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Ch. 1

1. 1831 Faraday Electromagnetic induction
1837 Morse Telegraph
1876 Bell Telephone
1958 SCORE Communication Satellite
1969 ALOHAnet professional wireless network
1986 WaveLAN commercial wireless network
1985 FCC authorizing public use of frequency bands
1988 first digital cellar system GSM
1991 2G cell phone network
1997 802.11 WiFi protocal release
1999 803.11 VoIP integration
2000 3G International Mobile Telecoms
2009 4G LTE Advanced

2. cellular system / mobile management / mobile IP / WiFi / WiMAX / Ad-hoc network / network security / WPAN / censor network / IOT / SDN

Ch 2

1. Wired Network: physical medium consisting of cables, carry different form of e signals
Wireless Network: medium made of electromagnetic waves or infrared waves. No wires but radio waves

2. the licensed bands: used only by the companies that licensed them
unlicensed bands: by anyone who wants to use them

3. 1) the spherical shape of the Earth
2) the earth's atmosphere
3) Interaction with the objects on ground

4. Reflection: change the direction of wave front, so that returns to the medium it originated.
Diffraction: the bending of light to the geometrical shadow of the obstacle
Scattering: deviate from a straight trajectory by one or more paths

5. Reflection: indoor, not principle in outdoor
Diffraction: less than reflection indoor
Scattering: indoor and outdoor

6. $\frac{P_r}{P_t} = G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2$
$P_r = \frac{G_t G_r P_t}{L}$ $L_p = \frac{P_t}{P_r}$
$L_p[dB] = 32.45 + 20\lg f_c + 20\lg d$
two-ray: $\frac{P_r}{P_t} = G_t G_r \cdot \frac{h_t^2 h_m^2}{d^4}$
$P_r = P_0 d^{-\alpha}$

7. free-space: $L_p[dB] = 32.45 + 20\lg f_c + 20\lg d$
$P_r = P_t \cdot G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2$, $P_r = \frac{G_t G_r P_t}{L}$
2-ray: $P_r = P_t \cdot G_t G_r \cdot \frac{h_t^2 h_r^2}{d^4}$
$P_L = 40\log(d) - 10\log_{10}(G h_t^2 h_r^2)$

8. add random variable X to the formula:
$L_p = L_0 + 10\alpha \lg D + X$

9. fade margin = Rx signal level DB − Rx sensitivity dB
difference between received signal & required to maintain reliable link

10. $L_p(d) = \begin{cases} A + B\lg d & \text{city} \\ A + B\lg d - C & \text{suburb environment} \\ A + B\lg d - D & \text{open} \end{cases}$
$A = 69.55 + 26.26\lg f_c - 13.82\lg h_b - a(h_m)$
$B = 44.9 - 6.55\lg h_b$ $D = 40.94 + 4.78(\lg f_c)^2$
$C = 5.4 + 2[\lg(f_c/28)]^2 - 18.33\lg f_c$

11. small-scale: rapid fluction over a short time or travel distance
multipath: signal added from different paths
Doppler Shift: the shift due to motion
spectrum: vary infinitely within a continuum

12. Rayleigh: $f_{ray}(r) = \frac{r}{\delta^2}\exp\left(-\frac{r^2}{2\delta^2}\right)$, $r \geq 0$
many reflection wave, angle $\sim 2\pi$ distribution
Ricean: $f_{ric}(r) = \frac{r}{\delta^2}\exp\left(\frac{-(r^2+a^2)}{2\delta^2}\right) I_0\left(\frac{ar}{\delta^2}\right)$
every path ~ Gaussion dis. angle on 2π
one strongh wave dominant

13. $V(t) = \frac{Vf}{c}\cos\theta(t)$
front motion wave, $\lambda \downarrow$, $f \uparrow$

14. signal strength: $\bar{u} = E(u) = \int_0^\infty u p(u)\,du$
$= \sqrt{\frac{\pi}{2}}\delta = 1.2533\delta$ // cell radius:
$\frac{U_m^2}{2\delta^2} = 0.693 \Rightarrow U_m = 1.1776$

15. Rayleigh: $LCR = \sqrt{2\pi} f_0 \rho e^{-\rho^2}$, $\rho = \frac{R}{\sqrt{\Omega_p}}$
AFD: $F_t = \left(e^{+\rho^2} - 1\right)/\left(\rho f_0 \sqrt{2\pi}\right)$, P is ratio of target envelop to average envelop level
Rician: $AFD \times LCR = 1 - e^{-\rho^2}$

Ch 3, 4

1. ~~spectrum efficiency~~ → CDMA GSM → TDSCDMA
WCDMA → CDMA 2000

2. cell radius decrease then transmitting power & system capacity increases

3. $C = MJN$, C: capacity N: N cells
$= MK$, K: cluster size J: signal channels

4. BS: a land station in the land mobile service
uplink: the transmission path from mobile station to base station.
downlink: from a cell site to the cell phone
Cell: a wireless connection within limited area
location area, MSC: server for handling GSM connections

5. VLR: register the MS in the network, check db if ∃ record of subscriber
HLR: VLR communicate with HLR obtain a copy of subscription info and store in db

6. handoff management: switch between base station in cells according to signal strength.
location ∧: location update and call delivery

7. higher speed for data transmission transfer improved privacy & security, more files can

8. CAC cell capacity is time-invariant in TDMA is simple and sufficient. In CDMA CAC admit a call when SIR requirements of existing and new call are guaranteed.

9. SGSN: serving GPRS support node, upgrade version of used for packet switch
HLR: home location register: store the copy of service profile / MSC: serve UE in its current location / GMSC: Gateway MSC

10. WCDMA, CDMA 2000, TD-SCDMA

11. global roaming, high speed transmission more files type can transfer

12. 2.5G: 1.25 MHz, 1.2288 Mcps, 1920-1935 (up) 2110-2125 (down) in China
WCDMA: 5 MHz, 3.84 Mcps, 1940-1955 (up) 2130 ~ 2145 (down) in China

13. telephone and text in 2G, data, picture transmission in 3G, video in 4G

14. Integrated all-IP architecture:

Ch 5

1. mobile cloud computing / mobile Website
mobile web initiative

Ch 6

1. the initial phase: detect switching needs
new connection generation phase: find new resource to switch the connection and perform routing operations
data flow establishment phase: transfer data from old connection path to new connection path.

2. Intra-switch handoff: when the mobile terminal moves from one base station to another both station connected to same switch

inter-switch handoff: the mobile terminal moves from one base station to another that connected to another switch.

3. MCHO, Mobile-controlled handoff, mobile decides for it self. makes the decision
NCHO, network controlled handoff, the network
MAHO, mobile assisted handoff, mobile provides data for the network to make the decision

4. soft handoff: "make-before-break" connection
Depending on pilot signal from 2 or more BSs, eventually a hard decision is made.
hard handoff: a firm decision is made when to handoff & has no simultaneous connection
Soft Ad: the mobile doesn't lose contact with system, also unnecessary call terminations occur
Hard Ad: performance is not effected even if the mobile system has to reconnect to BST.

5. feedback-based handoff scheme makes use of infomation fed back from the mobile
It attains fast handoff, with relatively small buffer requirements at both base station & mobile terminal

6. straight-line means MN move straightly
fluid flow model is a mathemetical model used to describe the fluid level in a reservoir subject to randomly determined periods of filling and emptying

7. underlying rate = total amount of underlying data sent from PDCP. up rate = total amount of up link data sent from PDCP

8. intra-handoff: MS detects the requirement then give BS an idle channel to send signal. start handoff. Once received signal Msc send the info to idle channel
inter-handoff: handoff switching, hand off bopback, handoff switching to the third party and minimizing the path.

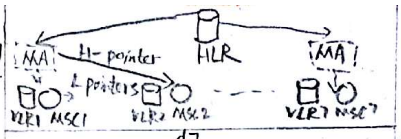
9. the cell further subdivided into smaller cells. The consequence is that the frequency assignments done again. Increase the handoff rate, because cells are smaller and a mobile is likely to cross cell boundry more often.

11. A two-tier architecture: Software architecture: a presentation layer or interface run on a client, and a data layer or data structure gets stored on a server. Seperate 2 components into different locations

12. Location update: reduce the uncertainty of the location, the mobile terminal reports current location from time to time.
The mobile terminal informs the network of its new access point so that the network can authenticate and modify the location and register in new database.
An example of LBS app is the delivery of mobile coupons or discounts to mobile subscribes who are near to advertising restaurants

13. time-based: the mobile base station would update the location of user after a particular time period.
Ad: comparatively easy to manage pattern different T according to user's mobile know the terminal is power-off or outside
dis: stationary user update, increase update cost
location uncertainty can't be bounded
distance-based: keep track of terminal for dis
Ad: better for users move less and move within specific distance < D
dis: if cross boundry frequently, unnecessary location updates occur
movement-based: keep track of number of cell movements or num. of boundry crossing
dis: user travel across boundry at that time unnecessary updates may happen

14. A pointer Forwarding based local anchoring scheme



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1. People want their Internet address to stay fixed with same at all time, so people can access their server. A static Ip address also help when VPN set up for remote access to business office resources

2. Mobile Node (MN) identify by its home address can continue communication while away from its home network. The Correspondent Node (CN) communicates with MN by its home address. Home Agent (HA) is responsible for the delivery of packets to current location of MN. The mobility of MN thus remains hidden from CN.
Foreign Agent (FA): Care of Address (COA) is an IP address of the FN, which MN visited

3. Mobile IP allows routing of IP datagrams to mobile nodes. Associate with its home address by providing info. about current point of attachment or organization's network.
With reverse tunneling, the routing within the Internet is independent of source address of datagram. With reverse tunneling, intermediate routers might check for a topologically correct source address.

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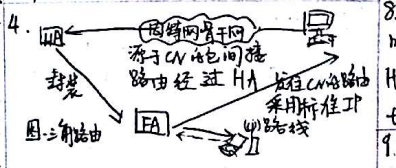

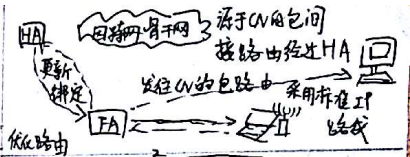

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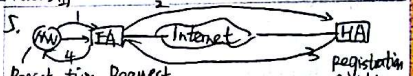


Registration Request
registration reply

1. MN send registration request to FA
2. FA process the registration request and retransfer it to HA
3. HA process request and relays the request to FA
4. FA replys to MN to inform the disposition of the request

6. If no new registration request arrives when the lifetime is out, we think the mobile node is no invalid.

7. A router advertisement can carry information about default routers, and carry further info about one or more care-of addresses. When the router advertisements are extended to also contain the needed care-of address they are "agent advertisements.
The mobile node can broadcast or multicast a solicitation that will be answered by foreign or home agents receives it.

8. mobile nodes use the registration request message to register with home agent. Home agent create or modify binding for that mobile nodes.

9. The registration may fail if any assumptions is not fulfilled, including regularizing a registration problem and leading to an appropriate behavior even in case of artifacts/severe noise.

10. IP in IP encapsulation: the whole IP datagram is encapsulated and be the payload of the new IP datagram.
GRE: defines any network layer protocol can encapsulate any other network layer protocol. inserted between original
Minimal encapsulation: The new IP head is IP ~~and~~ head and IP payload.

11. Mobile nodes establish the reverse tunnel if the intermediate router checks the correct source address of the topology. When the mobile node requests, they can request the reverse tunnel between the external agent and home agent, begins at the care-of-address of MN and terminates in home agents.

12. Because you can ensure a topologically correct source address for the IP data packet by setting up the reverse tunnel from the care-of address to home agent.

13. Need to establish Mobile IP association for mobile node
Check whether VPN address allocated for MN
home address allocated from? No
Yes
select new home address
select the same address as home

Ch 8

1. PCF, point coordination function, resides in a point coordinator, Access Point to coordinate the communication within the network. a CSMA/CA with binary
DCF, distributed coordination function, employs exponential backoff algorithm.

DIFs is acronym for DCF interframe spacing. SIFS is shortest interframe spacing, shortest among above networking terminology. duration rather than DIFS
PIFS enables access point wait for PIFS to occupy the wireless medium.
PIFS = SIFS + slot time

2. The RTS/CTS access mechanism is mainly used to minimize the amount of time spent when a collision occurs since collision occurs in these short messages.

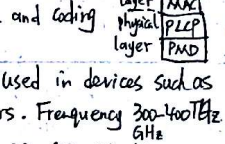
3. IEEE 802.11e defines a set of QoS enhancements for wireless LAN applications through modifications to the MAC layer. EDCA, enhanced distributed channel access, high-priority traffic has a higher chance of being sent than low-priority traffic.
HCF, the hybrid coordination function.
Within HCF, 2 methods of channel access, HCCA and EDCA.

4. Ad-hoc mode: allow each device to communicate directly with each other. No central AP controlling device communication.
Infrastructure mode: requires the use of AP, control wireless communication and offer increased security, faster transmission speeds and integration with wired network.

5. Infrastructure: base station connects mobiles into wired network, mobile charges bs providing connection into wired network.
Adhoc: no base stations. within link coverage nodes organize themselves into a network.

6. data link layer (MAC) responsible for reliable link-to-link data transfer.
physical layer: responsible for putting bits "on the air".

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



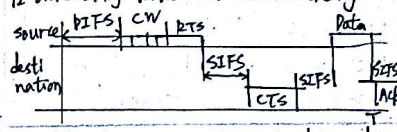
8. Infrared light used in devices such as mouse and printers. Frequency 300-400THz GHz
Used for short-range communication.
Ad: simple circuit/Low power consumption, higher security/ portable/DIS/LOS model
Dis: Short Range/Blocked by materials: people walls .../Low bandwidth/ slow speed
Radio: through free space by modulation of electromagnetic waves with frequency below than vision light.
AD: Simple circuit/ high speed/cover large areas
Dis: Limited number free frequency bands/ Shielding difficult/ interference other devices/ greater power consumption

9. 802.11: 1MAC and 3 PHY layer, 2 in 2.4GHz; 1 in IR band at 1/2 Mbps
802.11a: operates in 5GHz band at 54 Mbps
802.11b: both 2.4GHz and 5GHz at 5.5 Mbps and 11 Mbps respectively
802.11g: in 2.4 GHz at 54 Mbps

10. HIPERLAN 1 offer 5 different priority for data packets ready to be sent. One node finish sending, other nodes can compete for the right to send. This mechanism always grants nodes with higher priority access to the medium, no matter how high the load on lower priorities.

11. Distributed Coordination function, DCF, know as CSMA/CA, using during CP
Point coordination Function, PCF, used during CFP, a single AP controls access to the medium, a PC Agent resides in the AP.
HCF, hybrid coordination function.

12 unicasting with RTS/CTS exchange



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

14. Each node receiving RTS has to set the net allocation vector (NAV) in accordance with the duration field. NAV specifies the earliest point the station can try to access the medium again. If the receiver receives RTS, it answers clear to CTS after waiting for SIFS.

15. The 802.11 standard defines the PCF for carrying real-time traffic.
There are proprietary solutions try to differentiate real-time and non-rt traffic.
QoS Limitations: DCF, PCF

16. Used for power management, point coordination Timing. Hop Timing for FH PHY. Synchronization approach: all stations maintain local timer/ TSF/ Timing conveyed by periodic beacon transmissions

17. Infrastructure: AP monitors each host/ periodic beacon frames/ a TIM be delivered / PS mode host wakes up periodically for incoming packet from AP.
AD-HOC: Ps hosts wake up periodically/ ATIM window/ In the beginning of each ATIM window, each mobile host contend to transmit a beacon frame/ successful beacon.

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

19. Basic idea: let the faster nodes send out beacon more often and self correction of the clocks. Do the automatic self correction in multi-hop scenario.

20. Mobile devices are battery powered Enhancement of battery life enhances network lifetime
Idle receive state dominates LAN adapter power consumption over time

21. Infractnetwre: allow idle station to go to sleep / AP buffers packets for sleeping nodes/ Power Saving stations wake up periodically.
Ad-hoc: before a station goes to "sleep" wake up for every beacon transmission If hears an ATIM frame

22. Delivery TIM (DTIM): transmitted less frequently / for sending buffered broadcast packets. Ad hoc TIM (ATIM): transmitted in ATIM-window by stations who want to send buffered packets.

23. In 802.11, a handover means reassociating with the new AP. No new IP address is needed. Authentication

24. Breaks datagrams into smaller pieces so that can pass through a link with smaller unit

25. Sequence Control 2 Byte
QoS control, 2 Byte, HT control: 4 Byte

26. Transmitter Address/ Receiver Address Source Address/ Destination address

27. 802.11a: operates in 5.15 GHz to 5.356 speed: Up to 54 Mbps. Range: 10 feet Less prone to interference/ More expensive
802.11b: operates in 2.4 GHz, speed: 11 Mbps Range: 100 feet, least expensive WLAN

28. Confidentiality/ Access control/ Data integrity WEP: Wired equivalent Privacy

29. 1) Compute CRC for the message 2) Compute keystream 3) Encrypt plaintext
decryption: 1) build the keystream 2) decrypt the plaintext and verify

31. Open system / Shared key authentication
client sends request to AP / AP replies with clear-text challenge and send back / AP decrypts the response.

32. Wep: Ad: standard security feature
Dis: Shared key, numerous security flaws, incompatible key specification methods.
MAC: Ad. shared security feature/ Only device with matching MAC address

Dis. MAC table inconvenient to maintain MAC address easily copied and reused.
OSP: virtually all laptops and OS, on open network with no other authentication.

33. Active: the client radio transmit a probe request and listens for a probe response from an AP.
Passive: client radio listens on each channel for beacons sent periodically by an AP.

34. SIFS, short inter frame spacing. highest priority, for ACK, CTS, polling response

Ch 9

1. 50km transmission distance / 70M speed bandwidth / last-mile network access service/ multimedia communication

2. The WiMAX physical layer is based on orthogonal frequency division multiplexing OFMD is the transmission scheme of choice to enable high-speed data video & multimedia. IEEE 802.16 PHY layer defines the duplex mode length of frame, modulation coding tech.

3. OFDM is a frequency-division multiplexing scheme used as a digital multicarrier modulation method. A large number of closely spaced othgonal sub-carrier signals are used to carry data on several parallel data streams or channels.

Ch 10

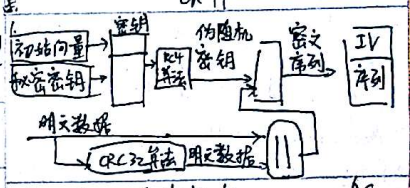
1. Same to ch.8 / 4.

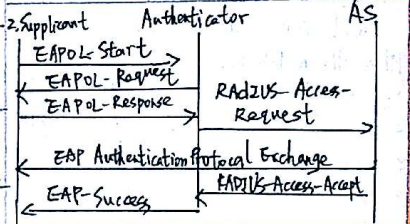
2. In many graph theory-based time slot assignment algorithms, the protocal interference model is widely used to obtain radio interference information.

3. Nodes inside the exclusion region are not allowed to transmit, to limit the interference caused to the receiver.

4. Hidden terminals are the nodes which are in the coverage area of the receiving node but out of the coverage area of sending node.
Exposed terminals are the nodes which are in the coverage area of the sending node but out of the coverage area of the receiving node.

5. Ch 11





3. IEEE 802.11i: pulls IEEE 802.1X in WLAN security, adds key maigement mechanism, and proposes TKIP and CCMP. WAPI: WAI, achieve the authentication of users.

Ch 12

1. Bluetooth 4.0, latest version in 2012 low power consumption / Low cost / compatibility between different BT equipment/ reduce delay / effective coverage expanded.

2. Stanby state and Connection state, including Page, Page Scan, Inquiry, Inquiry Scan

3. Tag Reader: receive control commands Electronic Tag: reader send energy query signal tag receive and provide back to reader.

4. Tag application / Chip / Antenna design / energy supply / Tag to Reader data transmission / Integrity & security / multi-target recognition

5. ETC for road charges / student ID card / electronic license plate

Ch 13

1. Wireless sensor network consists of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environ
2. Sensor node: Low Power / Support multi-hop Wireless Communication / Self configure / small physical size / Reprogram over Network.
3. Environmental / Habitat monitoring Acoustic detection / Seismic detection / Military surveillance / Inventory tracking
4. node problem involve a single node, link problem involve 2 neighboring nodes and wireless link between, path problem 3 or more nodes and a multi-hop path, global problems properties of the network as a whole.
5. data centric / self-organizing network / the number of nodes
6. the inherent trade-off between energy-efficiency and rapidity of event dissemination is characterist. Scarcity of energy renders for nodes to in an energy-efficient sleep mode. longer nodes stay in sleep mode, the slower will be the reaction time for disseminating an external event.
7. solar energy / mechanical vibration / temperature gradient / wind energy / water flow

Ch 14

1. UWB, SDR, RFID
2. high security / processing speed / resolution / transmission rate / system capacity / accurate positioning / low power consumption
3. Bluetooth: handle a lot of data but consuming battery life quickly and cost more. BLE: app don't need exchange large amounts of data, run on battery power for years
4. charge their transmitter parameters by interacting with their operating environment.
5. BAN, a wireless network of wearable computing devices. may be embedded in body implants, or surface-mounted on body. App: Healthcare domain / military sports, exchange info between individual & machines

Ch 15

1. SDN: network admin to programmatically initialize, control, manage network via open interfaces & abstraction of lower-level functionality
2. the data flow forwarding mechanism / central control of routing / app-oriented programming mechanism.
3. SDMN: SD- mobile networking
   SD-WAN: SD- wide area network
   SD-LAN: SD- local area network
4. charging traffic patterns / the consumperization of IT / rise of cloud service Big Data means more bandwidth

Ch 16 17 18

1. motor / camera / inertial nerigator / microphone / range finder / infrared receiver / pressure sensor / acceleraton sensor. -
2. Leap-Frog path design / real-time indoor mapping / fully distributed scalable smoothing / cooperative multirobot estimation

Ch 19

1. SISO: a communication system using a single transmit antenna and a single receiving antenna. MIMO: acronym for multiple input multiple output to avoid data inconsistency and can not be reassembled.
2. Y = HX + n, x transmission signal, y reception signal H channel matrix in frequency domain
3. SC: repeat transmission, on the data stream for a certain coding operation.
   SM: the transmitter divides data stream into multiple words and a transmitted from different antennas.
4. Distributed MIMO / virtual MIMO / centralized MIMO

Ch 21, 22

1. enable 2-factor authentication on your account / allows have direct control of bitcoins, private keys / make regular backups of your bitcoin wallet.
2. version information, format information information and check digit, identifier silent area.