100 Wireless Midterm

1. Explain operations of FDMA, TDMA, CDMA, and OFDM. (2*4= 8%)

2. List characteristics of (a) ad hoc network (b) sensor network (5*2=10%)

3. (a) How do CSMA (2%), CSMA/CD (2%), CSMA/CA (2%) and CSMA/CA with RTS/CTS (6%) work? (12% total)

4. Compare Nonpersistent CSMA Protocol (4%), 1-persistent CSMA Protocol (4%) and p-persistent CSMA Protocol (6%) (14% total).

5. How do pure ALOHA and slotted ALOHA work? (8%) How does slotted ALOHA improve throughput as compared to pure ALOHA? (2%) (10% total)

6. (a) What is channel allocation? (4%) (b) Describe how three basic channel allocation schemes work. (name 1%, operation 2%) (total 13%)

7. Which cellular system in the following belongs to the first, the second and the third generation cellular system? (2% each, 10% total)
   PHS, IS-95, AMPS, GSM, UMTS.

8. Explain causes of three types of Propagation Mechanisms. (name 1%, cause 2% for each type, 9% total)

9. Explain the following terms: (a) Cell Splitting (b) path loss (c) Co-channel Interference (d) Frequency Reuse (e) delay spread (f) Inter-Symbol Interference (ISI) (g) Reuse Pattern (2*7=14%)

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1. Explain operations of FDMA, TDMA, CDMA, and OFDM. (2*4= 8%)

Ans:

FDMA: the allocated frequency band is divided into a number of subbands, called channels, and one channel is allocated by the BS to each user (2%)

TDMA: one channel is used by several users, with BS assigning time slots for different users, and each user is served in a round-robin method.

CDMA: one unique code is assigned by the BS to each user and distinct codes are used for different users.

OFDM: Orthogonal multicarrier modulation

2. List characteristics of (a) ad hoc network (b) sensor network (5*2=10%)

Ans:

(a)

- A autonomous system of mobile nodes connected by wireless links. (2%)
- Network topology dynamically changes in an unpredictable manner. (2%)
- No fixed infrastructure and information is forwarded in peer-to-peer mode using multihop routing. (2%)

(b)

- A large number of tiny immobile sensors are planted on an ad hoc basis and transmit some physical characteristics of the environment. (2%)
- An associated BS collects the information gathered by the sensors on a data-centric basis. (2%)

3. How do CSMA (2%), CSMA/CD (2%), CSMA/CA (2%) and CSMA/CA with RTS/CTS (6%) work?

Ans:

(a)

CSMA (Carrier Sense Multiple Access) (2%)

- Start transmission only if no transmission is ongoing

CSMA/CD (CSMA with Collision Detection) (2%)

- Stop ongoing transmission if a collision is detected

CSMA/CA (CSMA with Collision Avoidance) (2%)

- Wait a random time and try again when carrier is quiet. If still quiet, then transmit

CSMA/CA with RTS/CTS

- Transmitter sends an RTS (request to send) after medium has been idle for time interval more than DIFS (2%)
- Receiver responds with CTS (clear to send) after medium has been idle for SIFS (2%)
- Then Data is exchanged (2%)

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4. Compare Nonpersistent CSMA Protocol (4%), 1-persistent CSMA Protocol (4%) and p-persistent CSMA Protocol (6%).

Ans:

Nonpersistent CSMA Protocol

Step 1: If the medium is idle, transmit immediately (same as p=1) (2%)

Step 2: If the medium is busy, wait a random amount of time and repeat Step 1 (2%)

- Random backoff reduces probability of collisions
- Waste idle time if the backoff time is too long

1-persistent CSMA Protocol:

Step 1: If the medium is idle, transmit immediately (2%)

Step 2: If the medium is busy, continue to listen until medium becomes idle, and then transmit immediately (2%)

- There will always be a collision if two nodes want to retransmit

p-persistent CSMA Protocol:

Step 1: If the medium is idle, transmit with probability p (2%), and delay for worst case propagation delay by one packet with probability (1-p) (2%)

Step 2: If the medium is busy, continue to listen until medium becomes idle, then go to Step 1 (2%)

Step 3: If transmission is delayed by one time slot, continue with Step 1

- A good tradeoff between nonpersistent and 1-persistent CSMA

5. How do pure ALOHA and slotted ALOHA work? (8%) How does slotted ALOHA improve throughput as compared to pure ALOHA? (2%) (10% total)

Ans:

(a)

ALOHA

- Whenever a terminal (MS) has data, it transmits. (2%)
- Sender finds out whether transmission was successful or experienced a collision by listening to the broadcast from the destination station. (2%)
- If there is a collision, sender retransmits after some random time (2%)

Slotted ALOHA

- Time is slotted
- A packet can only be transmitted at the beginning of one slot. (2%)

(b)

In slotted ALOHA packets must be transmitted within a slot. If a terminal has a packet to send, it

waits until the beginning of the next slot. Hence, slotted ALOHA has no partial collision. Therefore, it can improve the throughput by reducing the contention period. (2%)

6. (a) What is channel allocation and its advantage? (4%) (b) Describe how three basic channel allocation schemes work. (name 1%, operation 2%) (total 13%)

Ans: (a) A given radio spectrum is to be divided into a set of disjointed channels that can be used simultaneously (2%) while minimizing interference in adjacent channel by allocating channels appropriately (2%)

(b) Fixed Channel Allocation (FCA): a set of channels is permanently allocated to each cell. (name 2%, operation 2%)

Dynamic Channel Allocation (DCA): all channels are kept in a central pool and are assigned dynamically to new calls as they arrive in the system. After each call is completed, the channel is returned to the central pool.

Hybrid Channel Allocation (HCA): the combination of both FCA and DCA techniques. The total number of channels available for service is divided into fixed and dynamic sets.

7. Which cellular system in the following belongs to the first, the second and the third generation cellular system? (2% each, 8% total)

PHS, IS-95, AMPS, GSM, UMTS.

Ans: 1G: AMPS;

2G: IS-95, GSM, PHS;

3G: UMTS

8. Explain causes of three types of Propagation Mechanisms. (name 1%, cause 2% for each type, 9% total)

Ans:

- Reflection: Propagation wave impinges on an object which is large as compared to wavelength
- Diffraction: Radio path between transmitter and receiver obstructed by surface with sharp irregular edges
- Scattering: Objects smaller than the wavelength of the propagation wave

9. Explain the following terms: (a) Cell Splitting (b) path loss (c) Co-channel Interference (d) Frequency Reuse (e) delay spread (f) Inter-Symbol Interference (ISI) (g) Reuse Pattern (2*7=14%)

Ans: (2% each)

(a) Splitting a cell into several smaller cells can cope with increased traffic.

(b) Path Loss: The signal strength decays exponentially with distance *d* between transmitter and

receiver;

(c) Interference for all the cells using the same channel though they are physically located apart.

(d) The same frequency band or channel used in a cell can be “reused” in another cell as long as the cells are far apart and the signal strengths do not interfere with each other.

(e) When a signal propagates from a transmitter to a receiver, signal suffers one or more reflections. This forces signal to follow different paths with different path length, so the time of arrival for each path is different. This effect which spreads out the signal is called “Delay Spread”.

(f) ISI is caused by time delayed multipath signals. It has impact on burst error rate of channel. Second multipath is delayed and is received during next symbol

(g) the cluster size or the number of cells per cluster for frequency reuse