Chapter Publication

Domain: MOBILE COMPUTING

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CHAPTER

CURRENT 3G AND 4G TECHNOLOGIES FOR GSM AND CDMA

1.1 EDGE

Enhanced data for global evolution (EDGE) could be a high-speed mobile information standard, supposed to change second-generation global system for mobile communication (GSM) and time division multiple access (TDMA) networks to transmit information at up to 384 kilobits per second (Kbps). because it was initially developed only for GSM systems, it's additionally been known as GSM384. Ericsson supposed the technology for those network operators who did not win spectrum auctions for third-generation networks to permit high-speed information transmission. EDGE provides speed enhancements by dynamic the sort of modulation used and creating a higher use of the carrier presently used, for instance the 200kHz carrier in GSM systems. EDGE additionally provides an biological process path to third-generation IMT-2000-compliant systems, like universal mobile phonephone systems (UMTS), by implementing a number of the changes expected within the later implementation in third-generation systems. EDGE builds upon enhancements provided by general packet radio service (GPRS) and high-speed circuit switched information (HSCSD) technologies that square measure presently being tested and deployed. It allows a larger data-transmission speed to be achieved in smart conditions, particularly close to the bottom stations, by implementing an eight-phase-shift keying (8 PSK) modulation rather than gaussian minimum-shift keying (GMSK)[1].

1.1.1 Basics of EDGE

GSM EDGE cellular technology is an upgrade to the prevailing GSM / GPRS networks, and might typically be enforced as a code upgrade to existing GSM / GPRS networks. This makes it a very engaging possibility proving virtually 3G data rates for alittle upgrade to associate existing GPRS network.

GSM EDGE evolution will offer data rates of up to 384 kbps, and this suggests that it offers a considerably higher rate than GPRS. There are variety of key parts within the upgrade from GSM or GPRS to EDGE. The GSM EDGE technology needs a number of latest elements to be additional to the system:

Use of 8PSK modulation: so as to attain the higher data rates among GSM EDGE,

the modulation format is modified from GMSK to 8PSK. This provides a big advantage in being able to convey 3 bits per symbol, thereby increasing the most rate. This upgrade needs a modification to the base station. typically hardware upgrades is also needed, though it's typically merely a software change.

Base station: except the upgrade to include the 8PSK modulation capability, alternative tiny changes are needed to the base station. These are usually comparatively tiny and might typically be accomplished by code upgrades.

Upgrade to network architecture: GSM EDGE provides the aptitude for ip based data transfer. As a result, further network parts ar needed. These are a similar as those required for GPRS and later for UMTS. during this method the introduction of EDGE technology is a component of the general migration path from GSM to UMTS. The two main extra nodes needed for the network are the gateway GPRS Service Node (GGSN) and the Serving GPRS Service Node (SGSN). The GGSN connects to packet-switched networks like the net and alternative GPRS networks. The SGSN provides the packet-switched link to mobile stations.

Mobile stations: it's necessary to possess a GSM EDGE handset that's EDGE compatible. because it isn't attainable to upgrade handsets, this suggests that the user must obtain a new GSM EDGE telephone set.

Despite the amount of changes that require to be created, the price of the upgrade to maneuver to GSM EDGE cellular technology is often comparatively tiny. the weather within the core network ar needed for GPRS which can already be out there on the network, and therefore these parts can already be gift. The new network entities are required for UMTS and thus they're on the general upgrade and migration path. alternative changes to the bottom stations are relatively tiny and can typically be achieved very simply.

SGSN

The SGSN or Serving GPRS Support Node component of the GPRS network provides variety of takes focussed on the science parts of the general system. It provides a range of services to the mobiles: Packet routing and transfer Mobility management Authentication Attach/detach Logical link management Charging informa-

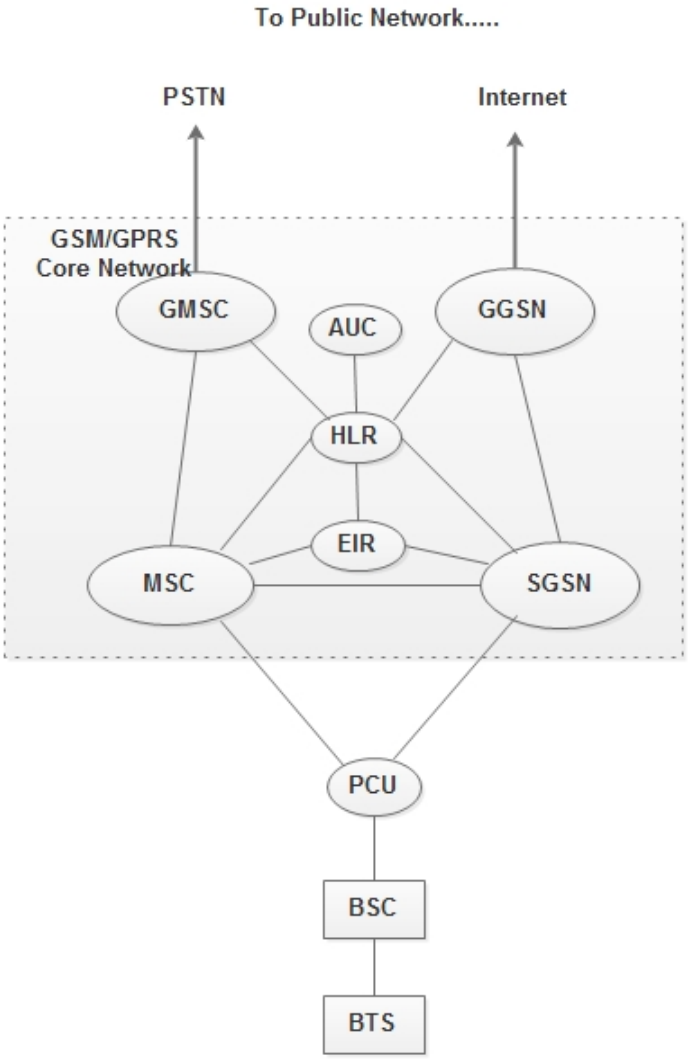

Figure 1.1: Architecture
[Architecture]

tion There is a location register at intervals the SGSN and this stores location info (e.g., current cell, current VLR). It conjointly stores the user profiles (e.g., IMSI, packet addresses used) for all the GPRS users registered with the actual SGSN.

GGSN

The GGSN, gateway GPRS Support Node is one among the most necessary entities inside the GSM EDGE specification. The GGSN organises the inter-working between the GPRS / EDGE network and external packet switched networks to that the mobiles is also connected. These could embody each internet and X.25 networks. The GGSN is thought of to be a mixture of a entree, router and firewall because it hides the inner network to the outside. operative, when the GGSN receives informa-

tion addressed to a particular user, it checks if the user is active, then forwarding the info. within the opposite direction, packet information from the mobile is routed to the correct destination network by the GGSN.

PCU

The PCU or Packet control Unit may be a hardware router that's additional to the BSC. It differentiates information destined for the quality GSM network (circuit switched data) and data destined for the edge network (Packet Switched Data). The PCU itself may be a separate physical entity, or additional usually currently it's incorporated into the bottom station controller, BSC, thereby saving further hardware prices.

1.2 CDMA

CDMA stands for Code Division Multiple Access. it's utilized in cellular communication almost like GSM and could be a second generation and third generation standard for mobile networks. it's the foremost secure mode of communication due to its unfold spectrum property.

CDMA could be a variety of multiplexing wherever a number of signals occupy one channel and optimizing the use of obtainable bandwidth. This technology is employed in ultra high frequency (UHF) cellular systems having a band starting from 800MHz to 1.9GHz.

CDMA uses to analog to digital conversion together with unfold spectrum technology. First, the audio signal is digitized to binary components.

The frequency of the transmitted signal is then created to vary in line with the code. Thus, it are often intercepted solely by a receiver whose frequency is programmed with a similar code.

The original CDMA standard known as CDMA One offers a transmission speed of up to fourteen.4 kbps in its single channel type and up to 115kbps in an eight-channel type. CDMA2000 and band CDMA deliver the information repeatedly quicker.

Advantages of CDMA

- Efficient utilization of mounted frequency spectrum.
- Flexible allocation of resources
- Multipath attenuation is also considerably reduced because of massive signal bandwidth.
- No limit on variety of users.
- Impossible to decipher the code sent and higher signal quality.
- No sense of hand-off once ever-changing cells.
- The CDMA channel is nominally 1.23MHz wide.
- Soft hand-off minimizes signal breakup because the phone passes from one cell to a different.
- CDMA is compatible with alternative cellular technologies, therefore permitting a national wide roaming.

1.2.1 CDMA2000 1x Network Elements

CDMA specification consists of following components

Mobile Station (MS):

The MS is that the mobile subscriber instrumentality, which may originate and receive calls and communicate with the BTS.

Base Transceiver Station (BTS):

The BTS transmits and receives radio signals, realizing communication between the radio system and therefore the mobile station.

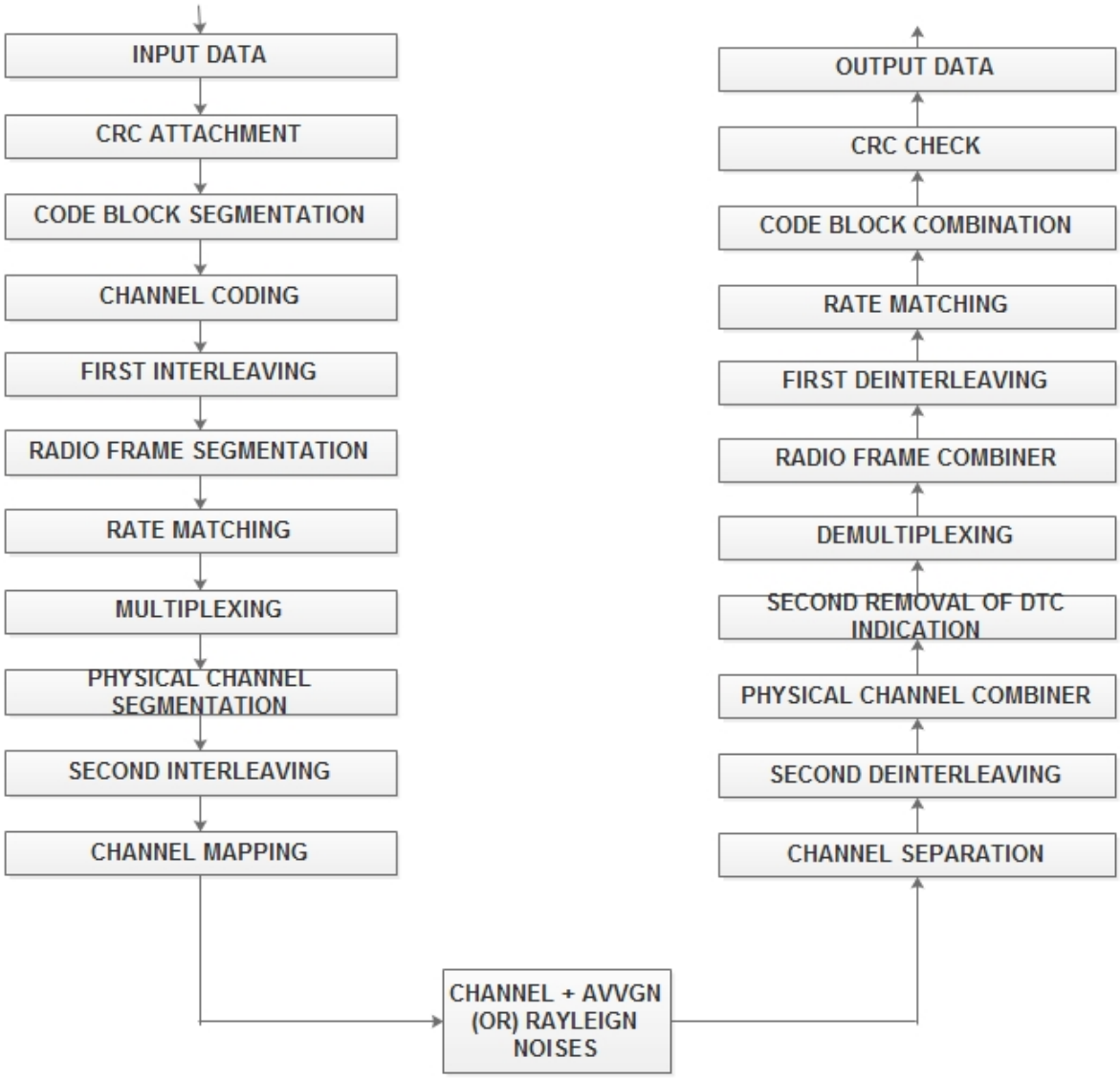

Figure 1.2: CDMA Architecture
[CDMA Architecture]

Base Station Controller (BSC):

The BSC implements the subsequent functions:

- Base Transceiver Station (BTS) control and management
- call association and disconnection
- mobility management
- stable and reliable link provision for the upper-layer services by soft/hard handoff

- power management
- radio resource management.

Packet control function (PCF):

The PCF implements the R-P association management. thanks to the shortage of radio resources, some radio channels ought to be free once subscribers don't send or receive knowledge, however the ppp connection is maintained endlessly. The PCF will defend radio quality for the upper-layer services via handoff.

Packet data Service Node (PDSN):

The PDSN implements the change of packet data services of mobile subscribers. One PDSN will be connected to multiple PCFs. It provides the interface between the radio network and therefore the packet knowledge network.

Home Agent (HA):

The agent locates at the place wherever the Mobile Node opens its account; receive the registration info from MN, Similar as HLR in mobile network. Broadcast the accessible info of MN. Setup the tunnel between FAHA. Transfer the info from different laptop to the MN via the tunnel.

Mobile change Center (MSC):

The msc implements the service change between the calling and known as subscribers. One msc is connected with multiple BSCs. The Master of Science may also be connected to the PSTN, ISDN or different MSCs. It provides the interface between the radio network and PSTN.

Visitor Location Register (VLR):

It is a dynamic information, stores the temporary info (all data necessary to line up decision connections) of the roaming subscribers within the native msc area. VLR is used to store the subscriber info of all the MSs in its local space, which may be used

to establish the incoming/outgoing decision connections, to support basic services, supplementary services and quality management.

Home Location Register (HLR):

It is a information for mobile subscriber management, the HLR (Home Location Register) is to blame for storing subscription info (telecom service subscription info and subscriber status), MS location info, MDN, IMSI (MIN), etc. The AC (Authentication Center) is physically combined with the HLR. it's a practical entity of the HLR, specially dedicated to the safety management of the CDMA system. It stores the authentication info. It additionally prevents unauthorized subscribers from accessing the system and prevents the radio interface information from being taken.

1.3 WCDMA

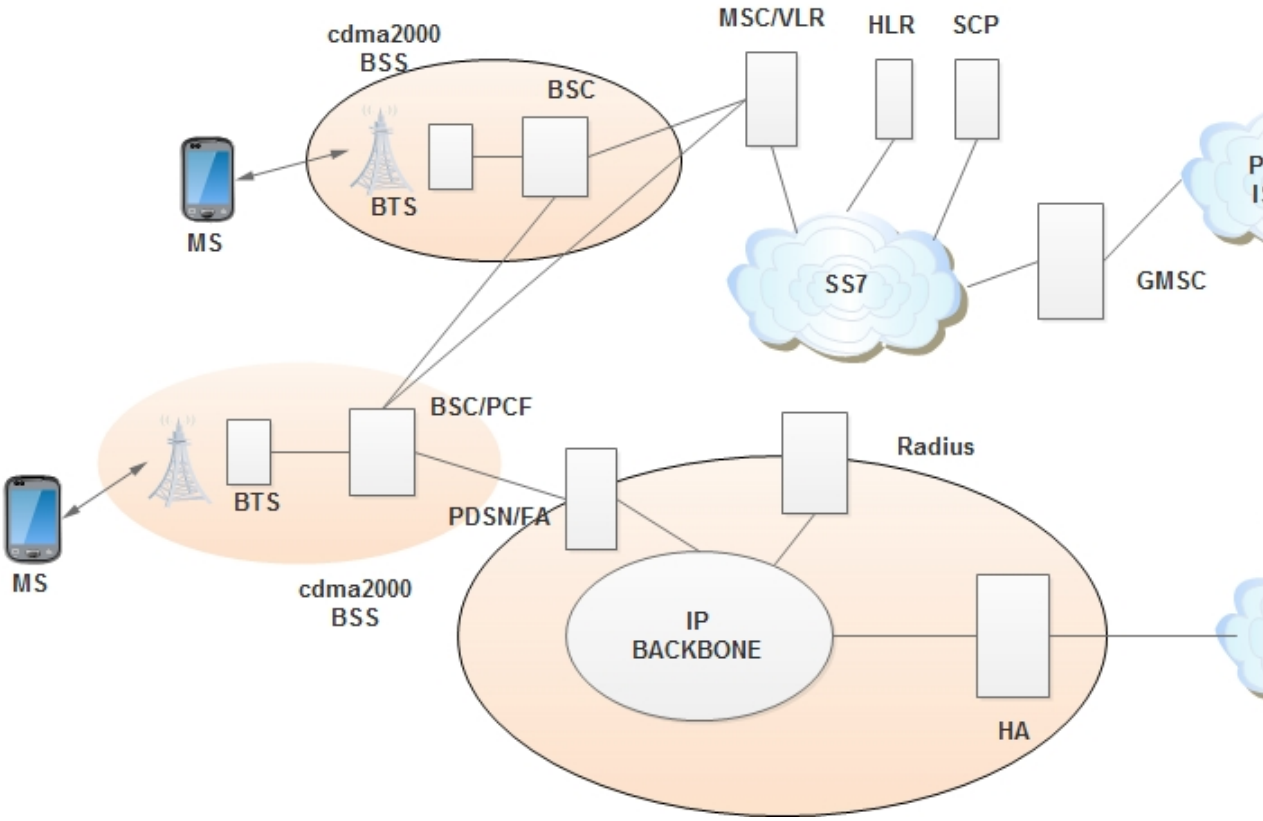

Figure 1.3: WCDMA FLOW

1.3.1 Features of WCDMA

- Bit rates up to 2 Mbps.
- Variable bit rate to offer bandwidth on demand.
- Multiplexing of speech, video, information on one link.
- Capability to handle variable delay needs. From delay sensitive to best effort packet data.
- Variable quality necessities. 100 pc FER to 10-6 BER.
- existence of 2G and 3G with inter-system handovers for increased coverage. Backward compatibility
- High spectrum efficiency.
- Support of asymmetric transmission and downlink. For uneven apps like internet browsing.
- existence of FDD and TDD modes.

Wideband code division multiple access may be a third generation mobile communication system that uses code division multiple access (CDMA) technology over a large band to supply high-speed multimedia system and economical voice services. The WCDMA infrastructure is compatible with GSM mobile radio communication system. WCDMA provides for high-speed knowledge and speech services. putting in or upgrading to WCDMA technology permits mobile service providers to offer their customers wireless broadband (high-speed Internet) services and to control their systems a lot of with efficiency (more customers per cell website radio tower).

The WCDMA system consists of mobile devices (wireless telephones and data communication devices referred to as user equipment-UE), radio towers (cell sites referred to as Node Bs), and an packet knowledge interconnection system switches and knowledge routers. The WCDMA system uses 2 types of radio channels; frequency division duplex (FDD) and time division duplex (TDD). The FDD

radio channels are primarily used for wide space voice (audio) channels and knowledge services. The TDD channels are generally used for systems that don't have the provision of twin frequency bands. This figure shows a simplified diagram of a WCDMA system.

The above diagram shows that the WCDMA system includes numerous varieties of mobile communication devices (called user instrumentation - UE) that communicate through base stations (node B) and a mobile switching center (MSC) or data routing networks to attach to different mobile telephones, public telephones, or to the net via a core network (CN). This diagram shows that the WCDMA system is compatible with each the 5 MHz wide WCDMA radio channel and therefore the narrow 200 khz GSM channels. this instance conjointly shows that the core network is basically divided between voice systems (circuit switching) and packet data (packet switching).

1.4 UMTS

1) UMTS Core Network (CN)

2) UMTS Terrestrial Radio Access Network (UTRAN)

3) User equipment (UE)

1) Core Network (CN)

The UMTS specification is partially supported existing 2G network components and a few new 3G network components. It inherits the fundamental functional components from the GSM design on the core network (CN) aspect. The CN provides circuit switched (CS) functions furthermore as packet switched (PS) functions.

The core network may be split into the subsequent different useful areas:

- Functional entities required to support notation services (e.g. 3G-SGSN, 3G-GGSN)
- Functional entities required to support metal services (e.g. 3G-MSC/VLR)
- Functional entities common to each kinds of services (e.g. 3G-HLR)
- Other areas which will be thought of a part of the core network include:

- Network management systems (billing and provisioning, service management, component management, etc)
- IN system service control point (SCP, service signaling point (SSP), etc.)
- ATM/SDH/IP switch/transport infrastructure

i. 3G-MSC

The 3G-MSC is that the main CN element to produce cs services. The 3G-MSC additionally provides the mandatory management and corresponding communication interfaces as well as SS7, MAP, ISUP (ISDN user part), etc. The 3G MS provides the interconnection to external networks like PSTN and ISDN.

ii. 3G-SGSN

The 3G-SGSN is that the main CN component for notation services. The 3G-SGSN provides the mandatory management practicality each toward the UE and the 3G-GGSN. It additionally provides the suitable communication ANd knowledge interfaces including connection to an IP-based network toward the 3G-GGSN, SS7 toward the HLR/EIR/AUC and TCP/IP or SS7 toward the UTRAN.

iii. 3G-GGSN

The GGSN provides interworking with the external notation network. it's connected with SGSN via AN IP-based network. The GGSN might optionally support AN SS7 interface with the HLR to handle mobile terminated packet sessions.

iv. SMS-IWMSC/SMS-GMSC

The overall demand for these 2 nodes is to handle the SMS from purpose to purpose. The practicality needed may be split into 2 components.
The SMS-IWMSC is an msc capable of receiving an originating short message from inside the PLMN and submitting it to the recipient service center.
The SMS-GMSC is an msc capable of receiving a terminated short message from a

service center, interrogating an HLR for routing data and SMS data, and delivering the short message to the SGSN of the recipient UE.

i. Firewall

This entity is used to guard the service providers backbone data networks from attack from external packet knowledge networks. the protection of the backbone data network may be ensured by applying packet filtering mechanisms supported access management lists or the other ways deemed appropriate.

ii. DNS/DHCP

The DNS server is used, as in any IP network, to translate host names into IP addresses, i.e., logical names are handled rather than raw IP addresses. Also, the DNS server is used to translate the access purpose name (APN) into the GGSN IP address. It may optionally be wont to enable the UE to use logical names rather than physical IP addresses.

A dynamic host configuration protocol server is used to manage the allocation of IP configuration data by automatically assigning IP addresses to systems designed to use DHCP.[4]

1.5 LTE

The LTE network known as EPS (Evolved Packet System) is an end-to-end (E2E) all IP network; EPS is divided into 2 components - LTE half that deals with the technology related to a radio access network (E-UTRAN) and EPC half that deals with the technology associated with a core network. an E2E all IP network implies that all traffic flows from a UE all the way to a PDN that connects to a service entity are transferred supported IP protocol among EPS.

In order for LTE services to be provided to a user over the LTE network, an E2E LTE network reference model (NRM) is mostly comprised of 3 further domains - BSS/OSS domain for subscriber, application domain for providing services, and IP transport network domain for causing IP packets in addition to basic EPS domain. The scope of this document is targeted on the essential EPS domain. different EPS

domain options, like the architectures for LTE interworking with 3GPP/non-3GPP and roaming, are out of the scope of this document and can be represented in different technical documents later.

LTE could be a standard for wireless data communications technology and an evolution of the GSM/UMTS commonplace. the most goals of LTE is to extend the capability and data rates of wireless data networks, improve spectrum potency, improve coverage, reduced latency and packet-optimized system that support mutliple Radio Access. Thus, so as to attain the goals, the design of the network if totally different from the previous wireless knowledge transfer network, GPRS.

Basically, the LTE standard solely supports packet switching with its all-IP network. the reason why LTE is intended only for packet switch is because it aims to supply seamless internet Protocol (IP) property between user equipment (UE) and also the packet knowledge network (PDN), with none disruption to the top users applications throughout quality. thanks to this characteristic, voice calls and text message natively (which are generally handled by circuit-switched networks like GSM and CDMA). In LTE design, Evolved UTRAN (E-UTRAN) is a vital role that is that the air interface of LTE upgrade path for mobile networks in the meantime it's among an evolution of the non-radio aspects underneath the term "System design Evolution" (SAE), which has the Evolved Packet Core (EPC) network. along LTE and SAE comprise the Evolved Packet System. Besides that, LTE network uses an eNodeB (evolved node B, basically an LTE base station), a MME (Mobile management entity), a HSS (home subscriber server), a SGW (serving gateway), and a PGW (a packet knowledge network gateway). These area unit thought-about as a part of the EPC except eNodeB.

In LTE, main perform of EPS is to supply the user with IP property to a PDN for accessing the web, still as for running service like voice over IP (VoIP). an EPS bearer is usually related to a QoS. Multiple bearers are often established for a user so as to supply different—totally different—completely different Qos streams or property to different PDNs. Figure on top of shows the general specification, together with the network components and also the standardized interfaces. At a high level, the network is comprised of the CN (EPC) and also the access network E-UTRAN.

whereas the CN consists of the many logical nodes, the access network is created of basically only one node, the evolved NodeB (eNodeB), that connects to the UEs. every of those network components is interconnected by means of interfaces that are standardized so as to permit multi-vendor ability. this offers network operators the chance to supply different—totally totally different—completely different network components from different vendors. In fact, network operators could select in their physical implementations to separate or merge these logical network components looking on commercial concerns.

The core network (called EPC in SAE) is liable for the control of the UE and establishment of the bearers. the most logical nodes of the EPC are:

PDN gateway (P-GW)

Serving entrance (S-GW)

mobility Management Entity (MME)

In addition to those nodes, EPC additionally includes different logical nodes and functions like the house Subscriber Server (HSS) and also the Policy control and Charging Rules function (PCRF). HSS that contains users SAE subscription data like the EPS-subscribed QoS profile and holds those data about the PDNs to that the user will connect, whereas PCRF is liable for policy control decision-making, further as for controlling the flow-based charging functionalities within the Policy control enforcement function (PCEF), that resides within the P-GW. From the figure on top of, MME that is that the control node that processes the sign between the UE and also the CN. The protocols running between the UE and also the CN are called the Non Access Stratum (NAS) protocols. The main functions supported by the MME are often classified as:

Functions related to bearer management This includes the institution, maintenance and unleash of the bearers and is handled by the session management layer within the NAS protocol.

Functions related to connection management This includes the institution of the connection and security between the network and UE and is handled by the connection or mobility management layer within the NAS protocol layer.

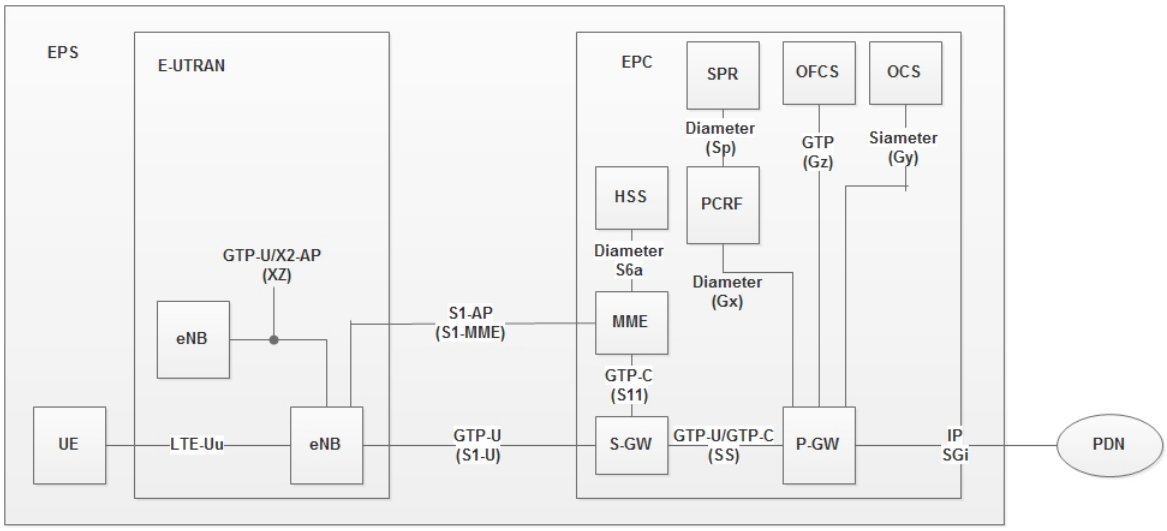

Figure 1.4: LTE Diagram Flow

1.5.1 E-UTRAN

The access network of LTE, E-UTRAN, merely consists of a network of eNodeBs.For traditional user traffic (as critical broadcast), there's no centralized controller in E-UTRAN; thus the E-UTRAN design is claimed to be flat. The eNodeBs are usually interconnected with ANother by means that of an interface referred to as X2 and to the EPC by means that of the S1 interface a lot of specifically, to the MME by means that of the S1-MME interface and to the S-GW by means that of the S1-U interface. The protocols that run between the eNodeBs and also the UE are referred to as the AS protocols" The E-UTRAN is chargeable for all radio-related functions, which might be summarized shortly as:
Radio resource management (RRM) This covers all functions associated with the radio bearers, such as radio bearer control, radio admission management, radio quality control, programing and dynamic allocation of resources to UEs in each transmission and downlink.
Header Compression This helps to confirm economical use of the radio interface by compression the information science packet headers that might otherwise represent a big overhead, particularly for little packets like VoIP.
Security All information sent over the radio interface is encrypted.
property to the EPC This consists of the sign toward MME and also the bearer path toward the S-GW.
For roaming design, it's shown as below:

1.6 HSPDA

HSDPA (High-Speed Downlink Packet Access) is a packet-based mobile telecom protocol employed in 3G UMTS radio networks to extend data capability and speed up transfer rates. HSDPA, that evolved from the WCDMA normal, provides transfer speeds a minimum of 5 times quicker than

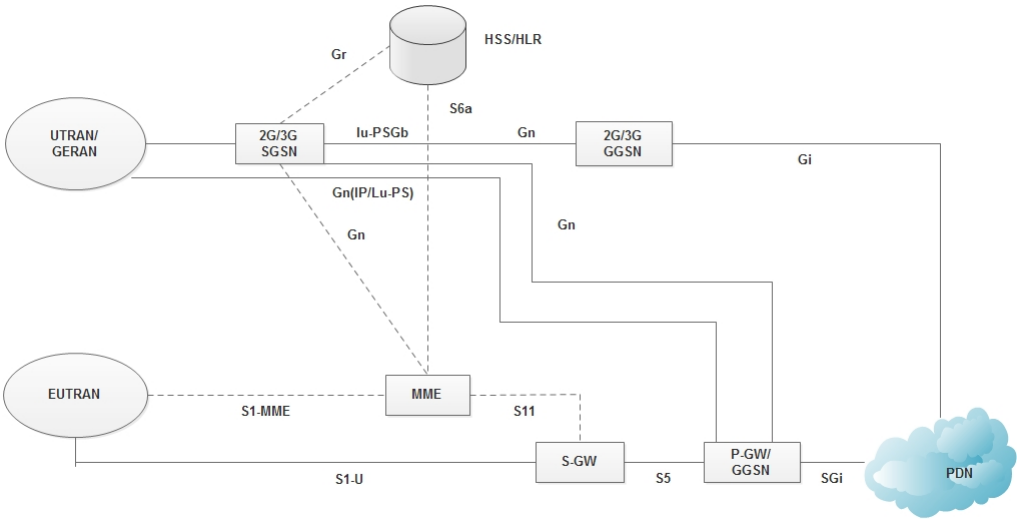

Figure 1.5: Roaming Design

earlier versions of UMTS, permitting users of HSDPA networks a broader choice of video and music downloads. HSPDA specifies knowledge transfer speeds of up to fourteen.4 Mbps per cell for downloads and a couple of Mbps per cell for uploads. In observe, users ar a lot of doubtless to expertise output speeds of 400-700 Kbps, with bursts of up to one Mbps.

1.6.1 Performace using HSDPA

Using HSDPA scheme it'll be potential to realize peak user information rates of 10 Mbps inside the 5 megahertz channel bandwidth offered under 3G UMTS. The new scheme incorporates a variety of advantages. It improves the general network packet information capability, improves the spectral efficiency and can alter networks to realize a lower delivery cost per bit. Users can see higher information speeds similarly as shorter service response times and higher handiness of services. but new mobile styles can need to be ready to handle the raised data throughput rates. Reports indicate that handsets can need to have a minimum of double the memory presently contained inside handsets. even so the benefits of 3G HSDPA mean that it'll be wide used as networks are upgraded and new phones introduced.

1.7 HSUPA

High Speed uplink Packet Access (HSUPA) is a UMTS / WCDMA transmission evolution technology presently being standardised in third Generation Partnership Project (3GPP); HSUPA is anticipated to be standardised by the 3GPP in UMTS unharness half dozen.
The new HSUPA mobile telecommunications technology is directly associated with HSDPA and therefore the 2 area unit complimentary to at least one another. It appears that HSDPA is that the a lot of advanced of the 2 technologies, however after they will operate side-by-side the ensuing system

can profit with major information transfer speed enhancements for receiving or causation.
Both procedures tally each other technically and, by the utilization of special modulation procedures, enable a higher use of cyber web infrastructure. the ability spectrum of the UMTS network is also increased at comparatively tiny expenditure. Improved intensive information services will then be offered. therefore HSUPA opens more areas for innovations and new business prospects.
HSDPA and HSUPA each supply high voice and information performance and along can modify the success of mass-market mobile informatics multimedia system. HSUPA enhances the transmission speed of UMTS / WCDMA networks and is that the next step when HSDPA.
HSUPA can enhance advanced person-to-person information applications with higher and regular information rates, like mobile e-mail and time period person-to-person gambling. ancient business applications together with several shopper applications can benefit from increased transmission speed. HSUPA can at the start boost the UMTS / WCDMA transmission up to one.4Mbps and in later releases up to five.8Mbps.

1.7.1 ENHANCEMENTS OF HSUPA OVER HSDPA

While the transmissions from the various UEs connected to identical Node-B are successive in time, like on a shared channel, the scrambling and channelization codes won't be shared between them as is completed in HSDPA on a shared downlink channel.
Because in the uplink the DPDCH (Dedicated Physical information Channel) and DPCCH (Dedicated Physical management Channel) area unit code-multiplexed and transmitted at the same time in time, the ratio of their transmit powers is vital for the achievable payload bit rates. The bigger a part of the UE's power is appointed to DPDCH the upper the pay-load bit rate accomplishable thereon channel however the less power is left for DPCCH and therefore the less reliable the signalling within the link. In UMTS unharness ninety nine the magnitude relation between the ability of DPDCH and DPCCH was set to a continuing. In HSUPA this magnitude relation are controlled by the Node-B.
In HSUPA, in contrast to in HSDPA, soft and softer handovers are allowed for packet transmissions. The management of the UE's transmit power in soft / softer relinquishment on E-DCH will be slightly totally different from that laid out in unharness ninety nine for DCH, namely: the most serving Node-B will be ready to issue each power-up and power-down commands however all alternative Node-Bs taking part within the relinquishment are ready to issue solely power-down commands. A power-down command can continually have precedence over a power-up command.

1.8 HSPA+

HSPA (without the "plus") may be a combination of 2 protocols: High Speed Downlink Packet Access (HSDPA) and High Speed transmission Packet Access (HSUPA) that merely implies that its download and upload speeds build on the initial 3G speeds for a peak rate of 14 Mbps down and 5.8 Mbps up.
HSPA+ was then introduced in 2008 and is usually referred to as 3.5G. HSPA+ upgraded 3G any into peak speed ranges of 10 Mbps, with real-world speeds averaging additional like 1-3 Mbps. Again, some cellular carriers with a 3G HSPA+ network have erroneously publicized their speed as 4G.

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