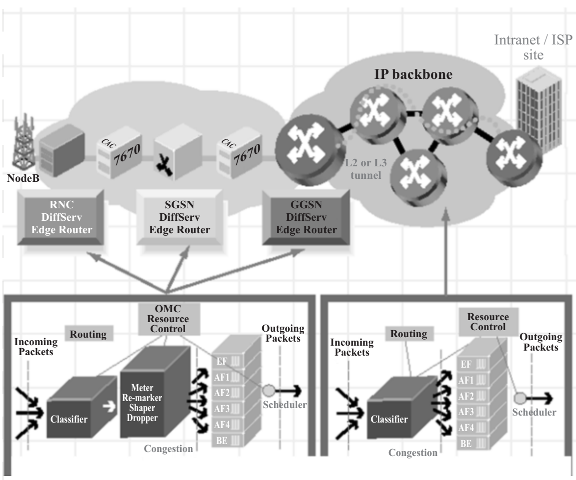

Fig. 7. Deployment of Differentiated Services under UMTS

3) Representation between IP Differentiated Services Classes and UMTS QoS classes

The UMTS session of the Differentiated Services architecture with the fast forwarding PHB class has the same characteristics. Stream class constraints on the average delay. It is obvious that the PHB can be small in mapping. The interactive class maps to the insured delivery but the problem is that the UMTS resources are not reserved. The interactive class and AF can be the DS's specific bandwidth share. The interactive class may be mapped to a minimum allowed bandwidth reservation with a minimum priority AF (Bronze Class). Then, the priority class may correspond to the AF of the interactive disposition priority attribute class. We need a mechanism to distinguish the AF class which must map to the class flow. These conditions must be mapped in the interactive class. We can use bronze-level media streaming and interactive classes that had a gold level of service AF. Finally, we want to map the background to the UMTS network. The following table describes possible mappings between QoS classes in UMTS and QoS classes in Differentiated Services.

TABLE VI
COMPARISON DIFFERENTIATED SERVICES WITH INTEGRATED SERVICES

UMTS QoS Classes	DiffServ PHBs
Conversational Class	Expedited Forwarding
Streaming Class	Forwarding-Gold Assured Class
Interactive Class	Forwarding-Bronze Assured Class
Background Class	Best Effort

4) Mapping of Differentiated Services Parameters to UMTS QoS Parameters

We never have any type of hard guarantees of packet delivery in a Differentiated Services Mechanism. The SLA just involves the Traffic outline (contains arrival rate & maximum burst size) while UMTS has some limits for every QoS domain. Several of UMTS QoS limits can be mapped to the parameters of Differentiated Services world. For example, Assured Data Rate and Extreme SDU range (UMTS limits) can be definitely planned to Arrival Rate and Extreme Burst Range in Traffic outline of SLA. Additional parameters of UMTS are particular and they do not have any equivalency.

The operator can use some default dependent values over the QoS class or application type for the attributes like “error of residual bit ratio” & “the sending of the specious SDUs”. The delivery of erroneous SDU defines the processing that we have to give an SDU in case of error detection, (forward with notification or discard) or without considering error detection. The “delivery order” attribute of the UMTS depends on the connectionless or connection-oriented nature of the traffic. If TCP is used, we can map it to 'YES' and if UDP is used, we may map it to 'NO'. “SDU error ratio” is also an important parameter while using Differentiated Services mechanism. The Background and Interactive UMTS classes are no doubt intolerant to this parameter. So, the default values may be used in these classes [xxii].

While on the other side, due to the variety of requests in Streaming and Conversational Class, the default values of this attribute cannot be used. A suitable and feasible solution to this problem is that we may let the User Equipment of SGSN to fix the worth of that limit according to as per the kind of application. This solution, on one hand, provides more flexibility in provisioning QoS in the network, but on the other hand, it adds more complexity in the system [i, vi, xiii, xv, xviii].

An alternative approach is to modify SLA in order to incorporate for all the missing values of UMTS attributes in the downlink direction. This is explained by using the below mention table:

5) *Comparison Differentiated Services with Integrated Services*

TABLE VII
MAPPING DIFFERENTIATED SERVICES TO UMTS CLASSES

Parameters	Differentiated Services	Integrated Services
Granularity of service Differentiation	Collective stream	Separate stream
The situation in Edge (e.g., scheduling buffer management)	Per-collective	Per-stream
Traffic category foundation	DS area (six bits) of IP caption	Some caption area
Service type differentiation	Perfect or absolute guarantees	Statistically or Deterministic assurances
Access controller	Needed for perfect difference only	Needed
Indicating Procedures	Not Needed for the comparative method; perfect method required semi-static objection or agents	Needed (RSVP)
Synchronization for Facility Differentiation	Restricted (per-hop)	P-to- P
Capacity of Facility differentiation	Everywhere in a system or in particular area	Multicast or unicast area
Scalability	Controlled the amount of sessions facility	Controlled the amount of stream
Network Secretarial	Depends on session running	Depends on stream character and QoS requirement
Network Administration	Related to present IP	Related to circuit switching
Inter domain Placement	Two-sided contracts	Multisided contracts

IV. RESULTS, ANALYSIS AND DISCUSSION

Simultaneous use of various types of services at the same time, different types of services with specific QoS requirements can characterize wireless access network to provide many problems and point to point quality.

Considering the enormous growth of mobile wireless communications for voice and data services, providing point to point quality of service and support for a variety of applications has the main operators and users. Because of the recognition of QoS, it has a great impact on customer satisfaction. The distinctive factor between UMTS carriers will be the ability to provide the appropriate QoS.

The three methods suggested in the earlier section are very important to provide a point to point quality of service architecture. Each architecture has its own advantages and disadvantages. Therefore, to solve these shortcomings, quality assurance services to provide the mobile cellular environment, we can achieve a combination of these mechanisms. So this is another mechanism to overcome any defects.

It includes two layers by using multi-protocol label switching, which uses differentiated services in the IP layer and in a quality method on the core network side in the service assurance form. Differentiated Services edge router, Gateway GPRS Support Node (GGSN), Serving GPRS Support Node (SGSN) and Radio Network Controller (RNC) are major complexities. Differentiated Services has implemented this method for some special advantages. The most important advantage is that there is no additional control signaling protocol. The control signal is carried by the GPRS tunneling protocol in the control plane protocol structure of the wireless network and application protocol. Packet classification and mapping MPLS form these edge routers. On the other hand, MPLS has certain disadvantages. An important consideration is the need to achieve a specific MPLS router. If the Label Switch Router changes or the Label-Switched Paths(LSP)changes, the routers include in the routing table must be updated. Therefore, proper map updates must be made to avoid overhead due to the dynamic routing table format. For this reason, sometimes we use Label Distribution Protocol (LDP).

Another way to provide quality services in a UMTS network is to use integrated services for differentiated services. This telecommunications sector has agreed that integrated services or differentiated services do not adapt to support multiservice network platforms. If you are using Differentiated Services in a core network, this method supports the idea of a control mechanism for Integrated Services at the network edge. The Integrated service architecture provides a method of quality of service for the sender of a service application in a heterogeneous network. To support this end-to-model, the Integrated Services architecture must support various types of network elements. The proposed reference model is shown in Fig. 8.

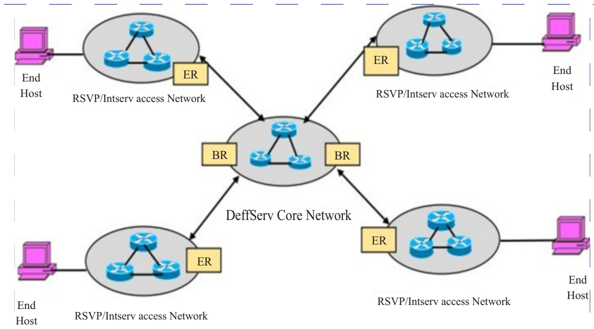

Fig. 8. Proposed Differentiated Services implementation in 4G

This proposed reference model is implemented using simulator i.e., Commercial & Industry Security Corporation (CISCO) Packet Tracer as shown in Figure 8. The proposed model represents the core network and backbone of RAN using Open Shortest Path First (OSPF), Routing Information Protocol (RIP), Border Gateway Protocol (BGP) and enhanced Interior Gateway Routing Protocol (EIGRP).

Based on our proposed referenced model in Fig. 8: we have simulated and draw the results in Fig. 9 and Fig. 10.

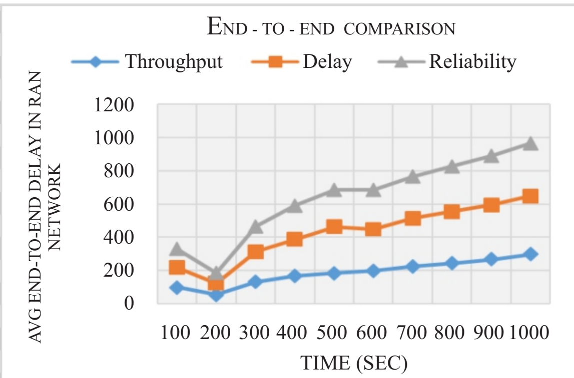

Fig. 9. AVG End-to-End Delay in existing RAN Network and constant throughput in end to end RAN network.

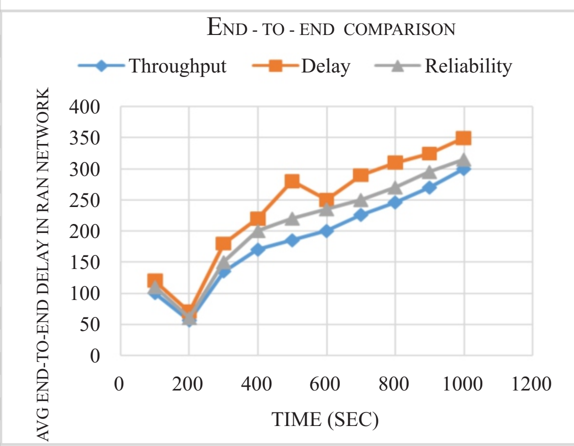

Fig.10. AVG End-to-End Delay in purposed RAN Network

Fig. 10 represents the less delay with increased reliability and throughput remains same by using our proposed reference model as shown in Fig. 8.

Contributions of Research Work

Integrated Survives and Differentiated Services support local area, including the middle of the Differentiated Services model in Integrated Services. The edge of the system component concerning these areas is generally identified as an edge router (ER) and a border router (BR). The previous research work is positioned in the Differentiated Services network area of the Differentiated Services system area.

Differentiated Services exists to manage local resources to meet the QoS requirements of end-user options. The best critical source is dynamic allocation of resources (by RSVP or other means (for example, bandwidth broker)).

Additional way is to use the Differentiated Services domain with Integrated Services. Therefore, this network resource management can be improved. It provides dynamic admission control and topology awareness.

Future Direction

Point to point QoS is an important factor in the success of mobile networks in the near future. QoS provides the appropriate mechanism which is necessary for the users among various services. Prevent performance degradation is very important in case of congestion for proper traffic management. The development of networks for IP-based networks is limited in quality and management of the delivery. In the core Networks aspect, the best way to achieve this is to use the QoS on Integrated Services. In the Differentiated Services, model of reduced Demand Control plane protocol and avoid overhead by MPLS.

This research work depicts a part of my MS thesis. We will extend it by implementing QoS for 5G UMTS networks to improve the performance in congestion management by using Integrated and Differentiated services in Pakistan in near future.

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