GSM Technologies

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Outline

First Part

- Zero Generation (0G)
- First Generation (1G)
- Second Generation (2G)
- 2.5G Technologies
- Third Generation (3G)
  - 3.9G Evolution
- 4G Technologies

Second Part

- Cellular Design
- Frequency Reuse
- Channel Assignment
- Handoff
- Frequency Allocation

First Part

Zero Generation (0G)

- In 1945, the zero generation (0G) of mobile telephones was introduced. 0G mobile phones, such as Mobile Telephone Service, were not cellular, and so did not feature "handover" from one base station to the next and reuse of radio frequency channels.
- Like other technologies of the time, it involved a single, powerful base station covering a wide area, and each telephone would effectively monopolize a channel over that whole area while in use.

First Generation 1G

- 1940s-50s: cellular concept discovered (AT&T)
  - NMT-450: Nordic Mobile Telephone
  - **AMPS: Advanced Mobile Phone System**
  - NTACS, TACS: Narrowband Total Access
- In July, **1978**Advanced Mobile Phone Service or AMPS started operating in North America.
- Illinois Bell and AT&T jointly rolled out analog based cellular telephone service. **Ten cells covering 21,000 square miles made up the Chicago system.**

1G-AMPS

- Analog Tech.
- 2 channel for one connection

Advanced Mobile Phone Service (AMPS)	
Parameter	Value
Mobile-to-base Frequency	824-849 MHz
Base-to-Mobile Frequency	869-894 MHz
Channel Spacing	30 kHz
Multiple access method	FDMA
Duplex Method	FDD
Users per channel	1
Modulation Methodology	FM

2G Cellular Network

- First generation cellular systems that relied exclusively on **FDMA/FDD and analog FM**,
- Second generation standards use digital modulation formats and **TDMA/FDD and CDMA/FDD** multiple access techniques.
- In the 1990s, GSM, IS-136 ("TDMA"), iDEN and IS-95 ("CDMA") …….
- 100–200g hand-held devices,
- **higher density of cellular sites** caused
- SMS tech. introduced
- Circuit switched transmission

Global System for Mobile Communications (GSM-900)		ications (GSM-1800)
Parameter	Value	Value
Mobile-to-base Frequency	880-915 MHz	1710-1785 MHz
Base-to-Mobile Frequency	925-960 MHz	1805-1880 MHz
Channel Spacing	200 kHz	200 kHz
Multiple access method	TDMA/FDM	TDMA/FDM
Duplex Method	FDD	FDD
Users per channel	8	8
Modulation Methodology	GMSK; BT=0.3	GMSK; BT=0.3
Channel bit rate	270.833 kb/s	270.833 kb/s

2G Technology

- Turkcell
  - 2G : GSM 900MHz, GSM 1800MHz
  - 3G : WCDMA 900MHz, WCDMA 2100MHz
  - 4G : TD-LTE, Band 40(2300-2400), Band 39(1880-1920), Band 38(2570-2620)
- Avea → 1800 Mhz
- Low frequency; more valuable and low energy requirement

375 Mbps'lik en yüksek 4.5G hızı Turkcell'le gelecek

Uluslararası Mobil Telekomünikasyon (IMT) Hizmet ve Altyapılarına ilişkin Yetkilendirme İhalesi'ne Turkcell damgasını vurdu. 800, 900, 1800, 2100 ve 2600 MHZ bandında toplamda 390.4 MHz frekans spektrumunun operatörlerin kullanımına tahsisi için yapılan ihalede Turkcell 1.623 Milyar Euro vererek toplamda 172.4 MHz frekansın sahibi oldu. Böylece Turkcell Taşıyıcı Birleştirme tekniğini kullanarak, Türkiye'de hizmetin kullanılmaya başlanacağı 1 Nisan 2016 tarihi itibari ile sunulabilecek en yüksek 4.5G hızı olacak 375 Mbps'i sağlayan tek mobil operatör olacak.

2.5G Cellular Network

- Motivation
  - 2G Technologies are Circuit Switched in which bandwidth remains idle ample amount of time during communication.
  - Why not use this idle time to transfer packets.
  - Transferring Packets is Cheaper.
- Use Existing infrastructure while adding some additional node which provide **packet** functionality to the network
- Technical specifications of the original **GSM, CDMA, and IS-136**standards which originally supported **9.6 kilobits per second** transmission rates for data messages.
- **higher data rate**transmissions for
  - web browsing,
  - e-mail traffic,
  - mobile commerce (m-commerce),
  - and location-based mobile services.

2.5G Cellular Network

- The 2.5G technologies also support a popular new web browsing format language, called **Wireless Applications Protocol (WAP),**that allows standard web pages to be viewed in a **compressed format specifically designed for small, portable hand held wireless devices. 2G FDMA, 2.5G TDMA update.**

- The three TDMA upgrade options include:
  - High Speed Circuit Switched Data (HSCSD)
  - General Packet Radio Service. (GPRS)
  - EDGE

2.5G -- GPRS

- Allows IP packets to be sent and received across mobile networks.
- Theoretical maximum speed: 171.2 kbps using all 8 time slots.
- GPRS is a packet-based data network, which is well suited for non-real time Internet usage, including the retrieval or email, faxes, and asymmetric web browsing, where the user downloads much more data than it uploads on the Internet

- Advantages
  - Provides data rate comparable to 3G.
  - Work on the same spectrum allocated to 2G.
  - Provide an opportunity to players to compete who do not want to invest heavily in 3G. (Require different base stations)
  - Users will pay for **actual data transmitted** not for the connection time.

2.5G -- EDGE

- EDGE is a more advanced upgrade to the GSM standard, and requires the addition of new hardware and software at existing base stations. Enhanced data rates for GSM evolution.

- Datarate **384 kBit/s**and more .
- 16-QAM was also proposed for EDGE.

3G Networks

- 3G standard support multi-megabit Internet access, Voice over Internet Protocol (VoIP), voice activated calls, unparalleled network capacity.
  - 3G W-CDMA (UMTS)
  - CDMA2000
    - cdma2000 1X
    - cdma2000 1xEV-DO
  - 3G TD-SCDMA

3G W-CDMA (UMTS-Universal Telecommunication System)

- UMTS air interface standard that has evolved since late 1996 under the European Telecommunications
- In 1998, consideration as a world standard.
- The 3G W-CDMA air interface standard had been designed for **“always-on”packet based**wireless service, so that computers, entertainment devices, and telephones may all share the same wireless network and be connected to the Internet, anytime, anywhere.

3G W-CDMA (UMTS-Universal Telecommunication System)

- W-CDMA will support packet data rates up to **2.048 Mbps per user(if the user is stationary),**thereby allowing high quality data, multimedia, streaming audio, streaming video, and broadcast-type services to consumers.
- Future versions of W-CDMA will support stationary user data rates in excess of **8 Mbps.**

- W-CDMA **5 MHz** radio channel, and each channel will be able to support between **100 and 350** simultaneous voice calls at once,

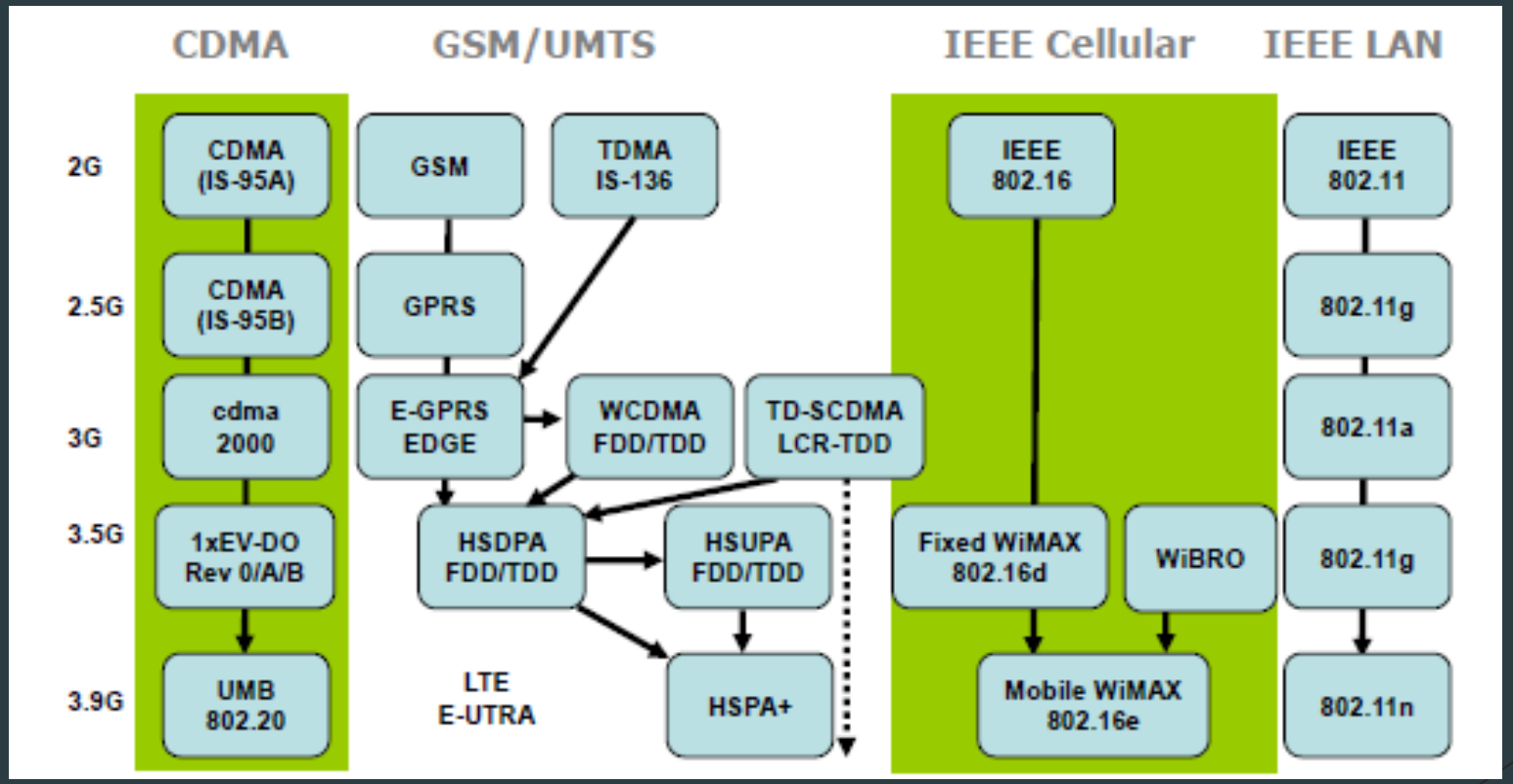
3G W-CDMA (UMTS-Universal Telecommunication System)

- Because W-CDMA will **require expensive new base station equipment**, the installation of W-CDMA will likely be slow and gradual throughout the world.
- **Frequency band:**1920 MHz -1980 MHz and 2110 MHz -2170 MHz (Frequency Division Duplex) UL and DL
- **Minimum frequency band required:**~ 2x5MHz
- **Frequency re-use:**1
- **Carrier Spacing:**4.4MHz -5.2 MHz
- **Data type:**Packet and circuit switch
- Modulation:QPSK

Comparison

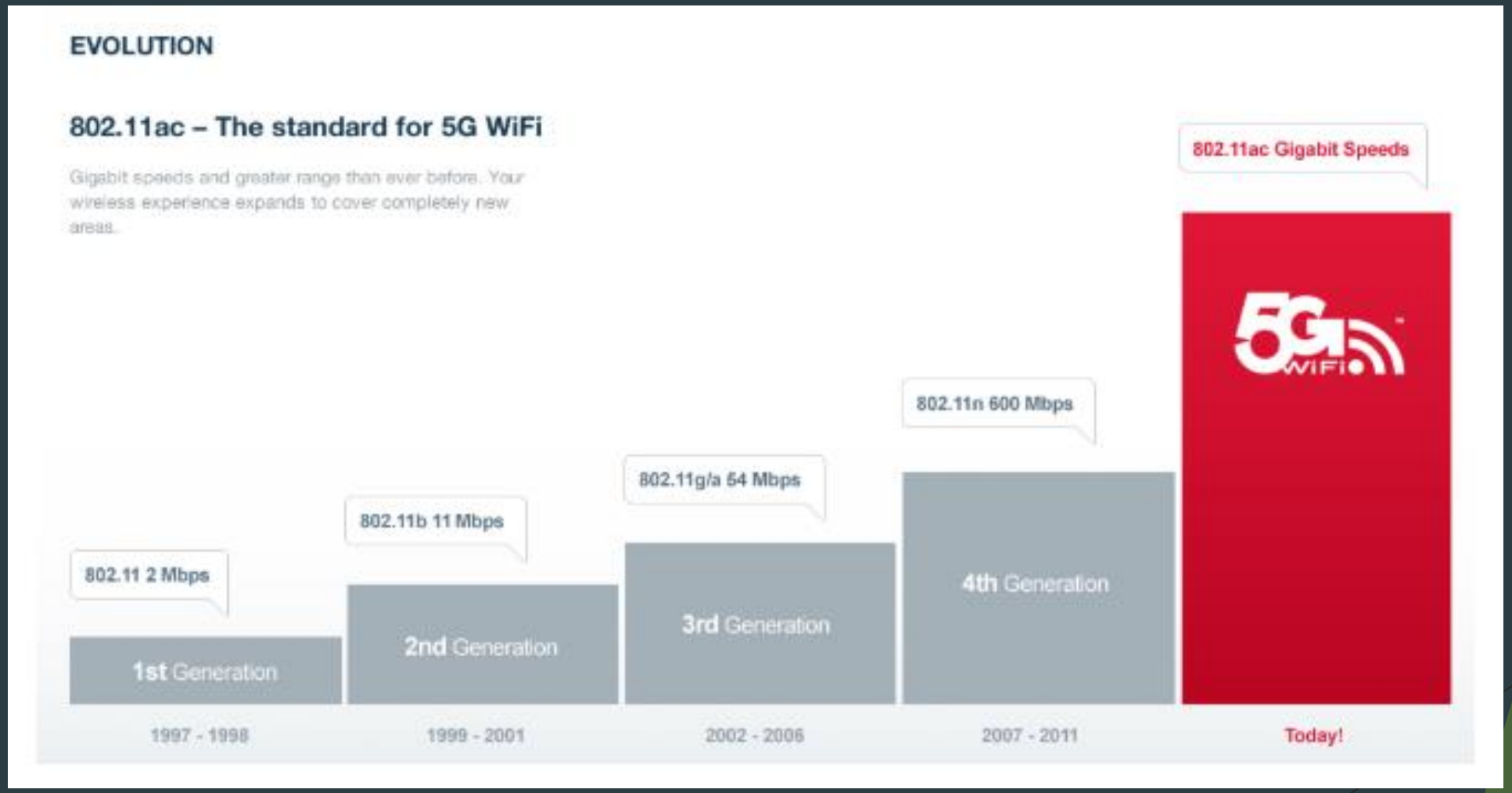
	1 G	2 G	3 G
Radio Access	Analog (FDMA)	Digital (CDMA, TDMA)	Digital (CDMA)
Data Rate	9.6, 19.2Kbps	9.6, 14.4Kbps	2Mbps
Service	Voice Oriented	Voice, Data	Multimedia
Roaming	National, Regional	National, Regional	Global

ALL Protocols



4G Tech.

- Motivation
  - Enhanced Mobile Gaming
  - Personal Media Repository
  - Virtual Presence
  - Broadband Access in Remote Locations
- Fully packet switching
- Bağlantı hızı, cep telefonlarında 100 Mbps, Wi-Fi ağlarında 1Gbps'dir. Aynı zamanda wimax band genişliği ile aynı boydadır.
- Ip v6 support
- CDMA


EVOLUTION
802.11ac – The standard for 5G WiFi
Gigabit speeds and greater range than ever before. Your wireless experience expands to cover completely new areas.
802.11 2 Mbps
802.11b 11 Mbps
802.11g/a 54 Mbps
802.11n 600 Mbps
802.11ac Gigabit Speeds
1st Generation
2nd Generation
3rd Generation
4th Generation
5G WiFi
1997 - 1998
1999 - 2001
2002 - 2006
2007 - 2011
Today!

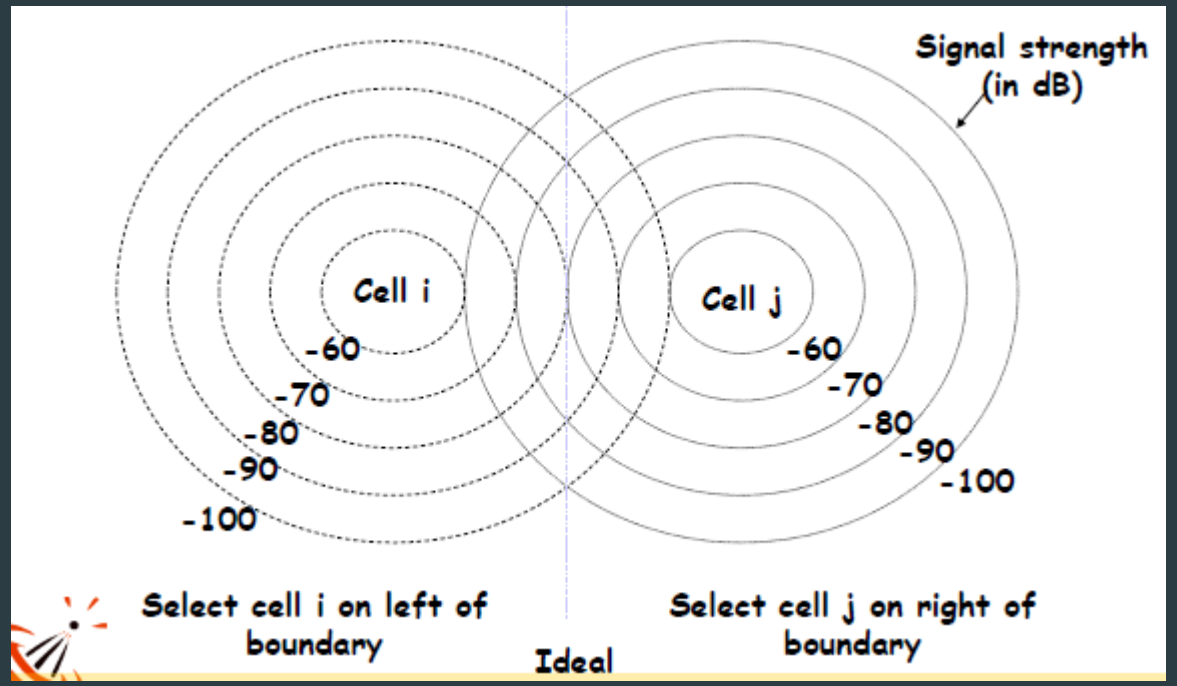
Second Part

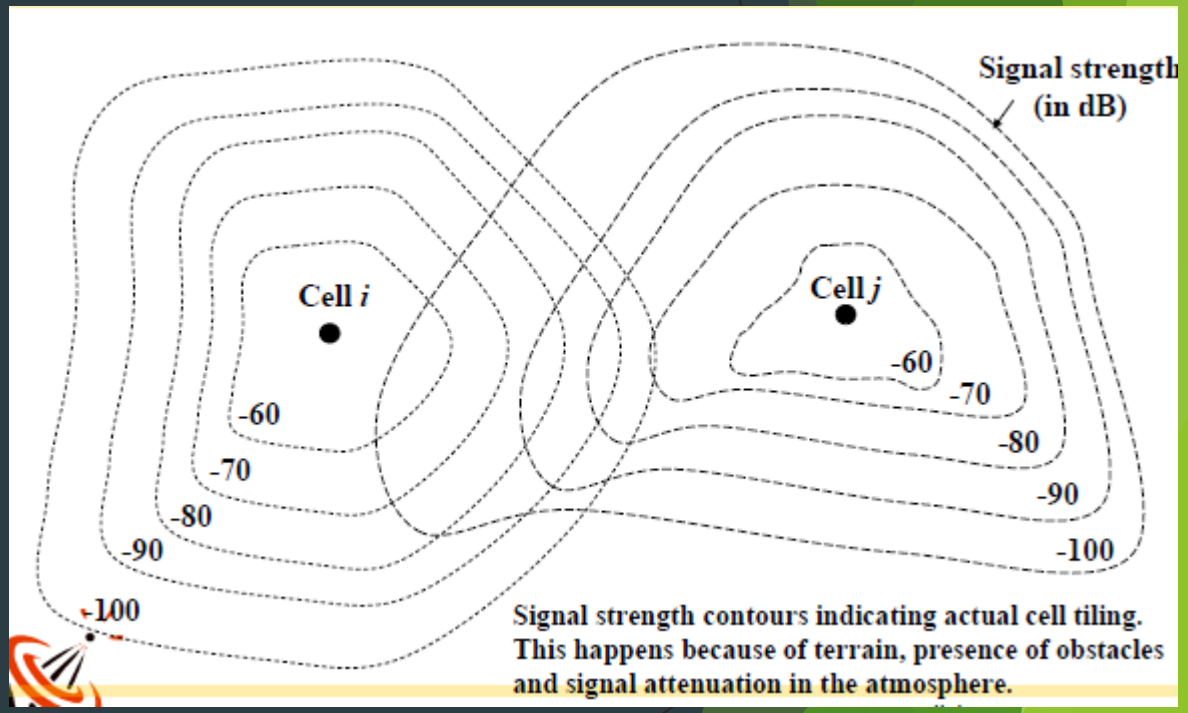
Outline

Second Part

- Cellular Design
- Frequency Reuse
- Channel Assignment
- Handoff

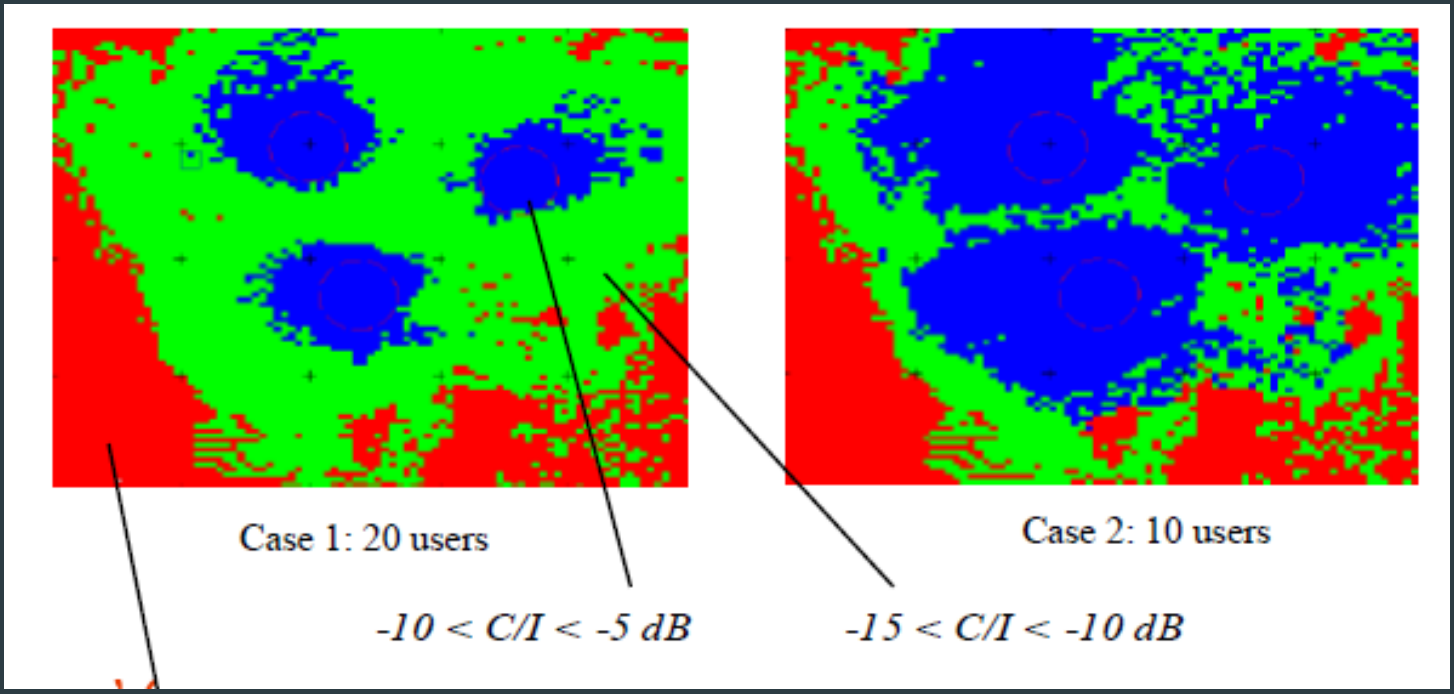
Cellular Design





- Mobile device always choose strongest signal

Cell Breathing



- Signal power usage

Frequency Reuse

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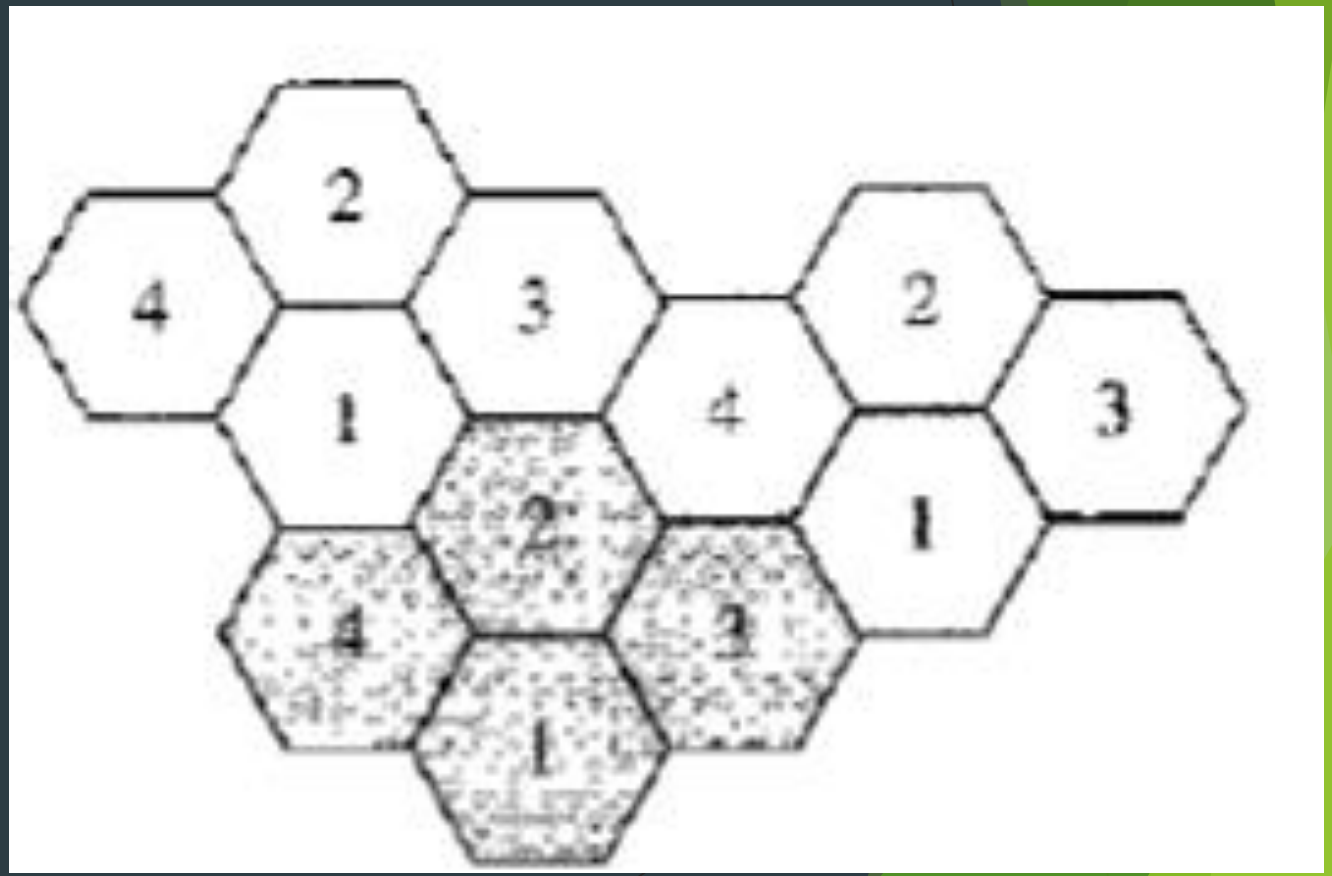
- 35 Mhz Sender
- 35 Mhz Receiver
- 1 communication has 2 channel
  - Send channel 25Khz
  - Receiver channel 25Khz
- 35000Khz/25Khz=1.400 different send channel
- 35000Khz/25Khz=1.400 different receive channel

- 1.400*8=11.200 user

How can we place the cells!!!

- We dont want to collusion with neigbhor cell
- Reuse faktör = 4
- We can reach any capacity of users we want



Channel Assignment

- Channel assignment strategies can be classified as either **fixed** **or** **dynamic**. The choice of channel assignment strategy impacts the performance of the system, particularly as to how calls are managed **when a mobile user is handed off** from one cell to another.

Fixed Channel Assignment(FCA)

- Each cell is allocated a **predetermined set of voice channels.**
- Any call attempt within the cell can only be served by the **unused channels** in that particular cell.
- If all the channels in that cell are occupied, **the call is blocked** and the subscriber does not receive service.
- Several variations of the fixed assignment strategy exist. In one approach, called the **borrowing strategy**, a cell is allowed to borrow channels from a neighboring cell if all of its own channels are already occupied.
- **The mobile switching center (MSC)** supervises such borrowing procedures and ensures that the borrowing of a channel does not disrupt or interfere with any of the calls in progress in the donor cell.

Dynamic Channel Assignment(DCA)

- Voice channels are **not allocated** to **different cells** permanently.
- Instead, each time a call request is made, the serving base station **requests a channel from the MSC.**

- The switch then allocates a channel to the requested cell following an algorithm that takes into account the
  - likelihood of future blocking within the cell,
  - the frequency of use of the candidate channel,
  - the reuse distance of the channel,
  - and other cost functions.

- DCA schemes can be **centralized** or **distributed**.

FCA vs DCA

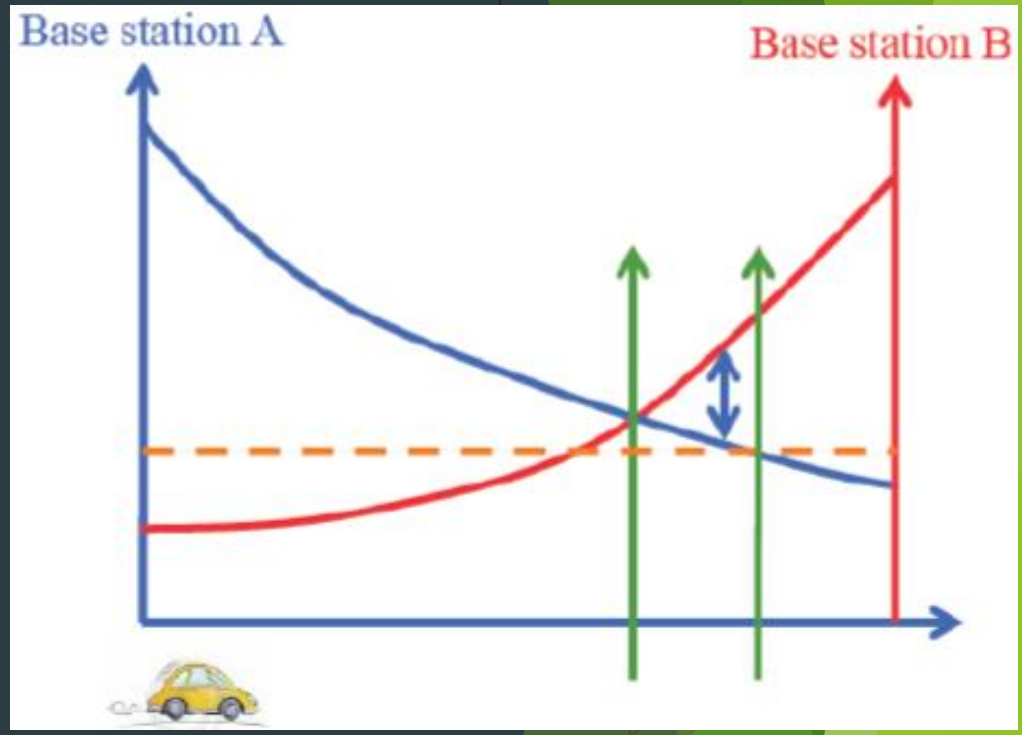
FCA	DCA
❑ Performs better under heavy traffic	❑ Performs better under light/moderate traffic
❑ Low flexibility in channel assignment	❑ Flexible channel allocation
❑ Maximum channel reusability	❑ Not always maximum channel reusability
❑ Suitable for large cell environment	❑ Suitable in microcellular environment
❑ Low flexibility	❑ High flexibility
❑ Radio equipment covers all channels assigned to the cell	❑ Radio equipment covers the temporary channel assigned to the cell
❑ Independent channel control	❑ Fully centralized to fully distributed control dependent on the scheme
❑ Low computational effort	❑ High computational effort
❑ Low call set up delay	❑ Moderate to high call set up delay
❑ Low implementation complexity	❑ Moderate to high implementation complexity

Hybrid Channel Assignment

- In hybrid channel assignment strategies, the concepts of **fixed and dynamic channel** assignment schemes are combined.
- In addition to the fixed set of channels assigned to each cell, there are channels in a **global** pool for use in case of shortage.
- When a call requires service from a cell and all of its **fixed channels are busy**, a channel from the **global pool is assigned** to the call.
- **The ratio** of fixed to global (dynamic)channels is a significant parameter which defines the performance of the system.
- Ratio is a function of traffic load and would vary over time according to the offered load estimations.
- **Superior performance with non-uniform traffic**

Handoff (Handover)

- It may happen that, during a conversation, ***the mobile station moves from one cell to another.***
- When it does, the signal may become weak. To solve this problem, ***the MSC monitors*** **the level of the signal** every few seconds.
- If the strength of the signal diminishes, the MSC seeks ***a new cell*** that can better accommodate the communication.
- The ***MSC*** then changes the channel carrying the call (hands the signal off from the old channel to a new one).



Hard Handoff

- ***Early systems*** used a hard handoff. In a hard handoff, a mobile station only communicates with one base station.

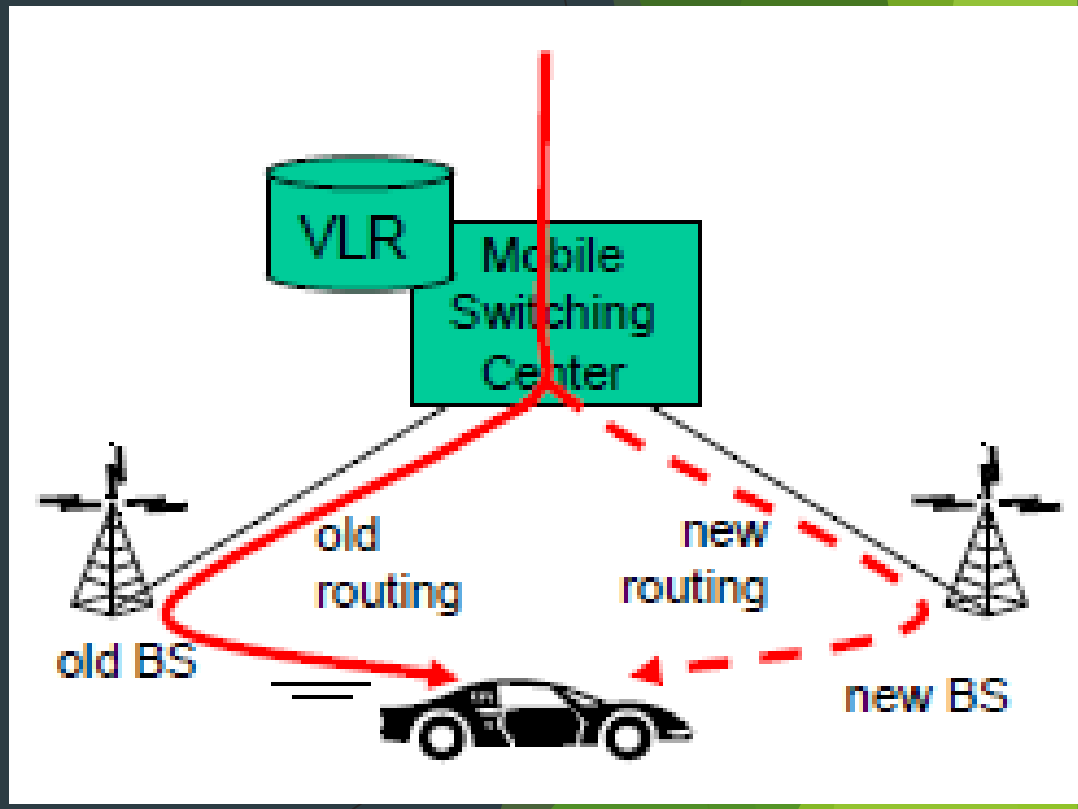
- When the MS moves from one cell to another, ***communication must first be broken*** with the previous base station before communication can be established with the new one. This may create a rough transition.

Soft Handoff

- ***New systems*** use a soft handoff.
- In this case, a mobile station can ***communicate with two base stations at the same time.***
- This means that, ***during handoff, a mobile station may continue with the new base station before*** breaking off from the old one.

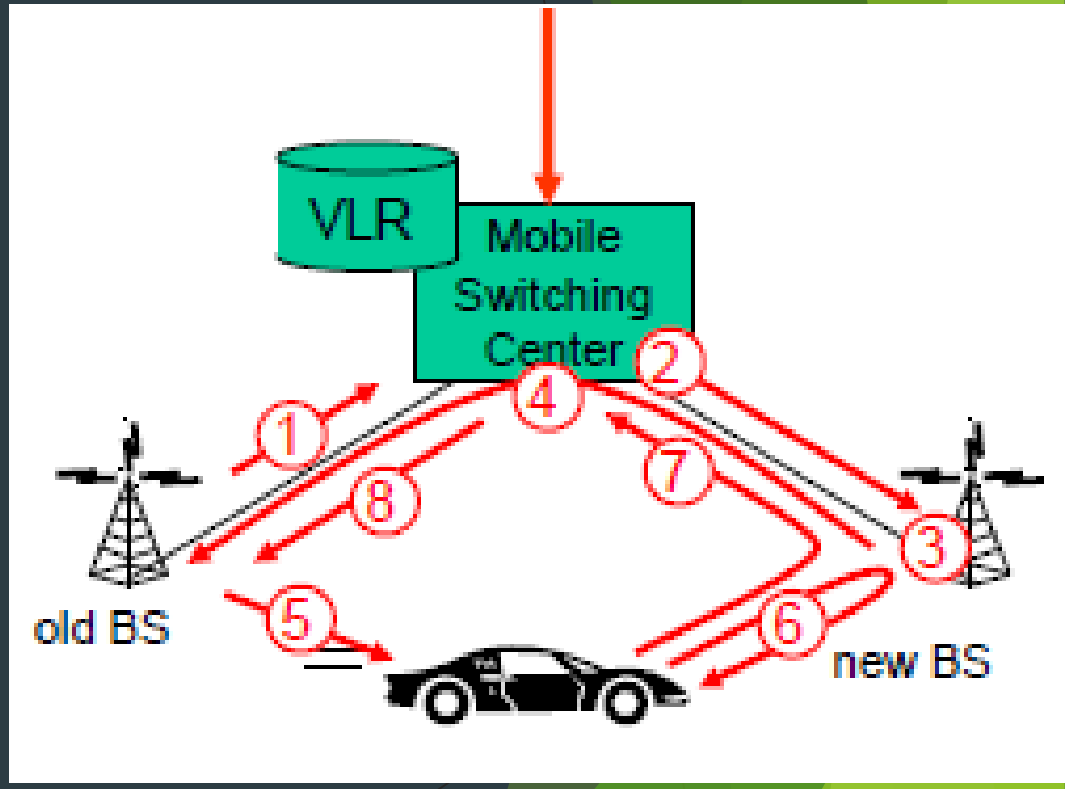
Reasons for Handoff

- Handoff goal: route call via new base station (***without interruption***)
- reasons for handoff: stronger signal to/from new BS (continuing connectivity, less battery drain)
  - load balance: free up channel in current BS
  - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)
  - handoff initiated by old BS



Handoff Steps

- 1. old BS informs MSC of impending handoff, provides list of 1+ new BSs
- 2. MSC sets up path (allocates resources) to new BS
- 3. new BS allocates radio channel for use by mobile
- 4. new BS signals MSC, old BS: ready
- 5. old BS tells mobile: perform handoff to new BS
- 6. mobile, new BS signal to activate new channel
- 7. mobile signals via new BS to MSC: handoff complete. MSC reroutes call
- 8 MSC-old-BS resources released



Thank You !!!

ÖNEMLİ

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