Evolusi,Arsitektur Dasar& Fungsi Perangkat Sistem Seluler

Teknik Transmisi Seluler

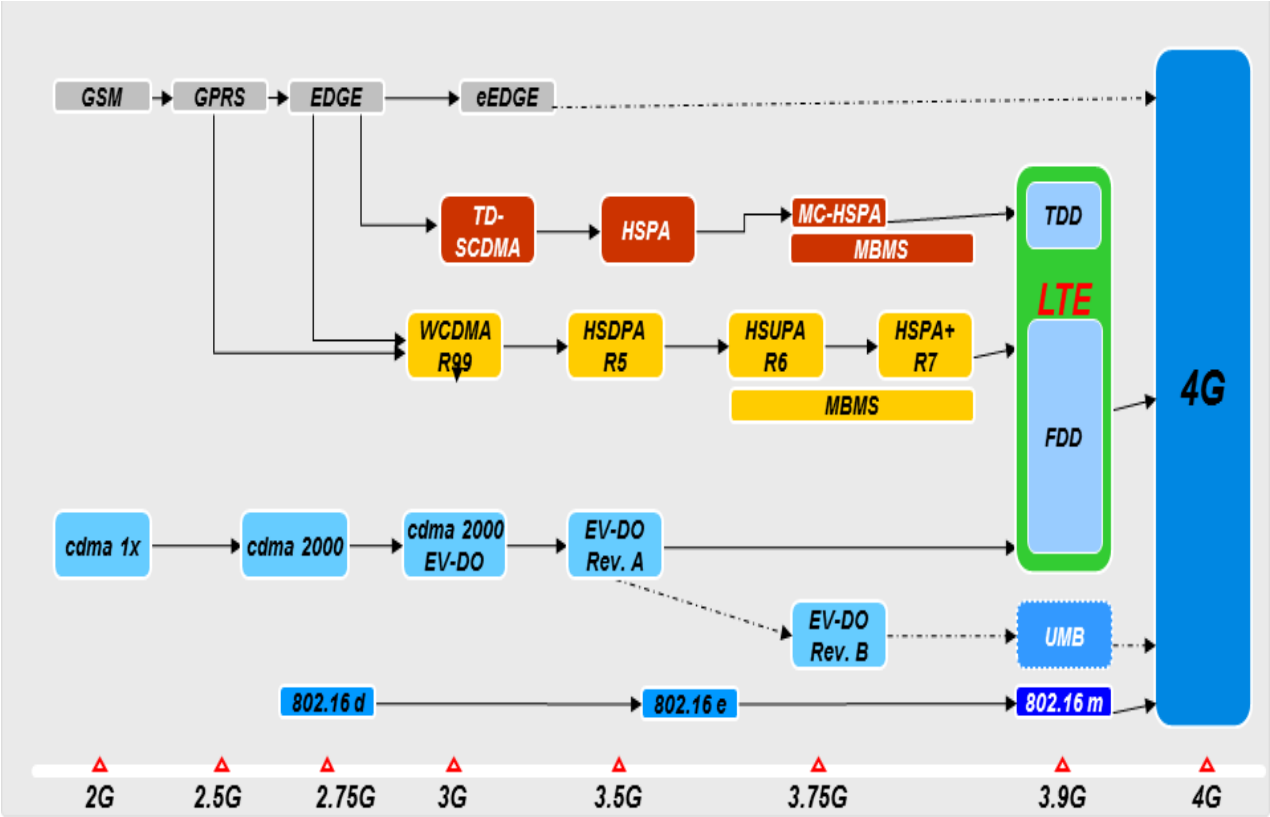
Prodi D3 TT

Evolusi Sistem Komunikasi Seluler

Alasan kenapa adanya evolusi?

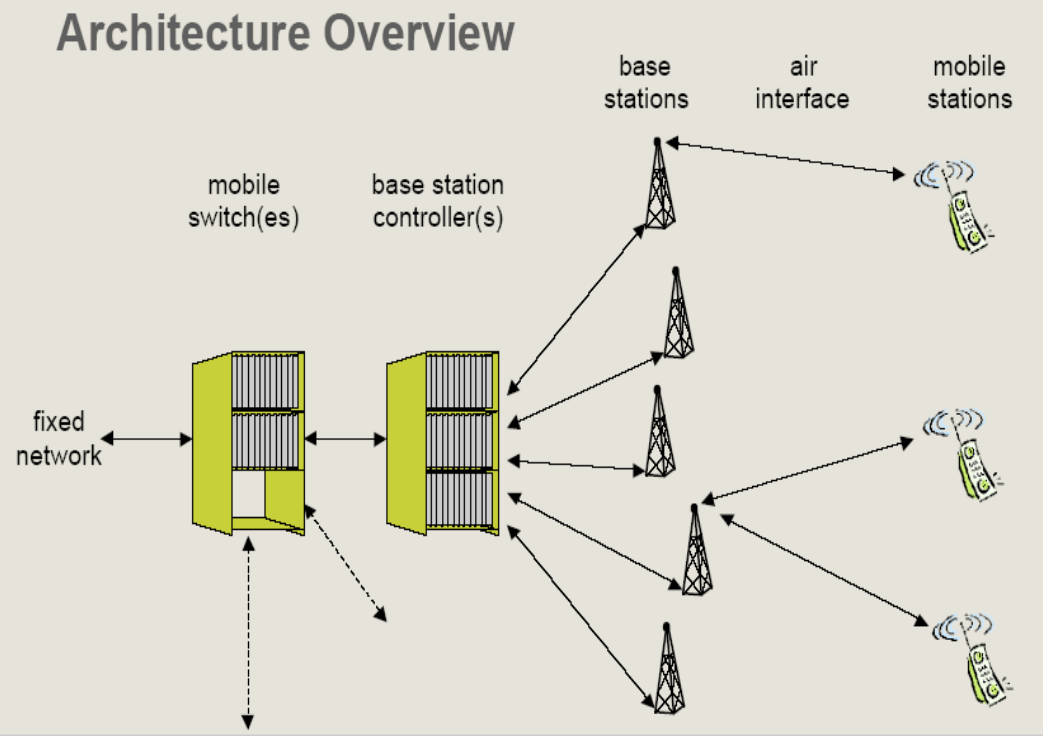
- Penggunaan Spektrum yang lebih efisien
- Kapasitas Jaringan yang lebih besar
- Kualitas layanan yang lebih baik
- Kecepatan data yang lebih optimal
- Kemampuan integrasi dengan jaringan lain
- Sistem berbasis IP (Paket switch Network)

Evolution Trend of Mobile Technology

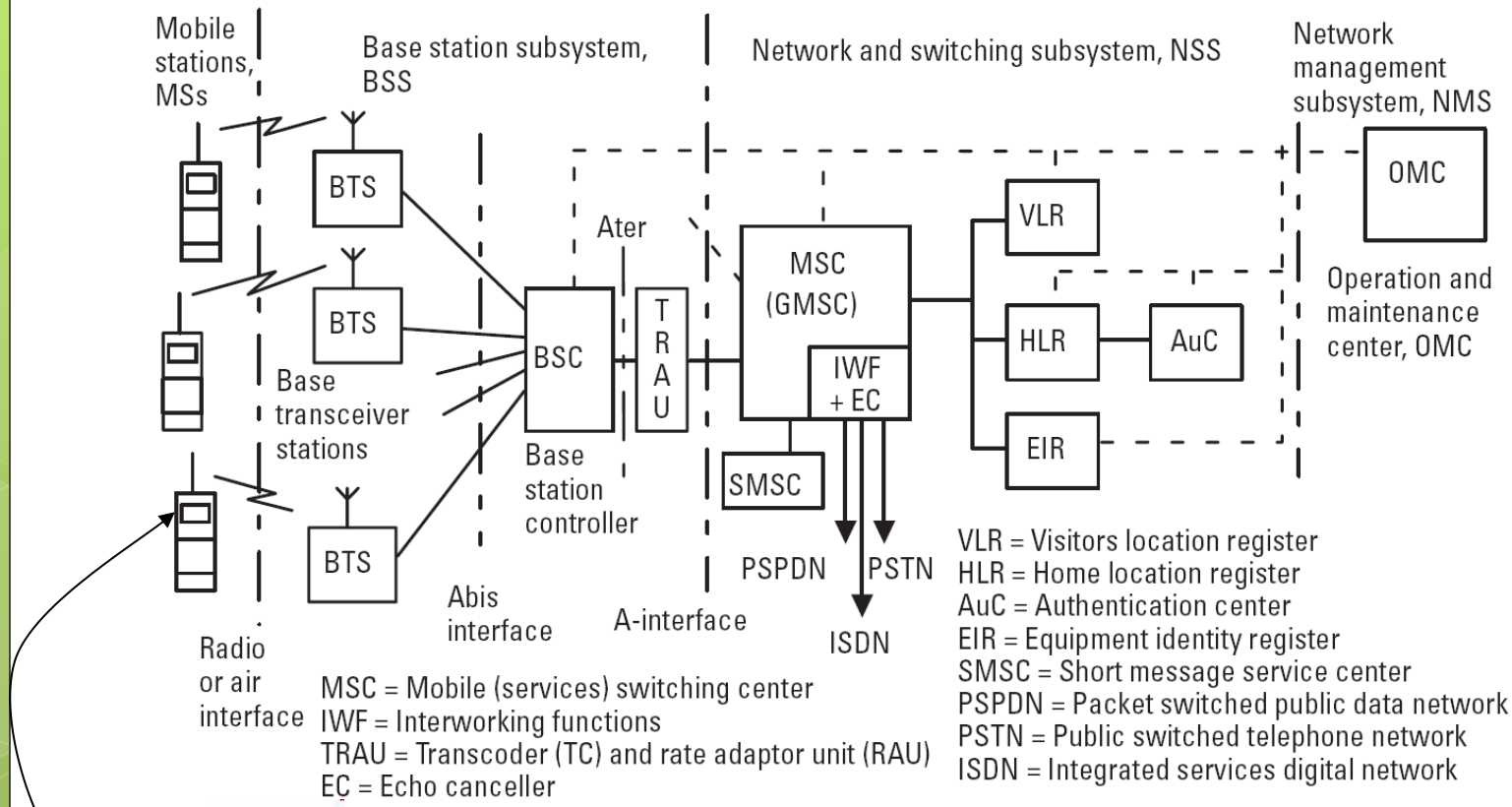


Arsitektur Jaringan Seluler

2G (GLOBAL SYSTEM FOR COMMUNICATION)



Struktur Jaringan GSM

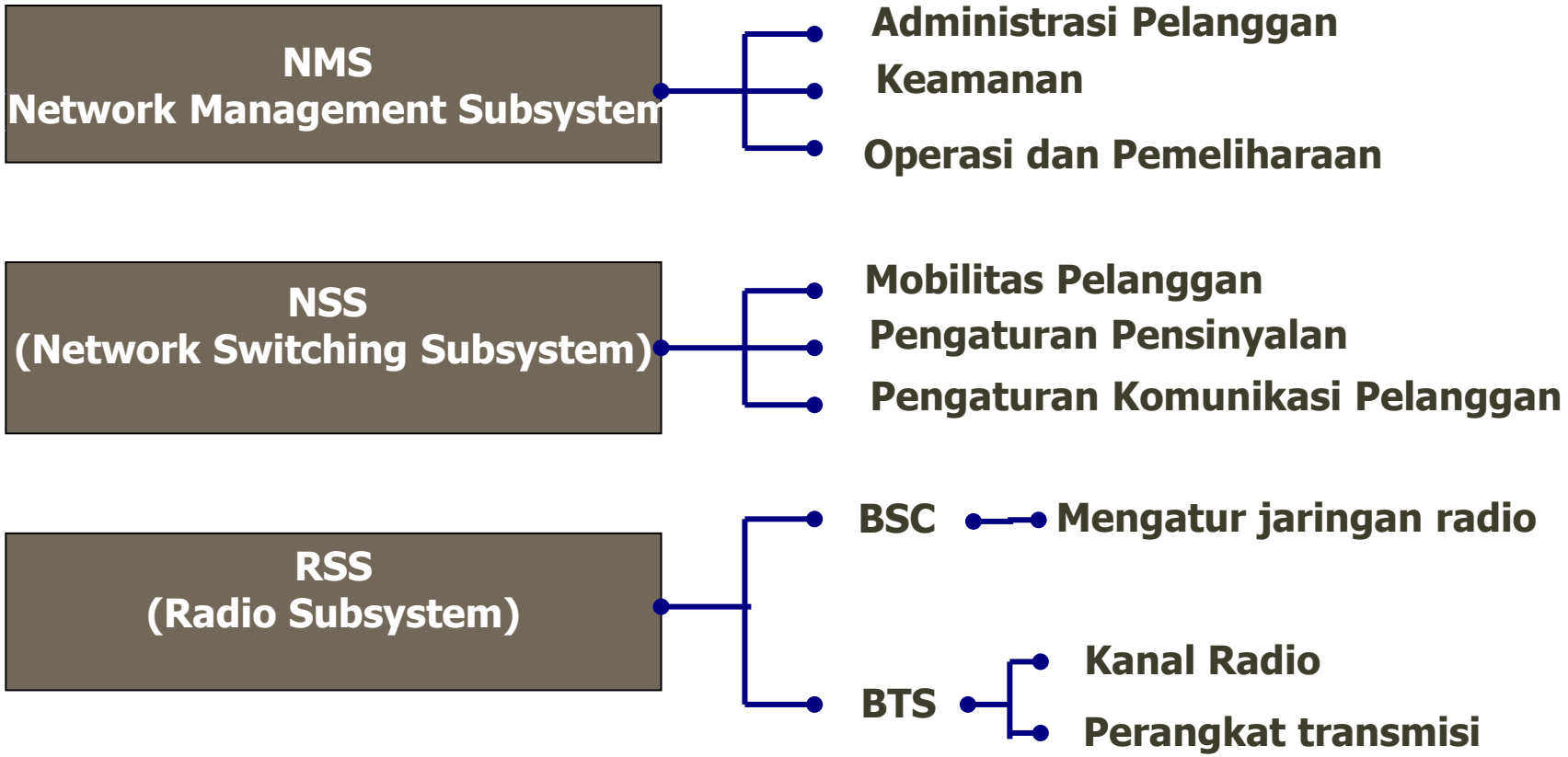


SIM : subscriber identity module

Arsitektur Jaringan GSM terdiri dari 3 bagian utama :

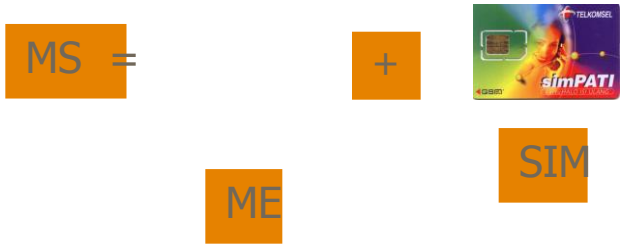
1. Radio Subsystem (RSS) = Base Station Subsystem (BSS) & Mobile Station (MS)
2. Switching Subsystem (SSS) = Network Switching Subsystem (NSS)
3. Network Management Subsystem (NMS)=Operation & Maintenance System (OMS)

Fungsi Subsystem GSM



Mobile Equipment

- Merupakan terminal tranceiver
- Diidentifikasikan dengan IMEI tertentu
- IMEI = International Mobile Equipment Identity
- MS terdiri dari :
  - Mobile Equipment (ME)/HP
  - Subscriber Identification Module (SIM)



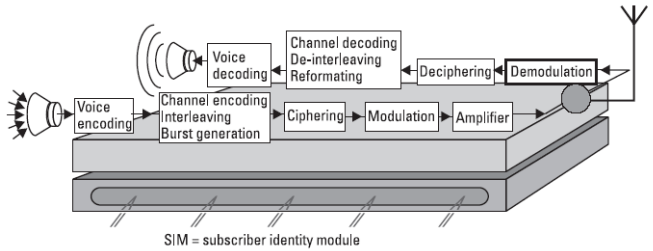


Figure 1.7 Circuit diagram of a GSM mobile station.

SIM CARD

- SIM = Subscriber Identity Module (SIM) adalah sebuah smart card yang berisi seluruh informasi user dan beberapa feature dari GSM
- ME/HP tidak dapat difungsikan tanpa SIM (kecuali Emergency Call)
- Dilengkapi dengan fungsi pengaman akses (PIN&PUK)
- Kartu SIM dapat digunakan diseluruh jaringan anggota GSM (internasional roaming)
- SIM terdiri dari :
  - Kartu SIM (ukuran standar ISO, 85 x 54 mm)
  - Modul plug-in (ukuran 25 x 15 mm)

  SIM + ME + cek PIN + Jaringan = MS aktif / valid

Perangkat BTS

- Provide the radio connection between mobile users and the switch
- One wireless system in a large metropolitan area may require hundreds of base stations to deliver unbroken coverage and provide sufficient capacity to handle all potential users

Base Transceiver Station (BTS)

- **BSS terdiri dari dua buah perangkat :**
  - ✓ **Base Transceiver Station (BTS)**
  - ✓ **Base Station Controller (BSC)**
- **BTS merupakan tranceiver yang mendefinisikan sebuah sel dan menangani hubungan link radio dengan MS.**
- **BTS terdiri dari perangkat pemancar dan penerima, seperti antenna dan pemroses sinyal**

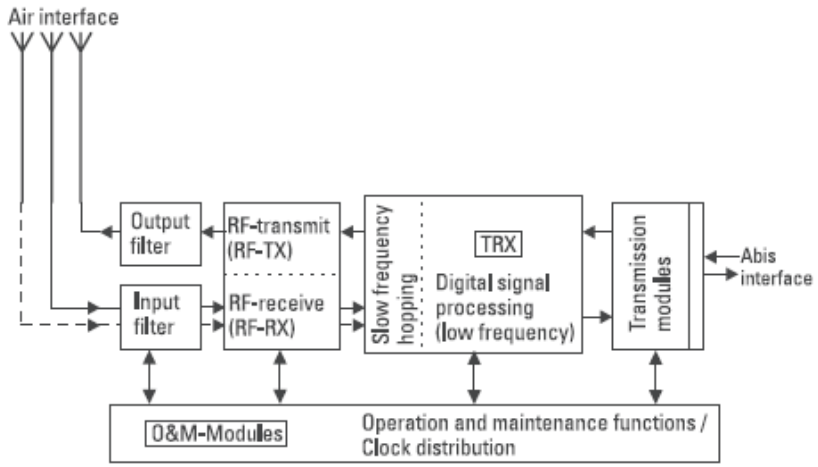


Figure 1.2 Principal schematic diagram of the base transceiver station.

Base Station Controller (BSC)

- **BSC mengatur sumber radio untuk sebuah BTS atau lebih.**
- **BSC menangani radio-channel setup, frequency hopping, and handover intern BSC**

Perangkat BSC

- The Base Station Controller (BSC) interfaces the Switch and the base stations
  - Compresses speech signals for more efficient transmission over the scarce radio spectrum
  - Controls the base stations and implements the handoff of calls from one base station to another as users drive across the system

Network and Switching Sub-system (NSS)

NSS terdiri dari :

- **Mobile Switching Center (MSC)**
- **Home Location Register (HLR)**
- **Visitor Location Register (VLR)**
- **Authentication Center (AuC)**
- **Equipment Identit Register (EIR)**

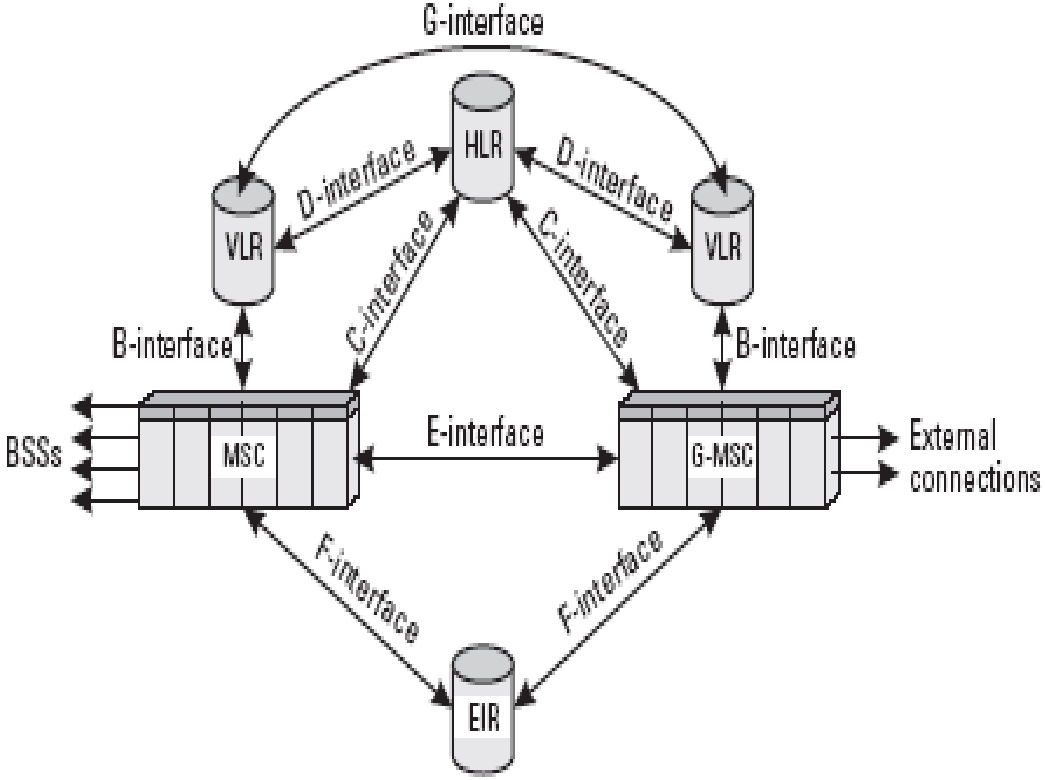


Figure 4.1 The NSS.

Mobile Switching Center (MSC)

- Melakukan fungsi switching
- Mengatur BSC
- Sebagai penghubung antara satu jaringan GSM dengan jaringan lainnya

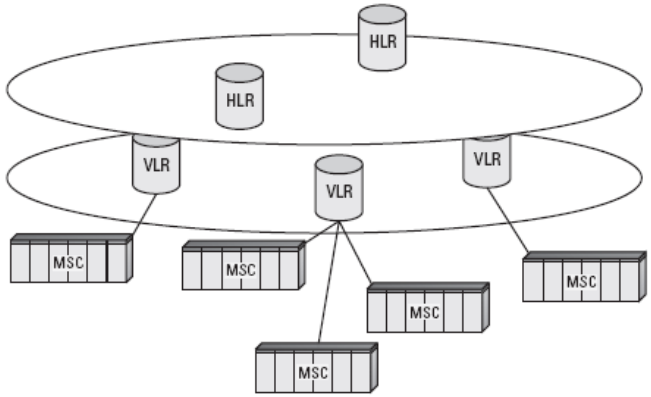


Figure 4.3 The NSS hierarchy.

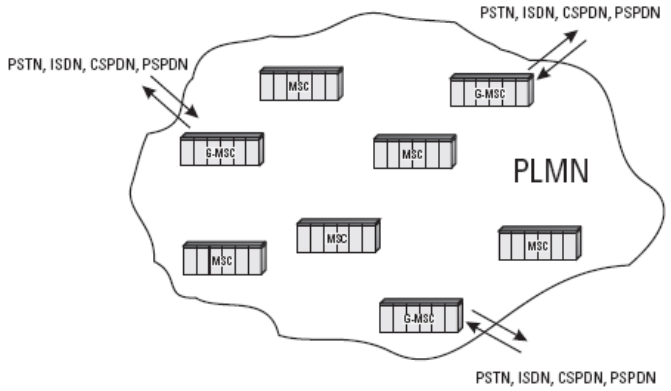


Figure 4.4 The functionality of the gateway MSC.

Home Location Register (HLR)

- HLR berisi rekaman database permanen dari pelanggan dan merupakan database user yang utama.
- HLR juga berisi rekaman lengkap lokasi terkini dari user.

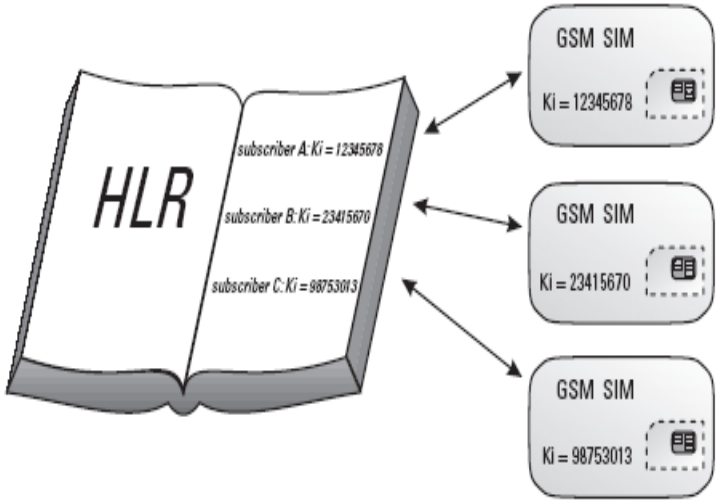


Figure 4.2 Only the SIM and the HLR know the value of K_i.

Perangkat HLR

- The HLR (Home Location Register) is the official database of all customers on a wireless system
- It can be part of the switch, or held in a server at a central location where multiple switches can interrogate it
- Information held in the HLR:
  - current account status/validity
  - phone's technical parameters
  - whether the phone is presently turned on, and if so, the identity of switch which is presently serving the phone
  - secret keys for authentication to avoid fraudulent use/cloning

Visitor Location Register (VLR)

- VLR berisi database sementara dari pelanggan
- VLR digunakan untuk pelanggan lokal dan yang sedang melakukan roaming.
- VLR memiliki pertukaran data yang luas daripada HLR.
- VLR diakses oleh MSC untuk setiap panggilan, dan MSC dihubungkan dengan VLR
- Setiap MSC terhubung dengan sebuah VLR, tetapi satu VLR dapat terhubung dengan beberapa MSC

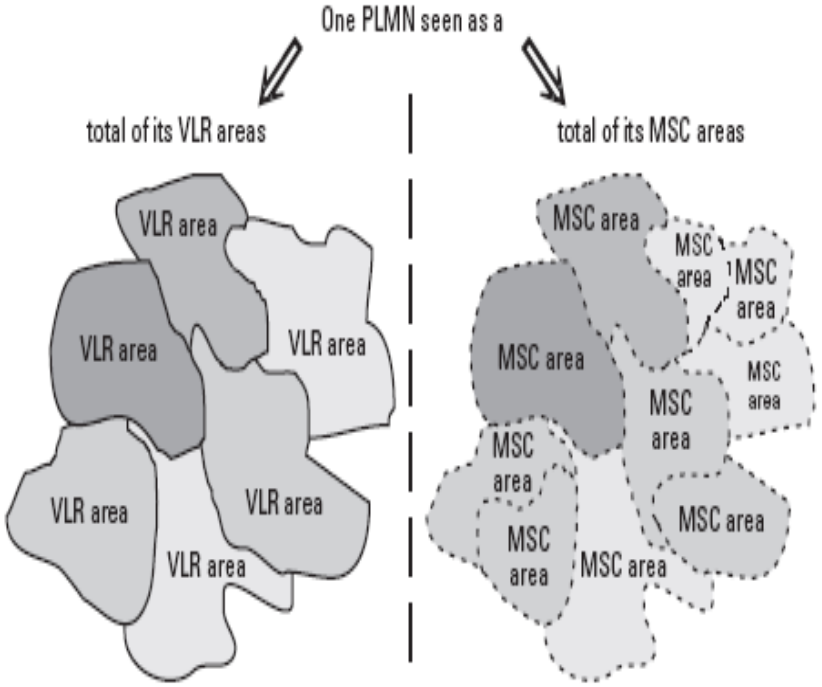


Figure 4.5 Geographic relationship between the MSC and the VLR.

Equipment Identity Register (EIR)

- EIR merupakan register penyimpan data seluruh mobile stations
- EIR berisi IMEIs (international Mobile Equipment Identities), yang merupakan nomor seri perangkat + tipe code tertentu

* catatan: EIR belum diterapkan di Indonesia.

Network Management Subsystem (NMS)

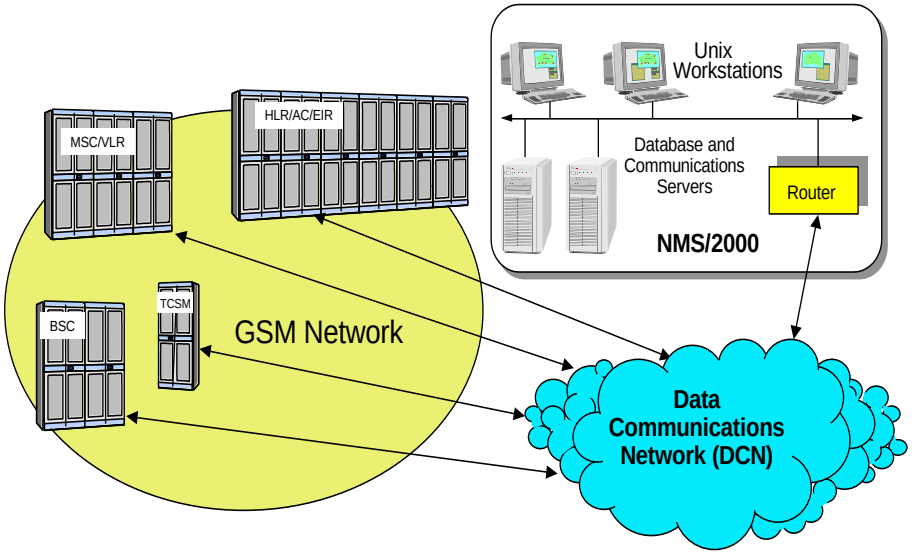
- Operation and Maintenance System (OMS)

  Merupakan bagian yang mengizinkan penyelenggara jaringan untuk membentuk dan memelihara jaringan dari lokasi sentral. OMS terdiri dari

  - OMC (Operation and Maintenance Centre): sebagai pusat pengontrolan operasi dan pemeliharaan jaringan. Fungsi utamanya adalah mengawasi alarm perangkat dan perbaikan terhadap kesalahan operasi.

- Network Management Centre (NMC)

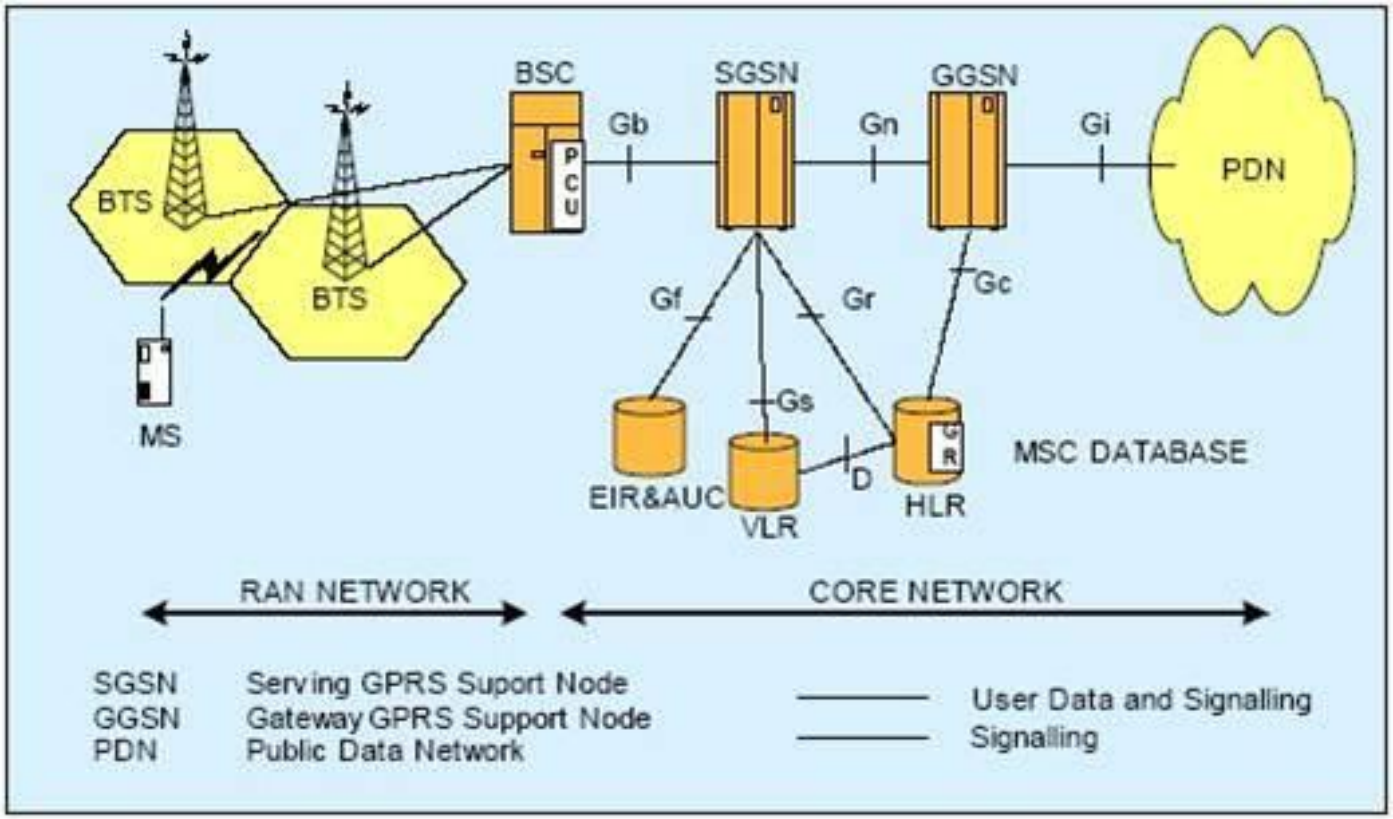
  Berfungsi untuk pengontrolan operasi dan pemeliharaan jaringan yang lebih besar



GPRS (General Packet Radio System)

- GPRS merupakan data paket yang terintegrasi dengan GSM
- Kecepatan data 171,2 Kbps
- Menggunakan paket swich , sedangkan GSM circuit switch
  - Paket switch : sebuah kanal akan digunakan secara bersama-sama selama kanal tersebut tidak penuh
  - Cicuit Switch : Setiap kanal mutlak dimiliki oleh satu user selama proses komunikasi terjadi

Arsitektur Jaringan GPRS



Fungsi Masing2 komponen GPRS

- MS (Mobile Switching)
- GGSN berfungsi sebagai gateway antara jaringan GPRS dengan Jaringan paket data Standar (PDN)
- SGSN berfungsi untuk proses Mobility management, Chipperring, kompresi data, paging, perhitungan trafik, charging, security dan pengaturan akses data.

Fungsi Masing2 komponen GPRS (2)

- PCU : bertanggung jawab atas semua protokol radio GPRS dan komunikasi dengan SGSN. PCU juga menangani frame relay, Network Service Signalling, Routing of Signaling message, Radio Link Control (RLC) dan Medium Access (MAC)

EDGE (Enhanced Data Rate for Global Evolution)

- Merupakan pengembangan dari jaringan GSM yang didesain untuk membagi sumber daya kanal radio secara dinamis antara layanan packet service dengan layanan circuit switch GSM
- EDGE berbasis Paket Switch
- Kecepatan data 473.6 kbps
- EDGE menggunakan teknik modulasi 8-PSK

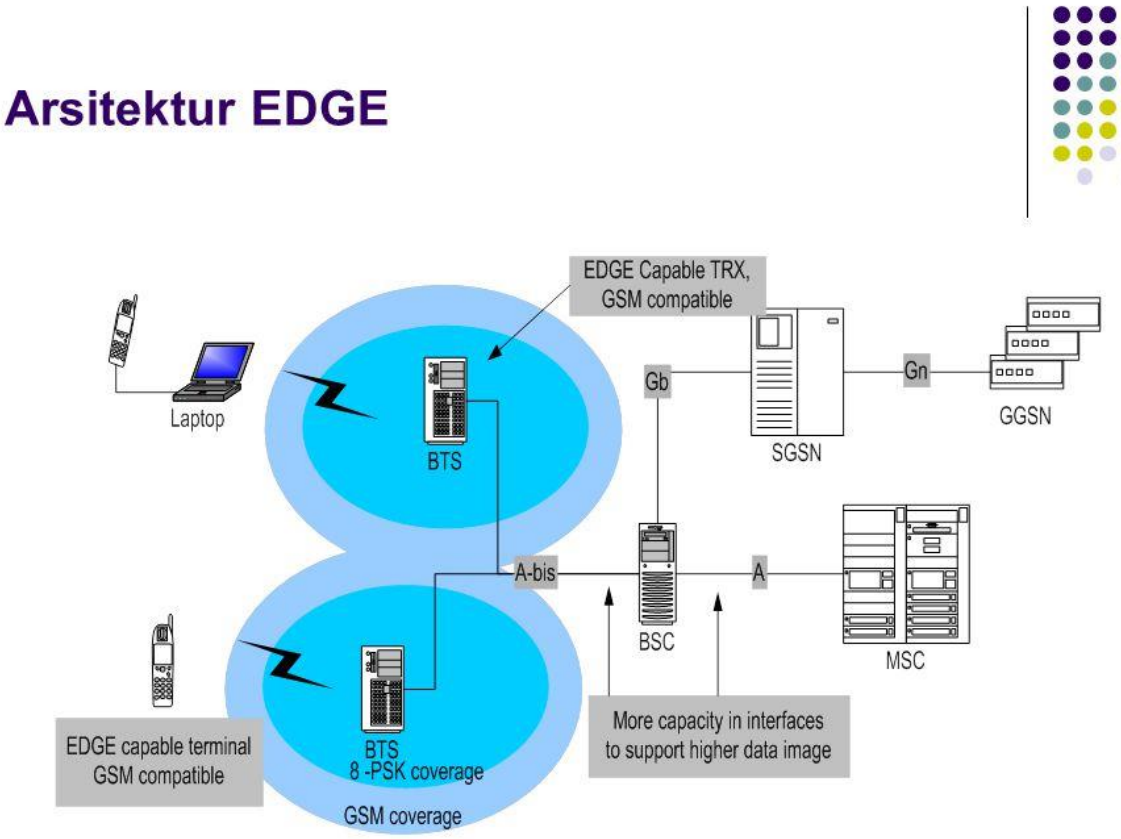
EDGE (Enhanced Data Rate for Global Evolution)

- Arsitektur sama dengan GPRS , perbedaannya ada pada BTS yang menambahkan sistem modulasi 8 psk pemancar dan penerima sehingga BTS lama bisa melayani sistem EDGE/GPRS dan GSM/GPRS
- Pada EGPRS/EDGE terdapat 9 jenis MCS

EDGE (Enhanced Data Rate for Global Evolution)

Scheme	Modulation	Th max/slot (Kbps)
MCS-9	8-PSK	59.2
MCS-8 MCS-7 MCS-6	8-PSK 8-PSK 8-PSK	54.4 44.8 29.6
MCS-5	8-PSK	22.4
MCS-4	GMSK	17.6
MCS-3	GMSK	14.8
MCS-2	GMSK	11.2
MCS-1	GMSK	8.8

Arsitektur EDGE

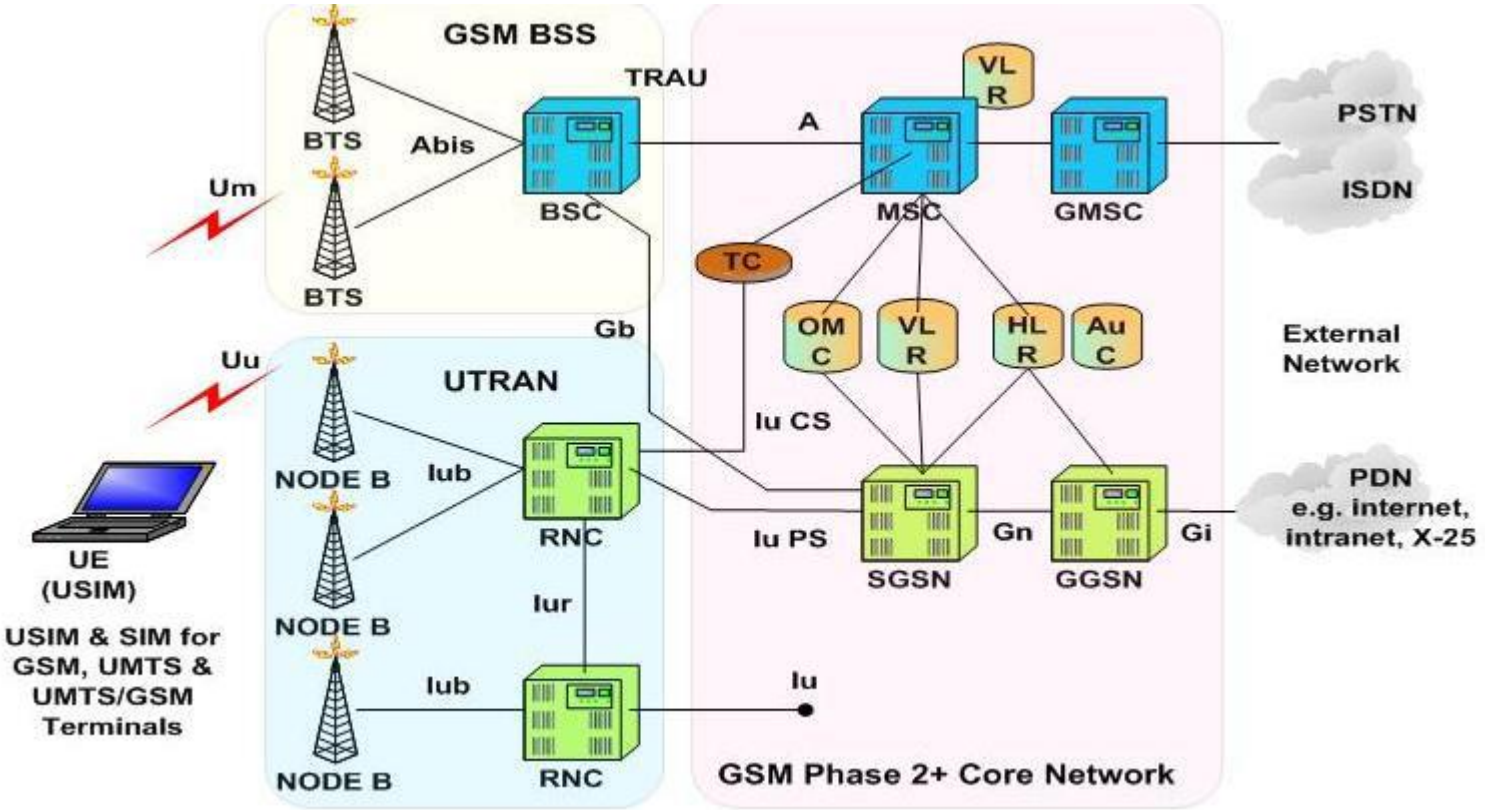


Bagaimana Arsitektur UMTS/WCDMA?

UMTS (Universal Mobile Telecommunication System)/WCDMA

- Perbedaan dengan GSM, GPRS dan EDGE adalah adanya UTRAN (UMTS Terrestrial Radio Access Network)

Arsitektur UMTS



Fungsi Elemen Arsitektur UMTS

- UTRAN terdiri dari RNS yang meliputi RNC (dianalogikan dengan GSM BSC)dan Node B
- RNC bertanggung jawab sebagai mengontrol node b dibawahnya, manajemen sumber radio yang tersedia pada node B.
- Node B adalah unit fisik untuk mengirim/menerima frekuensi pada sel. Node B mengukur kualitas dan kekuatan hubungan dan menentukan Frame Error Rate (FER), transmisi data ke RNC.

HSDPA, HSUPA, HSPA+

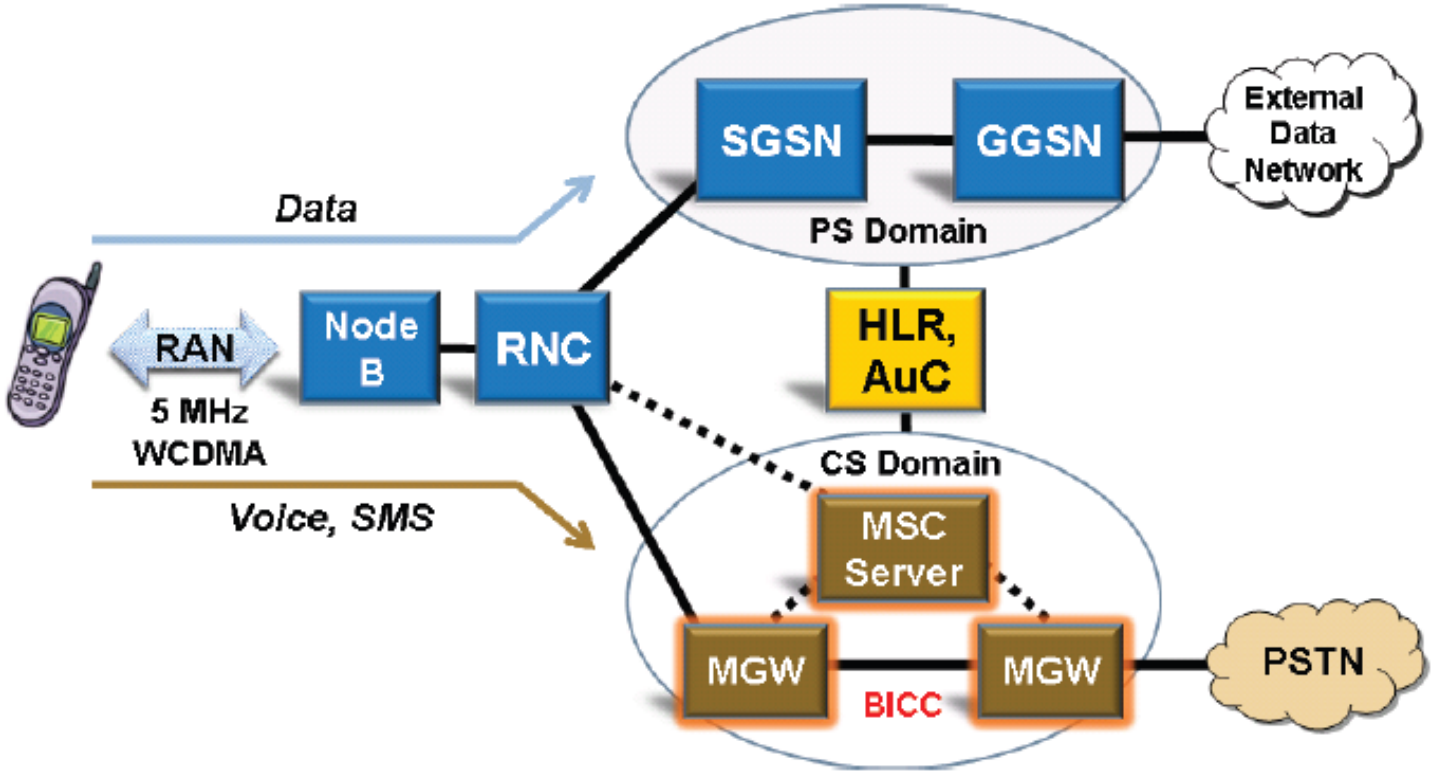
HSDPA (1)

- Pengembangan teknologi 3G, dimana kecepatan data mencapai 8-10 Mbps
- Meningkatkan user throughput maksimum untuk pengiriman paket data dari sisi downlink dan mengurangi delay transmisi paket
- Arsitektur seperti UMTS/WCDMA namun ada perubahan di sisi MAC yaitu adanya penambahan entitas MAC-hs (Medium Access Control High Speed) pada sub layer MAC pada nodeB.

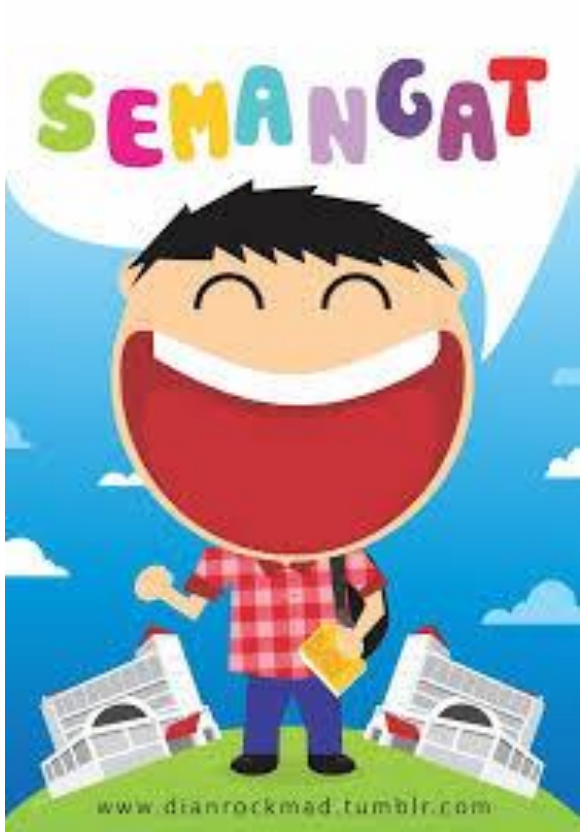
HSDPA (2)

- Teknik yang digunakan untuk meningkatkan data rate transmisi adalah AMC (Adaptif Modulation and Coding),HARQ (Hybrid Automatic Repeat Request), dan Packet Schedullin
- Dapat meningkatkan throughput rata-rata karena adanya level Modulation and Coding Scheme (MCS)yang semakin tinggi.
- 16 QAM + Turbo Code R=3/4→ Throuhput maksimal
- QPSK+turbo code R=1/4 → Jika kondisi kanal buruk

Arsitektur HSDPA, HSUPA,HSPA+

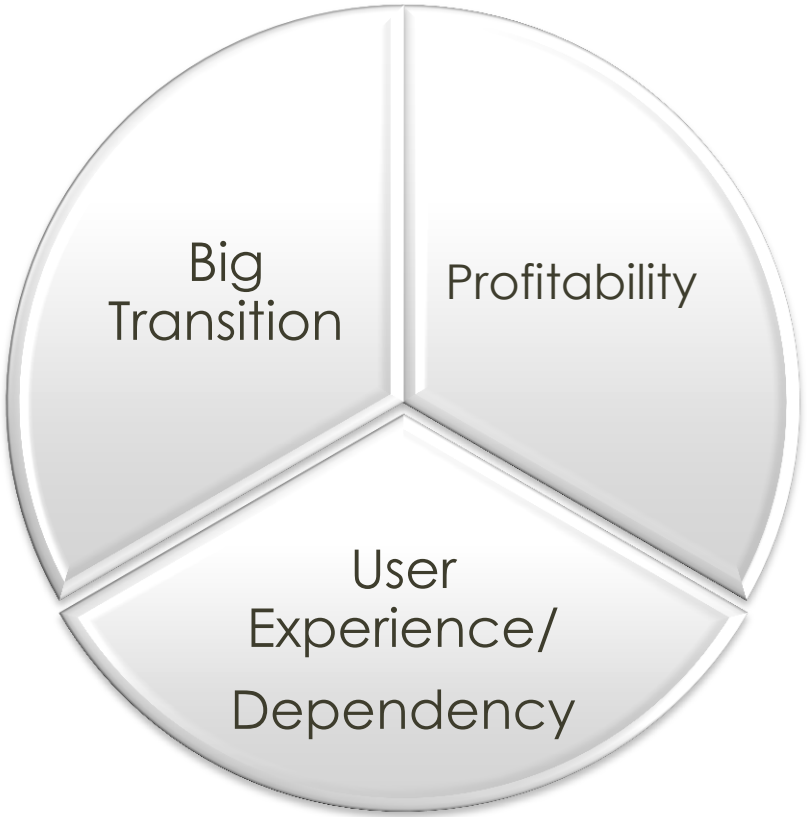


TUGAS!!!

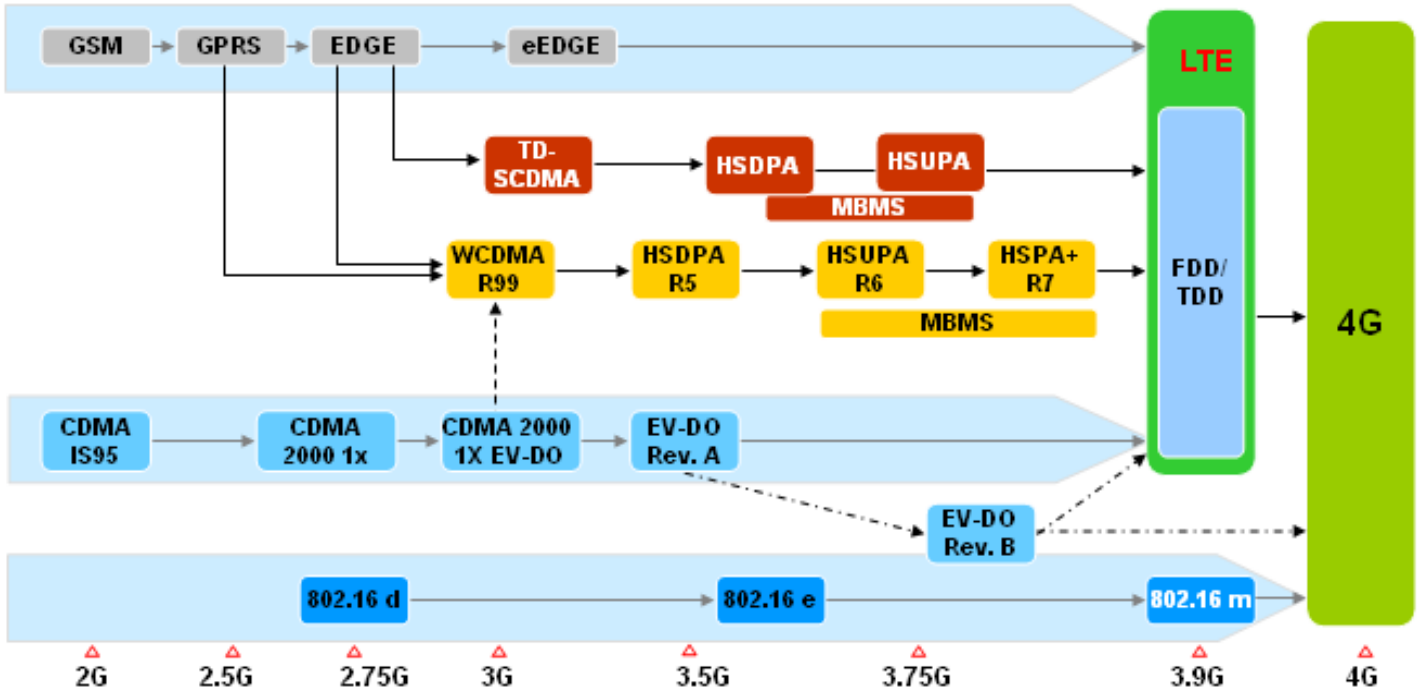


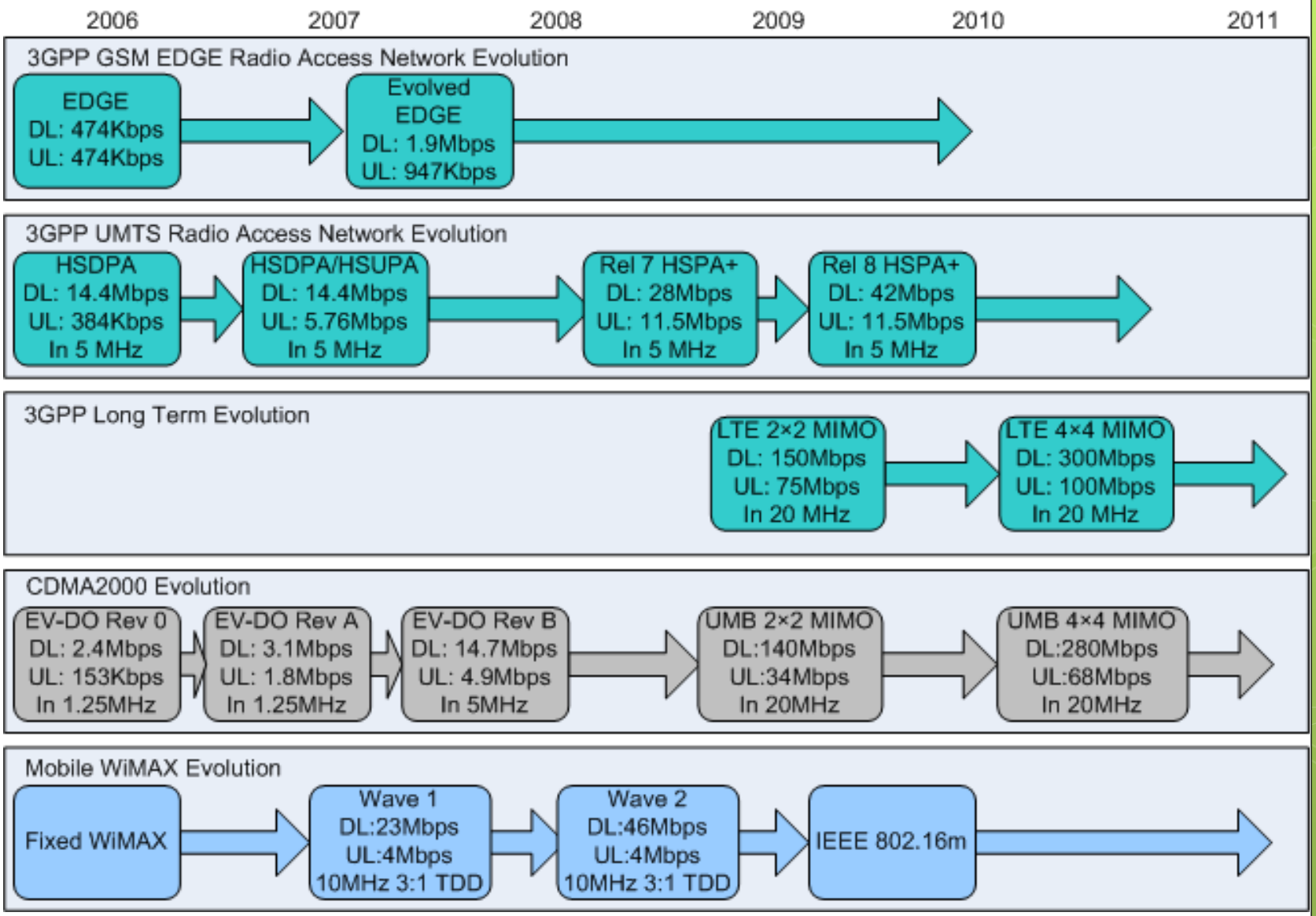
Long Term Evolution (LTE)

Drivers of Mobile Network Evolution



Evolution From 25 to 3.9G



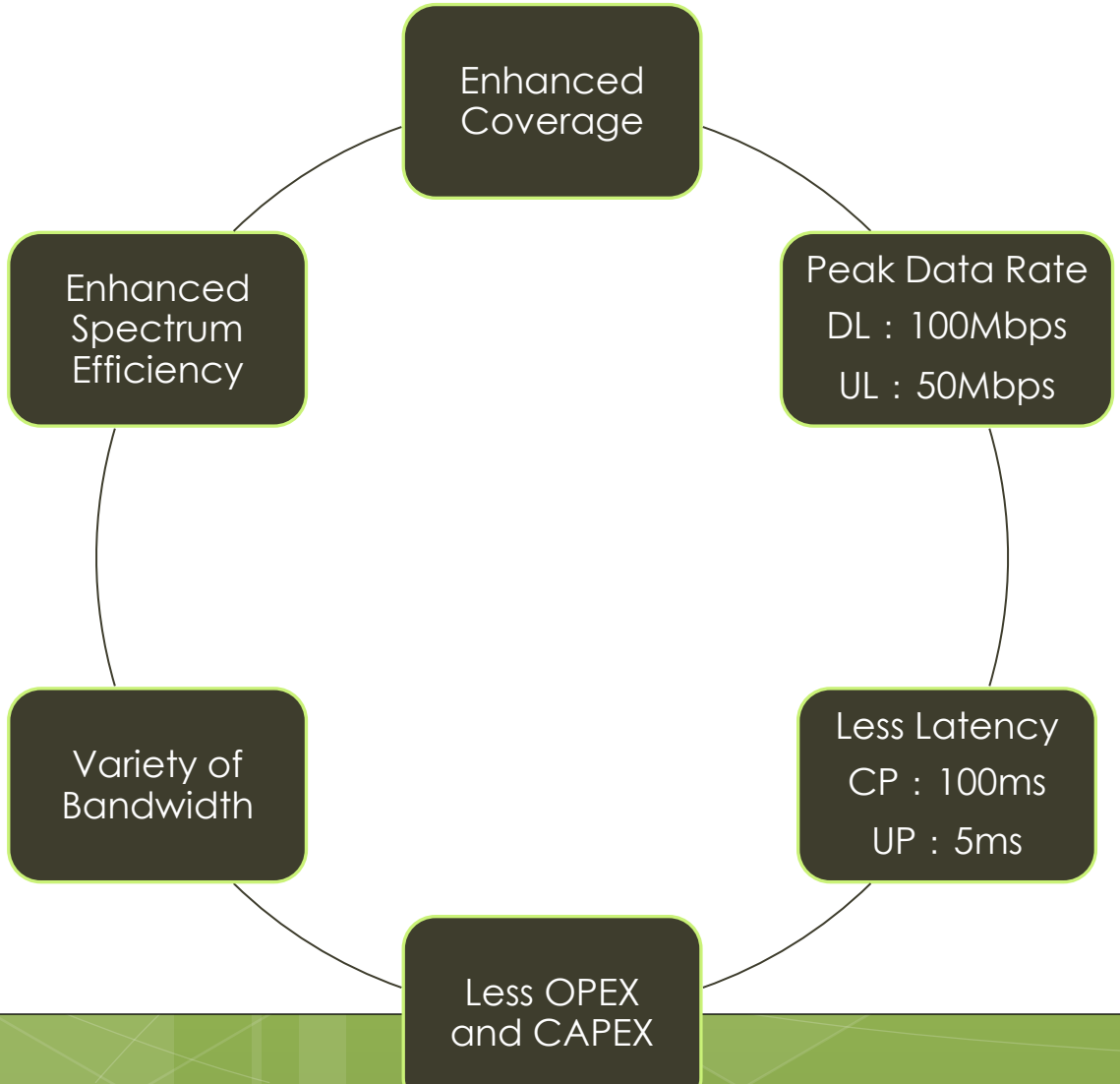

2006
2007
2008
2009
2010
2011
3GPP GSM EDGE Radio Access Network Evolution
EDGE
DL: 474Kbps
UL: 474Kbps
Evolved EDGE
DL: 1.9Mbps
UL: 947Kbps
3GPP UMTS Radio Access Network Evolution
HSDPA
DL: 14.4Mbps
UL: 384Kbps
In 5 MHz
HSDPA/HSUPA
DL: 14.4Mbps
UL: 5.76Mbps
In 5 MHz
Rel 7 HSPA+
DL: 28Mbps
UL: 11.5Mbps
In 5 MHz
Rel 8 HSPA+
DL: 42Mbps
UL: 11.5Mbps
In 5 MHz
3GPP Long Term Evolution
LTE 2×2 MIMO
DL: 150Mbps
UL: 75Mbps
In 20 MHz
LTE 4×4 MIMO
DL: 300Mbps
UL: 100Mbps
In 20 MHz
CDMA2000 Evolution
EV-DO Rev 0
DL: 2.4Mbps
UL: 153Kbps
In 1.25MHz
EV-DO Rev A
DL: 3.1Mbps
UL: 1.8Mbps
In 1.25MHz
EV-DO Rev B
DL: 14.7Mbps
UL: 4.9Mbps
In 5MHz
UMB 2×2 MIMO
DL:140Mbps
UL:34Mbps
In 20MHz
UMB 4×4 MIMO
DL:280Mbps
UL:68Mbps
In 20MHz
Mobile WiMAX Evolution
Fixed WiMAX
Wave 1
DL:23Mbps
UL:4Mbps
10MHz 3:1 TDD
Wave 2
DL:46Mbps
UL:4Mbps
10MHz 3:1 TDD
IEEE 802.16m

Technologies' Comparison

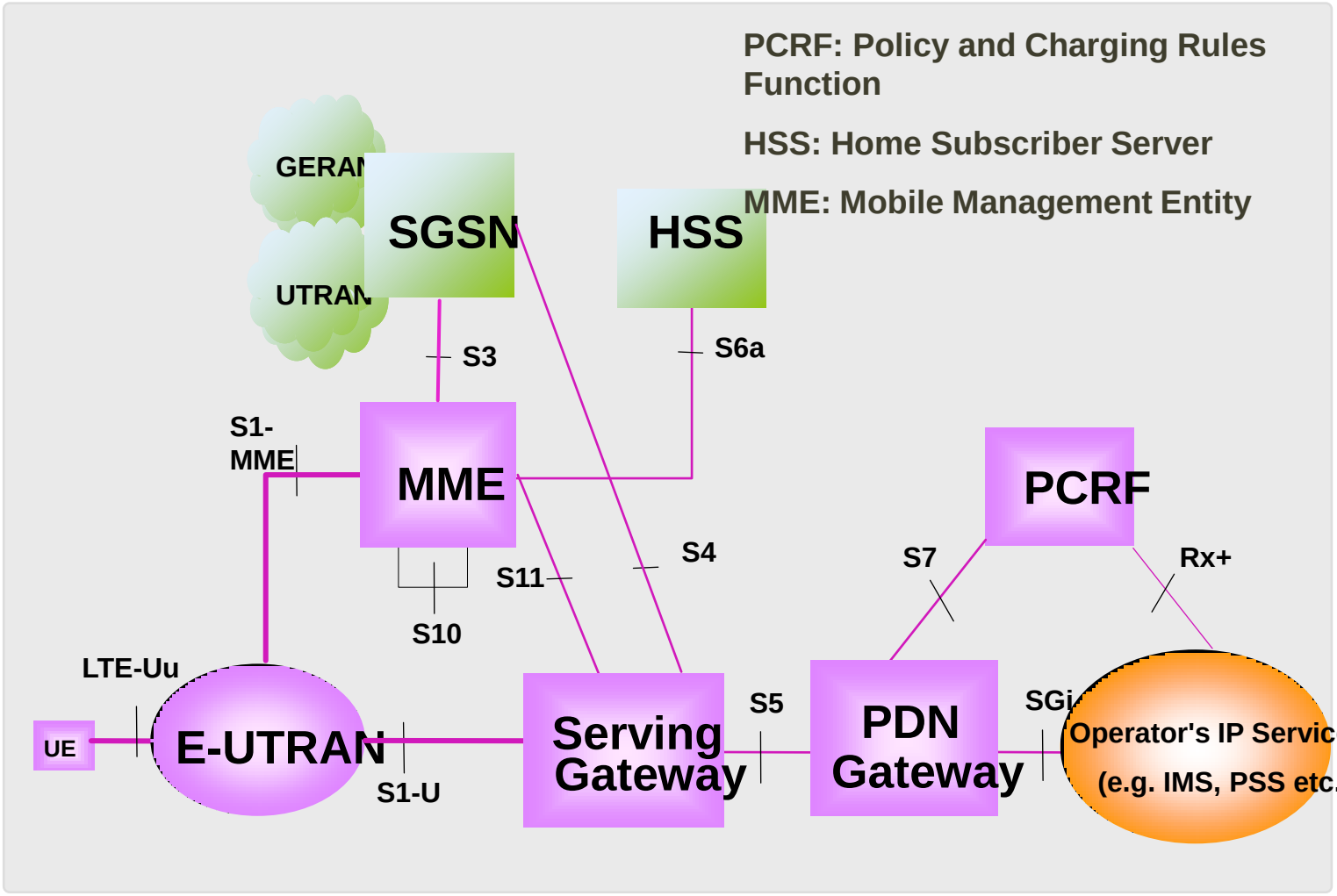
	802.16e (WiMAX)	HSPA+	LTE
FEATURE	TDD, OFDMA, MIMO, 64QAM, BW: 1.25 ~ 20MHz	FDD, WCDMA, MIMO, 64QAM DL, 16QAM UL, BW: 5MHz	FDD, OFDMA, TDD, SC-FDMA, MIMO, 64QAM, 1.4 | 3 | 5 | 10 | 20MHz
DATA RATE	63.36Mbps DL (2*2 10MHz) 28.22Mbps UL (2*2 10MHz)	42Mbps DL (2*2 5MHz) 11.5Mbps UL (5MHz)	150Mbps DL (2*2 20MHz) 75Mbps UL (2*2 20MHz)
STANDARD	2005.12 New spectrum	2008. Q3 3G spectrum	2009. Q3 3G spectrum New spectrum
	IEEE	3GPP	3GPP

- The development history from 2G and 3G to 3.9 G is the development history from low-speed voice services to high-speed multimedia services of mobile communications.

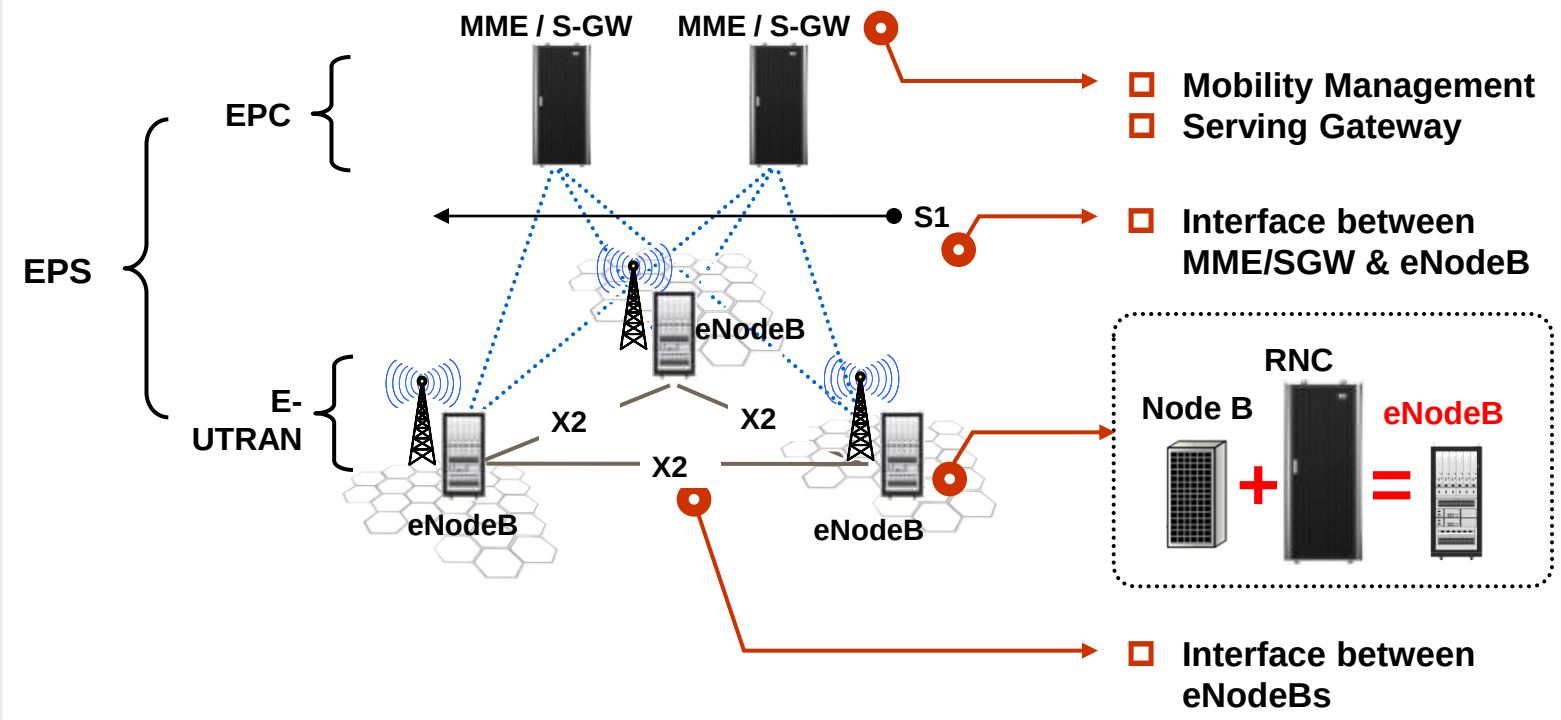
Key Requirements



LTE/SAE System Architecture Evolution

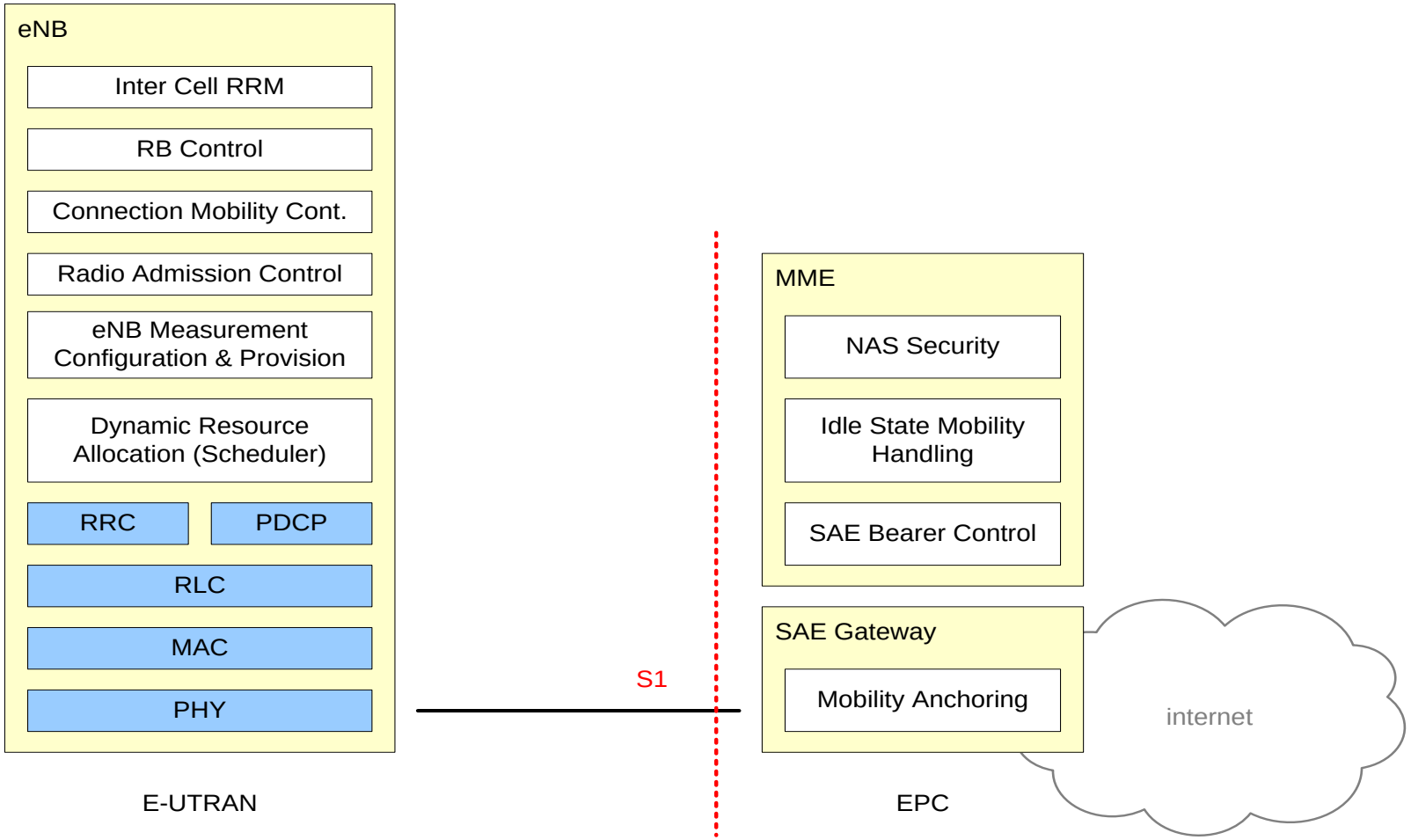


E-UTRAN Structure

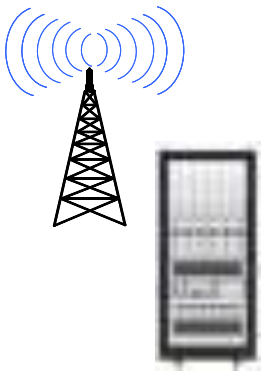


- Only one Node in E-UTRAN – eNodeB
- Evolved Packet Core – EPC
- Evolved Packet System – EPS
- Flexible band width
- Higher spectrum efficiency
- High peak rate, Lower latency

EUTRAN/EPC Function Module



eNodeB Function



eNodeB

- Radio Resource Management
- Compression and encryption
- Selection MME
- Routing
- Scheduling and transmission
- Measurement and measurement reporting
  CSG handling

MME Function

MME

- NAS signalling
- AS Security control
- Idle mode UE Reachability
- Tracking Area list management
- PDN GW/Serving GW/MME/SGSN
- Roaming
- Authentication

SGW Function

SGW

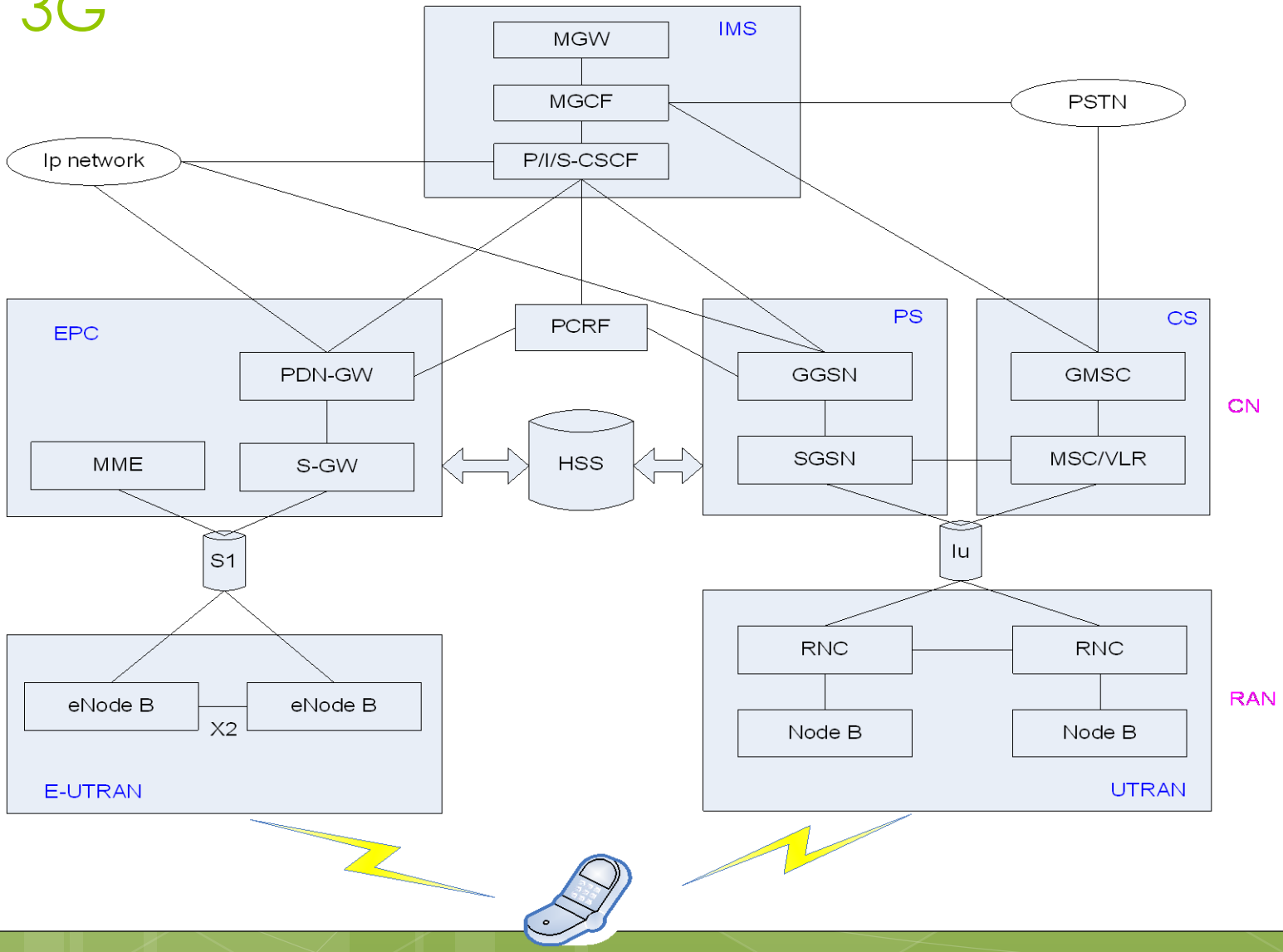
- Mobility anchoring
- E-UTRAN idle mode downlink packet buffering and initiation
- Lawful Interception
- Packet routeing and forwarding
- Transport level packet marking
- UL and DL charging per UE, PDN

PDN GW Function

PDN GW

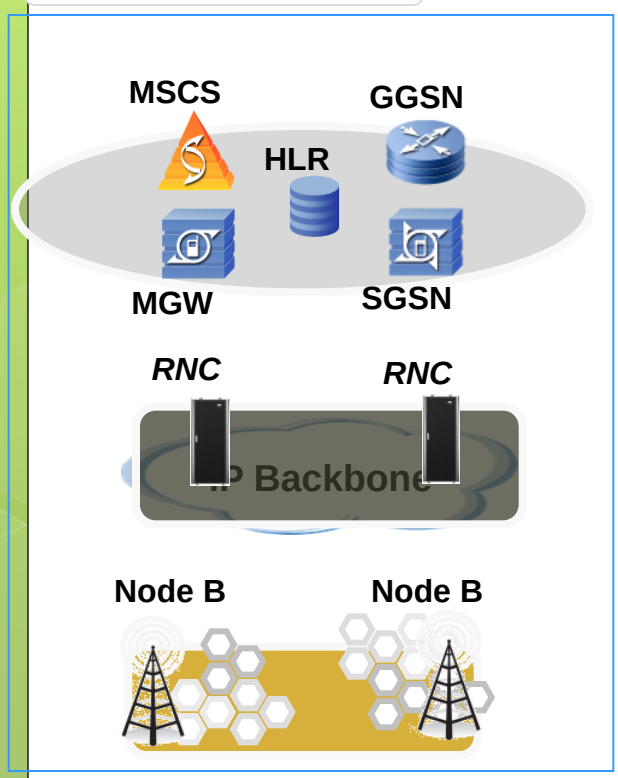
- Per-user based packet filtering
- Lawful Interception
- UE IP address allocation
- Transport level packet marking in the downlink
- UL and DL service level charging, gating and rate enforcement;
- DL rate enforcement based on AMBR

Compare the Architecture of LTE with 3G

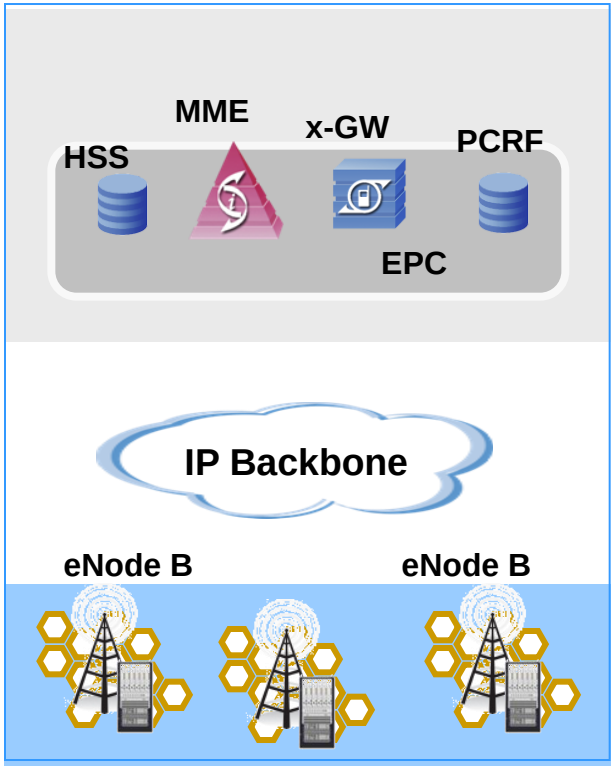


Flat and IP-based Network Architecture for LTE

WCDMA/HSPA



LTE Flat Structure



Without RNC

- *Less investment*
- *Easy maintenance*
- *Reduce transmission delay*
- *Better reliability*

MME/x-GW

Integrates CN & partial RNC functions

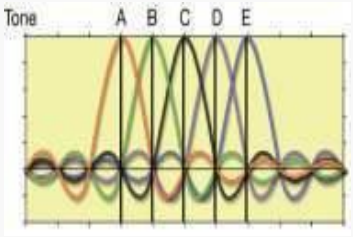
eNode B

Full function of Node B and major function of RNC

Flat network structure and IP-based network can reduce the TCO of LTE network.

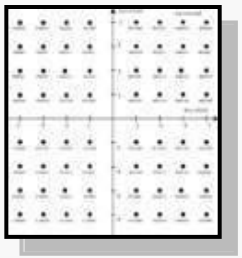
LTE Characteristics

LTE Key Technologies



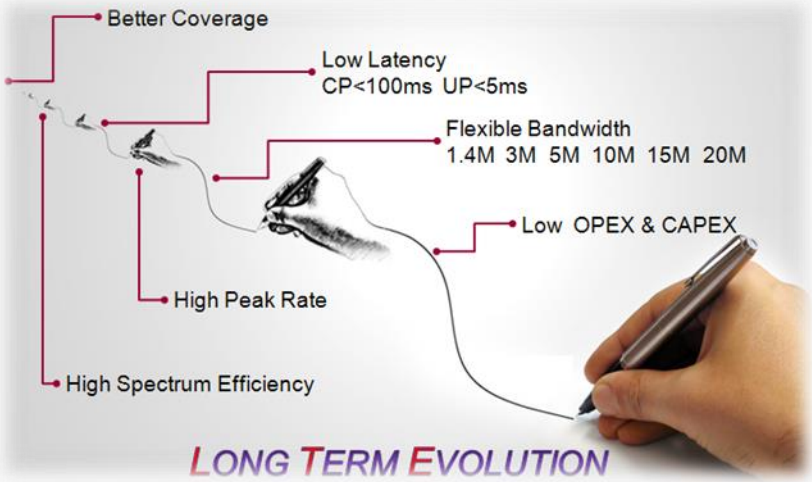
OFDM Modulation

MIMO



64QAM

LTE Requirements

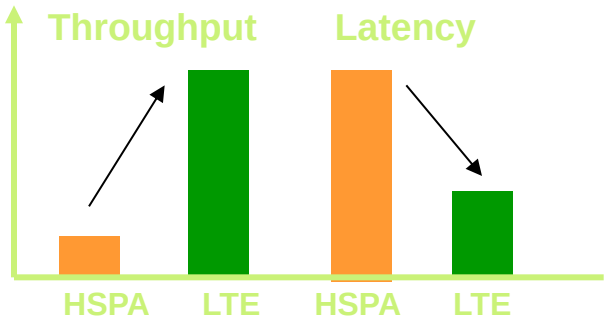


LTE Highlights

- Higher Peak Data Rate: Instantaneous data rate of 150Mbps for downlink and 50Mbps for uplink in 20MHz
- Higher Spectrum Efficiency: 3-4 times of HSDPA, 2-3 times of HSUPA
- Flexible Spectrum Allocation: Scalable channel bandwidth configuration, Support both FDD & TDD
- Better Business Experience: Lower latency with less than 5ms in ideal conditions

LTE Benefits for Operators and Users

User Experience →ARPU

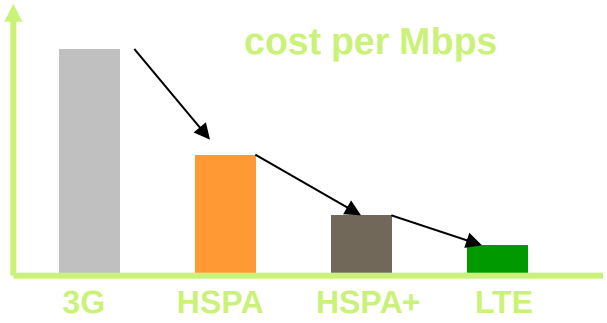


Investment Protection

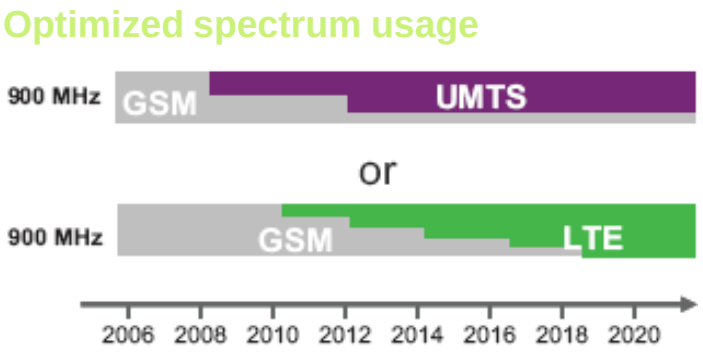
Reuse of

- Sites and infrastructure
- Backhauling
- Frequency bands

Low Cost per Mbps



Scalable bandwidth



LTE Enriches the Mobile Services





Mobile Broadband Changes the Future Life

- Mobile Email
- Netmeeting
- HD Video Conference

Mobile Office

Mobile Community

- Video Sharing
- Video Blog
- Video Chat
- Information

Lte

Mobile Entertainment

- Video on Demand
- Online Game
- HD video streanming

Mobile Business

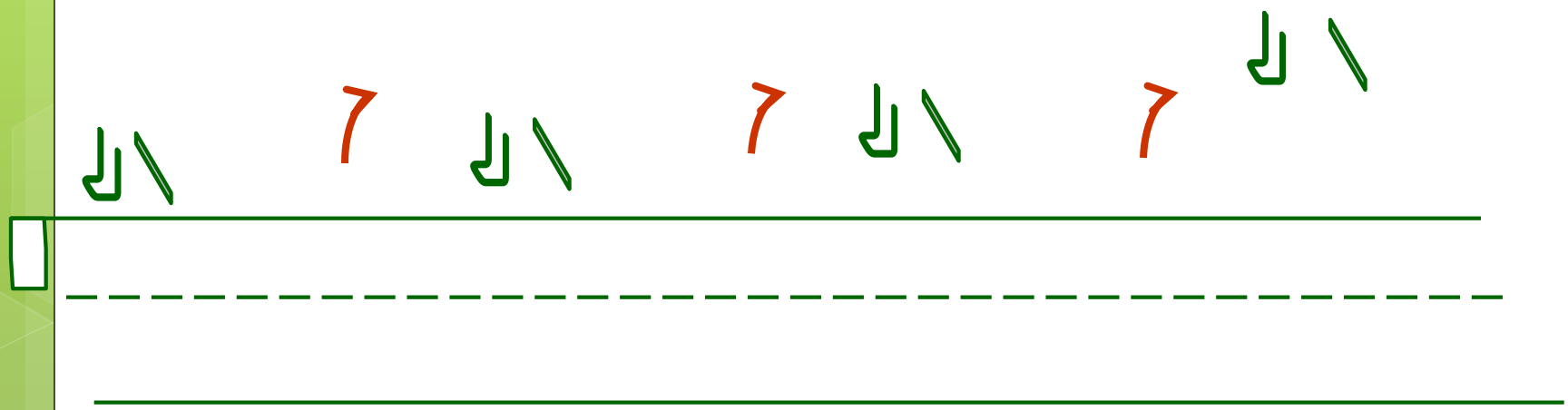
- Mobile Shopping
- Mobile Bank
- Mobile Stock



LTE improves user experience by high capacity, quick response, high data-rate and better QoS.

Key Technology Evolution

1G （FDMA）	2G （TDMA）	3G （CDMA）	LTE （OFDM+MIMO+IP）



LTE enhanced technology: OFDM, MIMO

LTE Key Technology Overview

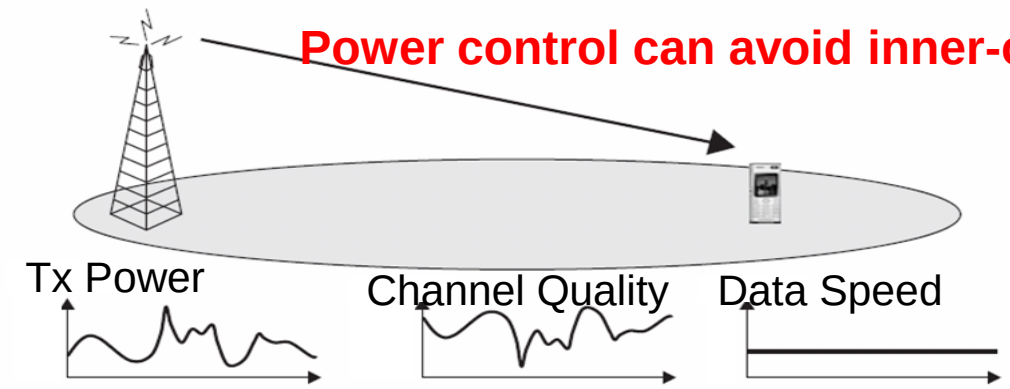
- OFDM
- MIMO
- AMC
- HARQ
- Channel Scheduling and Fast Scheduling
- ICIC (Inter Cell Interference Cancellation)

Link Adaptive Technology

- Link adaptive technology can be realized by two methods: power control and data speed control.
- Normally, the link adaptive technology is data speed control. In LTE, it is the Adaptive Modulation and Coding technology. AMC can make eNode B duly adjust modulation mode(QPSK, 16QAM, 64QAM) and coding rate according to channel status which is feed back by UE.
- For the long-delay packet data, AMC can improve the system capacity but no interference to the neighbor cell.

Link Adaptive Technology-Power Control

- Dynamically adjust Tx power, maintain the receiver's SNR, consequently guarantee link transmission quality.
- When the channel condition becomes worse, it needs increasing Tx power; when the channel condition becomes better, it needs reducing Tx power. Then this can guarantee the invariable transmission data speed.



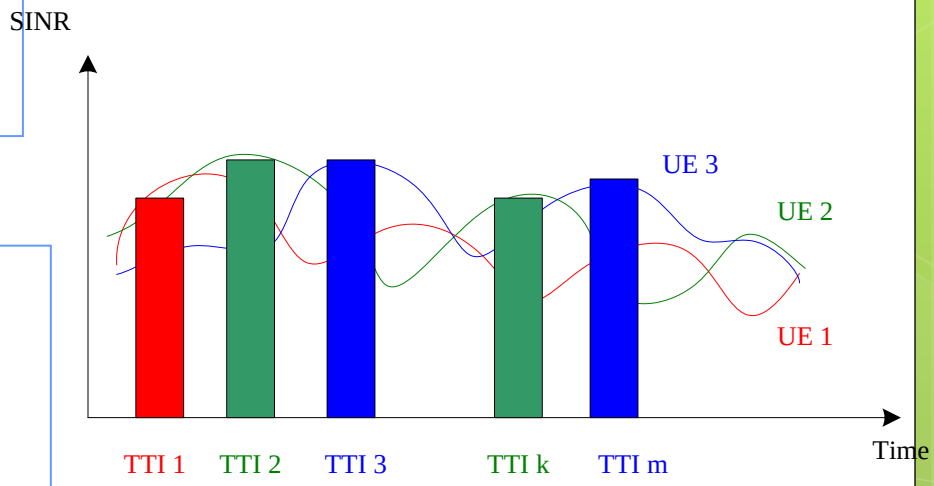
Link Adaptive Technology-AMC

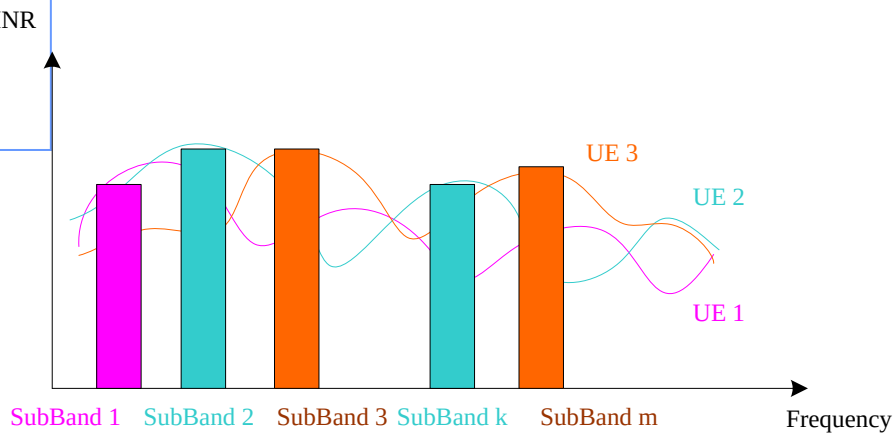
Modulation mode adaptive

Coding speed adaptive

Make the best of channel condition to transmit user data

- Better Condition：use higher speed transmit user data
- Worse Condition： use lower speed transmit user data





- Time Domain-AMC
- Frequency Domain -AMC
- Space Domain-AMC

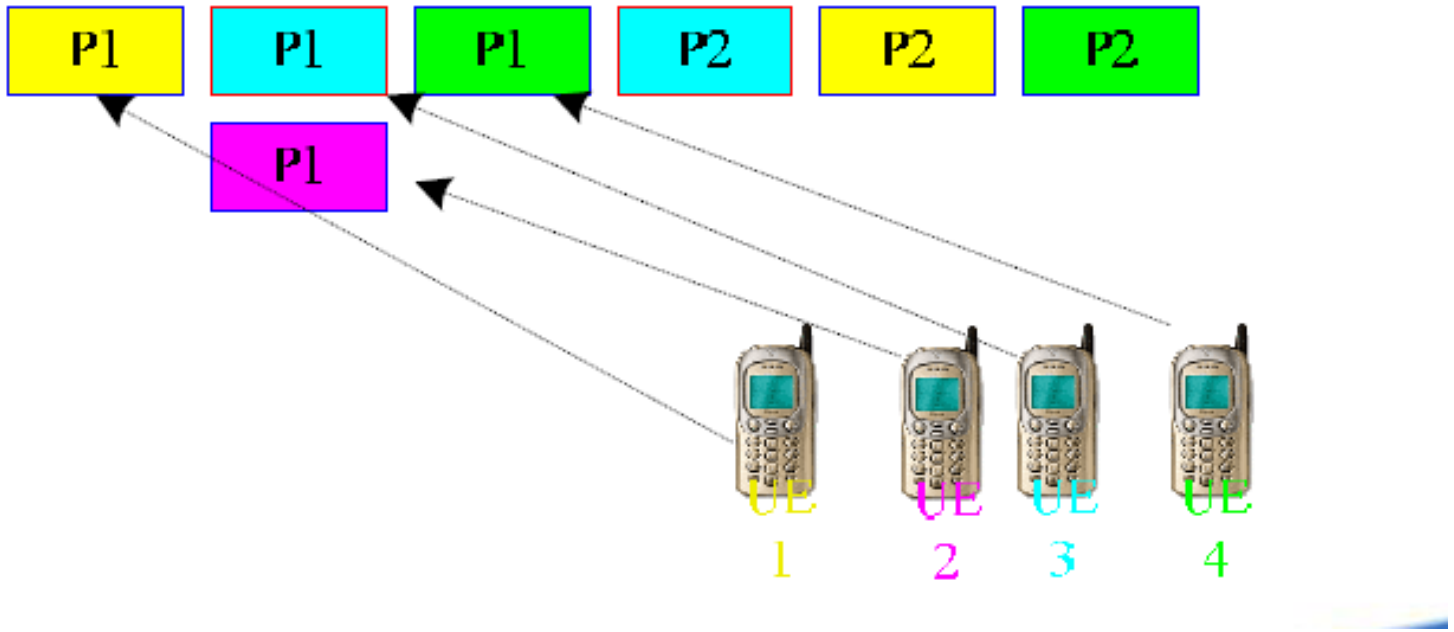
Link Adaptive Technology-LTE Uplink and Downlink Adaptive

- LTE uplink adaptive technology is based on uplink channel quality tested by BS, and straightly confirm the modulation mode and coding speed.
- LTE downlink adaptive technology is based on CQI feed back by UE and select the corresponding modulation mode and coding speed from pre-defined table.

CQI	Modulation	Coding speed x 1024	Efficiency
0	Out of scale		
1	QPSK	78	0.1523
2	QPSK	120	0.2344
3	QPSK	193	0.3770
4	QPSK	308	0.6016
5	QPSK	449	0.8770
6	QPSK	602	1.1758
7	16QAM	378	1.4766
8	16QAM	490	1.9141
9	16QAM	616	2.4063
10	64QAM	466	2.7305
11	64QAM	567	3.3223
12	64QAM	666	3.9023
13	64QAM	772	4.5234
14	64QAM	873	5.1152
15	64QAM	948	5.5547

HARQ

- FEC：Forward Error Correction



FEC Communication System

Advantage:

◆ Higher system transmission efficiency

◆ Automatic error correct, no feed back and retransmission

◆ Lower time delay

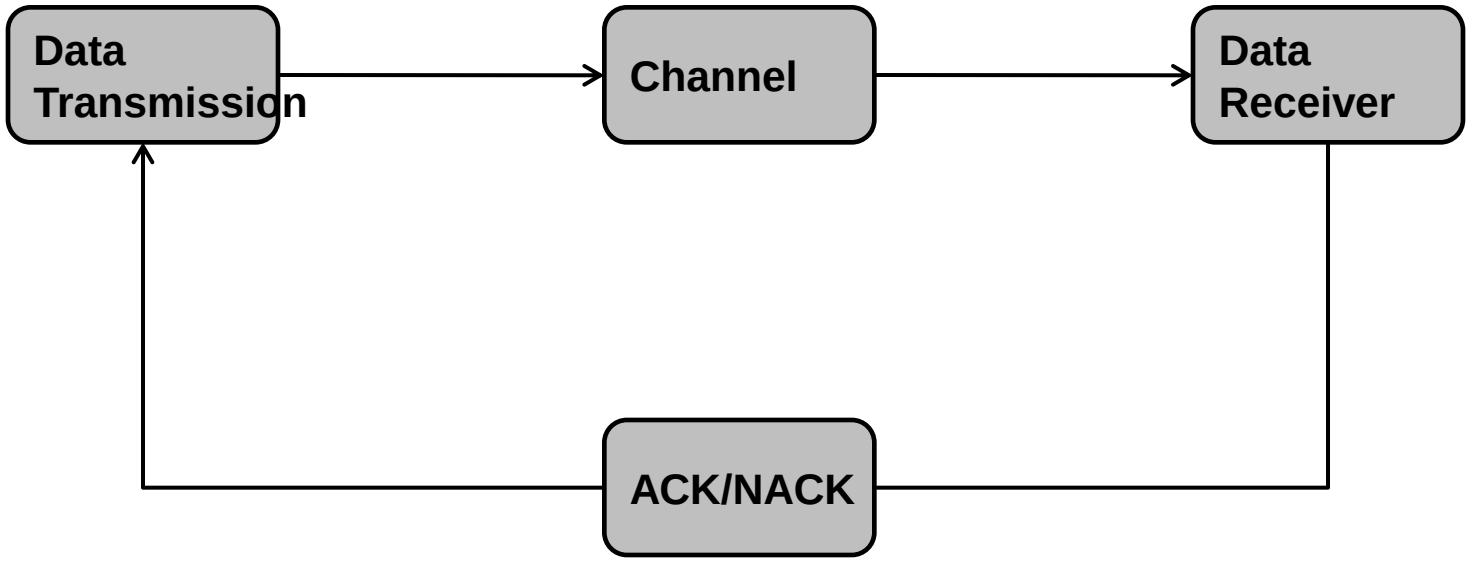
Disadvantage:

◆Lower reliability

◆ Lower channel adaptive ability

◆ To guarantee higher reliability, it needs longer code. So the coding efficiency is lower, the complexity and cost are higher.

ARQ Communication System

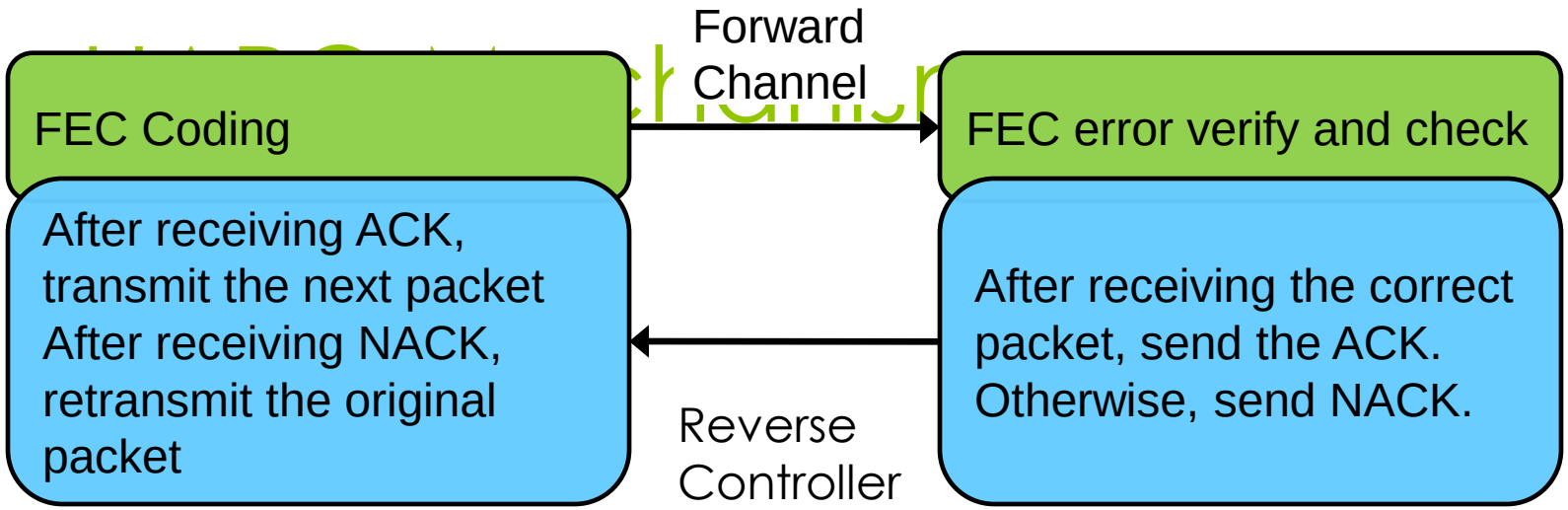


Advantage:

- Complexity is lower
- Reliability is higher
- Adaptability is higher

Disadvantage:

- Continuity and real-time ability is lower
- Transmission efficiency is lower



HARQ combines ARQ high reliability and FEC high efficiency

HARQ Characteristic

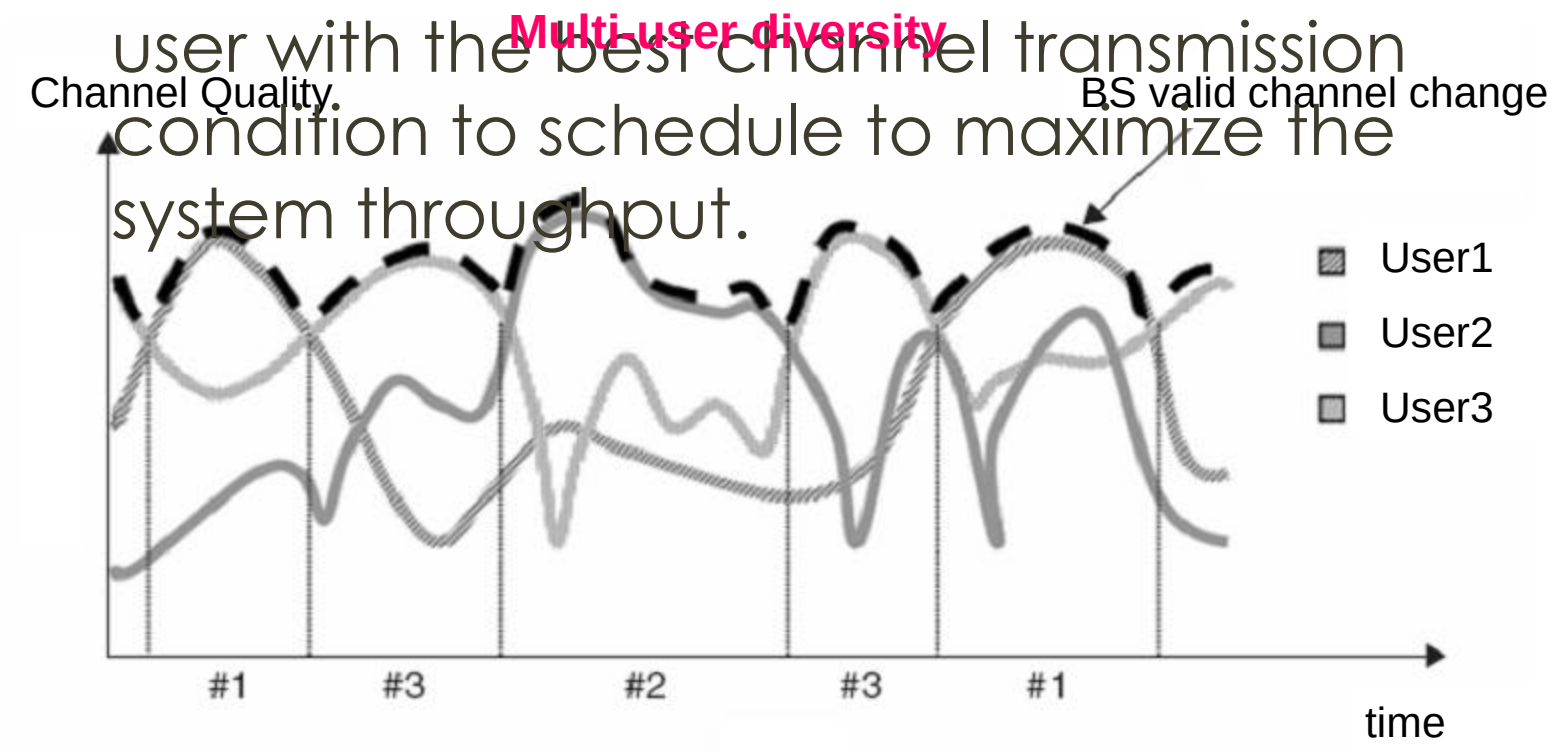
- N-Process Stop-and-Wait
- HARQ transmits and retransmits the transmission block.
- Downlink
  - Asynchronous adaptive HARQ
  - ACK/NACK is transmitted by PUCCH or PUSCH.
  - PDCCH indicates HARQ program number, initial transmission or retransmission.
  - Retransmission always is always scheduled by PDCCH.
- Uplink
  - Synchronous HARQ
  - Configure the maximum retransmission times for each UE.

HARQ- adaptive/non-adaptive HARQ

- The HARQ processing is introduced into 3GPP from R5 HSDPA, and reused in LTE.
- eNodeB supports both Chase-Combing (CC) HARQ and Incremental-Redundancy (IR) HARQ. CC HARQ uses the same redundancy version (RV) among all the transmission and retransmissions. IR HARQ uses the different redundancy version (RV) among all the transmission and retransmissions, to achieve the maximum combining gain.
- The DL HARQ in LTE is an asynchronous adaptive one, which means the retransmission can be arranged at any time after NACK is received for last transmission, and the retransmission can use wireless resources different with that of last transmission.
- eNodeB supports UL synchronous non-adaptive and adaptive HARQ processing, which means the retransmission have to occur in dedicated sub-frame after NACK is received for last transmission, while the retransmission can use the same or different wireless resources from last transmission.

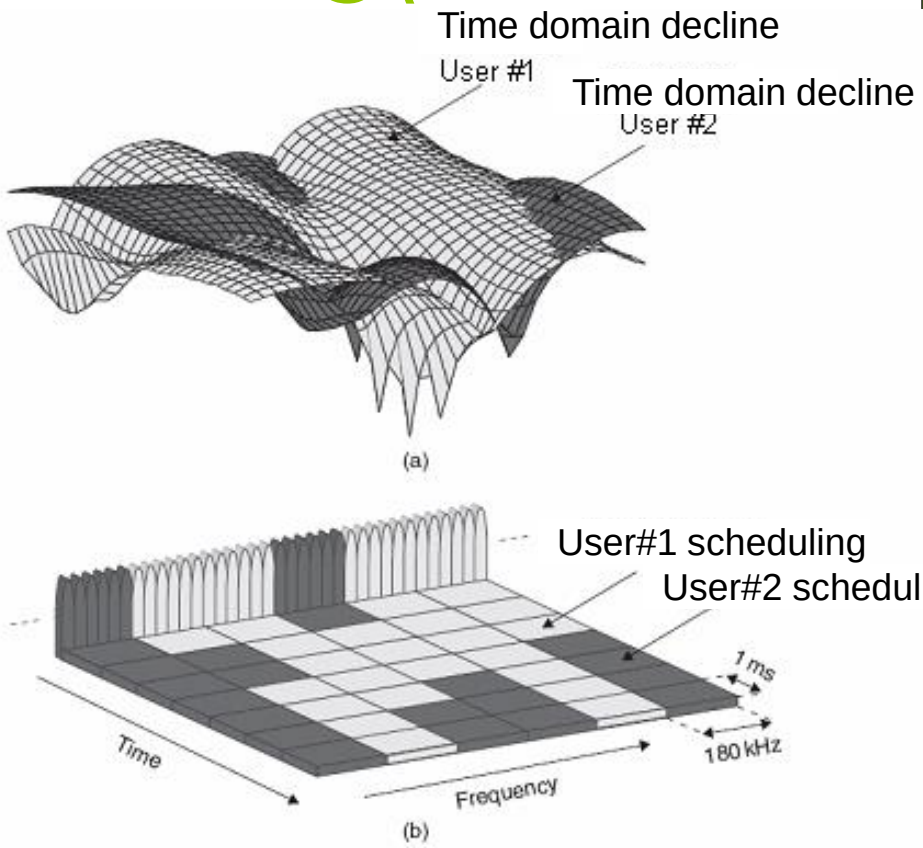
Channel Scheduling(1)

- For one resource block, it will select the user with the best channel transmission condition to schedule to maximize the system throughput.



Channel Scheduling(2)

- LTE supports channel scheduling based on frequency domain.



Downlink：Based on common reference signal

Uplink：Based on test reference signal

Fast Scheduling

- Fast sc
  sched

Scheduling Principle

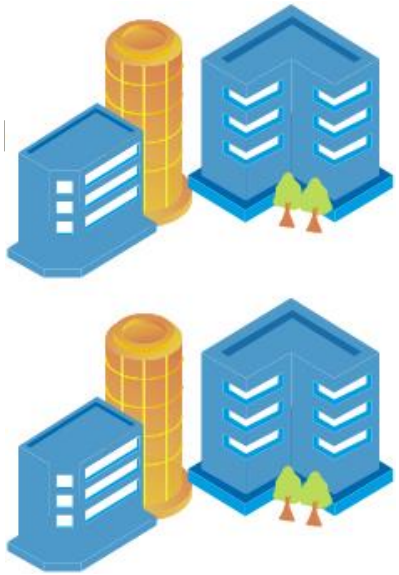
- **Round Robin(RR)**
- **Max C/I**
- **Proportional Fairness(PF)**

- Scheduling Methods: TDM, FDM, SDM

Polling based on time	Each user is served one by one, and has the same average server time. But the flux for each user is different due to the diverse environment.
Polling based on flux	No matter what kind of environment the user is located in, the user can be served one by one and be guaranteed to get the same flux.
Max C/I	System will trace the wireless channel's C/I of each user, and confirm the user's priority by C/I to ensure the served user at each moment have the maximum C/I
PF	Integrate the methods above, look after the most portion users satisfaction, and guarantee the higher system throughput.

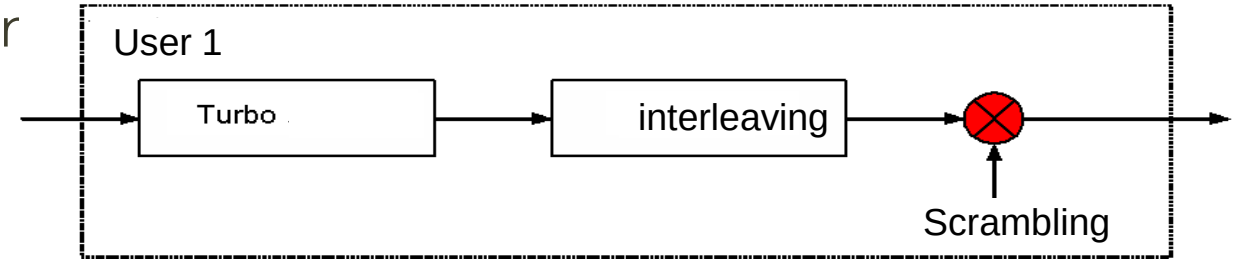
ICIC

- ICIC(Inter Cell Interference Cancellation) :
  - Scrambling
  - Frequency-Hopping Transmit
  - Beamforming and IRC
  - Inter Cell Interference Coordinatio
  - Power Control



ICIC-Scrambling

- LTE makes use of sequence randomization to avoid inter cell interference.
- Normally, scrambling is after the channel coding, and before the modulation. It is bit-scrambling.
  - PDSCH, PUCCH format 2/2a/2b, PUSCH : Scrambling sequence is related with UE id, cell id and slot start position.
  - PMCH : Scrambling sequence is related with MBSFN id and slot start position.
  - PBCH, PCFICH, PDCCH : Scrambling sequence is related with cell id and slot start position.
- PHICH's scrambling is after modulation when the sequence is expanding
  - Scrambling sequence is related with cell id and slot start positior

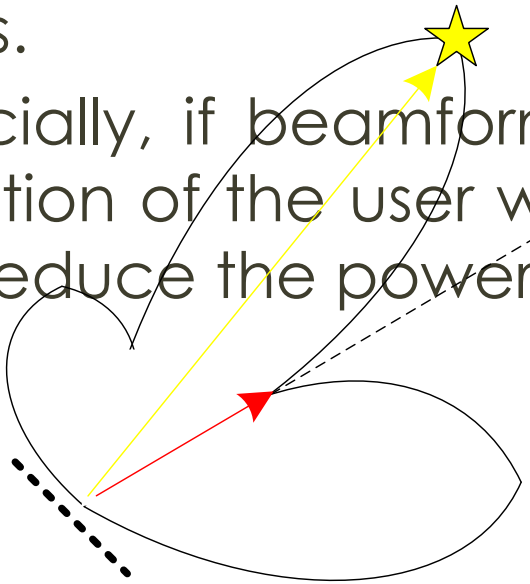


ICIC- Frequency Hopping Transmit

- LTE supports Frequency-Hopping transmission in downlink and uplink, it can randomize the inter cell interference.
  - Except PBCH, the other downlink physical control channel's resource mapping is related with cell id.
  - PDSCH, PUSCH and PUCCH's Frequency Hopping transmission is in sub-frame.
  - PUSCH's Frequency Hopping transmission happens among the sub-frames.

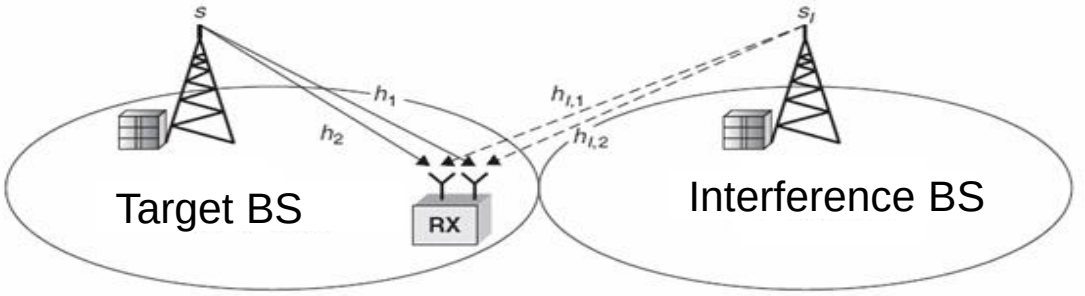
ICIC-Beamforming

- Increase the expected user's signal strength.
- Decrease the i[illegible]ce to the other users.
- Specially, if beamforming has known the location of the user who w[illegible]ed, it will reduce the power to this location.

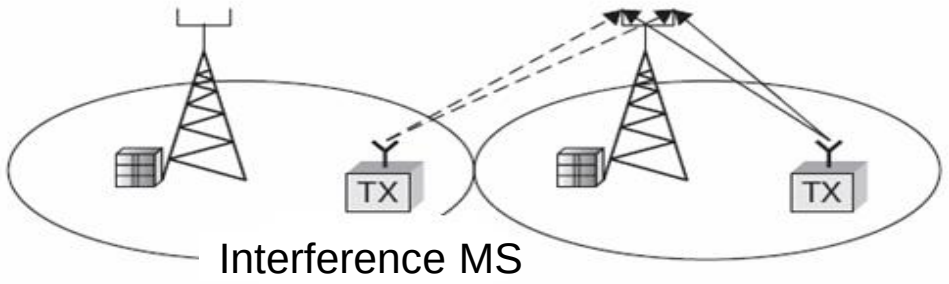


ICIC-IRC

- IRC (Interference Rejection Combining)
- When the receiver has multi-antennas, the receiver can use the multi-antennas to decrease the inter-users interference. The principle is to weight the received signal, restrain the strong interference.



downlink



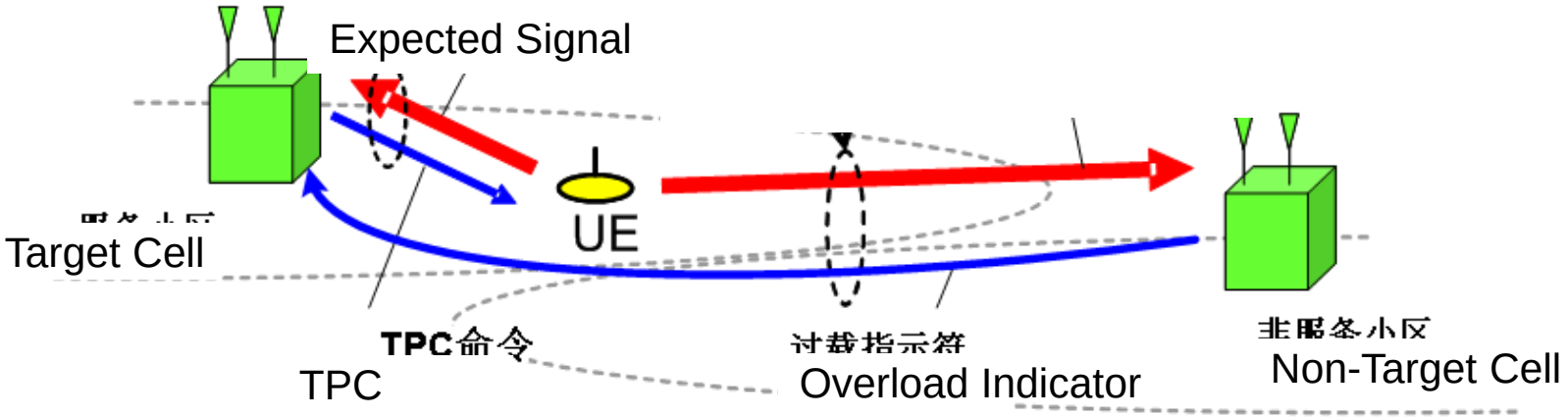
uplink

ICIC- Inter Cell Interference Coordination(1)

- LTE supports static ICIC algorithms. And there is no load information exchange through X2 interface for static ICIC.
- Based on RSRP measurement on serving cell and neighboring cells of the same frequency, UE can be divided into two groups: cell center users and cell edge users. The cell center users, whose received signal strengthen of serving cell is better than neighbors, are not likely to interfere or be interfered by users in neighbor cells;
- Based on cell topology and frequency division method (Fractional FR or Soft FR), all PRB resources can be classified into cell edge preference and cell center dedicated PRBs, without overlapping. These PRB resources can be allocated statically, or semi-statically;
- The frequency reuse factor for Fractional FR is 1 for cell central users, and 3 for cell edge users.

ICIC-Power Control

- Inter-Cell Power Control
  - To control the target cell IoT by informing the IoT to the other cell.



Power Control

- Power control is used in PUSCH, PUSCH and SRS.
  - PUSCH' TPC is given by PUSCH's scheduling signaling(DCI format 0) or multiplexed with other user's TPC(DCI format 3/3A).
  - PUCCH's TPC is given by PDSCH's scheduling signaling(DCI format 0) or multiplexed with other user's TPC(DCI format 3/3A).
  - SRS has no specific TPC, it borrows PUSCH'TPC, and be informed the power warp by higher layer.