# MOBILE COMPUTING

# Unit-1
# Introduction
# Cell and Channel Assignments

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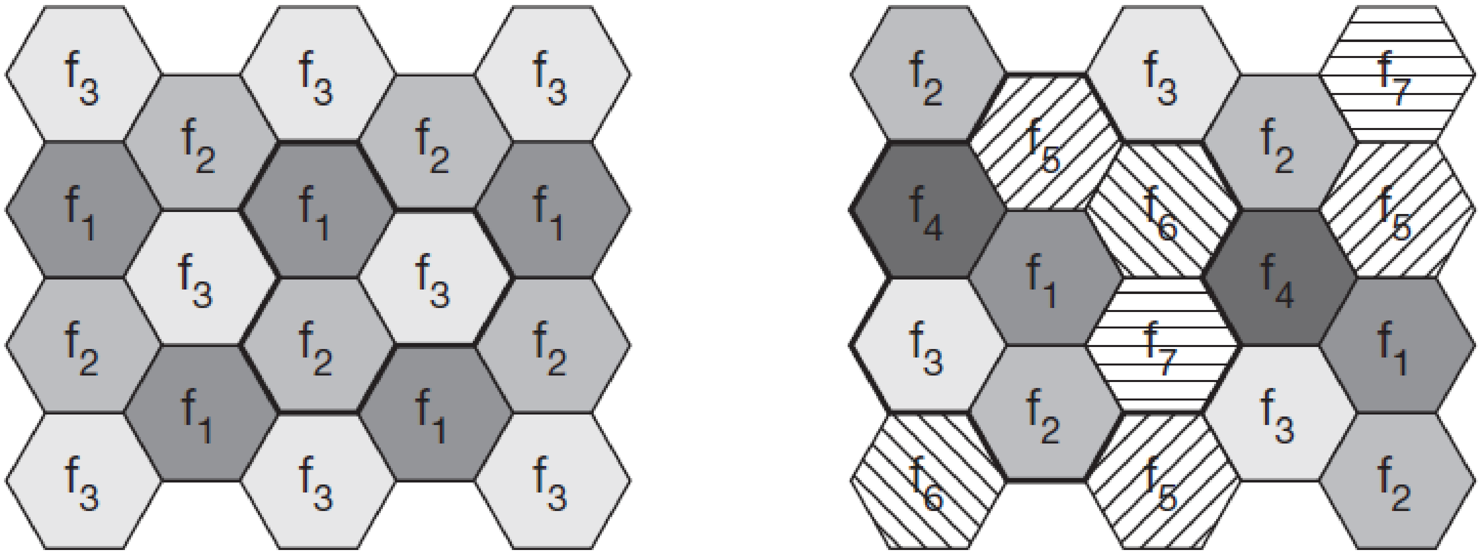
# Source & References:

**The materials presented in this lecture has been taken from internet sites and books. This can be used only for academic purpose only.**

1. **J. Schiller, Mobile Communications, Pearson, 2nd Ed**
2. **Asok K. Talukder, Mobile Computing-Technology, Applications & Service Creation, TMH**

# Fundamentals Of Cellular Systems Cont..

- Cellular systems for mobile communications implement **SDM**. Each transmitter(**base station)** covers a certain area, a cell.
- **Cell radii** can vary from tens of meters in buildings, and hundreds of meters in cities, up to tens of kilometers in the countryside. The shape of cells are never perfect circles or hexagons, but depend on the environment (buildings, mountains, valleys etc.), on weather conditions, and sometimes even on system load.
- A mobile station within the cell around a base station communicates with this base station and vice versa.




Cellular system with **three** and **seven** cell clusters

# Advantages of cellular systems with small cells are the following:

**Higher capacity:**

- Implementing SDM allows frequency reuse.
- If one transmitter is far away from another, i.e., outside the interference range, it can reuse the same frequencies.
- As most mobile phone systems assign frequencies to certain users (or certain hopping patterns), this frequency is blocked for other users. But frequencies are a scarce resource and, the number of concurrent users per cell is very limited.
- Huge cells do not allow more users. On the contrary, they are limited to less possible users per sq.km. This is also the reason for using very small cells in cities where many more people use mobile phones.

## Less transmission power:

While power aspects are not a big problem for base stations, they are indeed problematic for mobile stations. A receiver far away from a base station would need much more transmit power than the current few Watts. But energy is a serious problem for mobile handheld devices.

## Local interference only:

Having long distances between sender and receiver results in even more interference problems. With small cells, mobile stations and base stations only have to deal with ‘local’ interference.

## Robustness:

Cellular systems are decentralized and so, more robust against the failure of single components. If one antenna fails, this only influences communication within a small area.

# Disadvantages small cells also have some

**Infrastructure needed:**

Cellular systems need a complex infrastructure to connect all base stations. This includes many antennas, switches for call forwarding, location registers to find a mobile station etc, which makes the whole system quite expensive.

**Handover needed:**

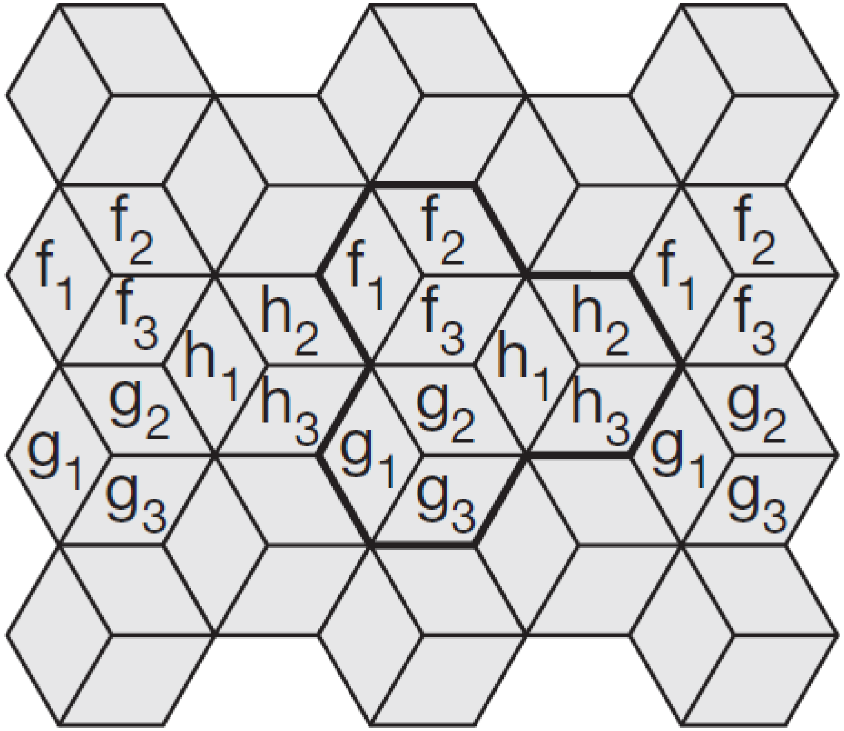
The mobile station has to perform a handover when changing from one cell to another. Depending on the cell size and the speed of movement, this can happen quite often.

**Frequency planning:**

To avoid interference between transmitters using the same frequencies, frequencies have to be distributed carefully. On the one hand, interference should be avoided, on the other, only a limited number of frequencies is available.

- To avoid interference, different transmitters within each other's interference range use FDM. If FDM is combined with TDM (see Figure 2.19), the hopping pattern has to be coordinated. The general goal is never to use the same frequency at the same time within the interference range (if CDM is not applied).

- To reduce interference even further (and under certain traffic conditions, i.e., number of users per sq. km) **sectorized antennas** can be used. Typically, it makes sense to use sectorized antennas instead of omni-directional antennas for larger cell radii.




**Cellular system with three cell clusters and three sectors per cell**

# Channel Assignment Schemes

## Objective

- Minimize co-channel interference : Interference from users/BS in co-channel cells transmitting at the same frequency

- Minimize adjacent channel interference
  - Interference from users transmitting at adjacent channel caused by power leakage in the modulation scheme

- Avoid cell congestion
  - Calls may be **blocked** if all channels are occupied, even though the channels in other cells are available

- The fixed assignment of frequencies to cell clusters and cells respectively, is not very efficient if traffic load varies.

- **E.g.**, in the case of a heavy load in one cell and a light load in a neighboring cell, it could make sense to ‘borrow’ frequencies.

- Cells with more traffic are dynamically allotted more frequencies. This scheme is known as **borrowing channel allocation (BCA),** while the first fixed scheme is called **fixed channel allocation (FCA).**

- **FCA** is used in the **GSM** system as it is much simpler to use, but it requires careful traffic analysis before installation.

A **dynamic channel allocation (DCA)** scheme, frequencies can only be borrowed, but it is also possible to freely assign frequencies to cells. With dynamic assignment of frequencies to cells, the danger of interference with cells using the same frequency exists. The ‘borrowed’ frequency can be **blocked** in the surrounding cells.

# Channel Assignment Schemes

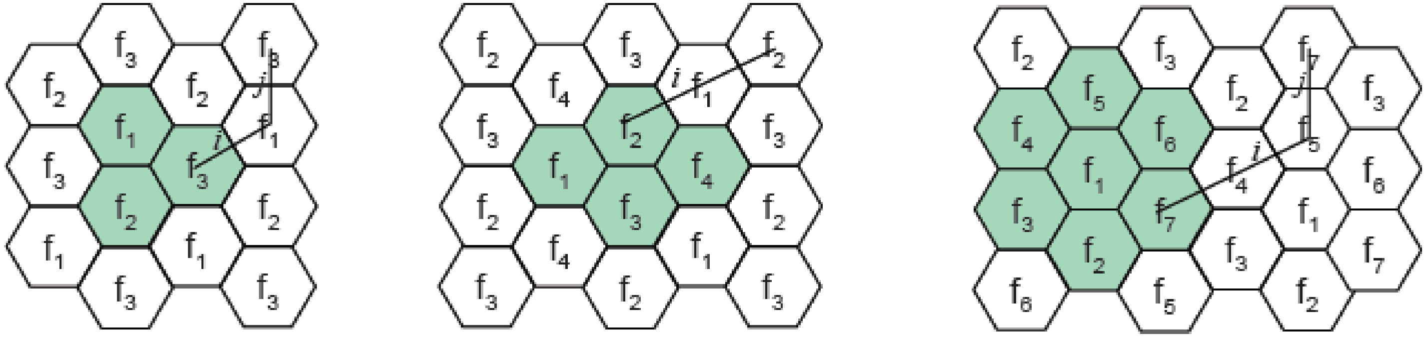
- **Fixed channel assignment :** A fixed frequency channel pattern is assigned according to the reuse pattern
  - To minimize the co-channel interference
  - Adjacent frequency channels are not assigned in the same cell
  - To minimize the adjacent channel interference
- If the cluster size is large enough, the adjacent frequency channels are also not assigned to neighbouring cells but to those farther away
- **Channel Borrowing**
  - To avoid cell congestion
  - A fully occupied cell is allowed to borrow *free* channels from neighboring cells
  - Involve MSC (mobile switching center) to supervise the borrowing procedure

# Channel Assignment Schemes

- Dynamic channel assignment: Channels are allocated to cells on demand
  - MSC assign channels based on the co-channel & adjacent channel interference
  - Maintain the minimum required SIR (Signal to Interference Ratio)
- Advantages
  - Increase system capacity
  - Reduce probability of blocking and drop call
- Disadvantages
  - Extensive computation in MSC
  - Keep track of real time data on channel occupancy, traffic distribution & radio signal strength indications (RSSI)
  - Real time channel assignment computations

# Fundamentals Of Cellular Systems Cont..

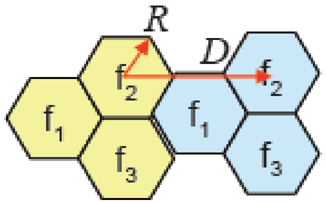
- Cluster size
  - Exist only for $N = i^2 + ij + j^2$



$i$=1, $j$=1, $N$=3 $i$=2, $j$=0, $N$=4 $i$=2, $j$=1, $N$=7

- Co-channel reuse ratio

$$Q = \frac{D}{R} = \sqrt{3N}$$




  - D: center-to-center distance between co-channel cells
  - R: center-to-vertice distance within a cell (i.e., radius)

# Thank You
# Any Questions