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A Proposed Framework for High Speed Downlink Packet Access (HSDPA) as a turbo charger in Universal Mobile

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ABSTRACT

Mobile communication industry is one of the fastest growing industries with in the technology sector. It started as first generation of mobile communication in 1979 with a limited voice communication facilities in some part of Europe but now it is widely available all over the world in that the rapid revolution in mobile communication technologies. Due to the consumer's demands for data sensitive applications, roaming, intelligent handset, internet, this technology has transformed from first to third generation fulfilling more customer's needs. The third generation named as UMTS (universal mobile telecommunication) services provide high quality voice services and multimedia services but still there is the demand for high speed downlink services to maintain high QoS .To fulfill the market needs the UMTS is on enhancement phase which named as HSDPA (high speed downlink packet access). HSDPA promises for QoS and provide a cost effective solution for the high downlink speed services. This study proposed evaluation framework for UMTS network by using high speed MAC layer on node B to achieve the HSDPA features and it will be done through the simulation of the designed network. The simulation tool which is used for simulation called OPNET.

Keywords: *UMTS, HSDPA, & OPNET*

1. INTRODUCTION

The promises of wireless revolution are finally starting to reach completion given the evolution of third generation (3G) technologies, which will allow the complete multimedia mobile experience, any time, any place and anywhere for a reasonable cost [1]. The number of subscriber is constantly growing. On the other hand a large diversity of new data services is evolving. Hence not only the total wireless traffic but also the data traffic is expected to rise. New services and more traffic load means revenues for the operator but also cost for deploying the new feature. The advancement of today's wireless technology began in early1980's with the introduction of first generation analog interface technology which supported voice only capabilities. This technology was limited in bandwidth and low in quality. The 1st generation analog system used very narrow radio channel that varies from 10 kHz to 30 kHz. The data signaling rates determines by calculating how fast message can be sent on control channels. The RF power level of mobile phones determines how far the mobile phone can operate from the base technology the second generation was introduced.

The second generation was principally voice only and it is supported higher bandwidth, better voice quality and some limited data services. Expansion of second generation was introduced in 2.5G system which focused on data service packet enhancement such as general packet radio service (GPRS). Moreover the continuous success of mobile communication system for the better quality of service QoS, more efficient system and more enhanced services have led to the third generation (3G) mobile telecommunication system [2].

2. UNIVERSAL MOBILE TELECOMMUNICATION (UMTS)

Universal mobile telecommunication (UMTS) is the standard version of 3G mobile communication in Europe. UMTS was initially proposed by the European telecommunication Standards Institute (ETSI), which represents a revolution of existing 2G networks (GSM) to the third generation. The release of UMTS standardizes the use of GSM/GPRS network and this standardization enables a cost effective migration from 2G to 3G. The initial enhancement of GSM toward UMTS is an enhanced data rates which uses enhanced modulation scheme PSK. It promises transmission rate up to 2Mb/s which makes it possible to provide multimedia services video telephony etc. However there is strong demand for multimedia application which require higher data rate above 2 Mb/s especially in downlink. In order to meet the requirement for high speed internet access and different multimedia application high speed downlink packet access (HSDPA) has been introduced [3] [4] [5].

2.1 Research Contribution

This study will help to understand the HSDPA concept whose goal to provide a high-speed downlink-speed to mobile stations by dedicating a HS-DSCH (High Speed Shared Channel) using 16 QAM (Quadrature Amplitude Modulation). The primary objective of HSDPA is to deliver the real time data to its destination prior to its time out expires. It also uses the intelligent sharing algorithm i.e. round robin to share dedicated channel resources among the mobile stations in a cell. A simulation model of HSDPA network will be design to calculate its performance.

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2.2 Research Objective

The main objective of this study is to design a simulation environment for calculating the efficiency of HSDPA technique over UMTS by using new modulation scheme, hybrid ARQ and intelligent sharing algorithms. In this research OPNET simulation software is used to describe and calculate system behavior. To develop a HSDPA simulation model, that can demonstrate better utilization of network resources and for maximum throughput with minimum changes in network architecture.

- To implement the fast intelligent sharing algorithm on base station as high speed MAC layer and using high frequency modulation, fix spreading factor within the existing network.
- To study of existing UMTS network standard source code by modifying according to the 3 GPP HSDPA standards.
- To study the existing network efficiency, throughput, and overall performance.

To achieve the above objectives of this research will have to answer some research question;

- What are the perceptive parameters which should be considered to analyze and investigate the HSDPA performance?
- HSDPA implementation by deploying fast scheduling
- algorithm, hybrid-ARQ, higher modulation scheme or dedicated resources on node B's MAC -hs will really help the user side (cost effective hand set and high data rates) as well as the service provider (cost effective deployment of HSDPA scenario) and what will be their impact on both sides hardware and software's?
- What suitable software for the HSDPA network performance simulation requires to investigating, analyzing and demonstrating?

2.3 Research Problem issues and HSDPA challenges

By the implementation of HSDPA lots of different challenging issues arise. Many electrifying problems are being addressed and some are yet to be addressed. The HSDPA handover, interaction between node B scheduler and RNC, Network and user equipment infrastructure has been discussed here among the many research problems.

- Handover: HSDPA provide fast intelligent scheduling but during the handover how the scheduling handled between two cells and how the scheduler itself within node B deals with HS-DSCH. What are the impacts on HSDPA for handover? [6].
- Hardware infrastructure: What are the impacts of existing infrastructure hardware of network and user equipment? Is HSDPA require more complex hardware on both end like new power amplifier required on node B and more complex UE required? [6].
- Speed and HSDPA: In order to have access to HSDPA network services a perceptive approach required to define what speed best suites the subscriber to use the network services in efficient manner? Can HSDPA be used at the speed of 0 m/h, 100 m/h, and 200 m/h? [6].

This Study will be based on the simulation studies. The simulation will be carried out on OPNET simulation package, and the results will be discussed to prove the validity of the suggested idea. It means the conducted research will be solely related to the positivistic methodology. So it is clear that positivistic methodology has been selected for this research. This research approach is not concern to the perceptions of the participant observation, individual activities.

The UMTS is highly compatible with the existing GSM and GPRS network. Besides the core network and upgraded Base station subsystem UMTS employs the new interface for UMTS network called UMTS Terrestrial Radio Access Network (UTRAN). The Two new elements are introduced in UTRAN are as following;

- The radio network controller (RNC)
- Node B

2.3.1 The radio network controller (RNC)

The Radio network controller (RNC) is a leading element in UMTS, which control Node B. It is connected to the Circuit Switched Core Network through media gateway and to SGSN in packet switched core Network. It controls the functionality of power control, load control, admission control, Packet Scheduling, Security Functions [7].

2.3.2 Node B

Node B is a term used in UMTS to represent the BTS. Node B is consisting of radio frequency transmitter and receiver to communicate to the UE's [7].

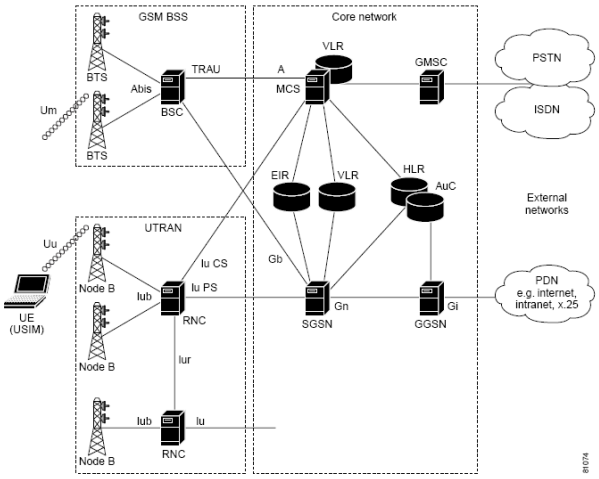

Figure 01: Architectural Diagram of UMTS

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2.4 Interfaces of UMTS

The UMTS defines four new open interfaces, which are given below [7],

- **Uu interface:** User equipment to Node B (the UMTS WCDMA air interface).
- **Iu interface:** RNC to GSM/GPRS (MSC/VLR or SGSN).
- **Iu-CS:** Interface for circuit-switched data (ATM adaptation layer type 2 AAL2 handles circuit switch connection).
- **Iu-PS:** Interface for packet-switched data (ATM adaptation layer type 5 AAL5 handles packet switch connection).
- **Iub interface:** RNC to Node B interface.
- **Iur interface:** RNC to RNC interface.

The Iu, Iub, and Iur interfaces are based on the transmission principles of asynchronous transfer mode (ATM) [7].

2.4 UTRAN Protocol Model

The structure of UTRAN protocol model is based on the principle that the layer and planes are logically independent of each other. Therefore if a change require in future enhancement the protocol can easily alter to fit according to the requirement. The general protocol model is given below [8].

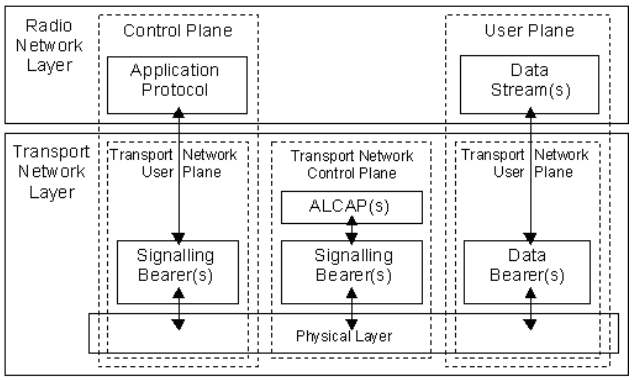

Figure 02. Protocol model for UTRAN model

2.4.1 UTRAN Protocol Model Radio Interface Architecture

The radio interface layer is divided into three protocol layers.

- The physical layer (L1)
- The data link layer (L2)
- Network layer (L3)

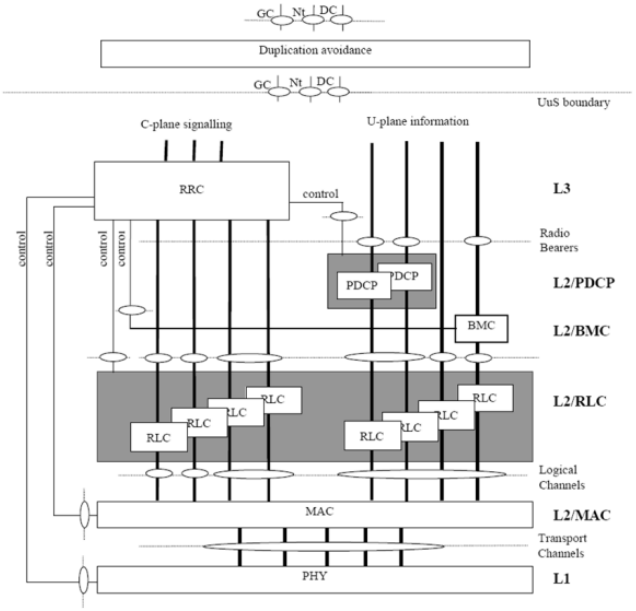

Figure 03: Radio Interface Protocol Architecture [9]

2.5 Evolution of UMTS toward High Speed Downlink Packet Access (HSDPA)

The third generation of mobile communication system also called universal mobile telecommunication system (UMTS), which is mainly planned to offer a wide range of multimedia services. In order to enhance UMTS network to such high rates, a new technology HSDPA (high speed downlink packet access) is planned to provide up to 14.4 Mbps service. The current WCDAM network can be upgrade for HSDPA which shows the high compatibility and not a dramatically change required on network side for UMTS enhancement and if on UE side the HSDPA not implement than UE can use the same UMTS services. This shows that HSDPA will be implemented on the top of the existing architecture. HSDPA is the enhancement in 3rd generation, normally called 3.5 generation of mobile communication. This allows the network based on UMTS to have higher data rates and it supports high downlink speed.

The concept of HSDPA is an extension of the DSCH (downlink shared channel) as HS-DSCH (high speed downlink shared channel) including some more new features such as adaptive modulation and coding (AMC), fast hybrid-ARQ and fast scheduling. This HS-DSCH channel can be shared between all users in a certain area. Introducing HS-DSCH means additional intelligence on HSDPA medium access control (MAC) layer is installed on node B. By adding the new functionality of MAC it's normally known as high speed medium access layer (MAC-hs).

To implement HSDPA on UMTS network or to enhance UMTS network there is no need of some new hardware but some special techniques of modulation, fat pipe and intelligent scheduling has brought under consideration to update UTRA.

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2.6 Techniques to support UTRA High Speed Downlink Packet Access (HSDPA)

There are some key features or techniques of HSDPA which make HSDPA the 4th generation of communication.

- HS-DSCH (high speed downlink shared channel) Protocol Structure.
- Hybrid ARQ (Automatic repeat request) Adaptive Modulation and Coding (AMC).
- Medium Access Layer (MAC).
- Spreading factor.
- Fast Scheduling.

3. OPTIMIZED NETWORK ENGINEERING TOOLS (OPNET)

OPNET is a complete engineering system capable of simulating large communication networks with specification protocol, detail modeling and performance analysis. It features include graphical design of models, event-scheduled simulation kernel, integrated data analysis tools, and hierarchical, object based modeling. It facilitates special problems for example distributed algorithm development [10]. OPNET analyzes structure behavior and performance by the discrete event simulations, which model system behavior around objects and distinct events for example the arrival of packets at various points in a network [10]. This approach support realistic modeling of complex system that can be represented as a series of related events. Each object has its own characteristics called attitudes which control the behavior during simulation [10].

3.1 OPNET Proposed Model of UMTS

The UMTS model of the packet wireless network is based on 3rd generation partnership project (3GPP) release 1999 standard. The network architecture of this release is divide into the radio access network (RAN) and the core network. The radio access network contains the user equipment (UE) which comprises of terminal equipment (TE) and mobile terminal (MT), and the UTRAN which consist of node B and radio network controller as shown in figure 4.

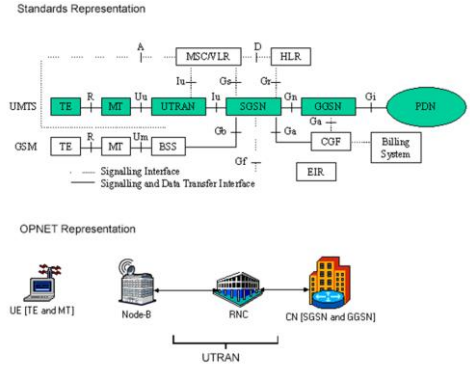

Figure 04. OPNET Proposed Model of UMTS

UMTS use WCDMA for radio access. In this model the model support FDD mode. The TDD is not supported. The radio frame has a length of 10 ms and is divided into 15 slots. Spreading factor may vary from 256 to 4 for an FDD uplink and from 512 to 4 for an FDD downlink [2]. The packet domain network consist of two network node, the GPRS support node (SGSN) and gateway GPRS support node (GGSN). The circuit switched core network includes the mobile switching center/ visitor location register [2].

4. CONCLUSION

The proposed model in this research is powerful, easily understandable and can be implementing practically because this is a very cost effective way to achieve the HSDPA performance with in the existing UMTS network. The designed model not only enhanced the network but it also remove the complexity of RNC.

In this research we implement the high speed MAC layer on node B which is the key change to achieve the HSDPA functionalities. This modification has made by adding some functionalities from RNC to node B and removing some functionalities from RNC. OPNET simulation results shows that the modification can greatly improve the network performance.

The author made modification is used in various scenarios and thus the obtained result state that the modification named as RIZWAN_HSDPA give better results in the parameters like load throughput, downlink throughput, downlink response time for different data sensitive applications. The author believes that more work needs to be done on the node B MAC-hs e.g. scheduling, spreading factor and hybrid ARQ to get better results overall.

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