UMTSAND LTE: Their Working Principles And Performance Analysis Of UMTS

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ABSTRACT

Science and Technology never leaves its way. One way or other, there is a change in Science and Technology. Many Wireless technologies like GSM, UMTS, LTE, WiMAX, Wireless LAN and Bluetooth have changed the way we communicate and exchange data by making services like telephony and Internetavailable anytime and from almost anywhere. Today, a great variety of internet sources offer background information about these technologies but they all fall short in one way or another.In this paper we discussed a complete survey on UMTS and LTE and its working principles performance analysis are discussed.

Keywords–GSM, LTE,UMTS.

1. INTRODUCTION

The first connection in the GSM network was set up in 1991 and this year marks the onsetof the dynamic development of cellular telephony we are experiencing today. The unquestionable success of the GSM telephony has motivated further research in the field and thedevelopment of new technologies for cellular telephony. Initially, it was assumed that cellularnetworks would also provide their users with multimedia services and would offer accessto the Internet. Subsequent research eventually succeeded in working out a standard for thethird-generation telephony (UMTS). However, UMTS network telephony has been developing at a much slower pace than its GSM predecessor, hampered by substantially high costsof rendering a network operational. Currently, services provided by the UMTS network areoffered by most cellular network operators. The number of mobile subscribers has increased tremendously in recent years. Besides the traditional mobile traffic, for instance the voice communication, the data usage such as streaming service, internet access, file sharing, etc. have grown fast day by day and the traffic volume has in many cases already exceeded the voice traffic volume. End users expect more diversified services and faster upload and download speed. Operators require higher data capacity with lower cost of data delivery for the growing markets. All these requirements and expectations boost the evolution of the wireless communication system.The Universal Mobile Telecommunications

System (UMTS) is a third generation wireless telecommunication system and follows in the footsteps of GSM and GPRS. Since GSM was standardized in the 1980s, huge progress has been made in many areas of telecommunication. This allowed system designers at the end of the 1990s to design a new system that went far beyond the capabilities of GSM and GPRS. UMTS combines the properties of the circuit-switched voice network with the properties of the packet-switched data network and offers a multitude of new possibilities compared to the earlier systems.

Long Term Evolution (LTE) is the next step forward in cellular3G services. Expected in the 2008 time frame, LTE is a 3GPP standard that provides for an uplink speed of up to 50 megabits per second (Mbps) and a downlink speed of up to 100 Mbps. LTE will bring many technical benefits to cellular networks. Bandwidth will be scalable from 1.25 MHz to 20 MHz. This will suit the needs of different network operators that have differentbandwidth allocations, and also allow operators to provide different services based on spectrum. LTE is also expected to improve spectral efficiency in 3G networks, allowing carriers to provide more data and voice services over a given bandwidth.

2. EVOLUTION FROM 1G TO 4G

First-generation (1G) mobile phones consist of voice only. These were replaced by second-generation (2G) digital phones with added fax, data, and messagingservices. The 3G technology has added multimedia facilities to 2G phones.

2.1 The first generation

1G mobile systemwas based on the analogue system. The prominent ones among1G system were advancedmobile phone system (AMPS), Nordic mobile telephone (NMT), and total access communication sys-tem (TACS).

2.2 The second generation

2G phones use global system for mobileCommunications (GSM) and were first used in the early 1990s in Europe. GSM providesVoice and limited data services, and usesDigital modulation for improved audioquality. Table 1shows the evolution from 1G to 4G.

2.3 The third generation

3G technologies adds multimedia facilities to 2G phones by allowing video, audio, and graphics applications. Over 3Gphones, you can watch streaming videoor have video telephony. The idea behind3G is to have a single network standard, instead of the different types adopted in the US, Europe, and Asia. UMTS is also called3G, broadband standardfor packet based transmission of text, digitized voice, video, and multimedia at data ratesup to 2 Mbps,offering a consistent set of services to mobilecomputer andphone users, nomatter wherethey are in theworld.

Table 1.Evolution from IG to 4G

EVOLUTION FROM 1G TO 4G	SERVICES OFFERED
1G	Voice only
2G	Fax, Data and Messaging Services
3G	2G+Multimedia Facilities
4G	Higher Capacity,Completely IP oriented, multimedia, data to hundreds of megabits

2.4 The fourth generation

4G mobile communications will have
Transmission rates up to 20 Mbps higher than of 3G.

2.4.1 4G objectives:

1. Speeds up to 50 timeshigher than of 3G. However,
the actual available band-width of 4G is expected to be about 10 Mbps.
2.3D virtual reality imagines personal video avatars and realistic holograms, and theability to feel as if you arepresent at an event even ifyou are not. People, places, and products will be able tointeract as the cyber andrealworlds merge.
3. Increased interaction between corroborating technologies. Other 4G applications include high performance streaming of multimedia content based on agent technology and scalable media coding methods.

3. RESEARCH CONTRIBUTION

At real time, some factors of UMTS is taken and tested in a live environment. Here a single city in Tamilnadu for instance is taken and tested for its performance of UMTS .Those factors include

3.1UMTS UE

The separation between mobile equipment (ME) and the UMTS subscriber identity module (SIM) card (USIM). Figure 3.1shows the user equipment functions. The UE is the counterpart to the various network elements in many functions and procedures.

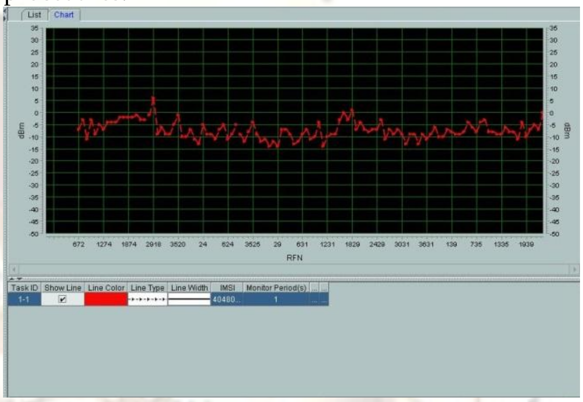

Fig 3.1UE Transmission Power

3.2 Throughput

Throughput can be measured by recording a trace of traffic over the IuPS interface or on the TE itself, and analyzing itwith a suitable application that summarizes the quantity of bytes transmitted per unit of time in the form of a graph. Obviously the throughput measurement obtained in this way is represented in a graph. Here we monitored the downlink throughput for every 3 second and uplink throughput for every second and the results are graphically shown. Throughput for downlink for an average user is 3-4 per MHz and for uplink 2-3 per MHz .

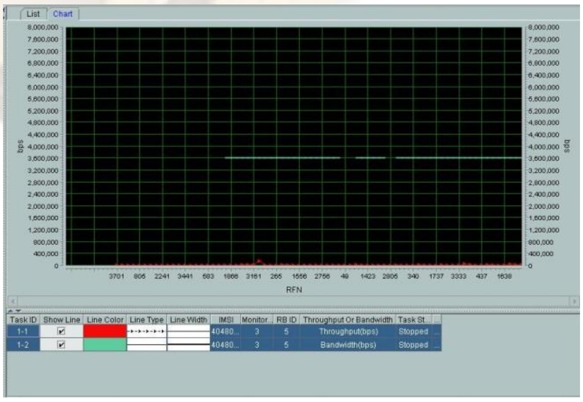

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Fig 3.2(a) Downlink Throughput

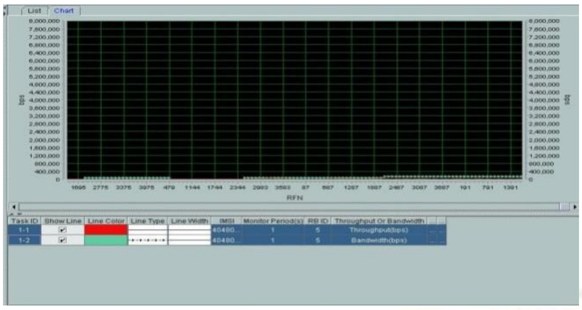

Fig 3.2(b) Uplink Throughput

3.3Power Control

Open loop power control (OLPC) is the ability of the UE transmitter to sets its output power to a specific value. It is used for setting initial uplink and downlink transmission powers when a UE is accessing the network. The open loop power control tolerance is ± 9 dB (normal conditions) or ± 12 dB (extremeconditions)

Inner loop power control (also called fast closed loop power control) in the uplink is the ability of the UE transmitter to adjust its output power in accordance with one or more Transmit Power Control (TPC) commands received in the downlink, in order to keep the received uplink Signal-to-Interference Ratio (SIR) at a given SIR target. The UE transmitter is capable of changing the output power with a step size of 1, 2 and 3 dB, in the slot immediately after the TPC_cmd can be derived. Inner loop power control frequency is 1500Hz.Both OLPC and SIR are presented in the below figure.

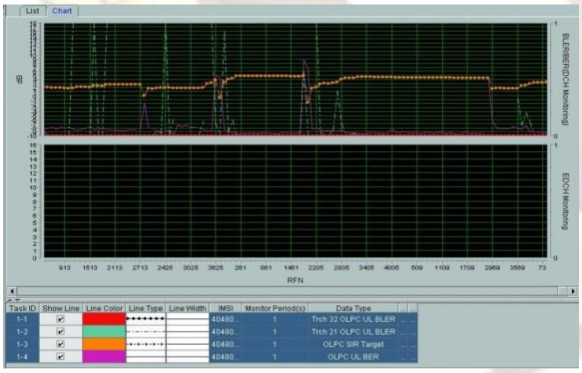

Fig 3.3(a)OLPC

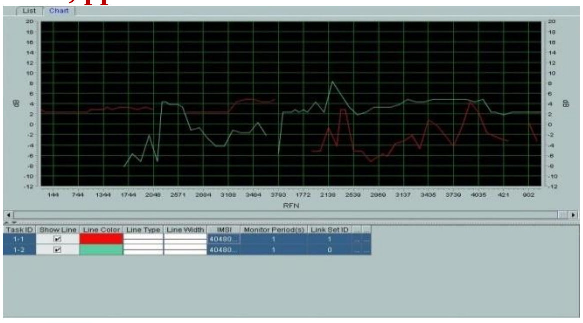

Fig 3.3(b)Uplink SIR

4. ADVANCED UMTS AND LTE

4.1 New Concepts of UMTS

4.1.1 The Radio Access Bearer (RAB):

An important new concept that is introduced with UMTS is the Radio Access Bearer (RAB), whichis a description of the transmission channel between the network and a user. The RAB is divided intothe radio bearer on the air interface and the Iu bearer in the radio network (UTRAN). Before datacan be exchanged between a user and the network it is necessary to establish a RAB between them.This channel is then used for both user and signaling data. A RAB is always established by requestof the MSC or SGSN. In contrast to the establishment of a channel in GSM, the MSC and SGSN do not specify the exact properties of the channel. Instead, the RAB establishment requests contain onlya description of the required channel properties. How these properties are then mapped to a physicalconnection is up to the UTRAN. RAB has the following properties service class, maximum speed, guaranteed speed, delay, error probability.The UTRAN is then responsible for establishing an RAB that fits the description. The propertiesnot only have an impact on the bandwidth of the established RAB but also on parameters like codingscheme, selection of a logical and physical transmission channel as well as on the behavior of thenetwork in the event of erroneous or missing frames on different layers of the protocol stack. TheUTRAN is free to set these parameters as it sees fit; the standards merely contain examples. As an example, for a voice call (service class conversational) it does not make much sense to repeat lostframes.

4.1.2 The Access Stratum and Non-access Stratum:

UMTS aims to separate functionalities of the core network from the access network as much aspossible, in order to be able to independently evolve the two parts of the network in the future.Therefore, UMTS strictly differentiates between functionalities of the Access Stratum (AS) and theNon-access Stratum (NAS**)** The AS contains all functionalities that are associated with the radio network (‘the accesses) and the control of active connections between a user and the radio network.

The handover control, forexample, for which the RNC is responsible in the UTRAN, is part of the AS.The NAS contains all functionalities and protocols that are used directly between the mobile device(UE) and the core network. These have no direct influence on the properties of the established RAB andits maintenance

4.1.3 Common Transport Protocols for CS and PS:

In GSM networks, data is transferred between the different nodes of the radio network with threedifferent protocols. The most important task of these protocols is to split incoming data into smallerframes, which can be transferred over the air interface.

•Circuit-switched data (e.g. voice calls): The TRAU converts the PCM-coded voice data, whichit receives from the MSC, via optimized codecs like EFR, HR or AMR. These codecs are muchmore suitable for data transmission over the air interface as they compress voice data much betterthan PCM. This data is then sent transparently through the radio network to the BTS. Before thedata is sent over the air interface, the BTS only has to perform some additional channel coding(e.g. increase of redundancy by adding error detection and correction bits).

•Signaling data (circuit-switched signaling as well as some GPRS channel request messagingand paging):This data is transferred via the LAPD protocol, which is already known from theISDN world and which has been extended for GSM.

•Packet-switched user and signaling data for GPRS:While user and signaling data are separated in GSM, GPRS combines the two data streams into a single lower layer protocol called RLC/MAC.

In UMTS, these different kinds of data streams are combined into a single lower layer protocolcalled the RLC/MAC protocol. Giving this protocol the same name as a protocol in the GPRS networkwas intentional. Both protocols work quite similarly in areas like breaking up large data packetsfrom higher layers into smaller chunks for transmission over the air interface.

4.2 ADVANCED LTE

4.2.1 Latency Reduction

LTE-Advanced aims to further reduce control plane and user plane latency in the access and corenetwork. As latency is already low, a further reduction is quite ambitious. The requirements areas follows:

•A reduced switching time from RRC Idle to RRC Connected state transfer in less than 50milliseconds.

•While in RRC connected state, the UE should return from a dormant state to a fully active state inless than 10 milliseconds.The feasibility study lists the following enhancements to achieve these requirements:

• combined RRC Connection Request and NAS Service Request;
• reduced processing delay in network components;
• a reduced RACH scheduling period;
• a shorter PUCCH cycle for quicker scheduling requests.

4.2.2 Carrier Aggregation

A relatively simple way to further increase individual data transmission speeds is to increase thechannel bandwidth. To remain backward compatible with 3GPP Release 8, the maximum carrierbandwidth of 20 MHz is not altered. Instead, carrier aggregation is used to combine the capacity ofseveral individual carriers. The aggregated carriers can be adjacent or non-adjacent, they can be ina single band and also in different bands. An individual carrier is referred to in the standards asa component carrier (CC). One configuration, for example, is to combine carriers in LTE bands 7(2600-MHz band) and 3 (1800-MHz band) to potentially achieve a total carrier bandwidth of 40 MHzin the downlink direction. Carriers can be aggregated asymmetrically in the downlink and the uplinkdirections. In the downlink direction, for example, carriers in two different bands can be aggregatedto a combined 40-MHz channel, while in the uplink direction only a 20-MHz carrier in a single bandis used. For the future, further carrier aggregation configurations are envisaged that would result ineven broader transmission channels.

4.2.3 8×8 Downlink and 4×4 Uplink MIMO

To further increase the datarates close to the center of the cell, LTE-Advanced introduces an 8 ×8Single-User MIMO transmission mode. Compared to the 2×2 MIMO mode used by LTE in practicetoday and the resulting maximum transmission speed of 150 Mbit/s when a 20-MHz carrier is used,speeds of up to 600 Mbit/s could be reached. Together with the aggregation of two 20-MHz carriers,theoretical top speeds exceed 1 Gbit/s. In practice, however, it will be challenging to incorporateeight receive antennas in mobile devices. Similar challenges will be faced on the base station side asthe number of antennas and the antenna sizes are further increased. This is challenging because of the available space on top of the antenna masts and the additional stress on the mast due to additionalwind forces.In the uplink direction, current mobile devices only transmit a single data stream. The base stations,however, can use multiuser MIMO methods, as discussed earlier, to increase the overall bandwidth inthe uplink direction of a cell by instructing several mobile devices to transmit simultaneously and thenusing MIMO techniques to separate the data streams. LTE-Advanced aims to increase the available datarates for a single user by introducing single user MIMO methods with antenna configurationsof up to 4×4. In an ideal situation, this results in a peak throughput of 300 Mbit/s in a 20-MHzcarrier and 600 Mbit/s in a 40-MHz aggregated carrier. Again, practical considerations concerning theplacement of four antennas in a small mobile device will limit the application of 4×4MIMOintheuplink direction to larger mobile devices such as pad computers, netbooks and notebooks.

4.3.4 Relays

Small and inexpensive femtocells connected to a cheap backhaul link such as DSL are one way toincrease throughput and to extend the coverage area of the network. Another complementary approachis relaying. Relay nodes, as standardized in 3GPP Release 10, act as standard LTE cells with their274 From GSM to LTEown physical cell-ID, broadcast channels, etc. Unlike macrocells, however, which use a copper, fiberor microwave backhaul, relays use the LTE air interface to an LTE macrocell to transport the data viathat cell to the core network. The relaying can take place on a carrier also used by a macro cell toserve mobile devices. Alternatively, a separate carrier channel that is exclusively reserved for the relaynode can be used. With both options, areas can be covered without additional microwave equipmentand without the need of a fixed-line backhaul connection
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4.3.5 Study on Coordinated Multipoint Operation

In UMTS, the soft handover mechanism, as described in Chapter 3, is used in cell edge situations. When a connection is in soft handover state, signals sent by a mobile device are received and decodedby several base stations and combined at the RNC level. In the downlink direction, the soft handovermechanism is used for dedicated channels but not for HSPA because of the complexity involvedin synchronizing the downlink transmissions of the cells, which act independently for high speedtransmissions. Even though only used for the uplink direction, soft handovers help to improve celledge performance and overall cell capacity, as in such areas, interference is high because of similarsignal strengths of several cells and a low overall signal level. In 3GPP Release 10, a study is performed for a mechanism with a similar effect for LTE-Advanced.These mechanisms are referred to as Coordinated Multipoint Operation (CoMP). Two CoMP modesare envisaged. The first CoMP mode uses only transmissions of a single base station with coordinated scheduling between base stations to a single mobile device and beamforming mechanisms toconcentrate the signal energy in the direction of a mobile device at the cell edge (coordinated scheduling/beamforming). In the second mode envisaged, several cells would transmit data simultaneously,thereby also increasing transmission speeds at the cell edge. As CoMP is only a study item in 3GPPRelease 10, the first functionality will onlybe standardized in Release 11 of 3GPP.

5. CONCLUSION

Technology will always give us some advantage as well as some disadvantage .In this paper we have discussed about the fore coming concepts of 3Gand 4G . In UMTS privacy plays a major role including tracking one's position through satellite, and of course expensive. One of the main concerns about4G is that due to high speed of thefrequency, it will experience severe interference from multipath secondary signalsreflecting off other objects. To counterthis problem, a number of solutions havebeen proposed, including use of a variable spreading factor and orthogonal frequency code-division multiplexing. It is only in the hand of future to overcome these difficulties and introduce newer concepts regarding 3G and 4G.

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