

Wireless Communications and Mobile Internet

Midterm Exam

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Ch1.

1. The earliest human wireless communication was in the pre-industry period. Communication as a telecommunication exists from 1830s. In 1997, the first version of WLAN was released.
2. a. cellular system b. mobile management c. mobile IP d. Wi-Fi e. WiMAX f. self-organizing network g. Wireless network security h. wireless personal LAN i. sensor network j. internet of things k. software defined network

Ch2.

1. Compared with wired media, wireless media is instable, has lower bandwidth and has non-both link with broadcast characteristics.
2. The licensed band has a specific use and cannot be used for other purposes.
3. a. terrain b. operation frequency c. speed of the mobile terminal
4. reflection: When the obstacle size is greater than the wavelength of the electromagnetic wave, reflection occurs.
diffraction: When the propagation path between the transmitter and the receiver is blocked by a sharp edge, diffraction occurs.
scattering: When the object size is electromagnetic wavelength or less order of magnitude and number of obstacles is huge, scattering occurs.
5. reflection: It occurs on the surface of the Earth and the construction, it's not the main mechanism outdoors and is strong in indoors.
Diffraction: It's weaker than reflection in indoor environment.
Scattering: It occurs at rough surface and exist both in indoor environment and outdoor environment.
6. $L_p = \frac{P_r}{P_t} = G_t G_r \left(\frac{h}{4\pi d} \right)^2$ where G is the antenna gain, h is height, d is distance and P is power.
7. In free space model: $L_p[dB] = 32.44 + 20 \lg f_c [MHz] + 20 \lg d [km]$
In two-ray model: $10 \lg P_r = 10 \lg P_t - 10 \lg d [m]$, $P_r = P_t d^{-4}$
8. The change in signal strength due to the change in position and called shadow fading. Its effect varies slowly with distance and is a long-term change at average level.
9. If the channel is distributed: $P(r) = \frac{1}{r} \exp\left(-\frac{2\alpha}{r}\right)$
For a fade margin of 20dB at given R , the error function equals zero, result in 5% outage probability.
10. $L_{p(d)} = \begin{cases} A + B \lg d & \text{in city} \\ A + B \lg d - C & \text{in suburban} \\ A + B \lg d - D & \text{in open environment} \end{cases}$ where $A = 69.55 + 26.14 \lg f_c$
 $B = 44.9 - 6.55 \lg f_c$
 $C = 5.4 + 2 \lg f_c + 0.7 \lg f_c$
 $D = 40.94 + 4.78 \lg f_c$
 $f_c = 18.33 \lg f_c$
11. multipath fading: Radio waves through the different distance of each path, resulting in a number of different phase of the signal at the receiving antenna at the superposition of the signal amplitude in a relatively short period of time changes which results in fading.
- Doppler shift and spectrum: The wave length of the objects radiation changes due to the relative movement of the wave source and the observer, causing the wave to be compressed, the wavelength becomes shorter and the frequency becomes higher.
12. If no channel is in a dominant position, Rayleigh distribution describes multipath phenomenon, otherwise, Ricean distribution describes multipath phenomenon.
13. $v(f) = \frac{v}{c} \cos(\delta(f))$, The Doppler shift is related to speed, angle and frequency.
14. For Rayleigh distribution: $f(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{\sigma^2}\right)$ r20.

For Ricean distribution: $f(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2 + \mu^2}{\sigma^2}\right) I_0\left(\frac{\mu r}{\sigma^2}\right)$ r20, r21

Ch3.

15. Average fade duration is $AFD = \frac{e^{\gamma} - 1}{\gamma}$
The level cross rate is $AFD \times LCR = 1 - e^{-\gamma}$ r20, r21
1. 2G system is based on TDMA and 3G system is based on CDMA
3G has simpler frequency planning, larger system capacity, greater frequency multiplexing factor, better anti-multipath capability and better communication quality.
2. The cellular system uses a transmitter with low power to make good use of available frequency band in a relatively small area with small cell radius. The capacity $C = MN = MK$ where K is the number of channels.
3. $\frac{1}{K} = \frac{1}{\pi} \frac{D^2}{R^2} = \frac{1}{\pi} \frac{R^2}{(D\sqrt{3})^2}$ and in the worst case, $\frac{1}{K} = \frac{1}{\pi} \frac{R^2}{(D\sqrt{3})^2}$ where $D = \sqrt{3}R$
4. Base station: a transceiver connecting a number of other devices to one another or to a wider area.
uplink: A transmission link from a scatter point to a centralized point.
downlink: A transmission link from a centralized point to a scatter point.
location area: mobile host is distributed to a local network and identified by local address.
mobile switch center: MSC processes the mobile switched signal in its control area and update the location of a mobile user.
VLR supports roaming functions for users outside the coverage area of their own HLR.
HLR is a mobile operator database. The data is accessible by all mobile switch centers and VLR.
6. handoff management: distribute the signal to the new channel.
location management: follow the mobile device and localize the device.
7. The difference between 3G and 2G is the speed of transmission of sound and data. Meanwhile, 3G has simpler frequency planning, larger system capacity and greater frequency multiplexing factor.
8. TDMA divide time into non-overlapping period and then split the frame into non-overlapping time slot so that user can have a one-to-one relationship to template the multiple access.
The principle of CDMA is based on spread spectrum technology which improves the frequency band efficiency compared to TDMA.
9. GSM supports GPRS and UMTS. It keeps track of the location of an individual MS/UE.
GSM and GPRS later for GTP-C message on UDP port 2123.
10. CDMA 2000 WCDMA TD-SCDMA
11. (1) achieving global roaming
(2) enabling high-speed data transmission and broadband multimedia service
12. For 3G system the transmission rate is 1.28Mbps
bandwidth: 1.6MHz operation frequency: 1880-1900MHz
2010-2025MHz, 2300-2400MHz
13. Types of channel access schemes: FDMA, TDMA, CDMA, SSMA, SDMA, PDMA
channel access methods: circuit mode and channelization methods
packet mode methods: duplexing method
Applications: The GSM cellular system combines FDMA and TDMA.
GSM with the GPRS packet switch service combines FDMA and TDMA.
Bluetooth combined frequency hopping with CSMA/CA.
14. One architecture is called IS-136, it's based on the combination of TDMA and GPRS models appropriate for low-bandwidth cellular networks with significant resource management capability.

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Chs.

1. mobile cloud computing, mobile web pages and pervasive computing

Chb.
1. MSC allocate the voice signal to new base station channel.
The mobile station identifies the new base station and measures the signal strength.

2. Intra handoff: MSC find that the signal of mobile station is weak and find a new neighborhood with a stronger signal strength.
Inter handoff: MSC can not find a station which can make the signal strength stronger so inter handoff is needed.

3. MCHO: MS continuously supervise the connected base station and candidate base station and MS choose the best.

NCHO: base station first test the parameter of MS and reports it to MSC, the decision is made by MSC

MAHO: Signal strength and BER is tested, the parameter is evaluated by base station and MSC.

4. hard handoff: At the same time, the mobile station occupies only one channel. However transmission interruption may occur.

soft handoff: avoid transmission interruption. However, it occupies a lot of channel resources.

5. The main concern in the design of a feedback-based algorithm is to optimize the size of the profile that the mobile will be send to the MSC.

6. A fluid flow model can be viewed as a large tank, assumed to be of infinite capacity. And straight line model is of finite capacity.

7. For the vertical handoff between UMTS and WLAN, there are two main interworking architecture: tight coupling and loose coupling.

8. Intra-switch handoff occurs when an MT moves from an AP connected to an MS to another AP connected to the same MS. Intra-switch handoff only requires one new VC.

Inter-switch handoff involves more VC to be setup.

9. handoff rate is: $\frac{1}{\tau} \sum_{i=1}^n \frac{1}{\tau_i} \text{Var}(t_i) \text{Var}(t_i - t_{i-1})$

10. The handoff rate depends only on the length of the boundary per unit area. $H = a(x_{\text{cross}} + y_{\text{cross}}) + b(x_{\text{cross}} + y_{\text{cross}})$

11. Two-tier network architecture displays information related to such sources as browsing merchandise. It communicates with other tiers by which it puts out the results to the browser tier and all other tiers in the network. It's a layer which users can access directly. It contains presentation tier and data tier.

12. When mobile device is in different variety areas, it reports to the cellular network and will detect the code of the current variety area. Once, different, it will send location update request to cellular network.

13. Time-based: easy to accomplish, but can not update location information immediately.

Movement-based: occupied a lot of resources but can immediately update the information.

Distance-based: error may occur.

Key.

Chc.
1. When the computer switch from one network to another, it needs to re-configure the IP address, which is inconvenient, so it may want to a permanent IP address.

2. MN: nodes whose position will frequently change.

HA: A node on the home link of the mobile node which protects the location info of the node.

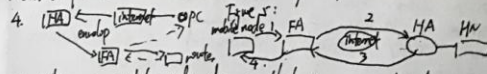
FA: A router on the local link where the mobile node is located.

CoA: An IP address associated with the mobile when the mobile.

nodes switches to foreign link.

Co: A communication object of a mobile node.

3. The sending router will encapsulate the protocol packets to be transmit and after the network transmission, the receiving router decapsulates the received packets and take out the original protocol.



5. When a mobile node discovers that its current network access point switches from one link to another, it's necessary to register.

6. If lifetime is not limited, it's hard to make the decision when to take back to bond.

7. Agent advertisement is monitored by the mobile node at all times to determine whether they are running out of the home network.

8. After the register request, the home agent will create a mobile bond for the mobile node and bind the mobile node's home address with current CoA.

9. Registration can be rejected by home agent or foreign agent.

10. IP in IP encapsulation was defined by RFC 2003, IP data packet is encapsulation directly. Head information remain unchanged.

Minimum encapsulation was defined by RFC 2004, new IP header is inserted between IP header and IP body.

QoS was defined by RFC 1701.

The choice among the encapsulations depends on the routing method.

11. Reverse tunnel is a tunnel that is made by the mobile node to its home agent, starting at the case of address of the mobile node and terminating in the home agent.

12. The establishment of a reverse tunnel allows the mobile node located on the foreign network to establish a topology-oriented packet. In this situation, it's the only way.

13. don't know

Chc.

1. DCF: Distributed Coordination Function SIFS: Short Inter-frame Space.

PCF: Point coordination Function PIFS: PCF Inter-frame Space.

DIFS: DCF Inter-frame Space.

3. 802.11e defines the quality of services for wireless LANs such as voice IP support. The 802.11e defines HCF, HCF replaces PCF and PCF is intended to provide improved access bandwidth and reduce latency.

4. Infrastructure mode requires at least one wireless access point, AP and all location wireless clients must be configured to use the same network.

Ad hoc mode do not need the use of a central device.

5. Infrastructure mode: base station acts as a wireless AP hub. Wireless AP can provide service to their client nodes within range.

Ad hoc: P2P wireless device directly communicate with each other.

6. The Data link layer and Physical layer.

7. The LLC sublayer is responsible for providing services to its upper tier. The main function of the MAC sublayer include encapsulation of data frames, addressing and identification of frames reception and transmission of frames.

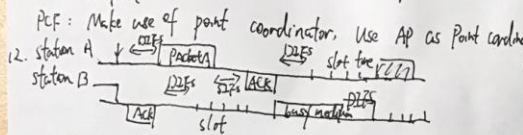
PLCP: when PLCP layer receive the PDU, adds a preamble to it and form PPDC.

PMO: modulate PPDC into a series of 0/1 bit.

8. Infrared: 1. adv: simple, cheap, no license needed. 2. disadvantage: interference by sunlight, heat source 3. use 27 GHz infrared light.

- 1. Adv: coverage of large area
- 2. disadvantage: very limited license free frequency bands
- 3. Use license free 2.4 GHz band at 2.4 GHz

- 9. Physical Layer convergence Procedure and Physical Medium Dependent network device along a path behaves in a certain way in which a specific group of packets have the same priority value.
- 11. PCF: It's a CA-based access, as far as possible to avoid conflict.



- 13. Unicast is the most common way on the Internet which is a one-to-one method.
- 14. Multicast is a one-to-group method.

- 15. Both the sender and the receiver should sleep after they heard RTS or CTS. Each node maintains the NAV to indicate the activity in its neighborhood.

- 16. Dos offer improved services to the end user. It allows for better use of existing network. Thus it is supported in infrastructure but not in Ad-hoc.

- 17. A Timing synchronization Function keeps the time for all stations in the same BSS synchronization.

- 18. Timing synchronization is achieved by stations periodically exchanging time information through beacon frames. In infra-BSS, the AP sends the TSF info in the beacons. In ad-hoc each station competes to send beacon.

- 19. A beacon is used to fulfill timing synchronization among users. Beacon and the sync field in PCP preamble have different functions.

- 20. Yes. However it does not work as well as syn in infrastructure. The convergence time of synchronization is too long and out of synchronization still may occur.

- 21. Most of the WLAN client are portable systems and powered (and).

- 22. Power management for 802.11 stations is defined in Clause 17.2 of the 802.11. It is involved through the MAC layer management entity, MLME, request service primitive. For infrastructure, Power save mode is available for nodes. It is based on a synchronous sleep scheduling policy. For ad-hoc, back bone based protocols such as SPAW are used.

- 23. ATIM is a management frame with no frame body. When STA receives ATIM, that formerly dozing station must begin the process of retrieving buffered frame.

- 24. DTIM beacon is identical in structure to the ordinary beacon.

- 25. 802.11 r was lunch to attempt to undo the added burden that security and quality of service added to the half-duplex.

- 26. Large packet are more susceptible to corruption by radio interference than smaller ones. Fragmentation can reduce network performance in condition of heavy interference.

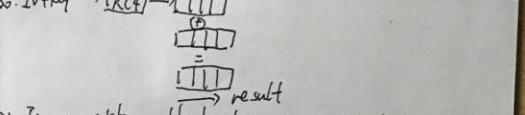
- 27. Control field indicates whether the mesh STA will

- be in light sleep mode or in deep sleep mode.
- 28. The four address field are used to indicate the BSSID, SA, DA and transmitting STA address and receiving STA address.

- 29. 802.11 a is an amendment to 802.11. It's different from 802.11 b in physical layer. The data transmission of 802.11 a is much faster than 802.11 b.

- 30. The goal of WEP is to make wireless network as secure as wired network.

- 31. WEP relies on a secret key K shared between the communicating parties for the security of the transmitted frame. Standard 64-bit WEP uses a 40 bit key.



- 33. In open system authentication, the WLAN client need not provide its credentials to the AP. Any client can authenticate with the AP and then attempt to associate.

- 34. During an active scan, client radio transmits a probe request and listens for a probe response from an AP.

- 35. During passive scan, the client radio listens on each channel for beacons sent periodically by an AP.

- 36. The fast DSS design change implemented as part of the 802.11 e amendment a WMM certification, User Priorities Access Categories and Queuing structures.

- 37. The throughput for pure ALOHA is $S = G \times e^{-2G}$, $S_{max} = 0.184$ when $G = \frac{1}{2}$. The throughput for slotted ALOHA is $S = 2G \times e^{-2G}$, $S_{max} = 0.368$ when $G = 1$.

- 38. WiMAX is based on a very flexible and robust air interface defined by IEEE 802.16. It has the characteristics of mobile broadband and 2G.

- 39. The original version of the standard on which WiMAX is based specified a physical layer in the 10 to 66 GHz which is updated and added specifications for 2 to 11 GHz range.

- 40. The 802.16 standard defines the physical layer of the duplex mode, frame length, modulation and coding technology.

- 41. Under OFDM: subcarriers are selected such that they are all orthogonal to one another over the symbol duration. It support BPSK, QPSK, 16QAM and 64QAM.

- 42. Infrastructure networks such as mobile cellular network need fundamental facilities so that they cannot be used under any situations. Ad-hoc network can quickly set up a temporary network.

- 43. Under protocol, interference model, the networking nodes are typically assumed to lie in a planar region, each node is associated with a circular communication range.

- 44. An exclusion region is a region around each receiver such that no interferer exist inside this region.

- 45. For single-sink undirected network, we show on matching upper and lower bound of 2 on the best-possible PPA. For multi-connectivity networks,

5. A Hidden Terminal is a node that is outside the coverage of the sending node and within the coverage of the receiving node. An exposed terminal is the opposite.

Ch11.

1. (1) request the work station to send the authentication frame.
- (2) AP returns a validation frame.
- (3) Request the work station to get the question text and encrypt with the WEP algorithm.
- (4) AP decrypt with shared key.

2. (1) Applicant sent EAPOL start frame to certifier.

(2) Certifier request applicant to provide id. info.

(3) applicant provide id. info.

(4) certifier envelop the info. to RADIUS Access Request frame.

(5) RADIUS test the validation of applicant.

3. WEP fails to against monitor attack.

802.11x: easy to complete flexible, low cost, reliable

WPA2: Make up for the disadvantage of 802.11 and WEP.

Ch12.

1. Increase the transmission distance to 60m and lower the power consumption by 90%.

2. Connection state and stand-by state

3. Reader: responsible for 2-way communication with electronic tags receive the control order from the host.

Electronic tag: communicate with reader.

4. chip technology Antenna design technology packaging technology tag application technology

5. Traffic field, Logistics field retail field.

Ch13.

1. Infrastructure

Station

Mobile

Base

Station

Mobile

Base

Station

Mobile

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Ch14

1. (1) Ultra Wideband wireless communication technology.

(2) Radio Frequency Identification

(3) Low power Bluetooth wireless technology.

2. Good security, processing gain, multi-path resolution, high transmission rate, strong anti-interference, low power consumption, low cost.

3. Low energy Bluetooth use independent Bluetooth low energy protocol which lower power consumption.

4. A cognitive radio is a radio that can change its design parameters by interacting with its operating environment.

5. Use human body as the center and take the human body into a part of the network.

Application: medical care
wireless access system
CPS
military

Ch15

1. SDN is a programmable network architecture that implements the separation of the control plane from the forwarding plane.

2. SDN: A new network architecture using the OpenFlow protocol the control plane of the router is separated from the data plane and implemented in software.

3. Open Computer Project protocol obsolesces forwarding.

4. Through SDN, network protocol can be completed more easily. The network equipment will be reduced greatly.

Ch 16, 17, 18

1. 25 motor 2 monitor, 520P 1 Instantial navigation

4 microphone sonar range finder Wi-Fi support.

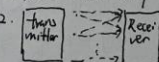
2. Leap-Tag Path design

Real-Time Indoor Mapping

Fully distributed scalable smoothing and mapping

Ch19.

1. MIMO has multiple antenna between transmitter and receiver while SISO only has one.



3. Space-diversity is used to lessen the transmission time and space-multiplexing is used to decrease the error bit rate in transmission.

4. Distribut MIMO Multiple user MIMO

Virtual MIMO

Virtual MIMO: because of the fact that user cannot have multiple antenna, virtual MIMO consider multiple user with single antenna as a whole block which has many antenna.

Ch21, 22.

1. The process of transaction protect the privacy of user, however, there exist SISO attack and double spending attack.

2. QR code:

structure link
mask
extended explanation