Lecture 7

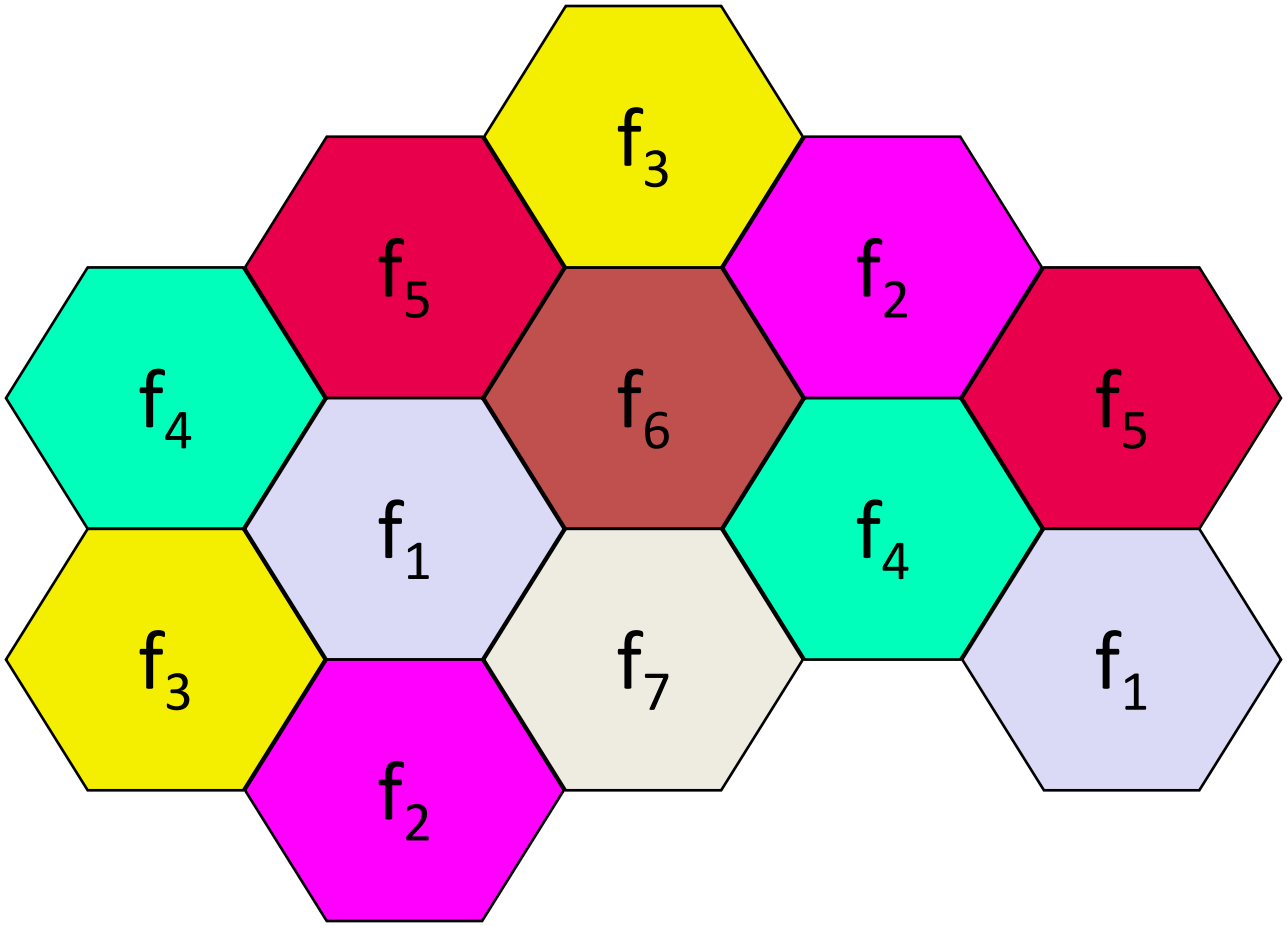
CS 621
Mobile Computing

Mobile Cellular Systems

Zubin Bhuyan,
Department of CSE, Tezpur University
http://www.tezu.ernet.in/~zubin

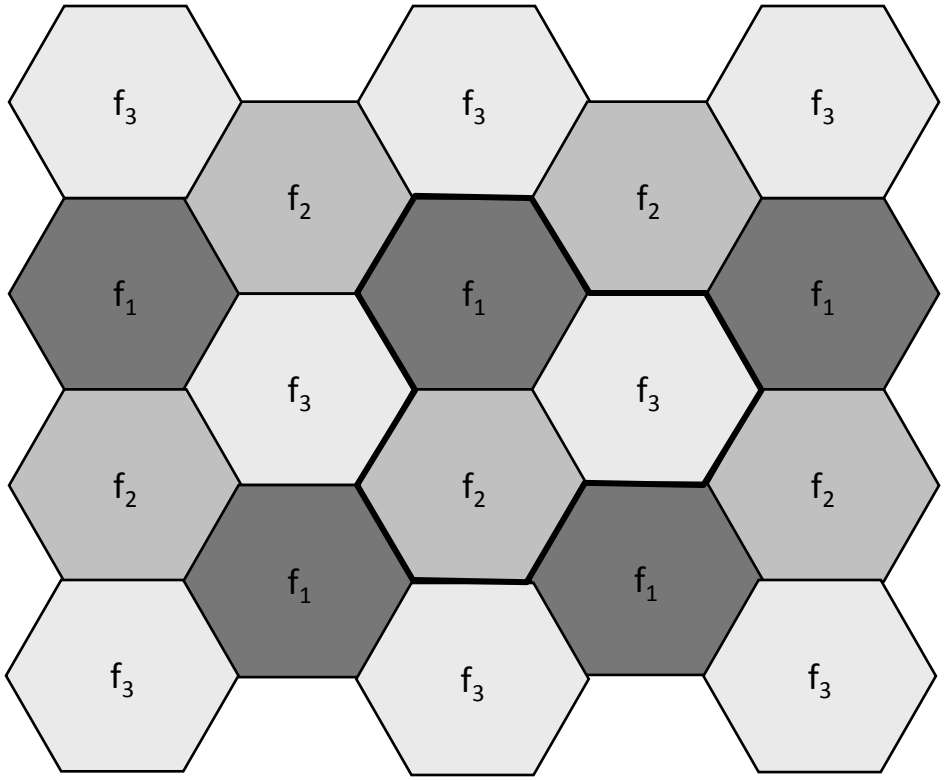
Several slides and images in this presentation have been taken from Prof. Nityananda Sarma's class notes/ppt. Several images have been taken from the book Mobile Communication by Jochen Schiller.

7 cells sharing system



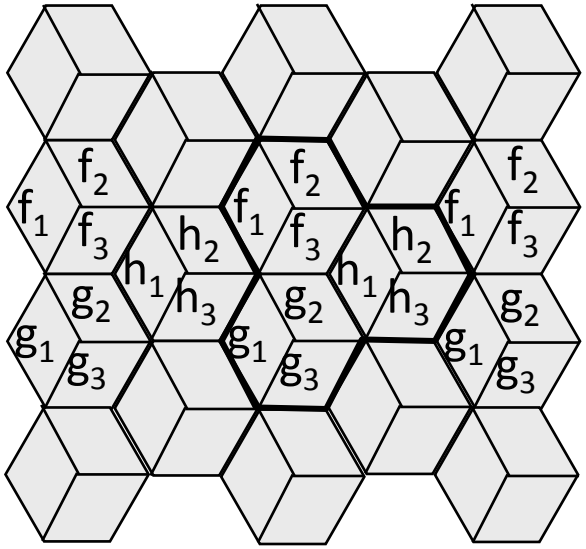
Standard 7 cells sharing system (K = 7)

Other Common Channel Sharing



3 cell cluster

Other Common Channel Sharing



3 cell cluster
with 3 sector antennas

Properties of Cell structure

- Typical Cell sizes
  - some cites few hundred meters (e.g. 100 m)
  - country side few tens of kilometers (e.g. 35 km)
- Advantages of cell structures:
  - more capacity due to frequency reusage
  - less transmission power needed
  - more robust, tolerate failures
  - deals interference, transmission area locally
- Problems:
  - fixed network needed for the base stations
  - handover (changing from one cell to another) necessary
  - interference with other cells

$$D = \sqrt{3K}R$$

Inside a cell

- Center-excited cell where the tower is placed somewhat near the center with a omni-directional antenna

- Edge-excited cell where the towers are placed on three of the six corners with sectored directional antennas.

Channels Reuse

- **Reminder:**
  - Cell structure can reuse frequency only when certain distance is maintained between cells that use the same channels.

Channel Assignment/Allotment Algorithms

- **Channel Assignment Strategies**: To achieve the objectives of:
  - increasing capacity & minimizing interference
- Fixed Channel Assignment/Allocation (FCA):
  - certain channels are assigned to a certain cell (called *nominal channels*)
  - Problem: different traffic load in different cells and it's very difficult to predict the number of calls (**Hot Spot Problem**).
  - Borrowing strategy allow a cell to borrow channels from a neighboring cell (Mobile Switching Center (MSC) supervises the procedure, without interfering donor cell).
  - Donor cell can not use the channel until it is released by the borrowing cell, thus result in higher call blocking probability.

Channel Assignment/Allotment Algorithms

- Simple Borrowing from the Richest (SBR) reduces call blocking probability in donor cells.
- Another one is to reduce the channel blocking on neighboring cells.
- A Donor cell may offer multiple channels, the borrower cell has to select the channel with BDCL (Borrowing with Directional Channel Locking)
- BDCL means selecting a channel which is already blocked in the potentially interfering cells.

Channels Reuse (Contd.)

- Dynamic Channel Allocation (DCA):
  - Each time a call request is made, the serving BS requests a channel from the MSC.
  - Mobile Switching Center (MSC) chooses frequencies depending on the frequencies already used in neighbor cells.
  - more capacity in cells with more traffic.
  - assignment can also be based on interference measurements (like BDCL).

Interference

- Co-channel interference
  - Signals from cells that share a channel cause co-channel interference
  - Can’t remove it by increasing power.
- Adjacent channel interference
  - Signals (which are adjacent in frequency to the desired signal) from adjacent cells and within same cell cause this.
  - Near-far problem: **An adjacent channel user is transmitting in very close range to a subscriber’s receiver, while receiver attempts to receive signal from BS on the desired channel.**
  - Use careful filtering and channel assignments to reduce it.
- But, available channels decrease for incoming calls.

Frequency reuse factor

- Total available channels = **S**
- K “adjacent” cells (called a cluster) share S channels (**Note: K is called Cluster size**)
- System has **M** clusters.
- Each cell gets **k** channels.
- **S = k.K**

- **Capacity of the system is C = MkK**
- **Frequency reuse factor is K**

Home Work

- Consider a cellular system in which there are a total of 1001 radio channels available for handling traffic. Suppose, the area of a cell is 6 km^2 and the area of the entire system is 2100 km^2.

i. Calculate the system capacity if the cluster size is 7.

ii. How many times would the cluster of size 4 have to be replicated in order to approximately cover the entire cellular area?

iii. Calculate the system capacity if the cluster size is 4.

iv. Does decreasing the cluster size increase the system capacity? Justify your claim.

S= 1001, K=?, k=? , M=?, C= MkK

THANKS!