Mobile Communication Networks

Revision questions II

1. What are the means to mitigate narrowband interference? What is the complexity of the different solutions?

2. What is DSSS? Why does DSSS is very robust to frequency selective fading?

3. What is FHSS and what are its main advantages? What is the equivalent of the spreading code of DSSS in FHSS?

4. What is slow and fast hopping in FHSS?

5. Is it possible to support multiple simultaneous communications with negligible interference using:
    a. DSSS? If yes, how?
    b. FHSS? If yes, how?

6. What are the main benefits of a spread spectrum system? How can the "spreading" be achieved? Is it needed a guard space or band (as in FDM or TDM)? Why?

7. Explain the term "orthogonality" in the design of spreading sequences without (or with limited) interference in CDMA systems?

8. What is intersymbol interference (ISI)? What causes intersymbol interference? Does it affect the transmission rate of a digital channel? How can you reduce intersymbol interference in the wireless communication system? Explain clearly.

9. What is orthogonality in the context of Multi-Carrier Modulation (MCM)? What are the main advantages of OFDM?

10. How does MCM tackle the problem of ISI?

11. A multi-carrier modulation (MCM) system (OFDM system), having an assigned bandwidth *B*, resorts to *N* subcarriers for an aggregate data transmission rate of *R*.
    a. What is the band occupied by each subcarrier?
    b. What is, the data rate in each subcarrier (considering no adaptive modulation)?
    c. What is, the bit duration in each subcarrier?
    d. What would be the bit duration in an equivalent single-carrier modulation system?
    e. What would be the data rate in an equivalent single-carrier modulation system?
    f. So, why is MCM so important to "modern" wireless communication systems (think about the consequences of multipath-propagation)?

12. What is the main physical reason for the failure of many MAC schemes known from wired networks? What is done in wireless networks to avoid this effect?

13. Assume all stations can hear all other stations. One station wants to transmit and senses the carrier idle. Why can a collision still occur after the start of transmission?

14. Consider the problem of hidden terminals. What happens in the case of such terminals if ALOHA, slotted ALOHA, CSMA, or CSMA/CA (with RTS/CTS) is used?

15. Can the CSMA/CA (with RTS/CTS) still fail in case of hidden terminals? Explain your answer.

16. What is the purpose of the contention window in CSMA/CA MAC schemes? What happens to it if its size is 8 time slots, and if a collision occurs?

17. How does CSMA/CA (DCF in IEEE 802.11) deals with variations in the number of users / offered load? How is fair share of the available bandwidth achieved?

18. Medium access schemes for the support of multiple users can be categorized as *centralized or distributed* and as *reservation based or random access* based. How do you classify the ones typically used in: (1) cellular networks; (2) WLANs IEEE802.11. Why?

19. What are (1) the benefits of MAC reservation schemes compared to MAC random access schemes, and (2) the benefits random access schemes over reservation schemes? (Consider access delay, bandwidth guarantees, efficiency in the use of the communication channel, and the number of users.)

20. What is the definition of *Spectral Efficiency*? For the same transmission bandwidth and symbol rate, which of the following digital bandwidths is more spectral efficient, ASK or 16-QAM? By which amount?

21. In a wireless system using FEC with a coding rate of ¾, how many bits in a received packet with total of 1000 bits are data bits? How many bits were devoted to error detection and correction?

22. Consult the Wikipedia link of the standard IEEE 802.11ac (in particular, check the table *Data rates and speed*). Quantify the impact in the theoretical throughput for single spatial stream caused by:
    a. the *Modulation type*;
    b. The *coding rate* (what represents the *coding rate*?).
    c. The *channel bandwidth* (how is it related to the Shannon capacity limit).
    d. The *guard interval* (what is its purpose?).

23. What is MIMO? Explain the main four distinct ways it can be beneficial no wireless communications.

24. With a MIMO configuration of 4x3, what is maximum number of spatial streams that is possible between a sender and a receiver?

25. What is the maximum number of parallel streams that is possible to have in a MIMO system with 2x3 antenna configuration?

26. Consider a transmission of a binary sequence, with data rate Rb = 10Kbps using a 32QAM modulation scheme and a coding rate of 1/2.
    a. If we change the modulation scheme from 32QAM to 64QAM, what will be the new data rate?
    b. What will be the new data rate if, besides changing the coding scheme from 32QAM to 64QAM, we also change the coding rate from ½ to ¾ ?

27. What are simplex, half-duplex, and full-duplex data transmissions?

28. Considering duplex channels, what are alternatives for implementation in wireless networks?

29. How many channels are available with the European spectral allocation for GSM.

30. Name and explain four types of multiple access techniques. Which of these techniques is considered to have some degree of inherent security? Why?

31. Explain the term interference in the space, time, frequency, and code domain. What are countermeasures for interference in SDMA, TDMA, FDMA, OFDMA, and CDMA systems?

32. What are the main benefits of a spread spectrum system? How can the "spreading" be achieved? Is it needed a guard space or band (as in FDM or TDM)? Why?

33. What is the purpose of power control in CDMA systems?

34. Why do cells in CDMA systems shrink when the number of active users increases?

35. Explain why CDMA offers universal reuse of channels (each channel can be used in all cells).

36. Compare TDMA and CDMA schemes, identifying the advantages of each scheme over the other.

37. What are the main reasons for using cellular systems? How is SDM typically realized and combined with FDM? (How does DCA influence the frequencies available in other cells?)

38. Why do cellular systems typically resort to slotted ALOHA protocol for initial connection setup?

39. How does a GSM system supports simultaneous transmissions of multiple users to/from a base station? Which scheme is used for uplink/downlink separation?

40. Can collisions occur while accessing a GSM system? Support your answer.

41. Name the main elements of the GSM system architecture and describe their functions. What are the advantages of specifying not only the radio interface but also all internal interfaces of the GSM system?

42. How did the GSM architecture evolve to support data services? Which new network elements were introduced? Describe their functions.

43. Why are so many different identifiers/addresses (e.g., MSISDN, MSRN, TMSI, IMSI, IMEI, LAI, CI) needed in GSM? Give reasons, describe their use, and distinguish between user-related and system-related identifiers.

44. How does a GSM network keep track of the location of moving users (without ongoing calls)?

45. Describe the functions of the Mobile Station (MS) and SIM. Why does GSM separate the MS and SIM? How and where is user-related data represented/stored in the GSM system? How is user data protected from unauthorized access, especially over the air interface?

46. What signaling information is exchanged between the network elements for establishing a mobile **terminated** call in a GSM network? (draw a diagram with the signaling steps, and the identifiers used in these signaling steps.)

47. What are the main architectural differences between the GSM/GPRS, the UMTS (WCDMA) network, and the LTE network?

48. How does an UMTS (WCDMA) system supports simultaneous transmissions of multiple users to/from a base station? Which schemes may be used for uplink/downlink separation? Which one is typically used?

49. What are the main differences between the GSM, UMTS, and LTE radio network and radio technology?

50. What does “cell breathing” mean, and what causes “cell breathing”? In which cellular systems can we find the “cell breathing” phenomenon?