International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 08, August 2015
Available at http://internationaljournalofresearch.org

The LTE Advance: FEMTOCELL

Rhythm Sharma (rhythm.sharma90@gmail.com) ,
Kuldeep Kumar (kuldeepkumarfatehabad@gmail.com)
Chaudhary Devilal University , Sirsa , Haryana

Abstract:

In this paper we can study the concept of femtocell –The LTE advance perspective where main aim of femtocell is to combine fixed-line broadband access with cellular telephony using the deployment of ultra-low-cost, low-power (3G,LTE,LTE-Advanced) base stations in the subscribers' homes or premises. It enables operators to address new markets and introduce new high-speed services and disruptive pricing strategies to capture wireline voice minutes and to grow revenues. One of the main design challenges of the femtocell is that the hierarchical architecture and manual cell planning processes used in macrocell networks do not scale to support millions of femtocells. In this paper, a user-deployed femtocell solution based on the base station router (BSR) flat Internet Protocol (IP) cellular architecture is presented that addresses these problems, and several aspects of the proposed solution are discussed.

Introduction:

LTE: Long Term Evolution is a standard name given to the mobile technology project of 3GPP(Third generation partnership Project) and to meet up with the set requirements for present and future needs of mobile communications. The 3GPP LTE project started in 2004. The introduction of the LTE is aimed at enhancing the Universal Terrestrial Radio Access Network (UTRAN). Its evolvement is aimed towards achieving the fourth generation (4G) mobile technologies.

Under the new LTE system which was to evolve around the 3GPP radio access technology over a period of time, some target summaries were made in order to give summarized targets and requirements for the LTE release 8, some of these are:

Reduced delays, particularly on latency;

Considerable increase in user data rates;

Increased in cell edge bit rate, most especially for even provision of services;

Decrease in cost per bit, which helps to improve spectral efficiency;

Absolute increase in flexibility for spectrum use;

A better and simpler network architecture;

Easy of access in terms of mobility;and most importantly Power consumption reduction for user equipment.

This table shows a progression towards the 4G technology based on the UMTS specifications evolution.

Sr. No.	Release	Functional Freeze	Main Radio Features of the Release.
1.	Rel-99	March 2000	UMTS 3.84 Mcps, WCDMA FDD and TDD.
2.	Rel-4	March 2001	1.28 Mcps TDD, also known TD-SCDMA.
3.	Rel-5	June 2002	HSDPA.

4.	Rel-6	March 2005	HSUPA (E-DCH).
5.	Rel-7	Dec 2007	HSPA+ (64QAM DL, MIMO, 16QAM UL), L LTE and SAE feasibility study EDGE Evolution.
6.	Rel-8	Dec 2008	LTE work item - OFDMA air interface, SAE work, new IP core network, 3G femtocells, dual carried HSDPA.
7.	Rel-9	Dec 2009	Multi-standard radio (MSR), dual cell HSUPA, LTE-Advanced feasibility study, SON, LTE femtocells.
8.	Rel-10	March 2011	LTE-Advanced (4G) work item, CoMP study, four HSDPA.

Evolution of UMTS specifications

Overall LTE architectural overview:

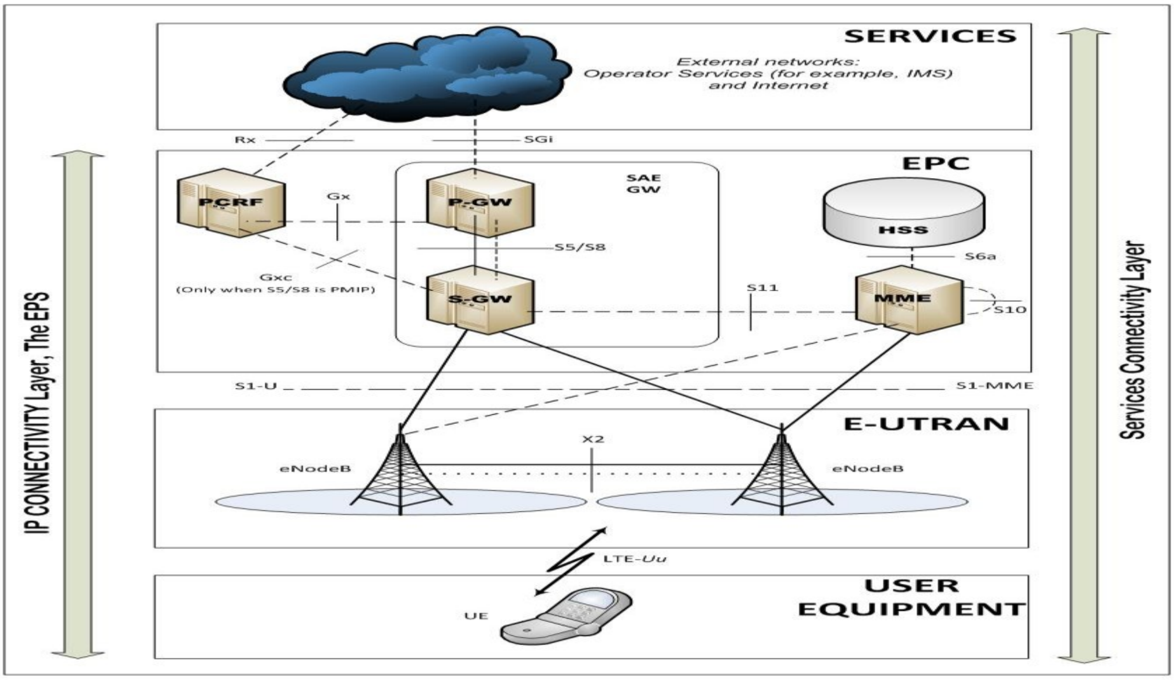
The LTE is an evolution of the radio access and the non-radio access; with the radio access evolving through the Enhanced UTRAN (E-UTRAN). The radio access basically is the evolution of the LTE Physical Layer, while the non-radio access grouped under the System Architecture Evolution (SAE), is the evolution of the network architecture of the LTE. The major components of the LTE System Architecture are:

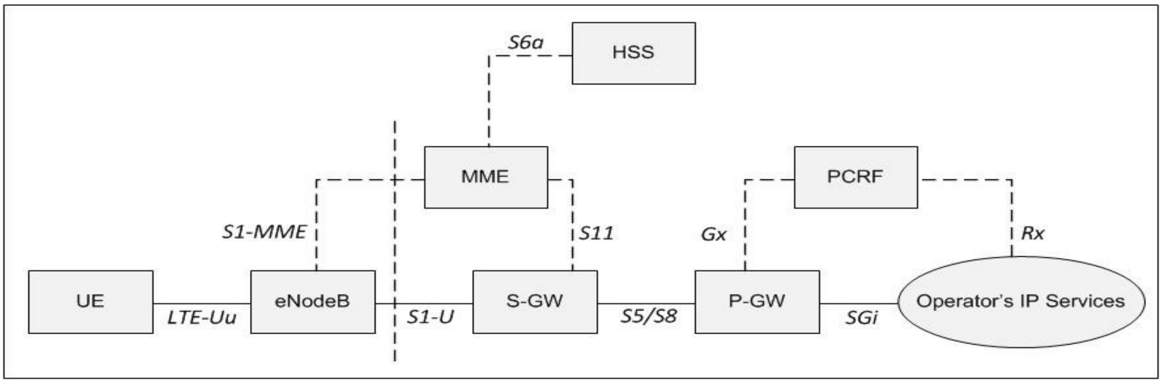
1. User Equipment (UE)
2. Radio Access Network (RAN)
3. Evolved Packet Core (EPC)

The Evolved Packet System (EPS) is comprised of the LTE Radio Access Net-work and Evolved Packet Core (EPC) RAN + EPS). At the high level, the LTE network is composed of the Core Network (CN), also called the EPC while there is also the Access Network. The figure 2.1 shows the basic overall system architecture with corresponding functional domains. The four major domain divisions are - Services, the EPC,E-UTRAN and the UE as indicated while figure 2.2, shows the EPS network elements and the standardized interfaces.

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 08, August 2015
Available at http://internationaljournalofresearch.org

Architecture for 3GPP access networks





The EPS showing Network Elements and Standardized Interfaces

Following terms used in this architecture:

Core Network: The Core Network (also known as EPC) the overall control of the UE and establishes the bearers2. The CN has a number of different logic nodes, some of which are:

1. Mobility Management Entity (MME);
2. Packet Data Network (PDN) Gateway (P-GW);
3. Serving Gateway (S-GW);
4. Evolved Serving Mobile Location Centre (E-SMLC);
5. Policy and Charging Rules Function (PCRF);
6. Home Subscriber Service (HSS);

MME: The MME is the main control node in the EPC. The control plane information coming from the eNodeB is mainly routed to the MME. One of the most essential functions of the MME is that it handles the signalling between the UE and the CN. Also, it handles the issue of security and authentication for keys offering; in addition to mobility management - where the MME does management functions by making request setup and release of appropriate resources in eNodeB and the S-GW; the MME also manages the subscription pro le and service connectivity. The responsible protocols between the UE and the CN are the Non-Access Stratum (NAS) protocols.

P-GW : The P-GW serves as the end point intermediary router between the EPS and external networks. It mainly provides IP connection at its active point; and is refer to as the highest level mobility or final anchor in the system. Also, it does IP addressing to UEs, performs traffic gating and filtering duties when needed.

S-GW: The S-GW is responsible for the U-plane tunnel management and switching; it acts as the mobile anchor between EPC and the LTE RAN. All the users' packets are routed through the S-GW. Although, the S-GW has a role in control functions, it is very important in terms of inter-connectivity to other 3GPP technologies like GPRS/GSM and UMTS. Also, when the UEs' bearers are setup, cleared or undergo modification, the S-GW make resource allocation depending on the various requests from the MME, P-GW.

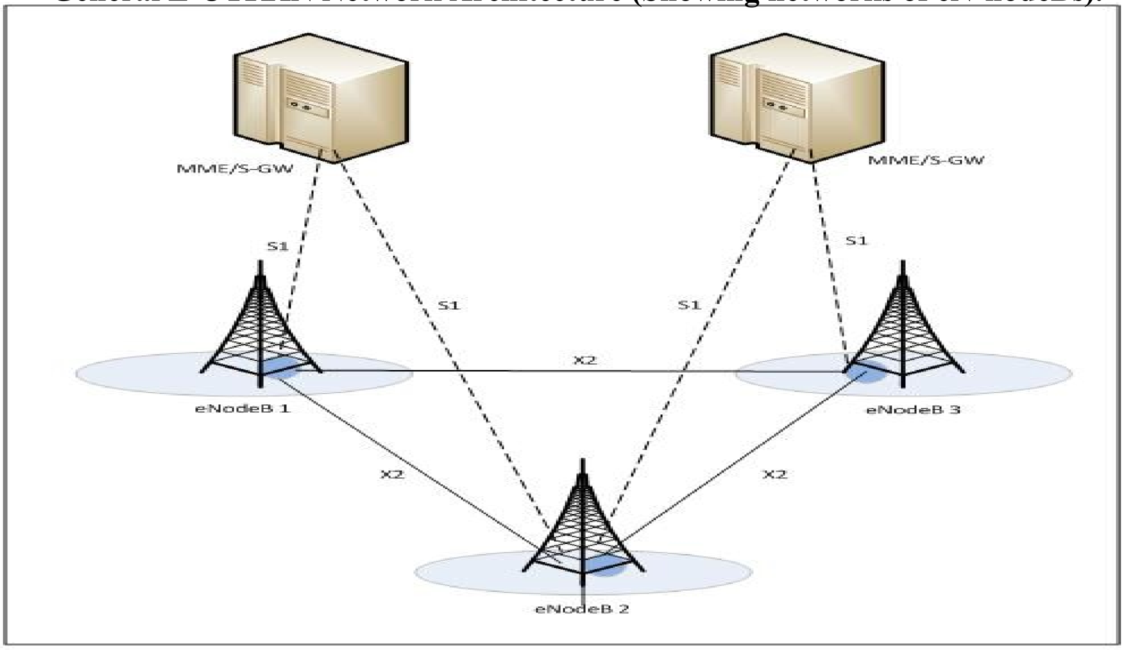
PCRF: The PCRF is responsible for the QoS as well as the policy control decision making. Also, it controls the flow-based charging for functions within the Policy Control Enforcement Function (PCEF) which is part of the P-GW. In other words, it does the Policy and Charging Control (PCC) functions.

HSS: The HSS is a database that contains all users' subscription details. It contains the information about the PDN every user is connected to or can connect to. Essentially, it holds all permanent subscribers' data. As part of its side functions, the HSS can also integrate the Authentication Centre (AuC).

The LTE Access Network

The LTE access network (referred to as the E-UTRAN) is a composition of networks of eNodeBs. It is responsible for radio related functions within the network; some of these are - Radio Resource Management, Header Compression, Security, Positioning and EPC Connectivity. One important point in the E-UTRAN is that, it does not have a central controller, which implies its name of Flat Architecture . As shown in figure 2.4, the eNodeBs are inter-connected by interfaces known as X2 interface and are connected to the EPC via S1 interfaces (this connection are done to the S-GW by S1-U interface and specifically, by S1-MME interface to the MME).

General E-UTRAN Network Architecture (Showing networks of eN-nodeBs).



The system of direct tunnelling in HSPA release 7 has been implemented in E-UTRAN, have simplified system architecture, which essentially defines the LTE air interface requirements for LTE. The protocols which operate between the UEs and the eNodeBs are referred to as the Access Stratum (AS) protocols.

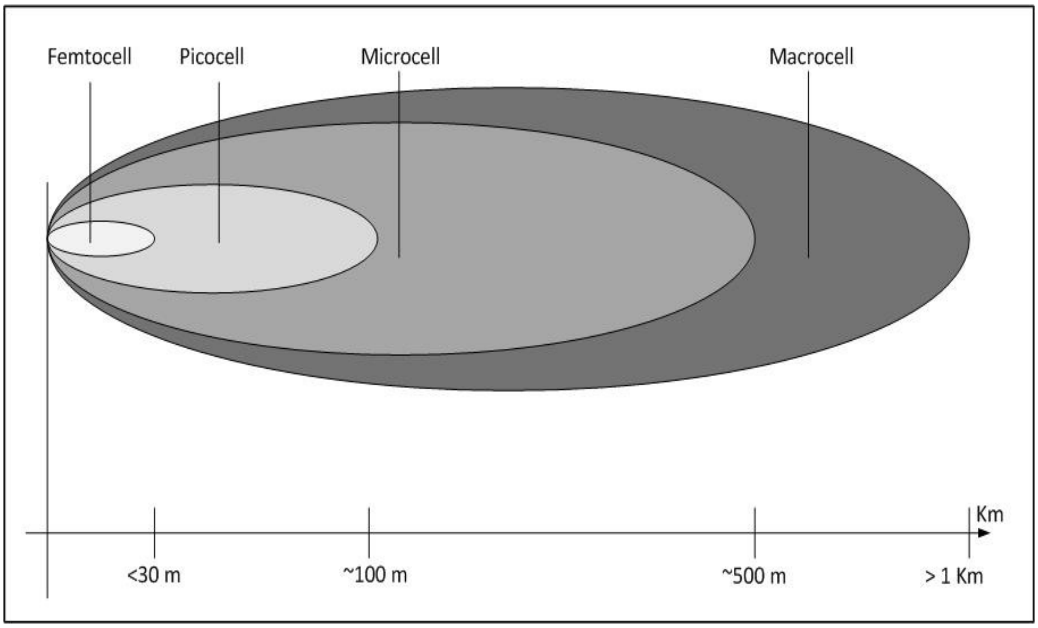
This table shows the summary of the main interface

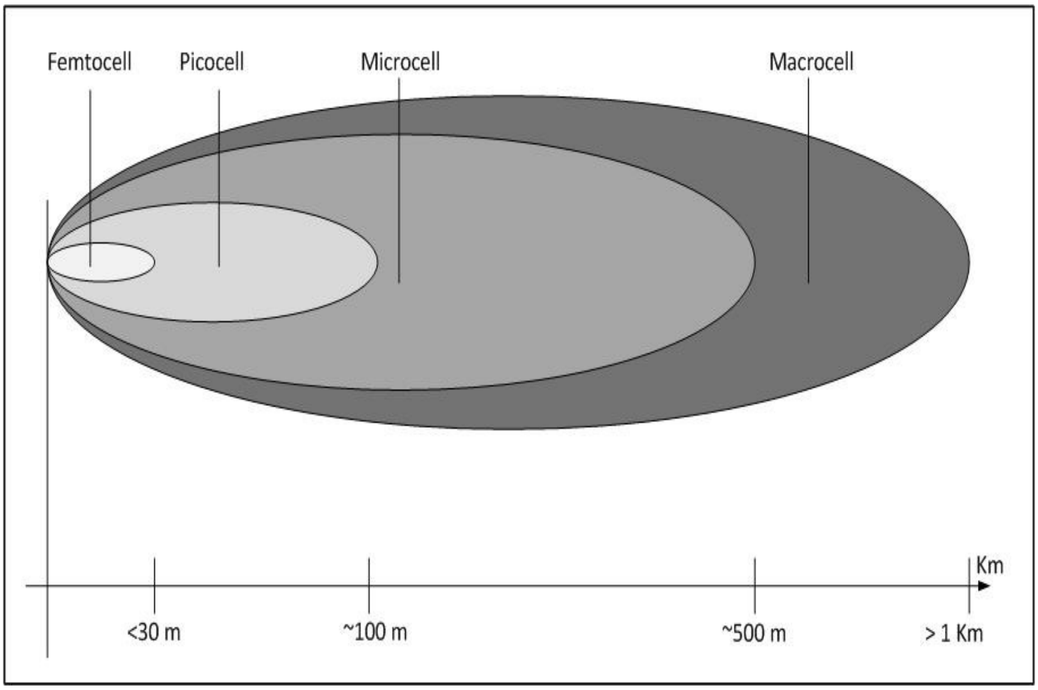
Sr. No.	Interface Types	Functions/Connectivity.
1	X2 interface	Used in mobility between eNodeBs, and also functions handover preparations and eNodeBs' neighbourhoods maintenance. The E-UTRAN can be referred to as a mesh of eNodeBs that are Totally connected via X2 interface.
2	S1-MME interface	This serves as the reference control node protocol between the MME and the E-UTRAN.
3	S1-U interface	This serves as the connecting interface between the E-UTRAN and the responsible S-GW.

Femtocells:

Femtocells (or Femto Base Station, FBS) are small, low-power cellular base station (or access points) that are user-installed which sufficiently enhance the conventional mobile communication for extended coverage area and improved capacity in cellular networks. Also, they can be referred to as typically designed radio access interfaces that connect the main macro cellular base station with user equipment for home or office use in small or large business locations.The development of the femtocell is a significant steps made to help network density in macrocells. The femtocells help to reduce the cell size for increased quality of service. Of much emphasis is the reduction in the maximum transmits power in femtocells as compared to the broader macrocells. As part of the small cell group, figure shows a significant comparison with respect to radius of coverage

Small cell comparison in terms of range





Benefits of femtocell :

The femtocell offers some significant advantages as discussed below:

1. **Coverage and Capacity**: The femtocells operate within a small distance, which helps to have a comparative low transmit power, and help to have higher SINR. As a result, there is always excellent signal reception for coverage and higher capacity.

2. **Macrocell Reliability**: The use of the femtocell helps to reduce the load on the macrocells. The macrocell uses some of its resources for better reception to serve mobile users; this is because the femtocells will absorb some of the indoor traffic.

3. **Cost:** In terms of cost reduction, the deployment of femtocells has been studied to reduce the CAPEX and OPEX for the service providers. Cost of electricity and backhaul is reduced and the cost of deploying extra macrocells is avoided as a result of the femtocells deployment which has significant compensation on the broader macrocell network.

4. **Subscriber Turnover**: It is quite popular that customers are not okay with indoors reception; and this has made customers to change their operators more often. So the use of the femtocell will help in creating a better customers' perspective in this regards.

In summary, the femtocells are essentially beneficial to the mobile operator and the users alike:

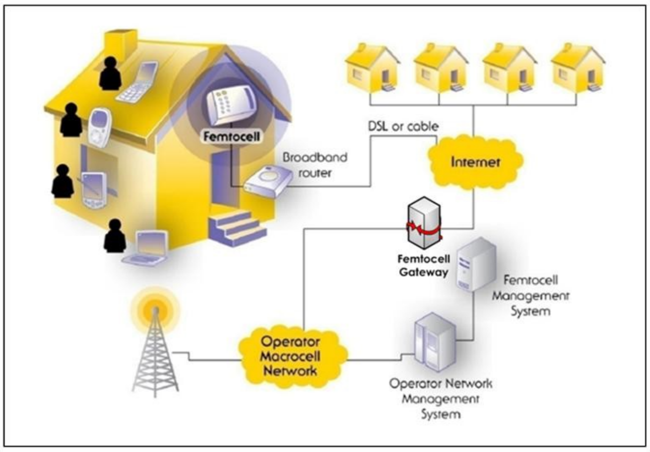
(a) For the mobile operators, there is the data offload from macrocell, expanded operator revenue, lower cost on backhaul and increased or perhaps steady number of customers.

(b) For the users, they enjoy better indoor coverage, excellent data speed in an all ubiquitous setting and improved terminal power consumption.

Femtocells Technologies:

As part of the major benefits attached to the use of femtocells is the use over the licensed spectrum and the use of the operators' network coupled with the use of the internet connections at home or office. The femtocell requires technology designs that could x into the carefully planned cellular networks of service providers.

The ability of the femtocells to offload data and video traffics will depend on how efficient and reliable the technology is. In a broad perspective, the femtocell is not just a small range device or perhaps, a high capacity device but it is significantly a device that has been designed from generation of technologies (or anticipated) to be able to interact easily with existing cellular networks conveniently at all the network layer. It does perform the tasks like handoffs, interference management, authentication and billing functions. Some of these functions have necessitated the quest for standardization, research and development coupled with compliance with growing radio access technologies.



Femtocell basic network

According to the Small Cell Forum12, some of the essential issues to be considered in the development of the femtocell technologies worldwide are primarily focused on: (a) Standardization, regulation and interoperability; and (b) Marketing and promotion of femtocell solutions. From this perspective, the most popular technologies of femtocells are the UMTS/CDMA2000 femtocells and the LTE/LTE-Advanced femtocells.

Future of Femtocell:

The future of femtocells is dependent on several factors that would either see the prospects of the development or mar its desired use by subscribers over the coming years, thereby reducing the confidence level. In examining the future of the femtocells with respect to this thesis, a close look has been given into examining most of the vital challenges faced by the femtocells in general. An evolving LTE roadmap with specific issues of advance interference management and enhanced self organising network techniques are very critical to the success of reducing the operating cost of HetNets in general. The issue of cost reduction is a particular point of concern for the network operators.

Technical Challenges for the future:

In solving some of the problems associated with the current deployments of femto-cells, listed below are some of the most technically challenging areas of concerns:

1. Security and backhaul
2. Self-Organizing Network
3. enhanced MIMO
4. Interferences

Conclusion:

Of much significance, the femtocells benefits were considered with discussion on what they off er and will continue to offer in terms of improved coverage and better capacity; more system reliability; cost reduction and a boost to subscribers' confidence. In additional, presented accordingly also, are some of the major issues that might set in if the future of the femtocells is not given necessary attention in terms of the security and some technical challenges it is facing by the deployment or installation or operation of the femtocells by some operators.

References:

[1] UTRA-UTRAN Long Term Evolution (LTE) and 3GPP System Architecture Evolution (SAE), Technical Paper, http://bit.ly/NhbfeE (Accessed August 2013).

[2] Small Cell Forum, HeNB (LTE Femto) Network Architecture, Release 1, Document 025.01.01, May

2011. http://www.smallcellforum.org (Accessed October 12, 2013).

[3] 3GPP TS 25.467 V8.1.0. (2009-03) Technical Specfication 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN architecture for 3G Home NodeB; Stage 2 (Release 8)

[4] 3GPP TR 32.821 V9.0.0 (2009-06) Technical Report 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Study of Self-Organizing Networks (SON) related Operations, Administration and Maintenance (OAM) for Home Node B (HNB), (Release 9).

[5] 3GPP TR 25.913 V9.0.0 (2009-12), Technical Report, 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN) (Release 9).

[6] 3GPP TR 25.892 V6.0.0 (2004-06), 3rd Generation Partnership Project; Technical Speci cation Group Radio Access Network; Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement, (Release 6).