TECHNOLOGY HORIZONS JOURNAL

Vol. 2 (2), 15 Feb 2018, pp. 10- 14

Universal Mobile Telecommunication System Signaling Messages Performance

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Received: 15 October 17

Accepted: 10 December 17

ABSTRACT

The purpose of this paper is to study, analyze and simulate different types of non-real time applications and Real time applications such as Web Browsing (WEB), Electronic Mail (E-MAIL), File Transfer Protocol and different types of voice codec. In addition, the paper explains, how these applications generate signalling messages such as Radio Resource Control, Node-B Application Part and Radio Access Network Application Part in a Universal Mobile Telecommunication System (UMTS) using an OPNET Modeler 14.5. After execution of the simulation, the result shows that the E-mail application and the codec GSM half rate generate large number of the signalling message.

Keywords— Universal Mobile Telecommunication System, real-time application, non real-time application, signalling message, OPNET Modeller.

I. INTRODUCTION

UMTS as 3rd generation of wireless technology that utilizes a Wideband Code Division Multiple Access. With channel bandwidths starting at 5 MHz, offer data rates up to two Mbps [1]. The larger the size of the signalling message in a system, the less bandwidth left to carry traffic data. This consequently leads to higher latency, and extra processing coding decoding these signalling messages. Keeping in mind that the size of the signalling messages matters, but the number of signalling messages Involved is a big contributor to additional latency and processing in the network[2].

II. PROTOCOL STACK:-

Fig 1 showing the control protocol stacks describe the following layer:-

A) The physical layer (L1):- access scheme based on Wideband Direct-Sequence Code Division Multiple Access technology Support all functions required for transmission of information on the physical medium offering information transfer services through the physical channels to higher layers.

B) Medium access control layers (MAC):- handles the transport channels, mapping the logical channels into transport formats and transferring to peer MAC entities protocol data units.

C) Radio link control layers (RLC):- provide the transference of higher PDUs to the receiving entity and transfer of user data with quality of service settings.

D) GPRS Mobility Management (MM/GMM):-When a mobile attaches to PS domain, the Serving GPRS Support Node establishes a General Packet Radio Service Mobility Management (GMM) for that mobile. The mobility management function in the SGSN uses the source cell identity to identify the cell wherein the source MS is located.

E) Call Control (CC):-includes some basic procedures for mobile call control like Call Establishment and Call Termination. Session Management (SM) protocol used between UE and SGSN to create modifies monitors and terminates sessions with one or more participants, including multimedia conferences and internet telephone calls [3].

F) The Radio Resource Control (RRC) Protocol:- The major part of the control signalling between user equipment (UE) and Universal Terrestrial Radio Access Network(UTRAN) is Radio Resource Control (RRC) messages[4, 5]. RRC messages carry all parameters required for establishing, release and modify Layer 2 and Layer 1 protocol entities. RRC messages carry in their payload all higher layer signalling (MM, CM, SM, etc.). The mobility of user equipment in the connected mode controlled by RRC signalling (Measurements, handovers, cell updates) [6].

The major function of the RRC protocol is to control the physical channels, radio bearers and transport channels. This done by the set-up, reconfiguration and release of different kinds of radio bearers shown in Figure 2. Before such actions can take place, the RRC protocol communication itself must initiate by using a number of minimum four signalling radio bearers. The resulting signalling connection together with any subsequently established other bearers called RRC connection.

During the RRC connection, set-up, reconfiguration and release of other radio bearers for user plane traffic may execute by exchanging commands and status information between the peer RRC entities over the

signalling radio bearers. The RRC connection will continue to exist until all user plane bearers released and the RRC connection between UE and RNC explicitly released [7].

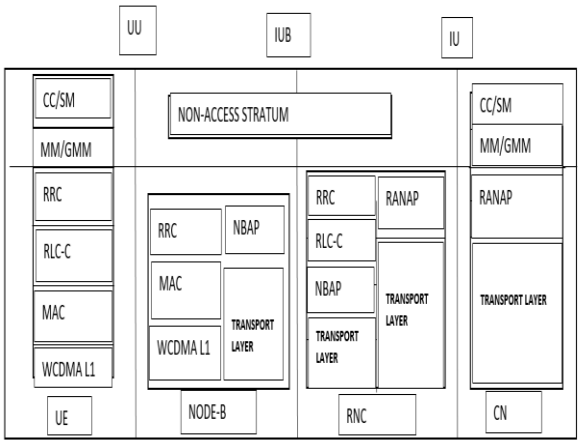

Figure. 1 UMTS protocol stack

G) Node B Application Protocol (NBAP) -:-

NBAP is a protocol, which maintains control plane signalling across the IUB interface and thus controls resources in the IUB interface and provides a means for Base Station (BS) and Radio Network Controller (RNC) to communicate. NBAP resides on top of the IUB transport layers and uses their services to transfer NBAP messages over IUB interface.

Correspondingly, the responsibility of NBAP is to establish and maintain a control plane connection over the IUB interface, to initiate set-up and release of dedicated user plane connections across the IUB interface and command the BS to activate resources for new radio links over the UU interface. All NBAP signalling functions divided into common procedures and dedicated procedures. Common NBAP includes procedures for configuration management of logical resources and procedures, which enable the BS to inform the RNC about the status of logical resources in the BS.

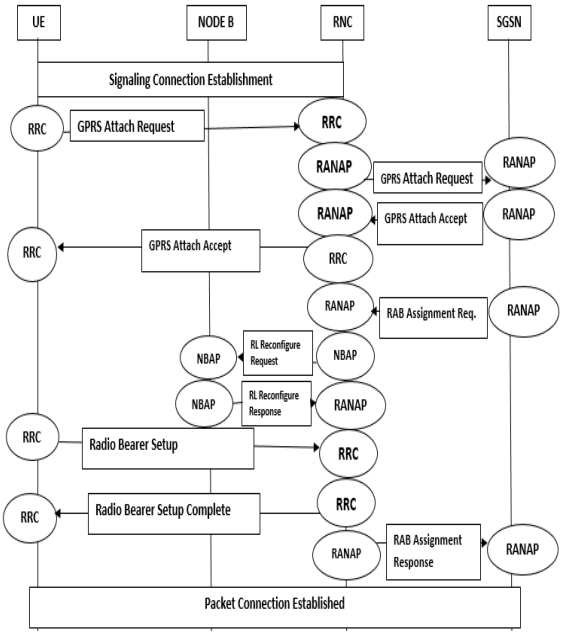

Figure.2 Packet connection establishment

Dedicated NBAP includes procedures for management and supervision of existing radio links, who is User equipment (UE) connected to the BS. These procedures allow the RNC to command the BS to establish or release some radio links for the user equipment context. Dedicated procedures also include radio link reconfiguration, management and support measurements on dedicated resources and corresponding power control activities, which allow the RNC to adjust downlink power level on the radio links[8]. The most frequently used, dedicated NBAP procedure tend to be radio link addition, radio link reconfiguration, radio link deletion, radio link restoration, radio link failure.

H)Radio Access Network Application Protocol(RANAP) -:-

This protocol called Radio Access Network Application Part (RANAP) and it is defined in the third Generation Partnership Project specification TS 25.413. Both circuits switched and packet switched domains use the RANAP protocol to access the services provided by the UTRAN. RANAP is the protocol that controls the resources in the IU interface. RANAP is located on top of the IU signalling transport layers. RANAP uses the signalling transport service to transfer RANAP messages over the IU interface. RANAP provides the means for the core network (CN) to control the establishment, modification, and release of the radio access bearer (RABs) between the UE and CN shown in figure 2. RANAP provides, for example, a means to control the overload in the IU interface if the amount of the user traffic grows too high [9].

III.METHODOLOGY:-

OPNET MODELER 14.5 used to simulate the UMTS Network. The OPNET Modeler provides tools for analyzing the output data. It has a detailed library of models that provide support for existing protocols and allow researchers and developers to either modify these existing models or develop new models of their own.

A) Topology and configurations

The network topology shown in Fig 3 describes the modelled UMTS Network using OPNET.This UMTS model consists of user equipment's (UE s), Node B(NB), and a Radio Network Controller(RNC), which are connected to the packet data network via a Serving GPRS Support Node (SGSN) and a Gateway GPRS Support Node (GGSN) over a common IP cloud. An ATM Link used to interconnect between the NB, RNC and SGSN, while an Ethernet link used to connect the SGSN and GGSN. Different types of applications used in this simulation, for example, File Transfer Protocol, EMAIL, Web Browsing and different types of Voice Codecs like (G.711, G.726, G.729, G.723, GSM FR, GSM HR, and GSM EFR). These simulations run with two different alternatives of inter-request time interval (5 or 1 Minute).

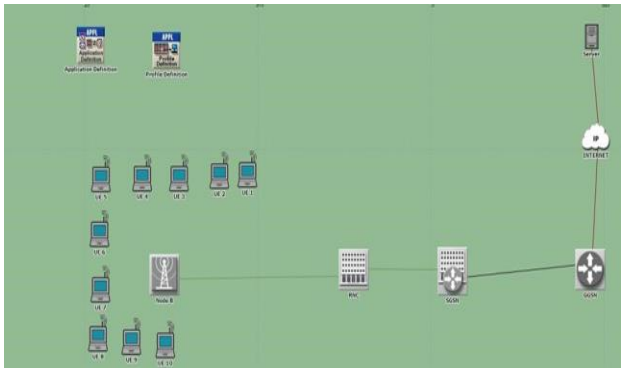

Fig.3 OPNET UMTS Model

IV. Performance Metrics:-

The key performance indicators used for analyzing UMTS signalling include- *A)* Radio Bearer (RB):-
The radio bearer is a logical data connection used to transmit user data between UE and RNC and does not indicate whether packet-switched or circuit-switched data is being, transmitted over the radio bearer [7]. And uses a channel like the random-access channel (RACH) and the forward access channel (FACH) [10].
B) Radio Access Bearer (RAB):- The RAB represents the logical connection between the UE and the core network. RAB are service specific and so a UE, which is simultaneously using multiple services, can have multiple RAB, e.g. a UE that has a CS speech connection while completing a PS file transfer has one RAB to the Mobile switching center (MSC) and a second RAB to the SGSN.
It is also possible to have multiple RAB to the same core network domain, e.g. a UE that is browsing the internet while downloading emails could have two RAB to the PS core network. RAB establishment starts when the core network forwards a RANAP RAB Assignment Request message to the RNC[4].
C) Radio Link (RL):- The Radio Link Protocol utilizes reliability mechanisms of the underlying protocols in order to deliver data and terminates at the Mobile Station and Interworking Function. The radio link setup used to establish the necessary air interface resources for a dedicated channel (DCH). That related to a Node B Communication Context in the Node B[10]. The NBAP Radio Link Setup Request message used to provide the Node B with DPCH information during initial connection establishment and during handover when the Node B does not already have any cells within the active set. If the Node B already has one or more cells within the active set then the NBAP Radio Link Addition Request message is used. This message includes less information because the Node B already has of the DPCH [4].

V. Results:-

After execution of the simulation, the results obtained in terms of a set of charts for different performance metrics.

A) The ratio of the Radio Bearer messages according to different Inter-Request Time: - Five minutes: -

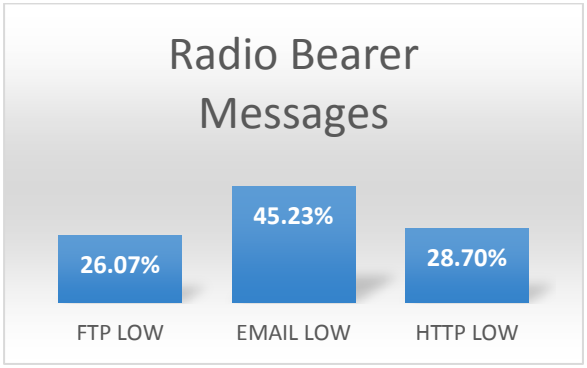

Fig.4 Radio Bearer messages

One minute:-

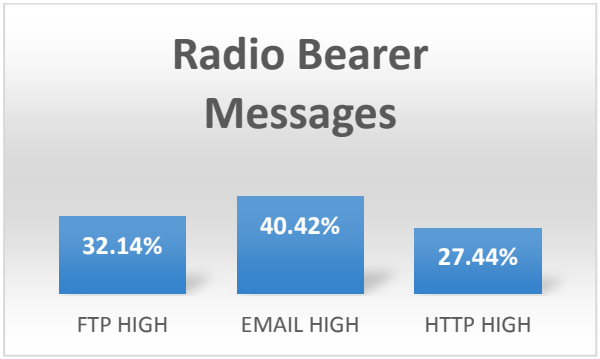

Fig.5 Radio Bearer messages

B) The ratio of the Radio Bearer according to different VOICE CODEC: -

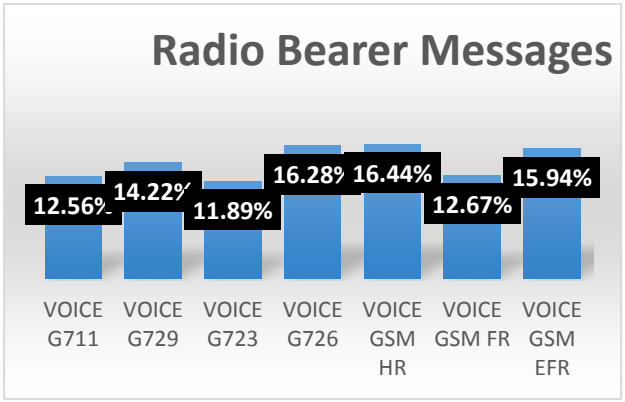

Fig.6 Radio Bearer messages

C) Ratio radio link according to different Inter-Request Time:

Five minutes: -

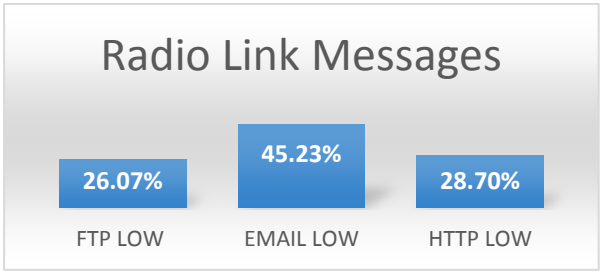

Fig.7 Radio link messages

One minute:-

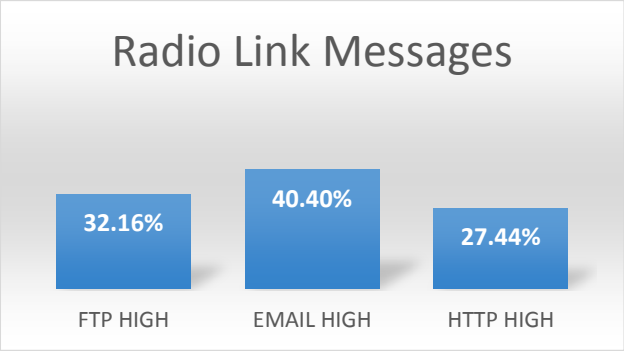

Fig.8 Radio link messages

D) The ratio of the radio link according to different VOICE CODEC: -

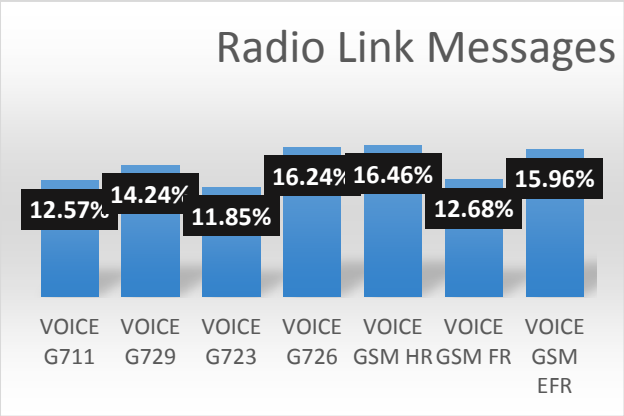

Fig.9 Radio link messages

E) The ratio of the Radio Access Bearer according to different Inter-Request Time: - Five minutes: -

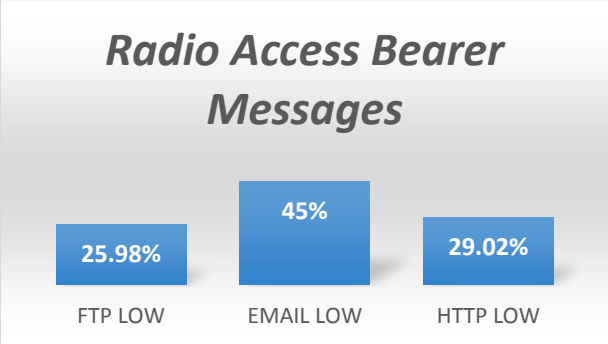

Fig.10 Radio Access Bearer messages

One minute:-

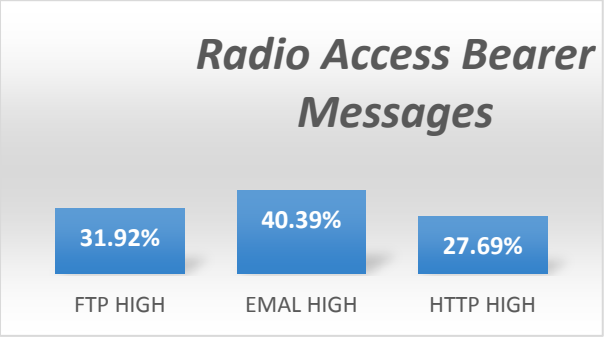

Fig.11 Radio Access Bearer messages

F) The ratio of Radio Access Bearer according to different VOICE CODEC: -

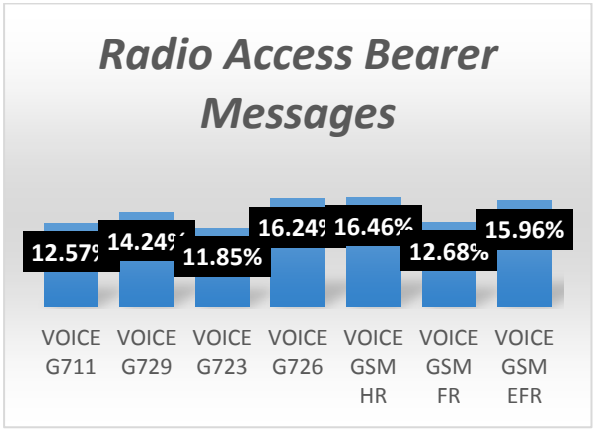

Fig.12 Radio Access Bearer messages

VI. Discussion: -

The result shows that the (E-mail) application has the highest number of signalling messages related to the selected three performance metrics: radio bearer, radio link and radio access bearer. When the interval of the inter request time is set to be 5 minutes , the number of signalling messages used by the Web browser is higher than the File Transfer Protocol .the results are been reversed when the interval of the inter request time is set to be 1 minutes. This happened because the OPNET model only simulates two primary FTP operations for data transfer: put and get. The FTP put operation uploads a file onto the FTP server while the FTP get operation downloads a file from the FTP server onto the client node. Both operations consist of two message types: control and data. Control messages are either request for a file (i.e., get operation) or acknowledgements of a file transfer completion (i.e., input operation). Data messages carry a file that transferred between the client and the server. The control message size is always 512 bytes, while the size of the data message is configurable. The client sends an HTTP request to a Web page the server receives the request, and the relating pages answered to the client. In this analysis procedure, if the Web page contains a few inline objects, the client node will ask for the follow-up objects from the Server.

For the real-time applications, e.g. voice the result shows that the voice codec (GSM-HR) has the highest number of signalling messages related to the selected three performance metrics: radio bearer, radio link and radio access bearer.

In addition, the codec (G.723) has the lowest number of the signalling message according to the radio link and radio access bearer and the codec (G.729) have the lowest number of the radio bearer. This happened due to the codec G.729 encodes 80 sample frames (10-mile second) of 16-bit linear PCM data into 10 8-bit code words and provides near toll-quality performance under clean channel conditions. The coder operates on 10-ms frames with 5 miles second of look ahead, enabling low transmission delays. The coder offers good speech quality

in network impairments such as frame loss and bit errors. G.723 encoding 8-kHz sampled speech signals for transmission at a rate of either 6.3 or 5.3 Kbps.

G.723.1 provides near toll-quality performance under clean channel conditions. The coder operates on 30-ms frames with 7.5 miles second of look ahead. The coder offers good speech quality in network impairments such as frame loss and bit errors. GSM HR It operates at 5.6 Kbit/s speech coding bit rate with 5.8 Kbit/s used for channel coding.

CONCLUSION: -

In this paper, calculated the ratio and the type of the signalling message using different types of application like voice, file transfer application, Email and web browsing. Therefore, the result shows that the Email application has the highest number of signalling message that effects the network-signalling load, which causes the call drops; and thus its effects to the quality of service of the network. Therefore, the result shows that the voice codec. Effects the signalling load when we have used the GSM HR codec the result shows that there is a large number of the signalling message in the network and when we used G.723 and G.729 the number of signalling message decreasing.

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