

EE327 - Wireless network

3/12/16 5140219016

1.1 The Birth of Telecommunications: the telegraph → the Birth of Radio

→ Transoceanic Communication → Voice over Radio and 1st TV transmission

→ Commercial TV and the Birth of Mobile Technology → Cellular Television

→ Wireless Data era → PC's era → mobile equipment era.

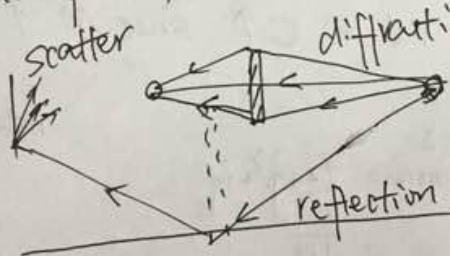
1.2 Cellular network, mobile IP, WIFI, WIMAX, Ad Hoc Network, Mobile network security, Internet of things, sensor network, SDN and etc.

	Wired Network	Wireless Network
2. speed	Higher	Lower, But advanced by LTE, LTE-A...
System Bandwidth	High	Low, expensive as frequency spectrum is very scarce
Cost	Low (cables)	Expensive (stations + routers + adapters + ...)
Mobility	Limited	Not Limited
Reliability	High, as manufactured cables have higher performance	Reasonably High. But failure of router will affect the entire network.

3 factors of radio propagation:

Spherical shape of the earth; the atmosphere; Interaction with the objects on the ground; ...

3 radio propagation mechanisms:



Signal propagation:

Transmission range:

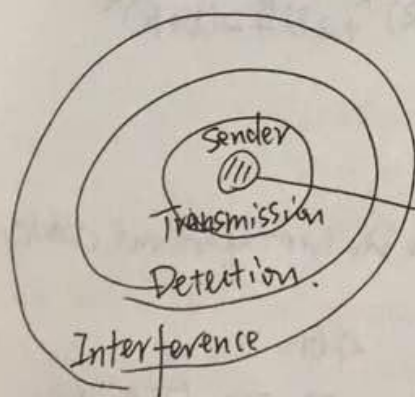
Within a certain radius of the sender transmission is possible

Detection range:

Within a second radius of, detection of the transmission is possible

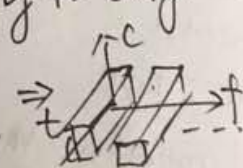
Interference range:

Distance Within a third even larger radius, the sender may interfere with other transmission by adding to background noise.

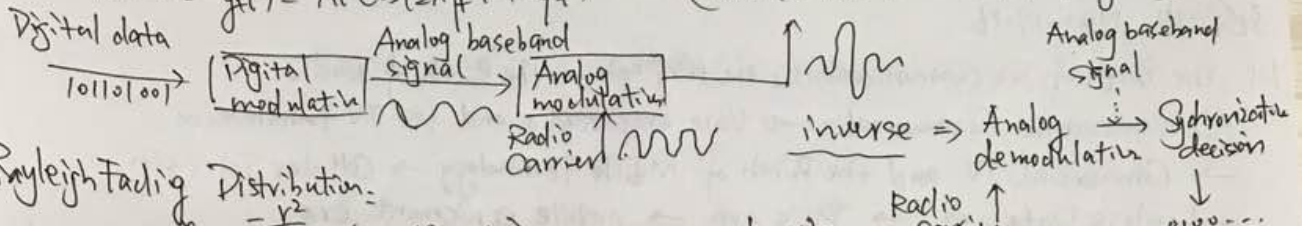


Ranges for transmission, detection and interference of signals.

FDM: Frequency division multiplexing
TDM: Time —
CDM: Code division — } 3 dimensional extension



Modulation: $g(t) = A_t \cos(2\pi f_c t + \phi_t)$ (varied with data and another signal)



Rayleigh Fading Distribution:

$$p(r) = \begin{cases} \frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}} & (0 \leq r \leq \infty) \\ 0 & (r < 0) \end{cases}$$

$$r_{median} = 1.1775$$

commonly used to describe the statistical time varying nature of the received envelope of a flat fading signal, or an individual multipath component.

Ricean Fading Distribution:

$$p(r) = \begin{cases} \frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}} I_0\left(\frac{A_r}{\sigma^2}\right) & (A_r \geq 0, r \geq 0) \\ 0 & (r < 0) \end{cases}$$

Line-of sight propagation. small scale fading envelope distribution.

Doppler Shift:

$$\frac{\text{Source Velocity}}{\text{Speed of light}} = \frac{\text{change in wavelength}}{\text{rest wavelength}}$$

Cellular System pros: Higher Capacity, Less transmission power, Local interference only, Robustness, cons: infrastructure needed, Handover, Frequency planning.

$K = JN$. K is the channel number (all), J is channel number (per group)

$C = MJN$. $N \downarrow \Rightarrow C \uparrow$ since $M \uparrow$

$$N = i^2 + j^2 + j^2$$

$$D_{norm} = i^2 + j^2 + j^2 = \sqrt{N}$$

$$\Rightarrow D = D_{max} \times \sqrt{3}R = \sqrt{3}NR$$

$$f = \frac{D}{R} = \sqrt{3}N$$

Frequency reuse ratio.



interference power:

$$\frac{S}{I} = \frac{S}{\sum_{i=1}^N I_i}$$

$$\Rightarrow \frac{S}{I} = \frac{(D/R)^k (\sqrt{3}N)^k}{N_1} = \frac{(\sqrt{3}N)^k}{N_1}$$

When ignore 2nd above R^{-k} And neglect: $\frac{S}{I} = \frac{2(D-R)^{-k} + 2D^{-k} + 2(D+R)^{-k}}{R^{-k}}$

3G: CDMA2000, WCDMA, TD-SCDMA. Code Division Multiple Access.

WCDMA:

ART FDD.

asynchronous, No GPS.

Bandwidth = 5 MHz

384 Mbps.

CDMA2000

RTT FDD

synchronization, GPS V

1.25 MHz

1.2288 Mbps.

TD-SCDMA:

RTT FDD.

Syn, V

1.6 MHz

1.28 Mbps.

4G:

LTE-TDD, LTE-FDD.

WiMAX, HSPA+

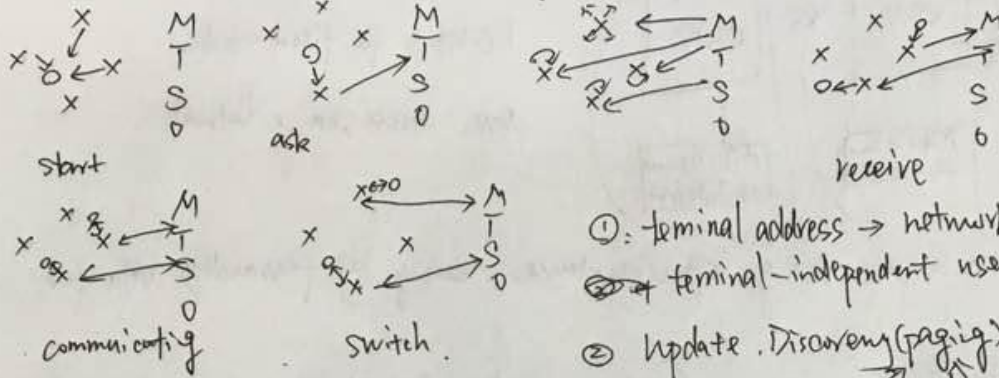
LTE Advanced V

future tech: mobile cloud computing, mobile web, ubiquitous computing.

Mobility Management {

 Naming and Addressing ① Packet Delivery to Mobile Destinations ③

 Location Management ② Handoffs ④ Roaming ⑤



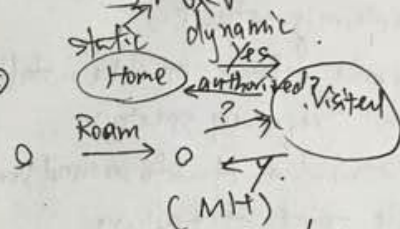
- ①: terminal address → network attachment point
- ②: terminal-independent user names
- ③: update, discovery (paging), interaction.

⑤ 3 modes. ④ occur at different protocol layers

 → Physical.

 → Logical Links

 → IP.

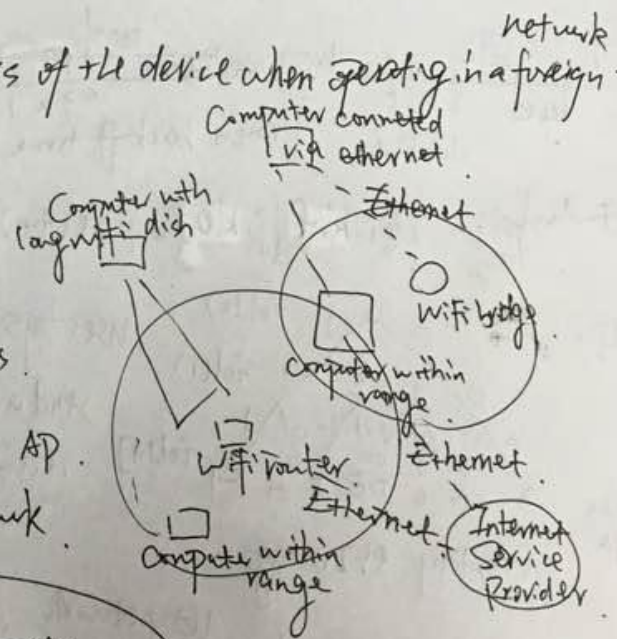
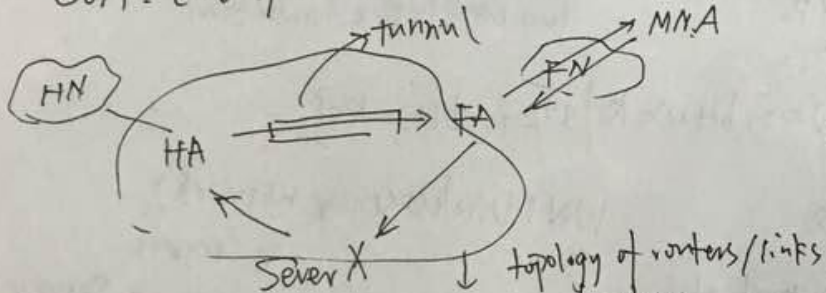


Mobile IP.

A home agent (HA) stores info about mobile nodes (MN). acts as a router on a mobile host's home network.

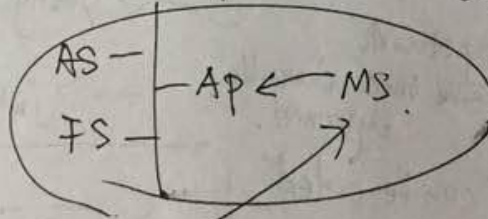
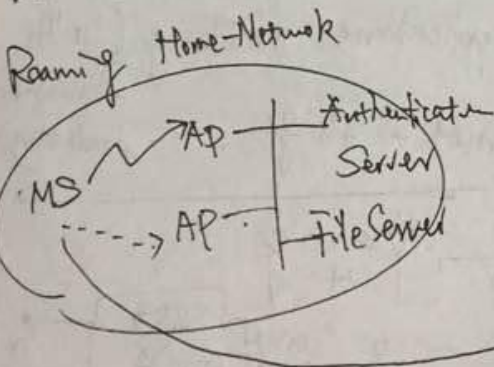
 Foreign agent (FA) — about visitors.

CoA: Care-of Address: network-native IP address of the device when operating in a foreign network.



WAN (Wireless Local Area Network) (Access Point) AP.

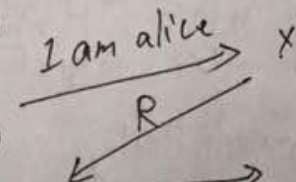
 Foreign Network.



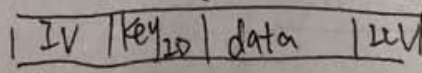
internal roaming

 external roaming.

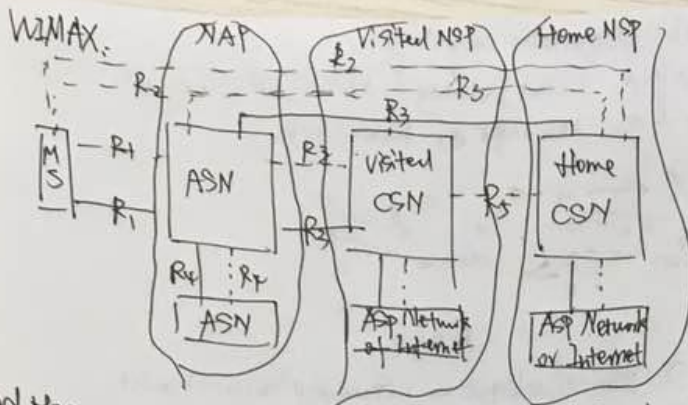
Wifi Authentication.



K_{AB}(R) which will be talked in detail in WEP.



MAC payload

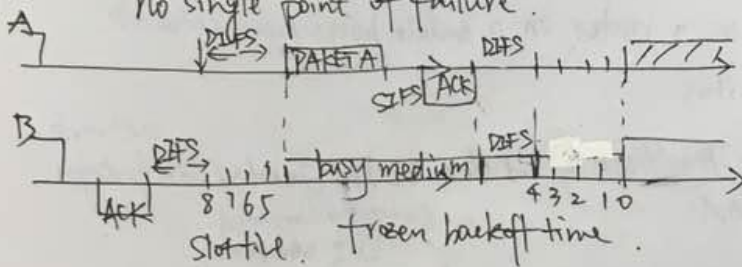


— Data Bearer Plane
 --- Control Plane
 1 Gbit/s for fixed station.
 ASN: Access Service Network.

Ad Hoc: does not rely on a pre-existing infrastructure, routing by forwarding data for other nodes.

Pros: Highly performing network.
 No expensive infra- must be installed.
 unlicensed frequency spectrum.
 Quick distribution of info around sender
 No single point of failure.

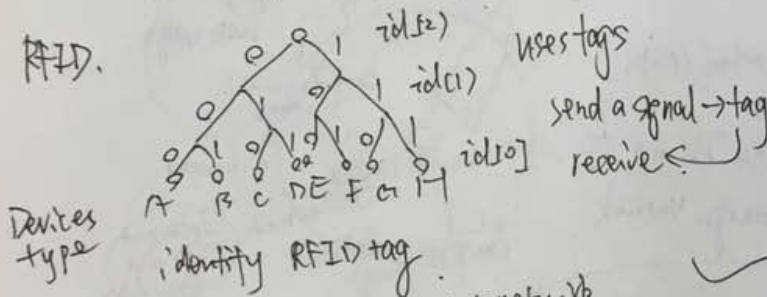
Cons: very dynamic topology (All network may be mobile)
 must have high degree of adaptability.
 No central entities.



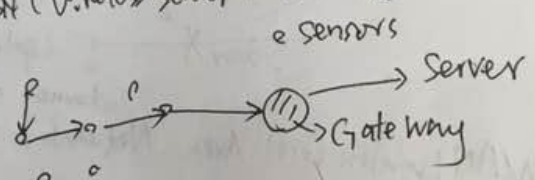
the station has to wait a random backoff time between two consecutive transmission.

$$DCF\text{-}Analysis = P\{i, R\} | j, R_0\} = P\{S(t+1) = i, b(t+1) = R_1 | S(t) = j, b(t) = R_0\}$$

RFID.

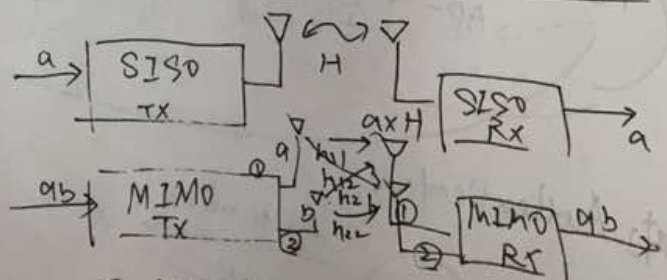
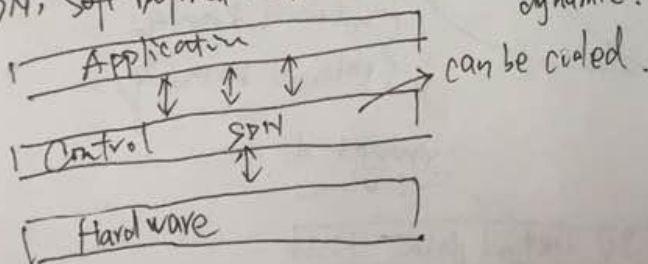


WSN (Wireless sensor network).



Many applications: monitoring (Health, Environment, Industry).
 → Internet of things.

SDN, Soft Defined Network. let network be more changeable, dynamic.



bitcoins, not secure

- ① technique: bank system is not perfect.
- ② economical: no backups & allows

Graphic Code:

Version info + Format info + Data error correction
 Keys + Required patterns + Quiet Zone