

## Chapter1

1. Wireless communication first appeared in preindustrial time, when people exchange messages by bonfires. Telecommunication appeared in 19<sup>th</sup> century. Since then, wireless communication had a great development. China also pay great effort in developing wireless communication.
2. Cellar System, Satellite Based GPS, Ad Hoc Networks, Sensor Networks, WiMAX, Wi-Fi, The Internet of Things.

## Chapter2

1. Wired media is a more stable connection, and its radiation influences the nearby signal in a small extend. Each signal has its own transforming wire. Wireless media is less stable, and the signals share the air as media which causes a lot of interference.
2. Licensed band relatively has a lower efficiency but less interference. Unlicensed band is usually crowded and may have more interference.
3. The propagation route, the environment, and the motions of the transmitter and receiver.
4. Reflection happens when the wave length is bigger than the obstacles, and usually occurs in the surfaces of earth, buildings and walls. Diffraction happens when the obstacle is sharp. Scattering occurs when the obstacle's size is of a smaller magnitude of the wave length.
5. Reflection is predominant indoor, while diffraction happens mostly outdoors. Diffraction make the waves appear even in the back of the obstacle. Scattering forms many transforming routes for the signals.
6. The power received by the receiver is direct ratio 1/d. So the longer the distance, the greater the power loss.
7. The slow fading causes a variable received power while moving, though the distance between the transmitter and the receiver remains the same. The pass loss varies slowly through distance.
8.  $L_p = L_o + 10^2 \lg D + X$ .
9.  $L_p(d) = A + B \lg d$  (city) or  $A + B \lg d - C$  (downtown) or  $A + B \lg d - D$  (open area).
10. Multipath fading: the signal corrupt after passing through different paths. Small-scale fading: the received signal strength change rapidly in small time or distance. Doppler-shift: when the transmitter moving, the received signal frequency changes.
11. Rayleigh distributions usually describe multipath phenomenon, while Ricean distributions describe the special situation that there is a dominant signal in the paths.
12.  $V(t) = V_f/c \cos \theta(t)$
13. Rayleigh:  $f(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right)$ .  
Ricean:  $f(r) = \frac{r}{\sigma^2} \exp\left(\frac{-(r^2+a^2)}{2\sigma^2}\right) I_0\left(\frac{ar}{\sigma^2}\right)$ .
14. Level of crossing rate:  $NR = \sqrt{2\pi} f m p e^{-p^2}$ . Average fade

$$\text{duration: } \tau = \frac{e^{-p^2} - 1}{\rho f m \sqrt{2\pi}}$$

## Chapter3&amp;4

1. GSM-GPRS-EDGE-WCDMA
2. K=JN
3. C=MJN
4. Base station, a wireless communications station installed at a fixed location and used to communicate. Uplink and downlink mean the feeder link used to transmit signals from terminals to stations and from stations to terminals. Cell is a small area in cellar system. Location area is a set of base stations that are grouped together to optimize signal. Mobile switching center a node which is used to handle mobility and hand-over requirements.
5. VLR: record the visitor; HLR: record the station.
6. To make communication more stable.
7. 3G improves the speed in transmitting audio and data. It also improves the quality of phone calls, and enhances the security.
8. TDMA uses digital modulation to improve the capacity of channels, but it performs not so good in district switching. WCDMA improves the capacity, the phone calls quality, and reuse factor.
9. SGSN: serving GRRS support node. GGSN: Gateway GRRS support node.
10. WCDMA, CDMA2000, TD-SCDMA.
11. High frequency, high speed, widely used, stable.
12. 5MHz bandwidth, 3.8Mcps code speed, 1940-1955MHz(up frequency), 2130-2145MHz(down frequency), GPRS transmission speed.
13. (1) SOAP Services (2) WebHttp Services (3) Data Services (4) Work flow Services (5) RIA Services
14. All follow the IP protocol.

## Chapter5

1. Mobile cloud computing, Mobile web pages, Mobile connection, Pervasive computing.

## Chapter6

1. Determine the appropriate threshold of signal strength to handoff; Determine whether to do quick handoff according to the speed of mobile station; Find the new base station that can give stronger signal; Build connection with new base station; Cut off connection with the original station.
2. intra-switch handoff happens in one MSC(Mobile switching center) inter-switch handoff happens between two MSC.
3. MCHO: Mobile Controlled Handoff; NCHO: Network Controlled Handoff; MAHO: Mobile Assisted Handoff
4. Hard handoffs: don't need to change channel but the communication should be cut off temporarily.  
Soft handoffs: communication can be maintained but will take up more channel resources.

5. Mobile devices detect signal strength from base station automatically, and feedback to base station.
6. Straight-line is the linear function model. Fluid-flow is a model used to describe fluid flowing in container.
7. Handoff rate is a fundamental index to evaluate the handoff performance and as a result it affects the overall performance of cellular mobile communication.
8. If MSC found that signal strength from a mobile station is decreasing, and meanwhile there is no cell in this MSC that has a stronger signal, then inter-switch handoff should be happened,
9. Couldn't find the answer.
10. If a cell split to several smaller cells, though system capacity and transmit power can be improved, the handoff will be carried out more frequently.
11. It consists of cellular network and WLAN(Wireless Local Area Networks).
12. location update: when the coding detected is different from last time, location should be updated, it consists of 2 steps: Authentication and data base update.  
Service delivery: Mobile devices initialization; give a call; call delivery; Receive call; keep call; handoff when cell change; database checking; terminal call delivery.
13. Time-based: detect location at regular time, it's easy to manage but doesn't work when users move fast; Movement-based: detect location based on users movement. It's flexible. When users are static, detect frequency can be decreased. Distance-based: accurate but need more resources.

#### Chapter 7

1. A permanent IP address allows a fixed IP address when a node change link.
2. MN: Mobile Node, HA: Home Agent, FA: Foreign Agent, COA: Care-of Address, CN: Communication Node
3. With: HA intercept data, and encapsulate data using reverse tunneling, then send to CoA; Without: HA send data to MN directly.
- 4.
5. Mobile node initiates registration when link change. Then Mobile node broadcast to home network for registration. After that, foreign agent will generate a Care-of Address and notice the home agent.
6. When errors take place in a registration, die out automatically and then re-register can correct the errors.
7. Manage and control the system.
8. Helps to exchange information of STAs and access the wire network.
9. Noise is too loud or be refused by agent.
10. IP in IP encapsulation: the whole IP data pack is encapsulated directly.

Minimum encapsulation: new IP head is inserted between original IP head and IP load.

General routing encapsulation: data for a protocol is capsulated in data for another protocol.

11. Reverse tunneling is a data encapsulation technology. By this technology, the original IP package would be encapsulated in data payload of another data package. IP address would be grouped and encapsulated respectively at the beginning of tunneling, and would be split at the end of tunneling.

#### Chapter 8

1. DCF is distributed coordination function, which is the fundamental MAC technique of the IEEE 802.11 based WLAN standard.PCF is point coordination function, which is a MAC technique used in IEEE 802.11 based WLAN standard. DIFS is DCF Inter-frame Space. SIFS is short Inter-frame Space. PIFS is PCF Inter-frame Space.
2. DCF also has an optional virtual carrier sense mechanism that exchanges short Request-to-send (RTS) and Clear-to-send (CTS) frames between source and destination stations during the intervals between the data frame transmissions.
3. IEEE 802.11e is an approved amendment to the IEEE 802.11 standard that defines a set of service. It enhances the DCF and the PCF through a new function, HCF. EDCA is enhanced distributed channel access. With ECDA, high priority has a higher chance of being sent.HCF is hybrid coordination function. Within the HCF, there are two methods of channel access, HCCA and EDCA.
4. Ad-hoc mode doesn't need access point. The wireless devices communicate directly in a point-to-point manner. Infrastructure mode needs access point between wireless devices.
5. In infrastructure mode STAs communicate through AP, AP helps to exchange information of STAs and access the wire network. In ad hoc mode, each station connects equally.
6. MAC layer with the support of the LLC layer provide access control functions and performs addressing mode and frame recognition. The MAC layer and PLCP communicate through the physical layer SAP using primitive language. Under PLCP, PMD supports the release and reception of physical layer entities between tow workstations through a wireless medium.
7. Infrared transmission uses IR diodes, diffuse light, multiple reflections. It's simple, cheap, available in many mobile devices, simple shielding possible, need no licenses. But it interference by heat sources and has a low bandwidth. Radio typically using the license free ISM band at 2.4GHz, which covers larger areas than infrared transmission. But there are very limited license free frequency bands and much interference with other electrical devices.
8. 802.11 specify the signal feature and modulate method in the

- physic field. 802.11a uses OFDM, and 802.11b uses DSSS, while 802.11g reserves both of them.
9. There are 8 priorities from 0 to 7 which guarantee the Qos.
  10. DCF,PCF, HCF
  11. Draw the diagram.
  12. With multicasting, the leg of the data path from the wireless client to the access point includes transmission error recovery. But multicast does not have ack packets and so there is no retransmission of lost packets.
  13. Because this information is used by all other stations to set their NAV, and determine the waiting time.
  14. Qos is supported in both infrastructure and ad hoc mode by classifying, marking, queueing, and scheduling.
  15. To get the correct information from the other stations.
  16. By TSF. In BSS, the AP sends the TSF information in the beacons. In Independent Basic Service Set (IBSS, ad-hoc), each station competes to send the beacon.
  17. PLCP is used for code synchronization, while it's still needed to keep synchronization when sending and receiving.
  18. Work not so good,because of the interference.
  19. To enhance the network lifetime, and make sure that we power off during idle periods and yet maintain an active session.
  20. In infrastructure mode it allows idle to go to sleep, AP buffers packets for sleeping nodes, power saving stations wake up periodically. In Ad Hoc, stations complete a handshake with other station before sleep, and wake up every Beacon transmission.
  21. DTIM determine the time when multicast frames are to be delivered by AP, determined by AP. ATIM is the time when other stations announce if they have buffered packets for a sleeping station.
  22. Distributed and terminal determined method. When terminal roaming in one subnet, it needs 1 switch. And 2 switch when terminal roaming through subnets.
  23. Easier to transmit and more safe.
  24. The MAC header contains four address fields, each containing different addresses in different cases. The principle is that address 1 for the receiving address, address 2 for the sender address, address 3 auxiliary and address 4 for the wireless bridge or MeshBss network.
  25. 802.11a is an IEEE wireless network standard. Its transmission technique is multi-carrier modulation technology. Unlike single-carrier system 802.11b, 802.11a uses the multi-carrier modulation technology of OFDM to increase the utilization of frequency channel. Because 802.11a uses the 5.2Ghz frequency spectrum, it cannot interoperate with 802.11b or the 802.11 standard.
  26. The goal of WEP is that the security of the wireless LAN is comparable to the limited LAN.
  27. Open System authentication and Shared key authentication.
  - 28.
  29. In Open system authentication, the WLAN client need not provide its credential to the Access Point during authentication. In Shared Key authentication, the WEP key is used for authentication in a four-step challenge-response handshake.
  30. The problem is that the key itself is easily intercepted. For the MAC filter, the disadvantage is that if you set up your router to use a white list, you must modify the white list time by time. For the captive portal, it is simple, but as a result of the AP access without using WEP, the air channel is easy to detect crack.
  31. During an active scan, the client radio transmits a probe request and listens for a probe response from an AP. With a passive scan, the client radio listens on each channel for beacons sent periodically by an AP. A passive scan generally takes more time and if the client does not wait long enough on a channel, then the client may miss an AP beacon.
  32. When the media is idle, high-priority data is waiting less time. Therefore, if you have any high priority data to preach, in low priority frames before attempting to access the medium, the higher priority to use the data would have medium. In order to maintain the interoperability of different data transmission rates, the time values of frame intervals are fixed, regardless of transmission rate.
  - 33.
- ### Chapter 9
1. WiMAX is a new broadband wireless access technique, which provides a quick access, and a maximum transmission distance of 50km. It also supports Qos, and has many services.
  2. It specified a physical layer operating in the 10 to 66 GHz range and using scalable orthogonal frequency-division multiple access(SOFDMA), and having multiple antenna support through MIMO.
  3. OFDM is based on the concept of frequency-division multiplexing (FDD), the method of transmitting multiple data streams over a common broadband medium. Each data stream is modulated onto multiple adjacent carriers within the bandwidth of the medium, and all are transmitted simultaneously.
- ### Chapter 10
1. Infrastructure need a fixed center control, has traditional topology. Ad Hoc need no center node, has a flexible topology.
  2. Protocol interference model has been widely used to obtain radio interference information. The range is defined as a circle centered on a transmitter node, and the relationship is defined according to the location of the receiver node.
  3. Zone around each receiver to lead a high transmission capacity

in ad hoc network.

- The modified transmission power will help that node to dynamically vary its propagation range at the physical layer.
- Hidden terminal is in the coverage of receiving terminal, but out of the coverage of transmission terminal. Exposed terminal is quite the opposite. Those problems can be solved by dual-channel.

#### Chapter11

- Encryption mechanism and certification mechanism. Encryption mechanism: The core algorithm is RC4 sequence secret code's algorithm, using the key as the seed to get the secret code's sequence with the PRKS xor the Content by the PRNG. Certification mechanism: WEP has used the Shared Key Certification Way.
- ①Applicants send EAPOL Start frame to Certifiers for starting certification process.②Certifiers send the request to acquire the applicants' relevant identity information. ③Applicants response the request and send their own relevant identity information. ④The certifiers package the applicants' relevant identity information into RADIUS Access Request frame and then send them to AS. ⑤The RADIUS server verifies the legitimacy of the applicant's identity. ⑥RADIUS informs the certifier of the authentication result. ⑦The certifier sends the authentication result to the applicant. If the authentication is passed, the certifier will open a controlled port for the applicant, allowing the applicant to access the services provided by the certifier.
- Web is a security method, WAPI is a privacy structure, while 802.11i is a protocol specified the security standard.

#### Chapter12

- Increasing the transmission distance and reducing energy consumption.
- Active state、Sniff state、Hold state and Park state.
- Reader : The reader is mainly responsible for two-way communication with the electronic tag, while receiving control commands from the host system.

Electronic tags: The electronic tag consists of an IC chip and a wireless communication antenna. The built-in RF antenna is used to communicate with the reader.

- Chip technology、Antenna Design Technology、Packaging technology、Tag application technology、Standard research problem technology、RFID anti-collision technology.
- Logistics field: It can be applied for cargo tracking、automatic information collection、storage management applications、port application、postal parcel、mailing and so on.  
Retail field: It can be applied for commodity sales data real-time statistics、commodity's supplement and steal prevention.  
Manufacturing industry field: Production data real-time

monitoring、quality tracking、automatic production、personality production and so on.

#### Chapter13

- The sensor network captures the message and sends it to the base station. The message is then transmit through satellite or directly to the internet, and finally send to the monitoring station to be monitored and collected.
- Self identify, self detect, synchronization, signal process, communication proctology, and network access.
- Mobile: environment detection, military application. Stationary: agriculture.
- Deploy by air plane, or set in buildings.
- It can work in three different frequency bands, with data transmission speed of 40kb/s, covered 1000 inches area. It also contains a 128KB flash, 4KB EEPROM, and supports UART.
- Every node can be transmitter or forwarder, so that one can trade metric for another.
- Solar energy, wind energy.

#### Chapter14

- SDN is a programmable network structure.
- SDN split the control layer and the transmission layer. It no longer uses IP as center, instead it uses a standard method to manage the networks collectively.
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- Traditional network depends a lot to hardware, but SDN split the physic and control layers to break the limit of hardware. So it's cheap and more flexible.

#### Chapter 16&17&18

- Motor, navigator, microphone, infrared receiver, sensor, Wi-Fi and Internet.
- Smart home, automatic driving, environment monitoring etc. For example, the ZRobot of the company Digilent. It has a camera, Wi-Fi supports, UART, and Bluetooth. It can run Linux operating system so that it can run different types of code and be used in many fields.

#### Chapter 19

- Compared to SISO, MIMO can use the antennas of transmitter to send signals independently. At the same time, it can receive and recover the data using the antennas of receiver.
- $y=Hx+n$ , H is the channel metric, n is the noise, y and x are the received signal and the transmitted signal respectively.
- Space reuse is simpler than a spatial subset, which can increase the rate of data transmission without increasing bandwidth.
- Distributed MIMO ,Virtual MIMO ,Multi-user MIMO.

#### Chapter 21&22

- The value of bit-coins is not secure, but the account, deal and privacy is secure.
- Version information, format information, check bit, identifier.