CH7 Homework

Wireless and Mobile Networks

1. Assume both sender and receiver use CDMA code of size 6 where M = 1, 1, 1, -1, -1, 1 and bit d=1
    a. Get encoded output at sender

    1, 1, 1, -1, -1, 1

    b. Get decoded original bit value d at receiver

    d= 1

2. Assume both sender and receiver use CDMA code of size 9 where M = -1, 1, 1, 1, 1, -1, 1, 1, 1 and bit d=-1
    a. Get encoded output at sender

    1, -1, -1, -1, -1, 1, -1, -1, -1

    b. Get decoded original bit value d at receiver

    d=-1

3. Assume both sender and receiver use CDMA code of size 8 where M = 1, 1, -1, 1, -1, 1, 1, -1 and bit d=-1
    a. Get encoded output at sender

    -1, -1, 1, -1, 1, -1, -1, 1

    b. Get decoded original bit value d at receiver

    d = -1

4. Assume there are 2 senders who interfere with each other and that the interfering transmitted bit signals are additive. Assume that sender 1 has a CDMA code of (-1, -1, -1, 1, 1, 1) and sender 2 has a CDMA code (1, -1, -1, -1, -1, 1) and their combined output is (-2, 0, 0, 2, 2, 0)
    a. Get decoded original bit value d for receiver 1

    Decoded bit d = 1

    b. Get decoded original bit value d for receiver 2

    Decoded bit d = -1

5. Assume there are 2 senders who interfere with each other and that the interfering transmitted bit signals are additive. Assume that sender 1 has a CDMA code of (1, -1, -1, -1, 1, -1) and sender 2 has a CDMA code (1, 1, 1, -1, -1, 1) and their combined output is (-2, 0, 0, 2, 0, 0)
    a. Get decoded original bit value d for receiver 1

    Unable to decode bit d because CDMA codes were not well chosen

    b. Get decoded original bit value d for receiver 2

Unable to decode bit d because CDMA codes were not well chosen

6. Assume there are 3 senders who interfere with each other and that the interfering transmitted bit signals are additive. Assume that sender 1 has a CDMA code of (-1, 1, 1, 1, -1, 1, -1, -1), sender 2 has a CDMA code (-1, 1, -1, -1, 1, -1, -1, -1) and sender 3 has a CDMA code of (-1, -1, 1, -1, 1, -1, -1, 1) and their combined output is (-1, 3, -1, 1, -1, 1, -1, -3)
    a. Get decoded original bit value d for receiver 1

    Unable to decode bit d because CDMA codes were not well chosen

    b. Get decoded original bit value d for receiver 2

    Unable to decode bit d because CDMA codes were not well chosen

    c. Get decoded original bit value d for receiver 3

    Decoded bit d = -1

7. Assume there are 3 senders who interfere with each other and that the interfering transmitted bit signals are additive. Assume that sender 1 has a CDMA code of (-1, 1, -1, 1, 1, -1), sender 2 has a CDMA code (1, -1, -1, 1, 1, -1) and sender 3 has a CDMA code of (-1, -1, -1, -1, -1, 1) and their combined output is (-1, 3, 1, 1, 1, -1).
    a. Get decoded original bit value d for receiver 1

    Decoded bit d = 1

    b. Get decoded original bit value d for receiver 2

    Unable to decode bit d because CDMA codes were not well chosen

    c. Get decoded original bit value d for receiver 3

    Decoded bit d = -1

8. Describe four key differences between wireless and wired communication links. **Note: Suggested keys are Signal Strength, Interference, Multipath propagation, and Error Rates.

    Answer:

    Signal Strength:

    Wireless: Signal attenuates as it propagates through matter (path loss).

    Wired: Signal loss is minimal due to physical connections.

    Interference:

    Wireless: Prone to interference from other devices operating on the same frequency.

    Wired: Less susceptible to interference.

    Multipath Propagation:

    Wireless: Signals can reflect off objects, causing multiple paths and delays.

    Wired: Generally avoids multipath issues.

    Error Rates:

Wireless: Higher Bit Error Rate (BER) due to noise and interference.

Wired: Lower BER due to stable transmission medium.

9. Explain the difference between infrastructure mode and ad hoc mode in wireless networks.

Answer:

Infrastructure Mode:

- A base station (e.g., an Access Point) connects wireless hosts to a wired network.
- Used in Wi-Fi and cellular networks.
- Supports handoffs between base stations for mobility.

Ad Hoc Mode:

- Wireless hosts communicate directly without a base station.
- Nodes organize themselves into a network, often for temporary setups like Mobile Ad Hoc Networks (MANETs).
- Common in Bluetooth and peer-to-peer Wi-Fi.

10. In an IEEE 802.11 (Wi-Fi) network, explain how the CSMA/CA protocol prevents collisions.

Answer:

- **Channel Sensing**: The sender listens to the channel before transmitting. If the channel is idle, it proceeds to transmit.
- **Random Backoff**: If the channel is busy, the sender waits for a random backoff time before trying again.
- **Acknowledgment (ACK)**: After successful reception, the receiver sends an ACK to confirm. If no ACK is received, the sender assumes a collision occurred and retries.

The **Request-to-Send (RTS) and Clear-to-Send (CTS)** mechanism can optionally be used to reserve the channel, reducing collisions in environments with hidden nodes.

11. A Mobile IP system involves indirect routing. Explain the steps for delivering a packet from a correspondent to a mobile user.

Answer:

Packet Sent to Home Agent: The correspondent sends a packet to the mobile user's permanent IP address (home address).

Home Agent Intercepts: The home agent intercepts the packet and encapsulates it in a new packet.

Forwarding to Foreign Agent: The home agent sends the encapsulated packet to the mobile user's care-of address via the foreign agent in the visited network.

Delivery to Mobile User: The foreign agent decapsulates the packet and forwards it to the mobile user.

12. With regards to the optional reservation of RTS-CTS.
    a. Explanation of RTS-CTS Reservation in Wireless Communication

    RTS (Request to Send) and **CTS (Clear to Send)** are optional mechanisms in IEEE 802.11 wireless networks designed to prevent collisions during data transmission, particularly in scenarios where the **hidden terminal problem** occurs.

    b. How do RTS-CTS help in the hidden terminal problem and the collision avoidance?

    Hidden Terminal Problem:

    Occurs when two nodes (e.g., Node A and Node C) cannot hear each other but are communicating with the same Access Point (AP) or a third node (e.g., Node B). This can lead to collisions at the AP.

    RTS-CTS ensures that all nearby nodes are aware of the upcoming transmission, preventing collisions.

    Collision Avoidance:

    Reduces the likelihood of long data frames colliding by reserving the channel before the actual data transmission starts.

    c. **How RTS-CTS Works**

    RTS Transmission:

    The sender (e.g., Node A) senses the channel. If it's idle, the sender transmits a short **Request to Send (RTS)** frame to the receiver (e.g., Node B).

    The RTS frame includes:

    - Source address.
    - Destination address.
    - Duration of the intended transmission (including the data and acknowledgment frames).

    CTS Transmission:

    If the receiver (Node B) is ready to receive, it responds with a **Clear to Send (CTS)** frame.

    The CTS frame also specifies the duration of the transmission.

    Data Transmission:

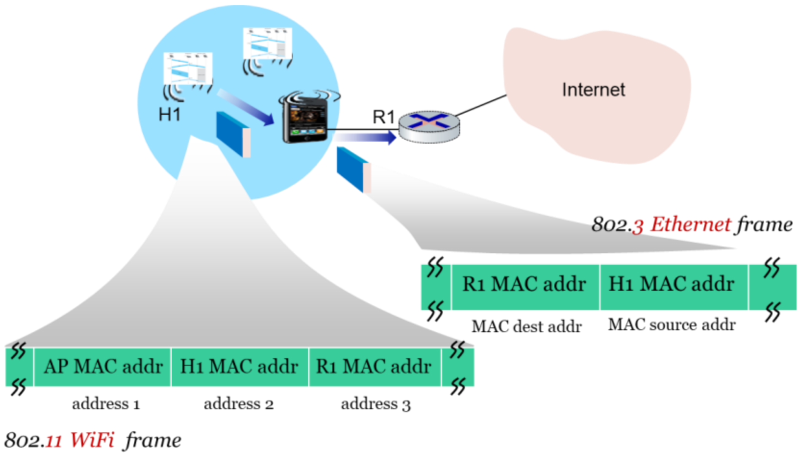
    Once the CTS frame is received, the sender (Node A) transmits the actual data.

    Channel Reservation:

    Neighbouring nodes that overhear the RTS or CTS frame defer their transmissions for the duration specified in these frames, ensuring no interference.

    ACK:

    After successful data transmission, the receiver sends an acknowledgment (ACK) frame.



13. In an 802.11 Wi-Fi network, the frame structure differs from the 802.3 Ethernet frame. Based on the figure above.
    a. Identify the purpose of each of the three addresses in the 802.11 Wi-Fi frame:
        i. **Address 1** (AP MAC Address)
        ii. **Address 2** (H1 MAC Address)
        iii. **Address 3** (R1 MAC Address)

Purpose of Each Address in the 802.11 Wi-Fi Frame

- **Address 1 (AP MAC Address)**:
    - This is the destination MAC address for the access point (AP). It identifies the immediate recipient of the frame within the wireless network.
- **Address 2 (H1 MAC Address)**:
    - This is the source MAC address of the wireless host (H1) that is transmitting the frame. It identifies the origin of the frame.
- **Address 3 (R1 MAC Address)**:
    - This is the MAC address of the router (R1) that is the next hop for the packet after it leaves the access point. It indicates the final destination within the local network.

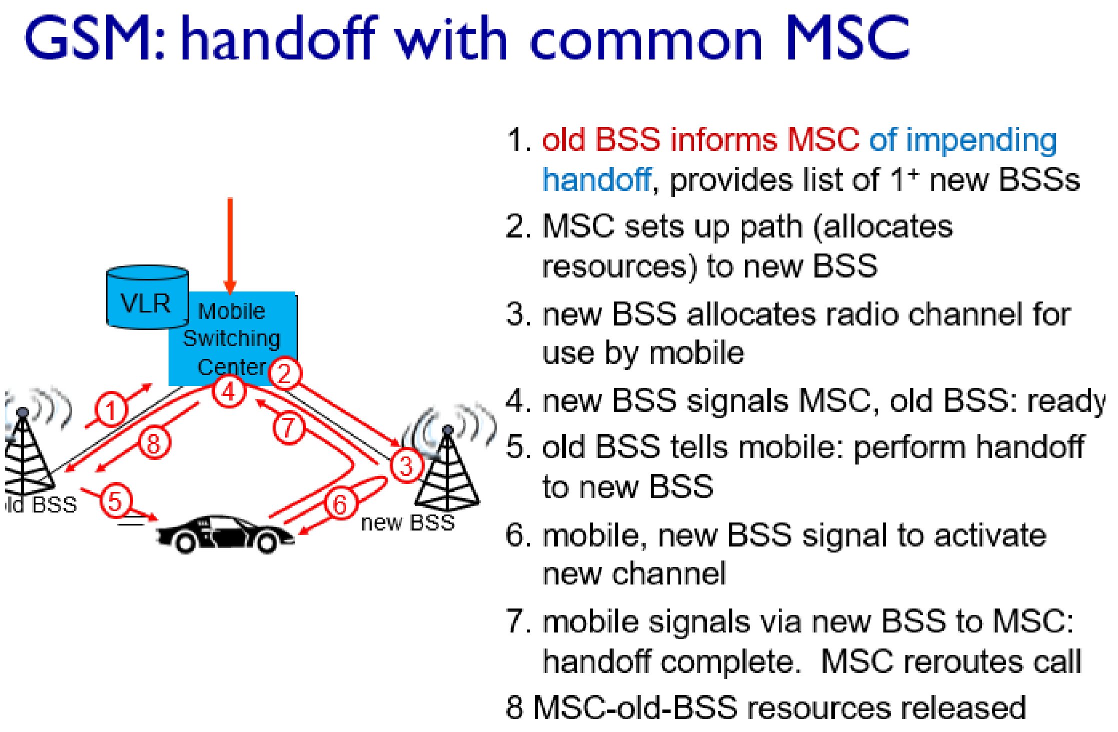
    b. Compare how the addressing works in 802.11 Wi-Fi frames versus 802.3 Ethernet frames. Why does the 802.11 Wi-Fi frame include three addresses, while the 802.3 Ethernet frame uses only two?

Comparison Between 802.11 Wi-Fi and 802.3 Ethernet Frames

- **802.11 Wi-Fi Frame**:
    - Includes three MAC addresses because the communication involves a wireless hop (H1 to AP) and a wired hop (AP to R1). The third address (R1 MAC address) ensures the packet can be forwarded correctly in the wired network.
- **802.3 Ethernet Frame**:

- Contains only two MAC addresses: source and destination. Since Ethernet operates in a wired environment, there's no need to include an intermediate address like the AP MAC address.

14. Explain the GSM handoff process with a common MSC.



In GSM, when a mobile device moves from one cell to another within the coverage area of the **same Mobile Switching Centre (MSC)**, the handoff process is relatively straightforward compared to inter-MSC handoffs. This is referred to as a **handoff with a common MSC**.

Steps in the Handoff Process with a Common MSC

1. **Signal Monitoring**:
   - The mobile device (user equipment) continuously measures the signal strength and quality of the serving cell and neighboring cells.
   - These measurements are reported back to the current Base Station (BSS) via uplink channels.
2. **Handoff Decision**:
   - The current Base Station Controller (BSC) or MSC decides to initiate the handoff when:
     - The signal strength from the current cell drops below a threshold.
     - A neighboring cell offers better signal quality.
     - Other factors such as interference or load balancing necessitate the handoff.

3. **Target Cell Resource Allocation**:
    - The BSC identifies the neighboring cell (under the same MSC) as the target for the handoff.
    - The BSC requests the target cell to allocate resources (e.g., a frequency channel or time slot) for the handoff.
4. **Mobile Device Notification**:
    - The BSC notifies the mobile device to prepare for the handoff and provides the details of the target cell (e.g., frequency and channel information).
5. **Handoff Execution**:
    - The mobile device switches from the frequency/channel of the current cell to that of the target cell.
    - The target cell establishes a connection with the mobile device.
6. **Handoff Completion**:
    - The BSC informs the MSC that the handoff is complete.
    - The MSC updates its routing information to ensure that the call or session continues through the new cell.
    - The resources allocated to the mobile device in the old cell are released.

15. Explain the handover between base stations in same cellular network.

Handover between base stations (BSs) in the same cellular network is the process of transferring an active connection of a mobile device (e.g., during a call or data session) from one base station (source BS) to another (target BS). This ensures seamless communication as the mobile device moves through the network. The steps are as follows:

Step-by-Step Process

1. Target BS Selection and Handover Request

- The **source BS** detects that the mobile device's signal strength is weakening due to movement.
- The source BS selects a **target BS** (usually the one with the strongest signal).
- The source BS sends a **Handover Request** message to the target BS, initiating the process.

2. Resource Allocation at Target BS

- The **target BS** pre-allocates the necessary resources (e.g., radio frequency channels or time slots) for the mobile device.
- The target BS responds with a **Handover Request Acknowledgment (HR ACK)**, confirming resource availability and providing the necessary parameters for the handover.

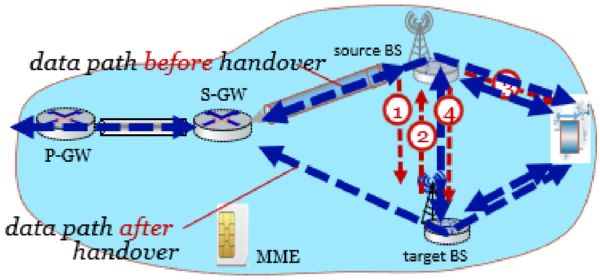
3. Mobile Device Handover

- The source BS informs the mobile device of the new target BS and the parameters required to connect to it.
- The mobile device switches to the target BS and establishes a connection.
- From the mobile's perspective, the handover appears seamless.

4. Data Path Update

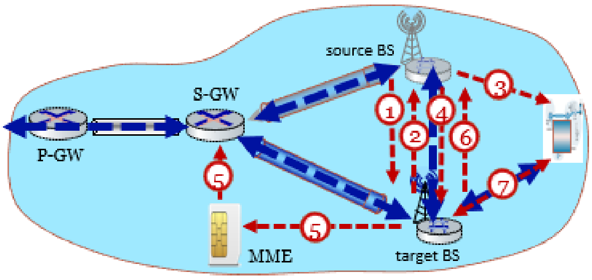
- The source BS stops sending data directly to the mobile device.
- Instead, it forwards any remaining data to the target BS, which delivers it to the mobile device.
- After the target BS successfully takes over, the source BS releases its resources for the mobile device.

Handover between BSs in same cellular network



1. current (source) BS selects target BS, sends *Handover Request message* to target BS
2. target BS pre-allocates radio time slots, responds with HR ACK with info for mobile
3. source BS informs mobile of new BS
   - mobile can now send via new BS - handover *looks* complete to mobile
4. source BS stops sending datagrams to mobile, instead forwards to new BS (who forwards to mobile over radio channel)

Handover between BSs in same cellular network



5 target BS informs MME that it is new BS for mobile

- MME instructs S-GW to change tunnel endpoint to be (new) target BS

6 target BS ACKs back to source BS: handover complete, source BS can release resources

7 mobile's datagrams now flow through new tunnel from target BS to S-GW