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Chapter 1

1. ① Faraday discovered Electromagnetic induction in 1831 ② Morse invented Telegraph in 1837 ③ Maxwell put forward Electromagnetic Field Theory in 1873. ④ Bell invented phone in 1876 ⑤ Tesla conducted a successful short wave wireless communication experiment in 1894 ⑥ Marconi invented radio in 1895 ⑦ Fessenden successful used AM technology to transmit the first long-distance music and oral radio programmes. ⑧ Both sides of the Atlantic had their first television broadcast at the same time in 1927. ⑨ The first public mobile phone system was established in five cities in the United States in 1946. ⑩ The communication satellite SCORE launched in 1958 ⑪ The first analog cellular system NMT was established in 1981. ⑫ The first digital cellular system—GSM was established in Europe in 1988 ⑬ The first version of the wireless network was released in 1997.

2. ① cellular system ② mobility management ③ mobile IP ④ Wi-Fi ⑤ WiMAX ⑥ ad hoc network ⑦ security of wireless networks. ⑧ Bluetooth and RFID ⑨ Wireless sensor network. ⑩ Internet of things. ⑪ Software defined network.

Chapter 2

1. Wired: transmission line, fibre-optical, optical cable.
   Wireless: transmitting through air, relatively unstable, low bandwidth.
2. licensed: 1GHz cellular system, 2GHz-PCS, WLAN, 28~60GHz LMDS, IR
   unlicensed: U-NII, unlicensed band of PCS released in 1994
3. medium, frequency, distance.
4. ① When the size of the obstacle is larger than the wavelength of the electromagnetic wave, the reflection occurs.
   ② When the propagation path between the transmitter and the receiver is blocked by the sharp edge, the diffraction occurs
   ③ When the size of an object is an order of magnitude or less than the wavelength of the electromagnetic wave, and the number of such obstacles in the unit volume is very large, scattering occurs.
5. ① indoors: scattering, reflection, diffraction
   ② outdoors: ground reflection, building reflection, roof diffraction.
6. $L_p = \frac{P_t}{P_r}$
   $\frac{P_r}{P_t} = G_t G_r \frac{h_t^2 h_r^2}{d^4}$
7. free: ① $P_r = \frac{P_t}{4\pi r^2} = \frac{G_t G_r \lambda^2 P_t}{L}$
   ② $r = D/2 = 2d$ m
   ③ $L_p = \frac{P_t}{P_r}$ $L_p[dB] = 32.45 + 20\lg f_c[MHz] + 20\lg d[km]$
   two-ray: ① $\frac{P_r}{P_t} = G_t G_r \frac{h_t^2 h_r^2}{d^4}$
   ② $P_r = P_t \cdot d^{-\alpha}$
   ③ $10\lg P_r = 10\lg P_t - 10\alpha \lg(d)$
8. In the mobile communication environment, the received signal intensity is different from the same distance from the same distance from the transmitter, and the change of signal intensity due to the change of position is called fading or slow fading. $L_p = L_0 + 10\alpha \lg D + X$
9. $L_p(d) = \begin{cases} A + B\lg d & \text{Urban environment} \quad A = 69.55 + 26.16\lg f_c - 13.82\lg h_b - a(h_m) \\ A + B\lg d - C & \text{suburban environment} \quad B = 44.9 - 6.55\lg h_b \\ A + B\lg d - D & \text{open environment} \quad C = 5.4 + 2[\lg(f_c/28)]^2 \end{cases}$
   $D = 40.94 + 4.78(\lg f_c)^2 - 18.33\lg f_c$
   small/middle city: $a(h_m) = (1.1\lg f_c - 0.7)h_m - (1.56\lg f_c - 0.8)$
   large city: $a(h_m) = \begin{cases} 8.29[\lg(1.54h_m)]^2 - 1.1 & f_c \le 200\text{MHz} \\ 3.2[\lg(1.75h_m)]^2 - 4.97 & f_c \ge 200\text{MHz} \end{cases}$
10. $L_p(d) = \begin{cases} A + B\lg d & \text{Urban} \\ A + B\lg d - C & \text{suburban} \\ A + B\lg d - D & \text{open} \end{cases}$
11. ① Multipath fading: the superposition of signals arriving at different paths
    ② Doppler, caused by the mobility of the terminal toward or away from the base station transmitter.
12. ① Rayleigh: no direct wave path between the transmitter and receiver without a dominant channel, there are a large number of reflection wave, arrive at the receiver an terna direction angle randomly. $0 \sim 2\pi$, independent. $f_{ray}(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right)$, $r \ge 0$.
    ② Ricean, strong signal component in the horizon. $0 \sim 2\pi$.
    $f_{ric}(r) = \frac{r}{\sigma^2} \exp\left(\frac{-(r^2+a^2)}{2\sigma^2}\right) I_0\left(\frac{ar}{\sigma^2}\right)$, $r \ge 0$, $a \ge 0$.
13. Doppler. The wavelength of an object's radiation varies with the relative motion of the source and the observer.
    $v(t) = \frac{vf}{c}\cos\theta(t)$
14. $f_{ray}(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right)$, $r \ge 0$.
    $f_{ric}(r) = \frac{r}{\sigma^2} \exp\left(\frac{-(r^2+a^2)}{2\sigma^2}\right) I_0\left(\frac{ar}{\sigma^2}\right)$, $r \ge 0$, $a \ge 0$.
15. $f(x) = \frac{2m^m x^{2m-1}}{\Gamma(m)\Omega^m} \exp\left[\frac{-mx^2}{\Omega}\right]$

Chapter 3 and 4

1. ① 1940: conception of Spectrum ② 1985: CDMA ③ 1995: 1G.
   ④ 1996-1997: 2G. ⑤ 2008, May: 3rd generation mobile communication standard: TD-SCDMA, WCDMA, CDMA2000.
2. $S/I = (D/R)^k / N_I = \frac{q^k}{N_I} = \frac{(\sqrt{3N})^k}{N_I}$
3. $S/I = (D/R)^k / N_I = \frac{q^k}{N_I} = \frac{(\sqrt{3N})^k}{N_I}$ ① uplink: link to the satellite from the ground station
4. ① Basic station: sharing mobile communication stations. ② down link: from satellite down link to one or more ground stations.
   ③ cellular network: using multiple low power radio block covering the entire service area. ④ service area: work area can be covered by radio
   ⑤ MSC: mobile switch center that is to provide call conversion service and control between local telephone and data systems.
5. ① HLR: responsible for the management of mobile users database.
   ② VLR: stores info. that is needed to retrieve the incoming and outgoing calls and info. about user's signing and additional services.
6. handoff: base station change, new base station identification, channel allocation.
   location: home agent, field agent, authentication
7. The speed-up of the transmission of voice and data.
8. GPRS core network. pipeline protocol. maintain the connection
9. TD-SCDMA, WCDMA, CDMA2000
10. The realization of global roaming, high speed data transmission, board band multimedia services. mobile phone business, video calls, mobile TV, wireless search
11. 200 kbits/s. 13. board band Internet access

14. 5th cellular network is a normalization mechanism for all-IP wireless networks.

Chapter 5

1. mobile cloud computing, mobile web, mobile Internet initiative

Chapter 6

1. ① signal change higher than a certain threshold, the switching process open. ② The mobile station identifies a new base station ③ a new connection is established between the mobile station and the base station.

2. ① inter: To avoid the hand off of the call interrupt if a mobile device moves from a cellular system to another controlled by a different MTSO.
② intra: switching made for use in a mobile device adjacent to a cellular system using the same MTSO control.

8. ① intra: a mobile signal of MOTSO finds other cell than uses intra cys handoff.
② MTSO cannot find. ···

10. Cell ↓, handoff rate ↑

12. mobile unit boots / shuts down → cellular network ask it to report location in a certain interval.

3. MCHO: mobile station monitor signal strength and select the best way. NCHO: network monitoring signal strength and oper switch. MAHO: mobile station monitoring signal strength. network switch on.

4. ① hard: adv: use only one channel at a time
dis: the ping-ponging effect. ② soft: adv: reduce the outage probability of the signal connected to the target cell.
dis: the phone side requires complex hardware conditions.

5. Monitoring signal intensity change of base station unit and mobile unit, Once the change exceeds the threshold, the switch is executed

6. straight-line model: the behavior of define users linear fluid-flow, water level of a reservoir in a random the period is needed

Chapter 7

1. Once the user's position has changed, then a new add but mostly through the TCP network data transmission, Changing the IP add will lead to a new connection. Besides, the user will be assigned a foreign add to replace the local add, then the use of a foreign add will make it difficult for users to access the local network.

2. ① The MN: location frequently changes. often from one link to another
② HA: mobile node home link on a router, sending data packets.
③ FA: A router on a foreign link whose mobile node is on.
④ COA: an IP add associated with the node when the mobile node switches to a foreign link.
⑤ CN: a mobile node communication object.

3. MH → FA tunnels packets to HA by encapsulation.
HA packet → receiver.

4. MN — FA ⇌ HA
IP Network — CN

5. ① mobile node sends a request to begin ② The foreign agent processes the request and relays it to the home agent ③ HA replies ④ FA processes the reply and relays it to MN.

5. By having a limited life time, the home agent of the registration can create or modify a mobility binding for that mobile agent

9. If a foreign or home agent X support reverse tunnels which receive a request with the 'T' bit set, it fails

10. ① IP in IP: the entire IP packet is encapsulated directly to the new IP.
② minimum encapsulation: new IP head is inserted between the original IP head and the original IP load.

Chapter 8

1. ① PCF is a media access control technique used in IEEE 802.11 based WLANs.
② DCF is the fundamental MAC tec of the IEEE 802.11 based WLAN standard.

2. DIFS is acronym for DCF Interframe spacing.

3. ① EDCA, high-priority traffic has a higher chance of being sent than low-priority traffic.
② HCF, the hybrid coordination function. With HCF, there are 2 methods of channel access. HCCA. EDCA.

4. ① ad: no base stations; nodes only transmit within link coverage; nodes org themselves into a network.
② infrastructure: base station connects mobiles into wired network; mobile chges base station providing connection into wired network.

5. ① ad: allows each other to communicate, but only within ad-hoc devices.
② Infrastructure: requires the use of an Access Point. faster data transmission speeds and integration with a wired network.

6. 802.11 is a set of data link and physical layer protocols.

7. ① LLC: is the upper sublayer of the data link layer.
② MAC: access mechanism, fragmentation, encryption.
③ PLCP: carrier sensing assessment, forming packets for PHYs
④ PMD: modulation and coding.

8. ① PLCP is a normalization mechanism for all-IP wireless networks.
② DCF is the fundamental MAC tec of the IEEE 802.11 based WLAN standard.

9. ① generic routing encapsulation: a protocol that has been developed prior to moving IP.

11. reverse tunnel is called reverse connection. It is often used to bypass the open port firewall restrictions the use of the reverse connection RAT will be sent to the client SYN IP package.

12. ① SIFS is shortest among above mentioned networking terminology
② PIFS is one of the interframe space used in IEEE 802.11 based wireless LANs.

2. The RTS/CTS access mechanism is mainly used to min the amount of time.

8. IR light is electromagnetic radiation with a wavelength longer than that of visible light.
adv: simple circuit, low power consumption, high security
disadv: cannot be used for long-distance connection; can't be used outdoors due to the infrared wave contained in the sunlight.

9. ① 802.11 MAC and 3 PHY layers.
② 802.11a: 5 GHz band at 2 Mbps
③ 802.11b: 2.4 GHz and 5 GHz; 5.5 and 11 Mbps.
④ 802.11g: 2.4 GHz, 54 Mbps.

10. 5 different priorities. one node finished, other nodes competes to send. Packets with higher priority gain access first

13. ① unicast transmission is the sending of messages to a single network destination identified by a unique address
② multicast is group communication where info. is addressed to a group of destination computers simultaneously.

14. The NAV may be thought of as a counter, which counts down to 0 at a uniform rate. When it is 0, the virtual CS indication is that the medium is idle; when not 0, the indication is busy. The medium shall be determined to be busy when the STA is transmitting. In IEEE 802.11, the NAV represents the num of microseconds the sending STA intends to hold the medium busy.

15. only in Infrastructure mode. not in ad-hoc mode because there's no AOS in ad-hoc mode.

16. A Timing Synchronization Function keeps the timers for all stations in the same Basic Service Set synchronized.

17. A local timer is used in all stations.

18. Time divided into beacon intervals which contain a beacon generation window each.
Beacon contains a timestamp, on receiving a beacon, STA adopts beacon's timing.

19. Yes. ASP is proposed in for time synchronization in multi-hop ad hoc networks, the basic idea of which is to let faster nodes send out beacon more often and self-correction of the clocks.

20. Since mobile hosts are supported by battery power. saving battery as much as possible is very important.

21. ① ad: beacon interval and ATIM window are known by all hosts; each station predicts which stations are in PS mode; the network is fully connected.
② Infrastructure: use CSMA/CA to access the channel; RTS, CTS, ACK, PS-Poll are used to overcome the hidden-terminal problem.

22. ① ATIM: transmitted in ATIM-Window by stations who want to send buffered packets; structured the same as TIM.
② DTIM: transmitted less frequently; sending buffered broadcast packets.

23. Handovers are based on measurements performed by the mobile terminal and base stations.

24. To form the packets that can pass through a link with a smaller MTU

25. The distinction to understand is that while an 802.11 device is transmitting to a receiving device, either one or both of these devices may not be the actual sources or destination of the L2 traffic.

27. ① 802.11a: 5 GHz. 25 GHz. 54 Mbps. 50 feet.
② 802.11b: 2.4 GHz. 11 Mbps. 100 feet
③ 802.11: 5~6 GHz.

28. To make wireless network as secure as wired networks.

30. WEP keys can be used for encrypting data frames

32. active: The IEEE 802.11 standards do not specify how long the client wait. 2 types.
passive: send beacons every 100 ms.

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Chapter 9

1. WiMAX tec provide high-speed Internet connection, data transmission distance up to 50km, with QoS protection, high transmission rate, rich and varied business. Using OFDM/OFDMA, AAS, MIMO and other advanced tec to achieve the mobile broadband services.
2. Transmission convergence sublayer is responsible for conveying sublayer data unit received from the MAC layer. And corresponding access scheme and synchronization control logic are implemented. Physical layer types used are: WMAN-Sc, WMAN-Sca, WMAN-OFDM, WMAN-OFDMA.
3. OFDM divided channel into several orthogonal sub channels, converting high-speed data signal into parallel low-speed data streams, modulated to be transmitted on each subchannel. Orthogonal signal can be separated by the relevant tec at the receiver which can reduce the mutual interference between sub channels, ICI. Relative bandwidth of the signal bandwidth of each sub channel is shorter than the channel. So each sub channel can be regarded as flat fading, which can eliminate inner symbol interference, because the bandwidth of each sub channel is only a small part of the original channel bandwidth, channel equalization becomes relatively easy.

Chapter 10.

1. One is the traditional AP mode while the other is the ad-hoc mode, each point are equal, any point can communicate with other nodes, without central point.
2. Define num of nodes as N. RI: interference distance. node j and i can transmit successfully if $D_{ij} \leq RI$. ② any nodes $d_{kj} \leq RI$ don't transmit.
3. IEEE 802.11 MAC protocol requires all users to share a channel, when neighboring users send messages at the same time, it will cause inter user interference.
4. The hidden terminal and exposed terminal, there are disorderly struggle will cause the network with hoc and ad time slot resources waste, increase the probability of data collision, seriously affect the network throughput, capacity and data transmission delay.

Chapter 11-12.

1. ① requesting workstation to send authentication frames. ② A validation frame is returned after AP receives. ③ AP after receiving the third frame, using the shared key to decrypt the query text.
2. ① the app sends EAPOL Start Frame. ② the authenticator sends a request ③ app responds to ②. ④ the authenticator encapsulates ⑤ RADIUS identifies ⑥ RADIUS sends results Dau→app.
3. ① WEP identity authentication is one-way ② WAPI, add an authentication WAI for user auth. ③ IEEE 802.11i, the intro of the IEEE 802.1X protocol

Chapter 13 - Chapter 22.

1. The hardware of a sensor node generally includes 4 parts: the power and power management module, a sensor, a microcontroller and a wireless transceiver.
2. Ambient energy harvesting from external sources are used to power small autonomous sensors.
3. ① Ultra-wideband wireless communication ② Software Defined Radio ③ Radio Fre identification. ④ Bluetooth Low Energy
4. ① Leap-Frog Path Design ② Real-Time Indoor Mapping ③ Fully Distributed Scalable Smoothing and Mapping. ④ Cooperative Multi-Robot Estimation and Control.
5. QR code, consisting of a square module, square array, graphics, delimiters, large capacity, quick decoding