Introduction to Telecommunications and Computer Engineering

Unit 5: Cellular Access Technology

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Acknowledgements

These notes contain material from the following source:

[1] *Cellular Access Technology*, by M.K.Hussain, CSE Department, North South University, 2005.

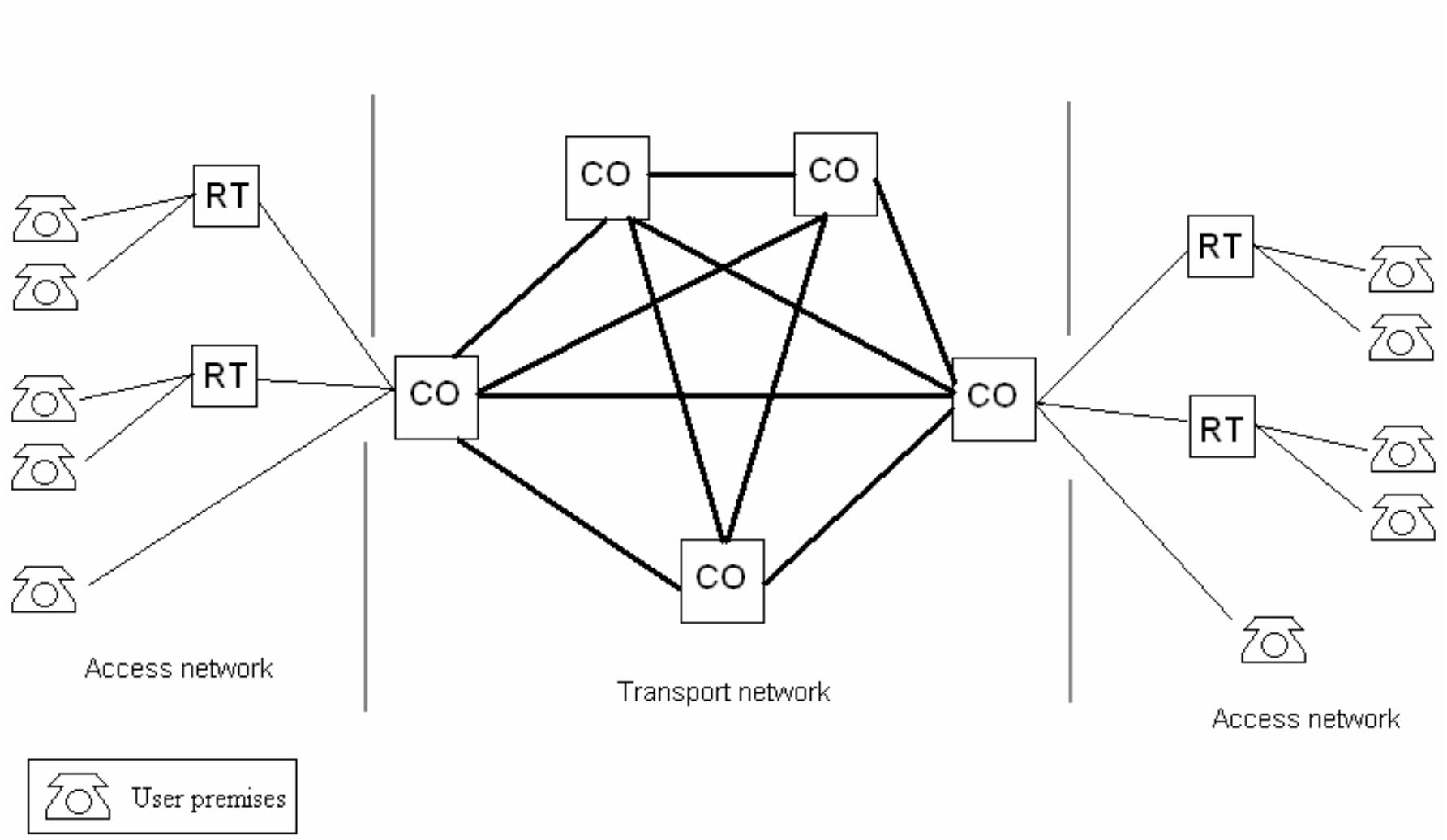
Structure of PSTN

All telephone lines from homes and offices are connected to a central office (CO) either directly or through a remote terminal (RT). Then all COs are connected to one another. A typical **Public Switched Telephone Network (PSTN)** is divided into two parts. They are:

1. Access Network: The connection of user premises with COs either directly or through RT is called access network. Generally the connections are made by traditional twisted pair copper wires. This connection is called subscriber line.

2. Transport Network: The connections of COs is called transport network. Today this network is spread over the whole world. Transport networks gather all the signals emanating from millions and millions of customer premises and then have to transmit this tremendous amount of information at high speed. This connection is made by fiber optics cable, satellite links, microwave links etc.

Structure of PSTN



From [1]

Multiple Access Technology

The technique of accessing (using) a common resource (here a channel) by more than one user simultaneously is called **multiple access**. If we consider a channel connecting two COs in the transport network, it needs to carry voice of data of many users at a time. So some sorts of multiple access techniques need to be applied here. There are many multiple access available a few of which are described here:

Time Division Multiple Access (TDMA): In this technique the common channel is assigned to the different users by dividing the time. That is, each user is allocated a certain time to use the channel. When the allocated time is over then another user will get chance to use the channel. This method is used by GSM networks.

Multiple Access Technology

Frequency Division Multiple Access (FDMA): In this technique the bandwidth of the common channel is divided into different users. That is, here each user has a range of frequency to operate with.

Code Division Multiple Access (CDMA): In CDMA each user will use the same frequency simultaneously having a unique code assigned to it. Users will differentiate each other using that code.

Wideband Code Division Multiple Access (W-CDMA): W-CDMA is a 3G technology that uses a wideband spread-spectrum mobile air interface that utilizes the CDMA method to achieve higher speeds and support more users compared to the implementation of time division multiplexing (TDMA) used by 2G GSM networks.

Cellular Telephone Systems

Cellular telephone is similar to two-way mobile radio in that most communication occurs between ***base transmission stations*** (***BTS***) and mobile units. BTSs are fixed transceiver with relatively high power transmitters and sensitive receivers.

In this system a geographic region is divided into many small areas called cells. The physical size of a cell varies depending on user density and calling patterns.

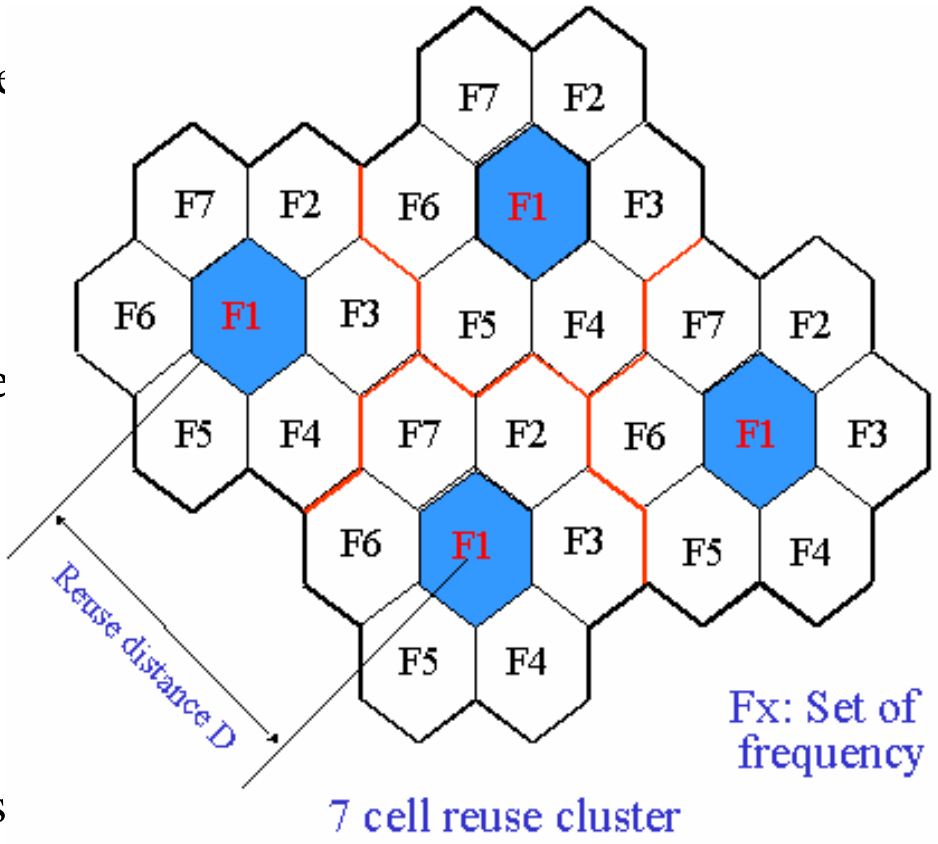
Cellular Telephone Systems

For example a large cell (called macro cell) can have a radius from 1 mile to 15 miles with base station power from 1 watt to 6 watts. On the other hand a small cell (called micro cell) can have a radius 1500 feet or less with base station power from 0.1 watt to 1 watt.

The size of a cell is considered to be hexagonal is shape to avoid overlaps between cells. So the area of a cell with radius R will be $(3\sqrt{3}R^2)/2$ instead of πR^2. Thus all the cells in a region will have a honeycomb pattern.

Frequency Reuse

Frequency reuse is the process in which the same set of frequencies (channels) can be allocated to more than one cell, provided the cells are separated by sufficient distance. Generally in a coverage area few cells are grouped together to form a cluster. In a particular cluster all the cells use different frequencies. But because of frequency reuse similar cells in different cluster can use the same frequency. In the figure we see there are four clusters having seven cells in each. The symbols F1, F2, F3, F4, F5, F6 and F7 denote the seven sets of frequencies, which are repeated in different clusters. Two or more cells using the same set of frequencies in different clusters are called **co-channel cells**.



From [1]

Interference

Cellular telephone system suffers from two types of interferences namely co-channel interference and adjacent cell interference.

Co-channel cell interference: In frequency reuse two co-channels use same set of frequencies. In this case a mobile unit in one cell may receive a weak signal from another co-channel cell. This kind of interference is called co-channel interference. A minimum amount of distance must be maintained between co-channels in order to reduce the co-channel interference.

Adjacent cell interference: Adjacent channel interference occurs when transmission from adjacent cells interfere each other. Proper filters should be used to reduce this kind of interference.

Handoffs

The transfer of a mobile unit from the control of one base station to the control of another base station is called a **handoff** (or ***handover***). It occurs when one mobile unit crosses the boundary of one cell and enters into another cell. In this case the mobile unit breaks its connection with the previous base station and gets connection with a new base station. There are two types of handoff:

1. Hard handoff: During the handoff if the connection is momentarily broken down then it is called hard handoff.

2. Soft handoff: A flawless handoff without any perceivable interruption of service is called soft handoff.