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Chapter 1

1. Faraday electromagnetic induction
(1831) → Morse telegraph (1837) →
Maxwell telegraph (1873) → Bell phone
(1876) → Marconi Radio (1895) → AM
(1906) → Television (1927) → Mobile
phone (1946) → communication satellite
(1968) → NMT (1981) → GSM (1988) →
Wireless network (1991)

2. Cellular system, mobile management
Wi-Fi, WiMAX, Self-organizing network,
Sensor network, SDN.

Chapter 2

1. Propagation media: cable/air,
stable/unstable, bandwidth large/
small.

2. Licensed band, can be used with
the authority of country. like WLAN.
Unlicensed band, can be used freely
like ISM, U-NII and PCS.

3. space, atmosphere, ionization

4. ① wave come to the interface and
back to spread; ② wave come to the
obstacle, it spread from origin direction

- ③ due to the potential in the air,
the wave spread to all directions.

5. Indoor: reflection, diffraction and
scattering; Outdoor: reflection by
ground and building, diffraction.

6. Distance ↑, Rcv ↓; antenna gain ↓,
Rcv ↓; station height ↓, Rcv ↓.

7. $\frac{P_r}{P_t} = G_t G_r \left(\frac{\lambda}{4\pi d} \right)^2$

8. Caused by the obstruction and
receive signal strength decreased.

9. $L_p = L_o + 10 \alpha \lg D + X$

10. freespace = 2; city = 2.6 ~ 3.5;
city shadow = 4; building = 5;
factory = 2.5.

11. small scale fading caused by
constructive and destructive inter-
ference of the multiple signal path
between transmitter and receiver.

12. Ricean Distribution.

13. Doppler shift: $v(t) = \frac{v_f}{c} \cos \theta(t)$
cause the transmitter and receive
are relatively move.

14. $f_{ray}(r) = \frac{r}{a^2} \exp\left(-\frac{r^2}{2a^2}\right)$

- $f_{ric}(r) = \frac{r}{a^2} \exp\left(-\frac{(r^2 + \sigma^2)}{2a^2}\right) \cdot I_0\left(\frac{\sigma r}{a^2}\right)$

15. $P_z(z) = \frac{2m^{m-1} \cdot z^{m-1}}{\Gamma(m) P_r^m} \exp\left(-\frac{mz^2}{P_r}\right)$

Chapter 3 & 4

1. from TDMA to CDMA in 2008.

2. transmitting power ↑, cell radius
↓, system capacity ↑.

3. $q = \frac{D}{R}$, $D = \sqrt{3NR} \Rightarrow$
 $q = \sqrt{3N} \Rightarrow N = \frac{q^2}{3}$

4. base station: public mobile
communication station; uplink: from
station to satellite; downlinks: from
satellite to station; cells: use many
small station to cover a whole area.
MSC: call service are provided.

5. HLR: a database contains all the
user information, VLR: A database
contain all the information of calls
and provide search information.

6. handoff management: new station,
old station, MSC; location management
MH, home agent, outside agent.

7. the transmitting speed of voice
and data is improved and provides
service around the world and provides
video and music and image service.

8. TDMA use the GSM to control the
call from user and WCDMA use the
MSC to control the users' calls.

9. SGSN/GGSN provide the network
packet service and manage the users'
data and count the cost; MSC/HLR
provides the build of user call and make
choice of the route and communicate
with HLR and VLR, and connect to
the Internet.

10. TD-SCDMA, CDMA2000, WCDMA

11. ~~world~~ world-wide service provides
high-speed data transform and
multimedia service.

12. transmission rate: 200 kbits/s.
bandwidth: 400 kbits/s.

13. Bandwidth Internet surf; mobile.
business, video call, mobile television;
mobile search.

14. Data Service
IP based core network
new radio 2G/3G BWA WLAN/WMAN NW

Chapter 5

1. Mobile cloud computing, mobile web
page, mobile access.

Chapter 6

1. monitor the signal intensity and
launch the transform the program when
it's too low, the equipment recognize
the new station and connect to it with
communication with the old station.

2. intra-switch handoff are used when
equipment are hand over between two
same MTSO control system; inter-
switch handoff are used when UEs are
handover between two different MTSO
cellular system.

3. MCHO: mobile station monitor the
signal intensity and choose the best
method; NCHO: network monitor the
signal intensity and launch the switch;
MAHO: mobile station monitor the signal
intensity and launch the switch.

4. hard handoff use a channel at a
time, but it will cause ping-pinging
effect; soft hand off can reduce the
probability of connection failure, but
require more complicate design inside
the user equipments.

5. We monitor the signal intensity
and if it variance beyond the threshold,
the mobile station will launch the
transform program.

6. straightline model regard the users
as the linear behavior ones and
fluid flow model regard the user
as reservoir and connection as pipe
and model the reaction in system in
this way

7. $f(t) = \frac{\beta^\gamma \cdot t^{\gamma-1}}{\Gamma(\gamma)} \cdot e^{-\beta t}$
 $f^*(s) = \left(\frac{\beta}{s + \beta} \right)^\gamma$, $\beta = \gamma \eta$

8. intra-switch hand off are used when
between two same MTSO, but inter-
switch hand off are used in different ones

1. $f(d_o, d_a) = a(d_o) [d_a]^{d(d_o)}$
 $g(d_o, d_a) = b(d_o) [d_a]^{c(d_o)}$
 << Handover Rates in Cellular Systems
 Towards a Closed Form Approximation >>
 10. the smaller is the cell, the hand-off rate is higher, cause the user has to change cell more often.

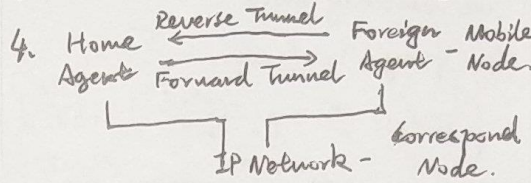
11. two-tier network architecture to run above the software represent level, and its data layer run on the server.
 12. location update: mobile network require the UE to report its location and report periodically; service delivery: mobile network find possible path for the receiver, if already success, the caller will call to end this delivery.
 13. time-based: more reliable but will miss some UE which moves very quickly; movement-based: has less pressure on the station but will miss some UE that moves very slow; distance based: most reliable but will put too much pressure on the station when many UEs are locate in the edge.

14.
 the station receive the UE's new position and decide whether to hand-off this UE.

Chapter 7

1. a permanent IP address provide you away for any other to find you. like a website and a personal database.
 2. MN: a server which always change its location; HA: keep the position information of a mobile server and forward the data to the mobile node; FA: mobile node use it to communicate with the HA; COA: a IP address that correlated to a mobile node when it is not at home; CN: A communicate object of a mobile node.
 3. mobile IP help the datagram deliver to the right node. And Mobile

IP find the node address from the server address by address mapping. Then it start to find a best way in the network to send the datagram.



5. Mobile node send its request to the foreign agent, and foreign agent respond the request, then home agent decide whether to delay the request; finally, the foreign agent respond to the mobile node according to the home agent.
 6. Because the home agent can decide whether to postpone the request, if the time is too long, the request will not stay in the foreign agent permanently.

7. IP Header (RFC 791).
 ICMP Router Advertisement.
 Type = 16. Length. Sequence No.
 registration lifetime. Reserved.
 Care of Address.

8. vers = 4. Type of service. Total length. Identification. Flags. Fragment offset. Time to live. Protocol. header checksum. source Address. home address. Destination Address. Type = 10. Code = 10. checksum. Reserved.

9. the transmission may fail and the home agent and foreign agent both can reject the request of registration.

10. IP in IP encapsulation: IP are encapsulate in to a datagram to deliver. Minimum encapsulation: new IP is locate between the old IP and data. Route Encapsulate: a datagram of a layer is encapsulate in the other layer's datagram.

11. RAT will send SYN packet to the IP, and agent decide whether allow the connection according to the packet.
 12. Cause some agent may has a firewall and only reverse tunneling can be accept by this agent.

13. Our mobile phone is the IP with firewall and some original servers are without firewall.

Chapter 8

1. DCF is a fundamental MAC technique of the IEEE 802.11 based WLAN standard. PCF is a MAC technique to coordinate the communication.

DIFS is acronym for DCF interframe spacing. SIFS stands consider the time to wait before sending. PIFS is sum of SIFS and slot time.

2. The RTS/CTS access mechanism is mainly used to minimize the amount of time spent when collision occurs.

3. IEEE 802.11e is an approved amendment to the IEEE 802.11 standard that defines a set of quality of service enhancements for wireless LAN and streaming multimedia.

EDCA let high-priority traffic has a higher chance of being sent than low-priority traffic.

HCF enhance the DCF and PCF.

4. Ad-hoc mode allow each device to communicate directly with each other, while infrastructure mode use access point to control the communicate.

5. Ad-hoc mode are composed of node only, route among themselves, and infrastructure has nodes and base station.

6. Data link Layer. } IEEE 802.11
 Physical Layer

7. LLC: control the logic link
 MAC: access, fragmentation, encryption
 PLCP: carrier sensing assessment.
 PMD: modulation and coding.

8. Infrared is used in short-range communication; while radio is used in large-range communication with high bandwidth.

9. 802.11 1 MAC and 3 PHY
 802.11 a 5 GHz band at 54 Mbps
 802.11 b 2.4 GHz and 54 Mbps
 802.11 g 2.4 GHz and 54 Mbps.

10. medium will choose the packets with highest priority to be send first to achieve the priorities.

11. DCF, PCF and HCF.

PCF requires a station wishing to transmit to listen for the channel status for a DIFS interval.

PCF enabled access point wait for PIFS duration rather than DIFS to occupy the wireless medium.

HCF control HCCA and worked like a PCF a lot.

12. Unicasting.

DIFS CW DATA SIFS ACK idle.

13. Unicast is the sending of messages to a single network destination identified by a unique address, while multicast is addressing message to a group of destination.

14. NAV is a virtual carrier-sensing mechanism used with IEEE 802.11. it limit the need of physical carrier-sensing at the air interface in order to save power.

15. In 802.11, PCF take role of QoS and only available in "infrastructure" mode, where stations are connected to network through AP. Both ad-hoc and not support the QoS service.

16. In 802.11, node has to communicate with each other by broadcast, which collision are not allowed, thus the hold and wait need all nodes to synchronization.

17. A TSF keeps the times the timers for all stations in the same basic service set synchronized. All stations shall maintain a local TSF timers.

18. Beacon is several slots in length, it let time to divided into beacon intervals, if the time of Beacon is early than STA, move forward the clock.

19. multi-hop environment use ASP to synchronize a multi-hop MANET, letting the faster nodes send out beacon more often and self correction of the clocks.

20. Because some mobile equipment are supported by battery, thus saving battery is a big thing.

21. power management in Ad-Hoc mode use CSMA to access the channel and use RTS, CTS, ACK to overcome hidden terminal.

In infrastructure mode is the same as in Ad Hoc mode.

22. ATIM transmitted in ATIM - Windows by stations who want to send buffered packets, while DTIM transmit less frequently than TIM.

23. Handover are detected by the location of the UE, if moving out side the cell, the cell will perform a handover operation to deliver the user to the adjacent cell.

24. Because the maximum message length is not the same, some messages are too long to transform in IP protocol, thus the fragment is needed.

25. Frame control, Duration, Sequence number, QoS control, HT control.

26. IEEE 802.11 is transmitting a message to a receiving device, so there can be 4 address: Transmitter Address, Receiver Address, Source Address, Destination Address.

27. IEEE is the amendment to IEEE 802.11 that define requirement for an OFDM, operated in 5.2 GHz and up to 54 Mbps. Less prone to interference and more expensive than IEEE 802.11.

28. WEP is a security protocol for Wi-Fi network, making wireless networks as secure as wired network.

29. WEP use a 40-bit key, which is concatenated with a 24 bits initialization vector to form RC4 key.

30. The client sends an authentication request to the AP, AP reply with a clear-text challenge. The client encrypts the challenge-text using WEP key and sends it back, then AP decrypts the response.

31. Captive portals is flexible and easy to implement, but not standard, and require regular re-authentication. WEP/WPA is easy to implement but not transparent. MAC filtering is easy spoofed but it doesn't identify a person.

32. Active scan occurs when the client changes its IEEE 802.11 radio to the channel being scanned, and passive scan occurs when waiting for periodic beacon from APs on the channels being scanned.

33. For different priority message, it has to wait different time before transmitting, the higher is the priority, the shorter is the waiting time.

34. A station has more links will get more throughput and along with the transmitting node.

Chapter 9.

1. High speed transmitting, QoS guarantee, various services.

2. TCL encapsulate the MAC datagram and take control of the control logic. PMD deal with the channel coding and modulation.

3. OFDM split channel into several small channel and use low-speed.

parallel data flow to transmit in the above splitted channel.

Chapter 10.

1. Infrastructure mode is a single core network while ad hoc mode is a peer network.

2. Only when $d_{ij} \in R$ and all nodes satisfied $d_{ij} \leq R_L$ is not transmitting. Then node i and j can successfully transmitted.

3. Exclusion region are designed to avoid the interference between two close user when both sending.

4. Upper bound:

$$TH = \frac{E[IP]}{\min(H_L, b) \times T}$$

lower bound:

$$TH = \frac{E[IP]}{\min(H_L, b) \times T + \max(H_L, b, 0) \times T}$$

5. Hidden terminals will cause collision and exposed terminal cause the waste of time slot.

Chapter 11

1. the same as question 29.

2. use the physical layer's character to authenticate the equipment connected to LAN.

3. the same as question 32.

Chapter 12.

1. low consumption and low delay.

2. Page, page scan, inquiry, inquiry scan

3. RFID, RFID Tag reader, Application software system.

4. Data transmit between Tag and Reader, Tag supply, anti-collision.

5. ETC system in tollbus, trace of product, bank/credit card.

Chapter 13.

1. sensor network monitor the data transmitting, base station deliver the message to end user or other stations, management nodes are used for MSN management.

2. power management module, sensor, microcontroller, wireless transceiver.

3. Mobile Application: intelligent monitoring system; stationary APP: smart factory.

4. sensor network broadcast their status to the surroundings and organized into a network, then suitable path are computed for the data.

5. range is short and data rate is high.

6. reliability, data rate and network life time are the three network trade. Those three are relative to each other.

7. Nuclear factory is suitable for MSN, cause it need much small sensor to monitor its condition.

Chapter 14.

1. cognitive radio, body area network, software defined radio.

2. low cost, large capacity, high rate, good security, multi-path.

3. Bluetooth low energy is simplification of bluetooth, is designed base on bluetooth with single-mode-form.

4. CR monitor its performance and then determine the RF environment and adjust the radio's settings to deliver the required quality of service subject to user requirements.

5. short distance, high speed, inside the body, low consumption.

Apply in healthcare and space.

Chapter 15.

1. SDN is an architecture purporting to dynamic, manageable, cost-effective and adaptive applications.

2. Data transmitting based on flow, Routing based on central controller, coding facing to the APP.

3. Video and correlation application, combined storage, spannable data center.

4. SDN let us manage the network more easily and easy to upgrade the system and make application more easy to develop and implement.

Chapter 16, 17, 18.

1. Camera, microphone, GPS, Wi-Fi, velocity sensor, pressure sensor, touch sensor, barometer.

2. car safety system, auto-driving, auto parking, Indoor mapping.

Auto parking is realized by capture the surroundings and calculate the best way to get into the parking position.

Chapter 19.

1. MIMO has more than one path between the receiver and sender, while SISO has only one path.

2. $X = [X_1, X_2, \dots, X_N]^T$
 $Y = [Y_1, Y_2, \dots, Y_N]^T$
 $H = \begin{bmatrix} h_{11} & h_{12} & \dots \\ h_{21} & h_{22} & \dots \end{bmatrix}$
 $Y = HX + n$, n is AWGN.

3. space-diversity use multiple path to transmit the data to provide better quality. Space-multiplexing use multiple path to transmit different data to better use the antenna.

4. Distributed MIMO, Multisuser MIMO, Networking MIMO. Multi-user MIMO let the difference between different channel more clear and improved the capacity.

Chapter 21 & 22.

1. The value of bitcoin is not stable, and it is hard to be stolen and hard to know the each dealer. So it is relatively safe.

2. Version information, Format Information, Data and error correction keys. Required pattern.