

Wifi-Protocol-1

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Plan

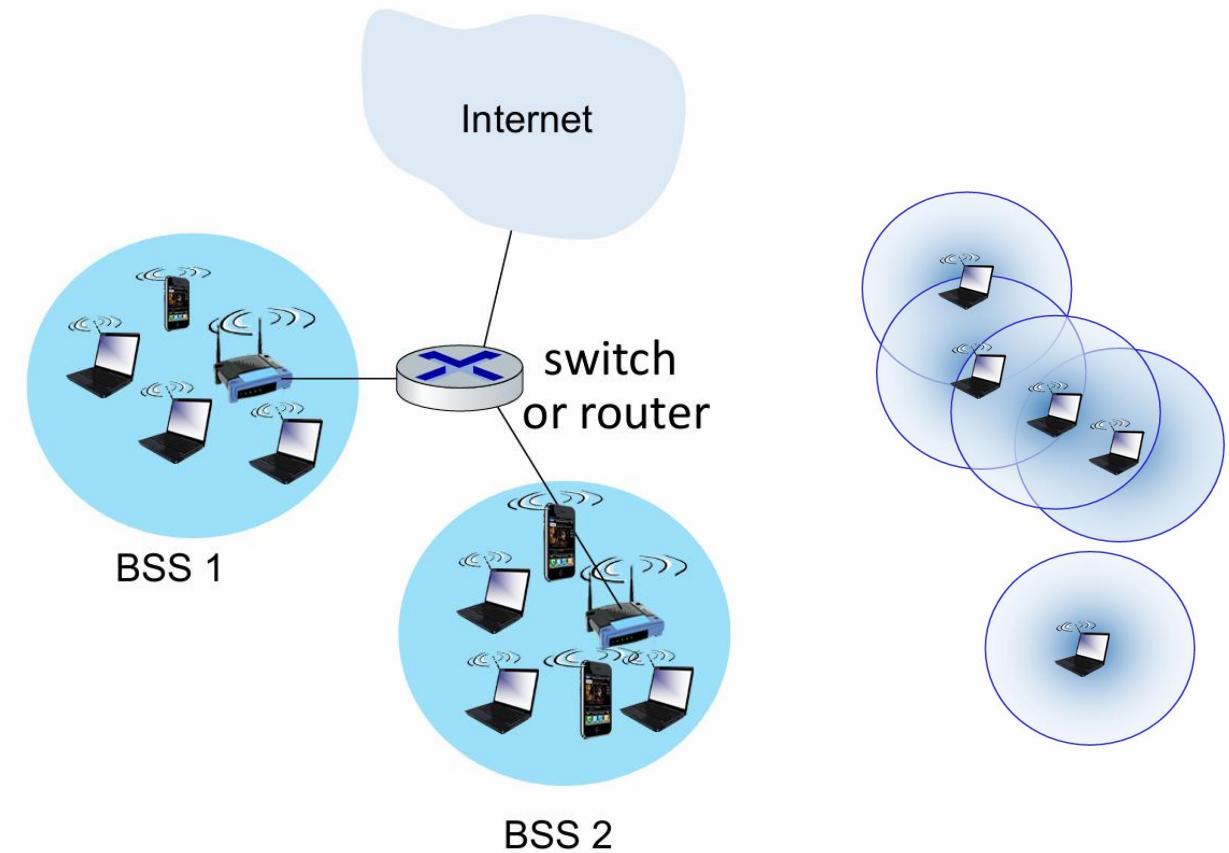
- Contents of Wifi-protocol (week 1)
- Wireshark + Security Vulnerability of Wifi-protocol (week 2)
- Security Vulnerability Attack practice with online platform (week 3)

IEEE 802.11 Wireless LAN (Wi-Fi)

- Technical Standard for Wireless LAN
- Started from 1997, currently revising
 - ex) Wifi 6E (802.11ax)
- Layer
 - Data Link Layer
 - Physical Layer

IEEE 802.11 Architecture

- Infrastructure mode
 - Access Point (Base station)
 - Basic Service Set (or cell)
 - cf. ESS
- Ad hoc mode



IEEE 802.11 Association

- Host scans channels & listening for Beacon Frames
 - Beacon frames: SSID(AP's name) + MAC address
- Select AP for authentication
 - EAPoL
- AP-Host association
- DHCP (host gets IP address)

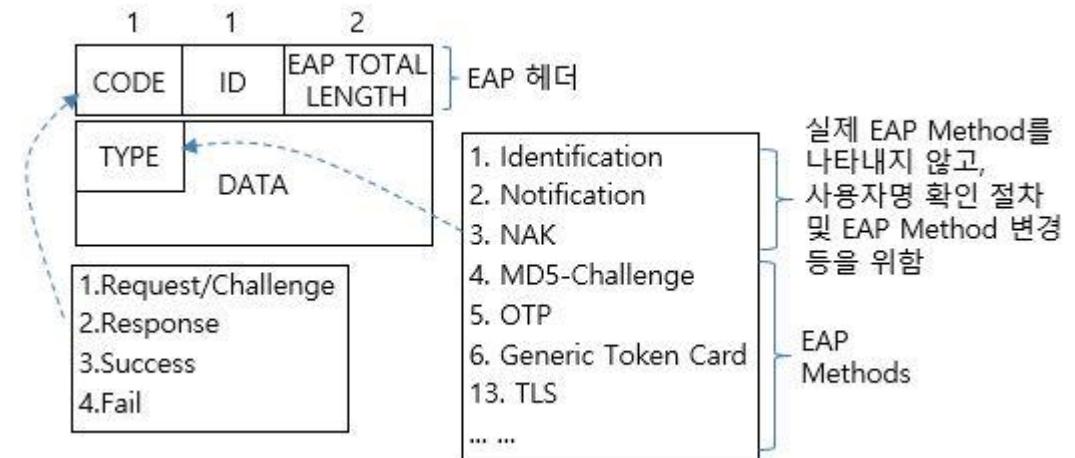
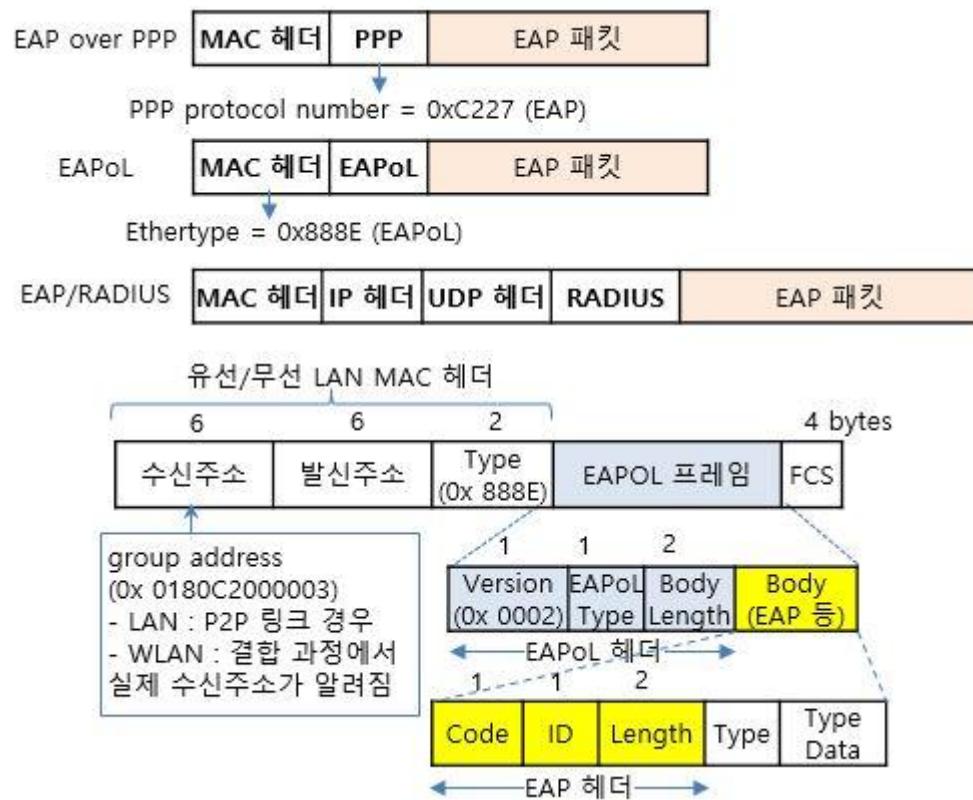


Beacon frame

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▼ IEEE 802.11 Beacon frame, Flags: .....
  Type/Subtype: Beacon frame (0x0008)
  ▼ Frame Control Field: 0x8000
    .... .00 = Version: 0
    .... 00.. = Type: Management frame (0)
    1000 .... = Subtype: 8
    ▶ Flags: 0x00
    .000 0000 0000 0000 = Duration: 0 microseconds
    ▶ Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)
    ▶ Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
    ▶ Transmitter address: Cisco_70:18:d0 (50:0f:80:70:18:d0)
    ▶ Source address: Cisco_70:18:d0 (50:0f:80:70:18:d0)
    ▶ BSS Id: Cisco_70:18:d0 (50:0f:80:70:18:d0)
    .... .... .... 0000 = Fragment number: 0
    1011 1101 1111 .... = Sequence number: 3039
    [WLAN Flags: ....]
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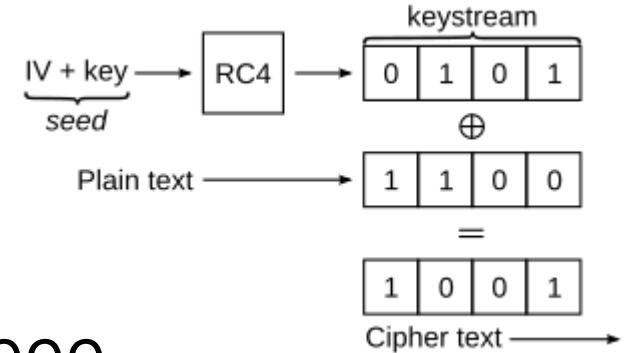
IEEE 802.11 EAPoL

- EAP(Extensible Authentication Protocol) Encapsulation over LAN
- Authentication Framework



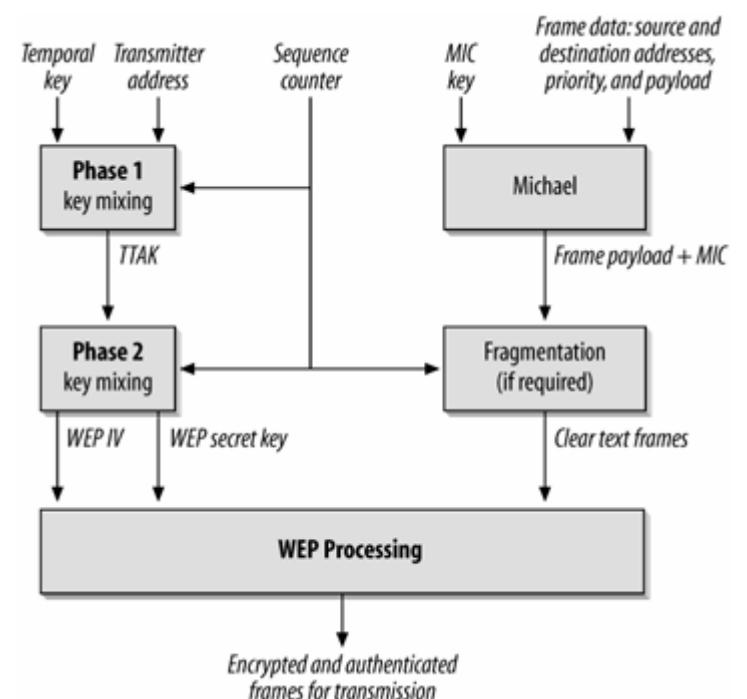
Encryption Method: WEP

- WEP: Wired Equivalent Privacy, Developed in 1999
- 4-step challenge and response
 - Client sends authentication request to AP
 - AP sends clear-text challenge to client
 - Client encrypts the text with WEP key and send it to AP
 - AP decrypts the response
- Weak security: Stream-Cipher with static key



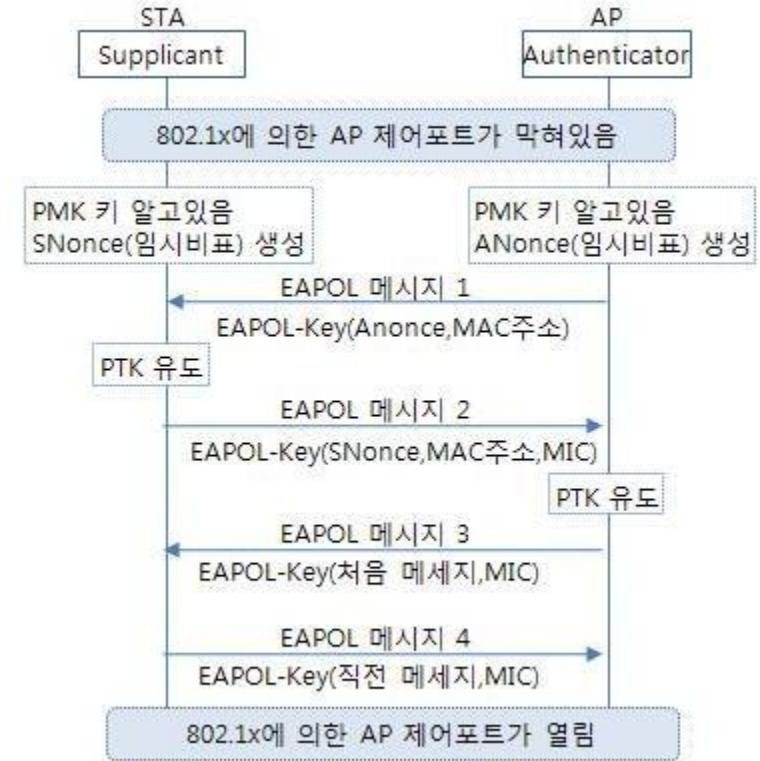
Encryption Method : WPA

- WPA: Wi-Fi Protected Access, also based on RC4
- WPA implements TKIP(Temporal Key Integrity Protocol)
 - key mixing function
 - Sequence counter
 - Message Integrity Check (replaces CRC)
- Weak security: Stream Cipher, MIC



PSK (Pre-Shared Key)

- Used in WPA/WPA2
- Authentication + PTK generation
- 4-way Handshake
 - AP sends a random number (ANonce) to client
 - Client responds with its random number (SNonce)
 - AP calculates PTK and sends an encrypted message to client.
 - Client decrypts the message with PTK



Encryption Method : WPA2

- WPA2 is enhanced version of WPA
- AES based Counter mode with CBC-MAC
- Weak security: MIC (4-way handshake)
- KRACK(Key Reinstallation Attack) (M3), PMKID offline dictionary attack(M1)

M1, M3

```
▼ 802.1X Authentication
  Version: 802.1X-2004 (2)
  Type: Key (3)
  Length: 117
  Key Descriptor Type: EAPOL RSN Key (2)
  [Message number: 1]
  ▼ Key Information: 0x008a
    .... .010 = Key Descriptor Version: AES Cipher, HMAC-SHA1 MIC (2)
    .... 1... = Key Type: Pairwise Key
    .... .00 ... = Key Index: 0
    .... .0... = Install: Not set
    .... 1... = Key ACK: Set
    .... 0... = Key MIC: Not set
    .... 0. .... = Secure: Not set
    .... 0. .... = Error: Not set
    .... 0. .... = Request: Not set
    ...0 .... = Encrypted Key Data: Not set
    ..0. .... = SMK Message: Not set
  Key Length: 16
  Replay Counter: 1
  WPA KeyNonce: 15adf473164f43a34f211ebc34495b588af5b915c0dd4478f5fbc89d2f7bd0fa
  Key IV: 00000000000000000000000000000000
  WPA Key RSC: 0000000000000000
  WPA Key ID: 0000000000000000
  WPA Key MIC: 00000000000000000000000000000000
  WPA Key Data Length: 22
  ▼ WPA Key Data: dd14000fac04b9c9f71f0c96f62b6c11f545d2dff41b
    ▼ Tag: Vendor Specific: IEEE 802.11: RSN PMKID
      Tag Number: Vendor Specific (221)
      Tag length: 20
      OUI: 00:0f:ac (IEEE 802.11)
      Vendor Specific OUI Type: 4
      Data Type: PMKID KDE (4)
      PMKID: b9c9f71f0c96f62b6c11f545d2dff41b
```

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▼ 802.1X Authentication
  Version: 802.1X-2004 (2)
  Type: Key (3)
  Length: 151
  Key Descriptor Type: EAPOL RSN Key (2)
  [Message number: 3]
  ▼ Key Information: 0x13ca
    .... .... .010 = Key Descriptor Version: AES Cipher, HMAC-SHA1 MIC (2)
    .... .... 1... = Key Type: Pairwise Key
    .... .... .00 ... = Key Index: 0
    .... .... 1.. = Install: Set
    .... .... 1... = Key ACK: Set
    .... .... 1. .... = Key MIC: Set
    .... .... 1. .... = Secure: Set
    .... .... 0.. .... = Error: Not set
    .... 0... .... = Request: Not set
    ...1 .... = Encrypted Key Data: Set
    ..0. .... = SMK Message: Not set
  Key Length: 16
  Replay Counter: 2
  WPA KeyNonce: 15adf473164f43a34f211ebc34495b588af5b915c0dd4478f5fbc89d2f7bd0fa
  Key IV: 00000000000000000000000000000000
  WPA Key RSC: 0000000000000000
  WPA Key ID: 0000000000000000
  WPA Key MIC: e481fe9d4a2e0a53dd1119fb36104330
  WPA Key Data Length: 56
  WPA Key Data: b43c7737faedb17306b5ea1d5059fd5379d0145fa6ddac1e08d460de93cd72c103a7f
```

Encryption Method : WPA3

- 192-bit encryption in WPA3-Enterprise mode
- SAE(Simultaneous Authentication of Equals) instead of PSK (Pre-Shared Key) exchange
- Safe and personalized encryption
- Evil Twin, Fragattack (WEP~WPA3)

SAE (Simultaneous Authentication of Equals)

- Password-authenticated key exchange (PAKE)
- Dragonfly handshake
- Forward secrecy guaranteed
- Dragonblood attack(Downgrade attack, Timing/Cache-based side-channel attack, DoS attack)