Final Year Project Proposal

Evolution of 2.5G Radio Access Network towards the Prospects of High Speed Downlink Packet Access

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Introduction:

The increasing availability of a broad range of new high-speed data services is fuelling demand for more bandwidth in order to improve the user experience, especially over mobile networks.

High Speed Downlink Packet Access (HSDPA) technology is a cost-efficient upgrade to UMTS systems and promises to deliver performance comparable to today's wireless LAN services, but with the added benefit of mobility and ubiquitous coverage.

HSDPA is a technology upgrade to UMTS networks that delivers superior speed, capacity and efficiency improvements.

Objective:

The objective of our project is to study and simulate the evolution of 2.5G/EDGE Radio Access Networks (RAN) towards High Speed Downlink Packet Access focusing on architecture update.

Background:

As the world is entering an era of technology convergence, the wireless panorama is changing 'fast and furious'. The recent convergence of the Internet and mobile radio has also accelerated the demand for "Internet in the pocket" on light, low-cost terminals, as well as for radio technologies that boost data throughput and reduce cost per bit. Mobile networks are now going multimedia, potentially leading to an explosion in throughput from a few bytes for the Short Message Service (SMS) to a few Kbits/s for the Multimedia Messaging Service (MMS), to several 100 kbits/s for video content.

This trend to higher data rates over wireless networks will culminate in the introduction of Third Generation (3G) ITU International Mobile Telecommunications 2000 (IMT2000) systems.

Mobile operators who have invested heavy amounts in existing infrastructure will obviously show reluctance towards deployment of new 3G infrastructure. An extremely flexible expansion and migration strategy along the road to the 3G would be “soft” network evolution that does not render existing installations superfluous.

Investment risks are minimized and competitive positions strengthened through the gradual deployment of technology. Intelligently expanding existing infrastructures is often all it takes to be able to offer new forms of mobile data services in practice quickly and flexibly.

Basically four transmission systems play a role in the evolution from GSM to the Third mobile radio generation (3G), namely:

- HSCSD (High Speed Circuit Switched Data)
- GPRS (General Packet Radio Service)
- EDGE (Enhanced Data Rates for GSM Evolution)
- UMTS (Universal Mobile Telephone System)

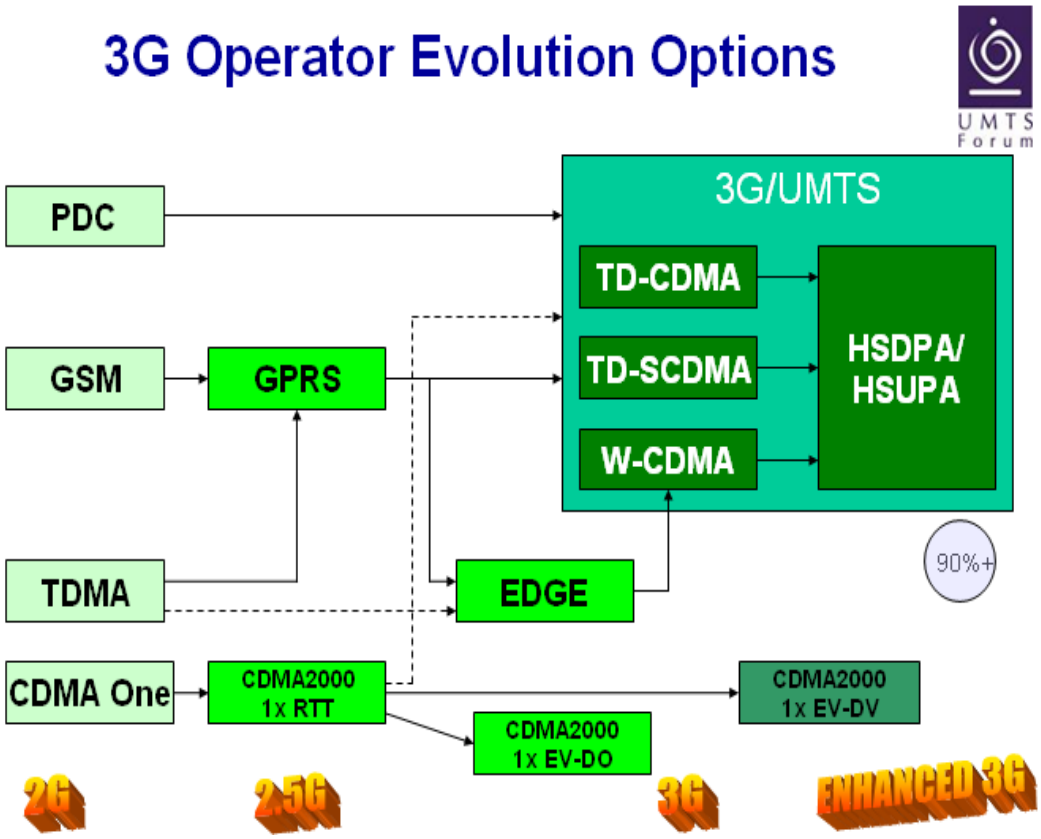
The present network architecture stands on EDGE, it stands for Enhanced Data Rates for Global (instead of “Global”, originally: GSM) Evolution. Based on the GSM standard, EDGE permits faster data rates – and so is intermediate step from GSM technology toward UMTS.

UMTS (Universal Mobile Telecommunication System) is the name given to a totally new performance dimension in mobile radio. UMTS is the cornerstone of what is called the third mobile radio generation (3G) for voice and data communication, both packet and circuit-switched. UMTS employs separate frequency bands so is free from the bottlenecks of GSM systems.

Once UMTS is implemented, it would pave the path for HSDPA (High Speed Downlink Packet Access). HSDPA provides a smooth evolutionary path for the Universal Mobile Telecommunications System (UMTS) networks to higher data rates and higher capacities, in the same way as Enhanced Data rates for GSM Evolution (EDGE) does in the Global System for Mobile communication (GSM) world. HSDPA

is primarily implemented in the Node B (identical to a BTS in a GSM network) and the RNC (Radio Network Controller, both are the entities on RAN (Radio Access Network).

The following block-diagram illustrates the evolution flow.



Methodology:

The project will be divided in to two phases. The first phase will involve comparative study of 2G and 3G technologies thoroughly to clearly understand the basic fundamentals of EDGE, UMTS/W-CDMA and HSDPA. We will study the various research papers available on said technologies, magazines, IEEE Library, UMTS forum, 3GPP forum, Nokia Research Center and other available resources.

The second phase would focus on the culmination of EDGE based Radio Access Network towards prospects of HSDPA. The steps involved in this migration process would be:

i) Spectrum Planning and Testing, to allow use of the 3G Band. This would be accomplished using RF planning Tools.

ii) RAN (Radio Access Network) Upgrade, to allow the present architecture to be adapted for HSDPA. This would involve modification required in all entities of RAN to accommodate HSDPA in co-existence with present architecture. This would be demonstrated using simulation on network simulators.

iii) Operation and Maintenance Challenge, talking about co-existence we would also focus on inter-operation of networks within same architecture. The operation ability form user end will also be discussed.

Demonstrations and implementations of this phase would be shown on software based simulators described later in the document.

Tentative Project Break down:

The study phase load would be equally shared among all members. The second phase break up is as follows:

1) Arsalan Tariq Mir:

Responsible for Spectrum Planning and Testing for 3G networks.

2) Syed Ammar Faheem:

Responsible for RAN Architecture Upgrade

3) Saad Najeeb:

Responsible for Operations and Maintenance Challenge

Note: The project breakdown is tentative and the assigned work might change depending on the work-load on each group member.

Advantages:

HSDPA is an evolution of UMTS that offers the higher data rates that are needed to realize multimedia services for cellular mobile communication systems. Eventually every UMTS market will see HSDPA deployments - the technology offers operators too much of an edge to be ignored.

Major advantages include:

- Peak data rates of up to seven times higher than those in the most advanced UMTS networks
- A four-fold improvement in network capacity
- Reduced round-trip time between network and terminals
- Sophisticated scheduling allowing favorable allocation of resources

HSDPA's improved spectrum efficiency enables much faster downstream throughput - between network and terminal - than current UMTS technology. Although the theoretical maximum data transfer speed of HSDPA is 10- 14Mbps, the technology will deliver a 2 – 3Mbps downlink on average. Shared among users in an adequately covered area, this will provide each user with a 300K – 1Mbps downlink, i.e. comparable to current wireless LANs and domestic fixed line broadband.

HSDPA is the main driver for higher performance mobile networks which includes the need for:

- More efficient access to office applications and a response to commercial pressure to replicate LAN experience on the move
- A fixed-line broadband alternative that can support new consumer services – e.g., interactive gaming, voice over IP and SIP-based multimedia
- A service-offering to succeed EDGE in GSM markets
- A more efficient technology to reduce the cost of the on-going network growth
- A technology that lowers the cost per byte for data and VoIP services

Summing up, HSDPA is an extremely cost-effective path to higher data rates and provides more efficient use of valuable spectrum. It enables operators to compete effectively in increasingly converged markets and satisfy the need for enhanced QoS and bandwidth-hungry services in an efficient and cost-effective manner.

Tools Required:

To fulfill our objective we may require the use of the following tools/software:

- Qualnet
- Opnet
- Omnet
- TEMS
- JAVA Applets

Project Feasibility:

This project may require dedication 15 hours per week = 3 members * 5 hours, and can easily be accommodated in the FYP day.

As we are doing this project in association with ZONG our focus would be to provide their RAN network a path towards HSDPA.

This project has the scope of mobile internet and will focus on the HSDPA evolution. Since RAN has been undergoing regular up-gradation over the years, adapting it for HSDPA will not be an issue.

This project will be able to provide in-depth study of all RAN aspects of HSDPA and will simulate its implementation. This would not only develop our learning for the technology but also may serve as a guide to mobile operators who wishes to evolve its network to include features offered by HSDPA.

Reference:

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[3] Technology white paper from Alcatel
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