



INTEGRATED TECHNICAL EDUCATION CLUSTER
AT ALAMEERIA

E-716-A

Mobile Communications Systems

Lecture #6

Basic Concepts of Cellular Transmission (p3)

Instructor:

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Agenda

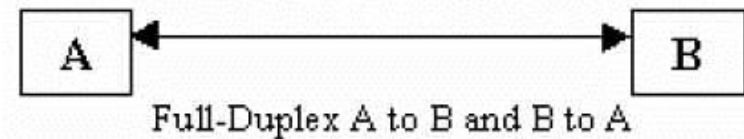
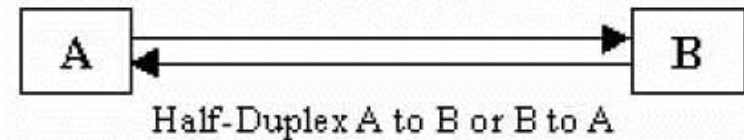
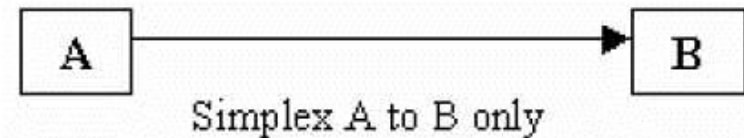
- 1 Duplexing Techniques
- 2 Call Steps in Cellular Systems
- 3 Handoff Strategies

DUPLEXING TECHNIQUES



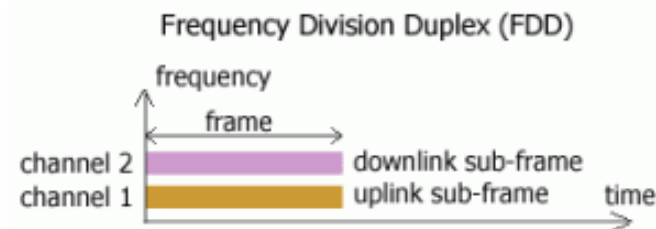
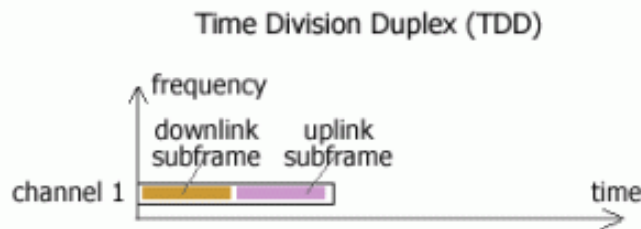
Simplex vs. Duplex

- **Simplex** communication refers to communication that occurs in one direction only.
- **Duplex** communication system is a point-to-point system composed of two connected devices that can communicate with one another in both directions.
- There are *two types* of duplex communication systems:
 - **half-duplex**
 - provides communication in both directions, but only one direction at a time (not simultaneously).
 - **full-duplex**
 - allows communication in both directions to happen simultaneously.



Duplexing Methods

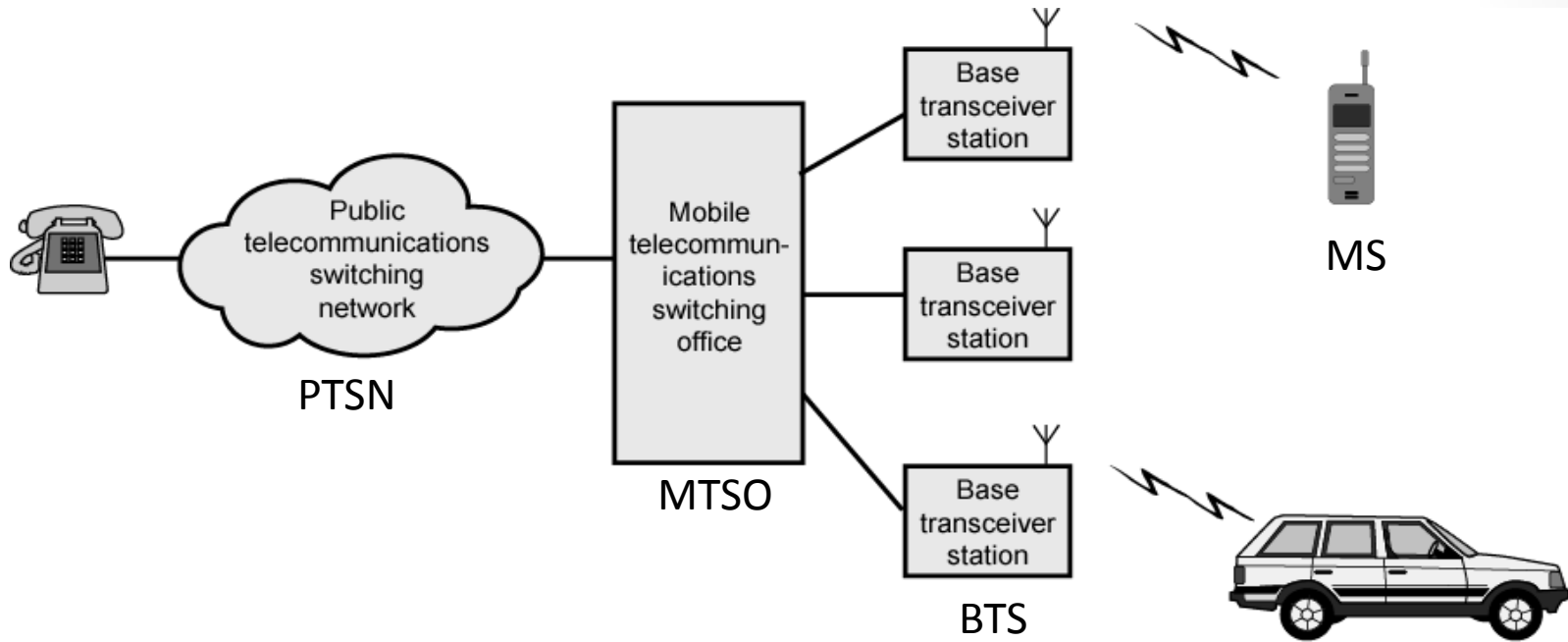
- As channel access methods are used in point-to-multipoint networks (such as cellular networks) for dividing forward and reverse communication channels on the same physical communications medium, they are known as duplexing methods, such as time-division duplexing and frequency-division duplexing.
- **Time-division duplexing (TDD)** is the application of time-division multiplexing to separate outward and return signals.
- It emulates full duplex communication over a half duplex communication link.
- **Frequency-division duplexing (FDD)** means that the transmitter and receiver operate at different carrier frequencies.



CALL STEPS IN CELLULAR SYSTEMS



Overview of Cellular System



- Base Station (BS) – includes an antenna, a controller, and a number of receivers
- Mobile telecommunications switching office (MTSO) – connects calls between mobile units
- Two types of channels available between mobile unit and BS
 - Control channels
 - Setting up and maintaining calls
 - Establish relationship between mobile unit and nearest BS
 - Traffic channels
 - Carry voice and data

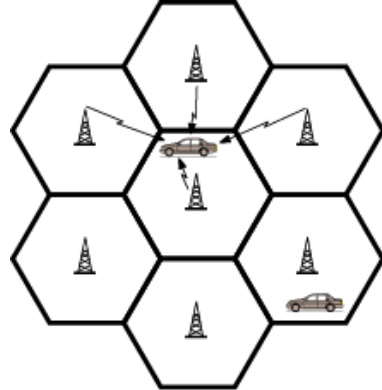
Typical Call in Single MTSO Area

- Mobile unit initialization
 - Scan and select strongest set up control channel
 - Automatically selected BS antenna of cell
 - Usually but not always nearest (propagation anomalies)
 - Handshake to identify user and register location
 - Scan repeated to allow for movement
 - Change of cell
 - Mobile unit monitors for pages
- Mobile originated call
 - Check set up channel is free
 - Monitor forward channel (from BS) and wait for idle
 - Send number on pre-selected channel
- Paging
 - MTSO attempts to connect to mobile unit
 - Paging message sent to BSs depending on called mobile number
 - Paging signal transmitted on set up channel

Typical Call in Single MTSO Area..

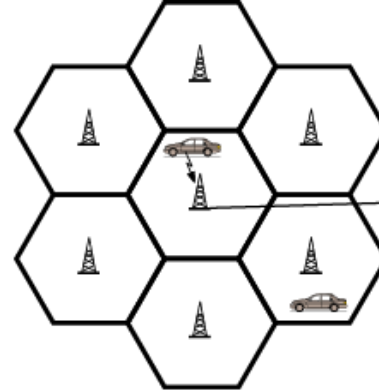
- Call accepted
 - Mobile unit recognizes number on set up channel
 - Responds to BS which sends response to MTSO
 - MTSO sets up circuit between calling and called BSs
 - MTSO selects available traffic channel within cells and notifies BSs
 - BSs notify mobile unit of channel
- On-going call
 - Voice/data exchanged through respective BSs and MTSO
- Handoff
 - Mobile unit moves out of range of cell into range of another cell
 - Traffic channel changes to one assigned to new BS
 - Without interruption of service to user

Call Stages



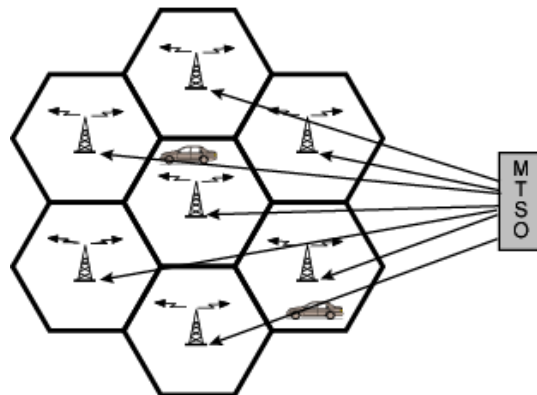
(a) Monitor for strongest signal

MTSO



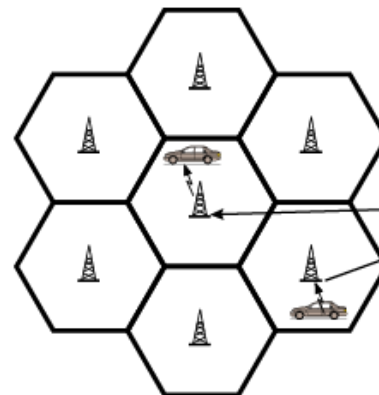
(b) Request for connection

MTSO



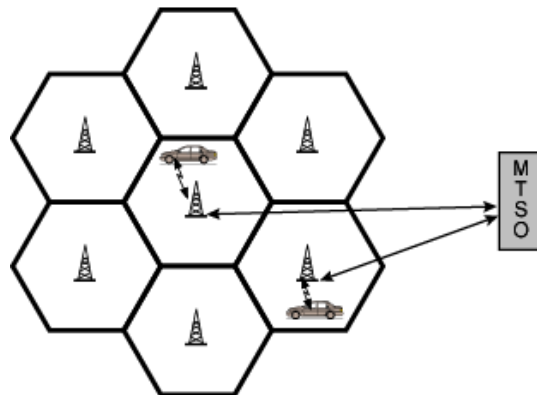
(c) Paging

MTSO



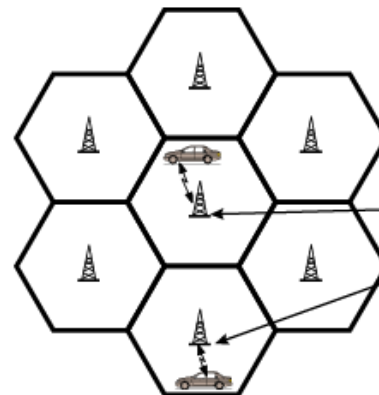
(d) Call accepted

MTSO



(e) Ongoing call

MTSO



(f) Handoff

MTSO

Other Functions

- Call blocking
 - During mobile-initiated call stage, if all traffic channels busy, mobile tries again
 - After number of fails, busy tone returned
- Call termination
 - User hangs up
 - MTSO informed
 - Traffic channels at two BSs released
- Call drop
 - BS cannot maintain required signal strength
 - Traffic channel dropped and MTSO informed
- Calls to/from fixed and remote mobile subscriber
 - MTSO connects to PSTN
 - MTSO can connect mobile user and fixed subscriber via PSTN
 - MTSO can connect to remote MTSO via PSTN or via dedicated lines
 - Can connect mobile user in its area and remote mobile user

HANDOFF STRATEGIES



Handoff/Handover Types

- In cellular telecommunications, the term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another channel.
- Types:
 - *Inter-cell* handover: the source and the target are different cells (even if they are on the same cell site).
 - *Intra-cell* handover: the source and the target are one and the same cell and only the used channel is changed during the handover.
 - *Hard* handover: the channel in the source cell is released and only then the channel in the target cell is engaged.
 - *Soft* handover: the channel in the source cell is retained and used for a while in parallel with the channel in the target cell.

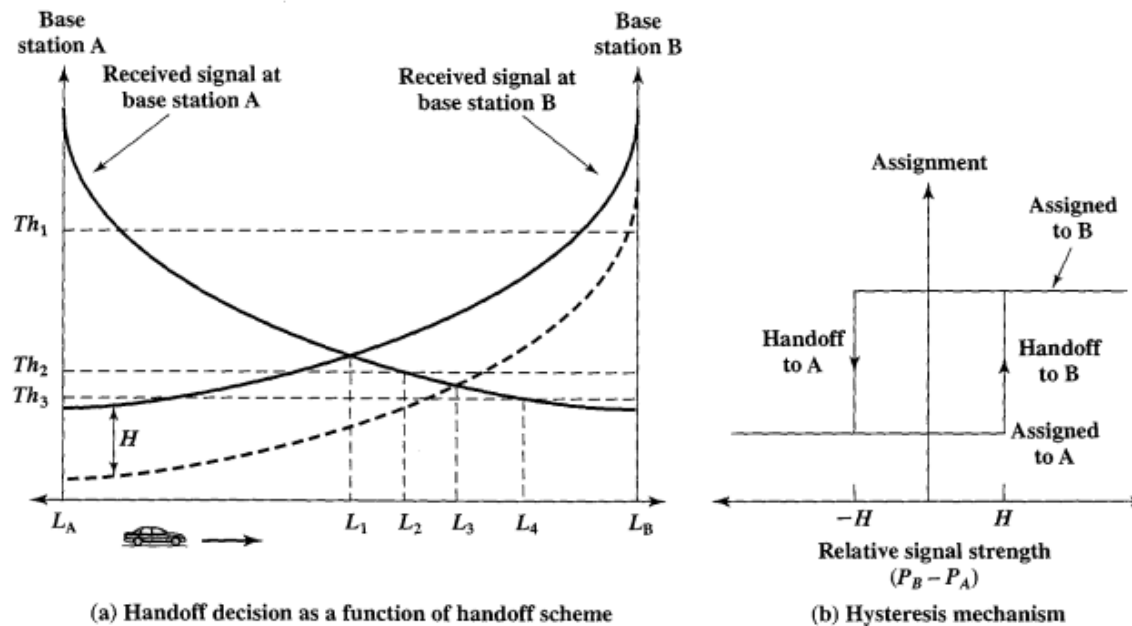


Handoff Performance Metrics

- Cell blocking probability – probability of a new call being blocked
- Call dropping probability – probability that a call is terminated due to a handoff
- Call completion probability – probability that an admitted call is not dropped before it terminates
- Probability of unsuccessful handoff – probability that a handoff is executed while the reception conditions are inadequate
- Handoff blocking probability – probability that a handoff cannot be successfully completed
- Handoff probability – probability that a handoff occurs before call termination
- Rate of handoff – number of handoffs per unit time
- Interruption duration – duration of time during a handoff in which a mobile is not connected to either base station
- Handoff delay – distance the mobile moves from the point at which the handoff should occur to the point at which it does occur

Handoff Strategies Used to Determine Instant of Handoff

- Relative signal strength
- Relative signal strength with threshold
- Relative signal strength with hysteresis
- Relative signal strength with hysteresis and threshold
- Prediction techniques



- The handoff decision is complicated by the use of power control techniques.

Power Control

- Design issues making it desirable to include dynamic power control in a cellular system
 - Received power must be sufficiently above the background noise for effective communication
 - Desirable to minimize power in the transmitted signal from the mobile
 - Reduce cochannel interference, alleviate health concerns, save battery power
 - In spread spectrum systems using CDMA, it's desirable to equalize the received power level from all mobile units at the BS
- Types of Power Control:
 - Open-loop power control
 - Depends solely on mobile unit
 - No feedback from BS
 - Not as accurate as closed-loop, but can react quicker to fluctuations in signal strength
 - Closed-loop power control
 - Adjusts signal strength in reverse channel based on metric of performance
 - BS makes power adjustment decision and communicates to mobile on control channel

- For more details, refer to:
 - Chapter 4, J. Chiller, Mobile Communications, 2003.
 - Chapter 10, W. Stallings, Wireless Communications and Networks, 2005.
- The lecture is available online at:
 - https://speakerdeck.com/ahmad_elbanna
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