Wifi-Protocol-1

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Plan

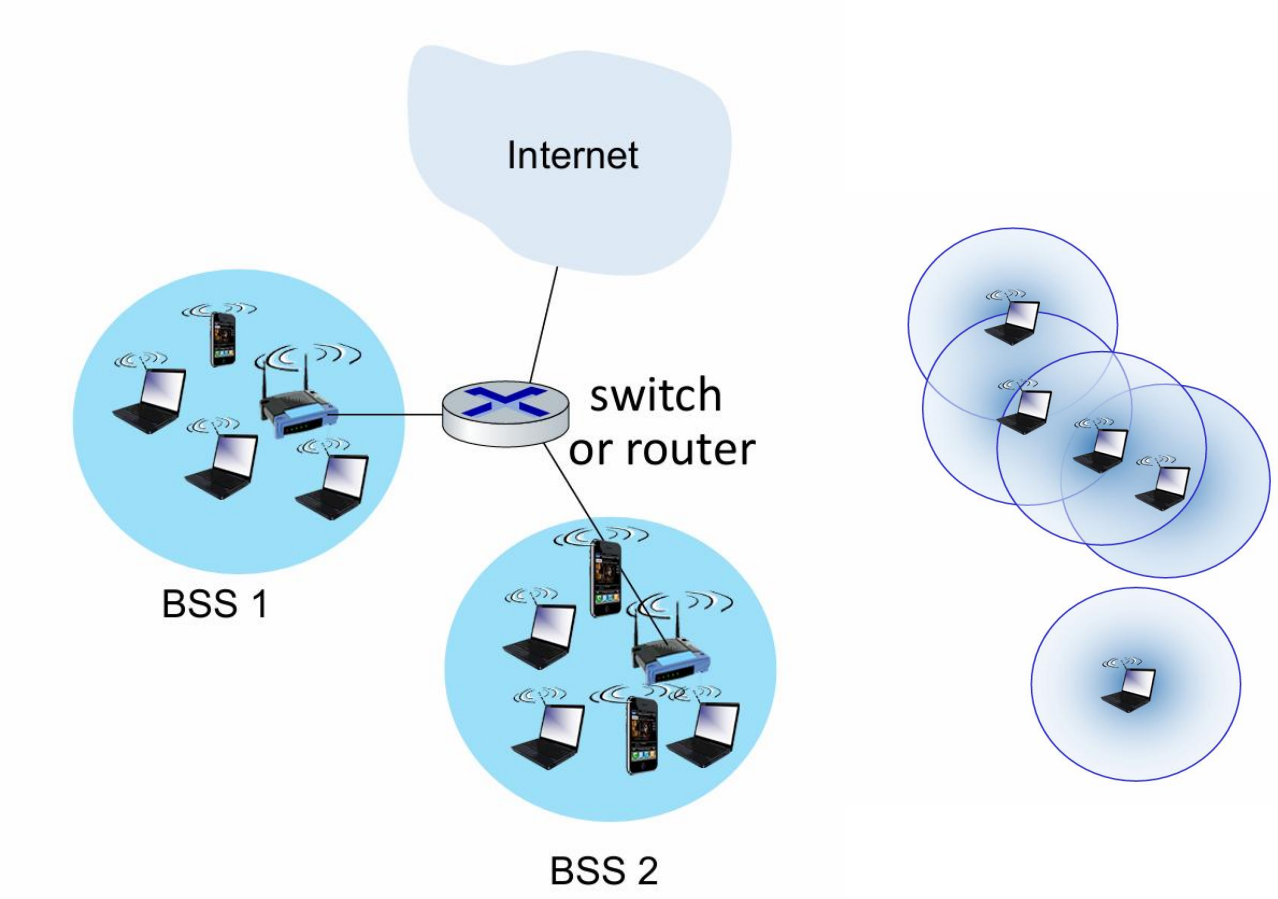
- Contents of Wifi-protocol (week 1)
- WireShark + Security Vulnerability of Wifi-protocol (week 2)
- Security Vulnerability Attack practice with online platform (week 3)

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

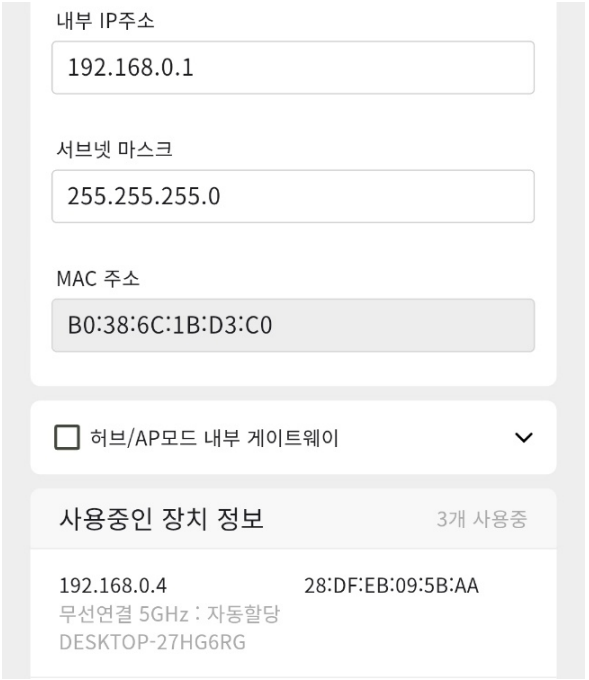
IEEE 802.11 Architecture

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

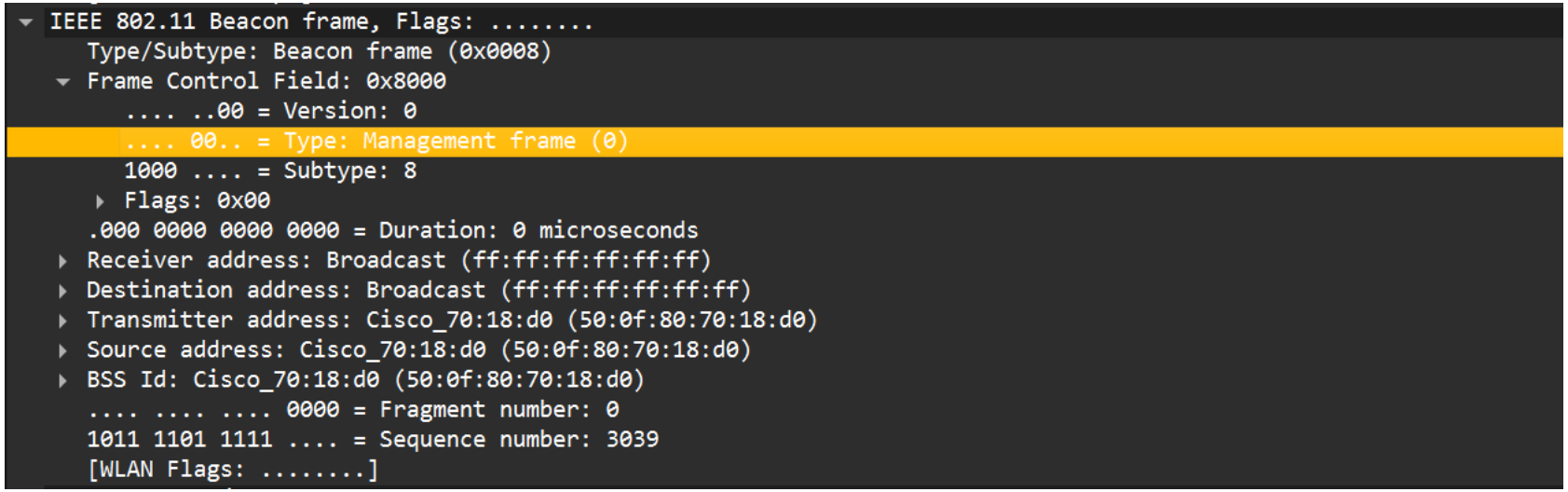


IEEE 802.11 Association

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

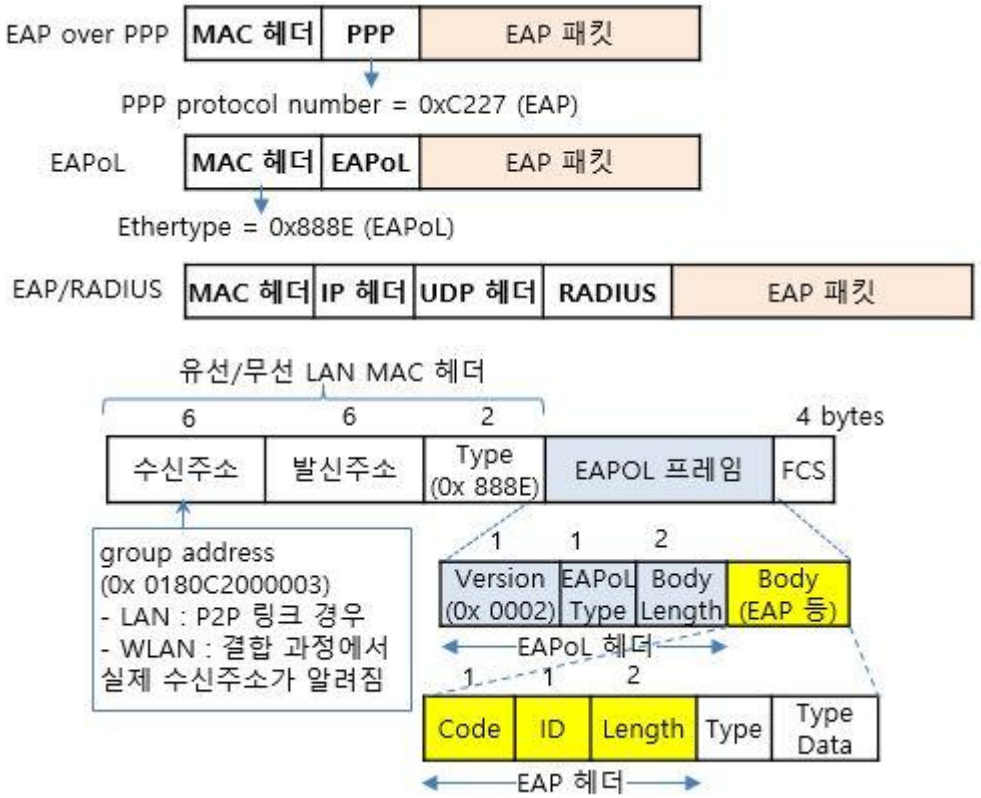


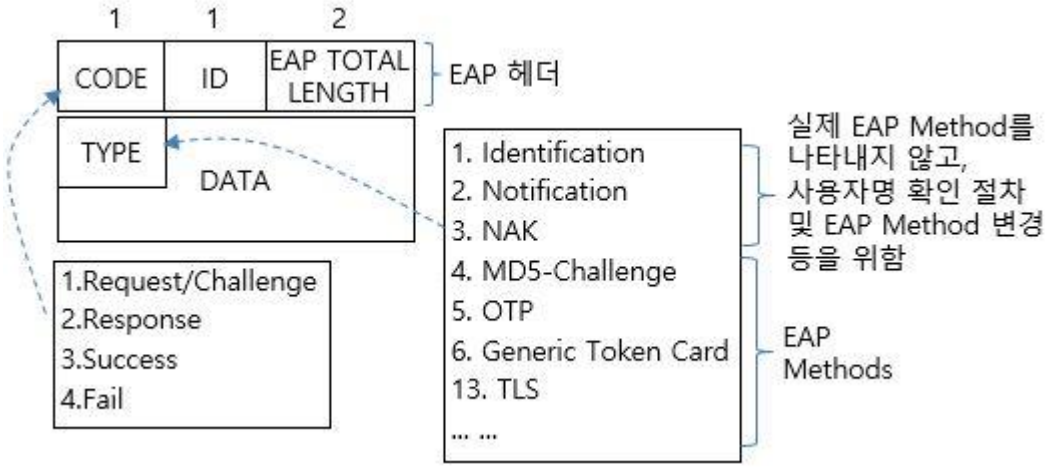
Beacon frame



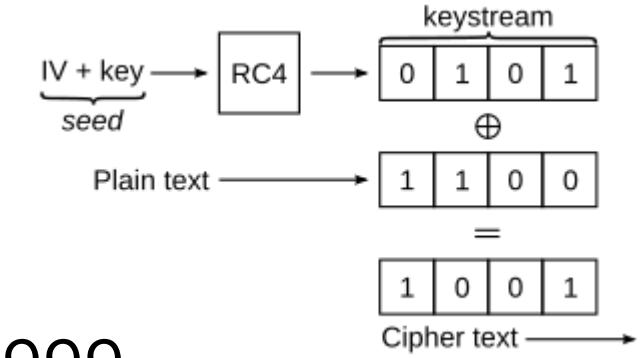
IEEE 802.11 EAPoL

- 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

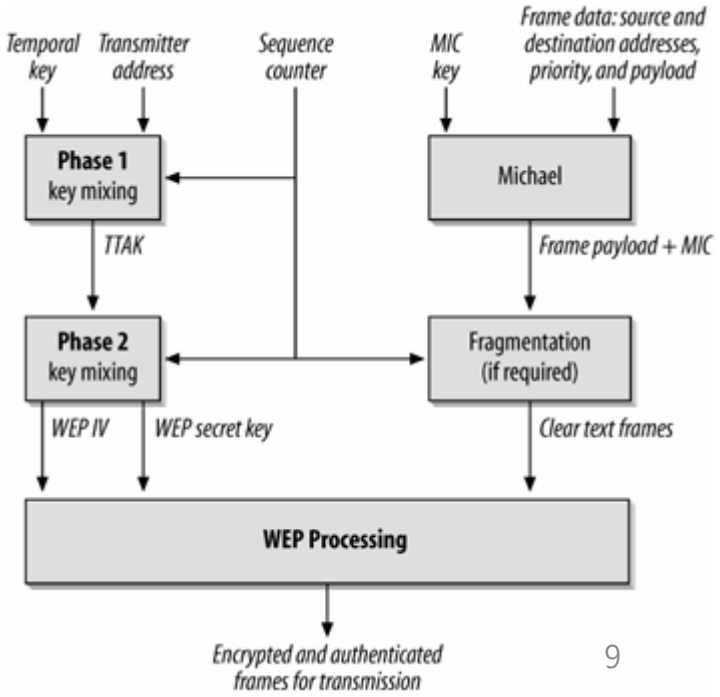
- Weak security: Stream-Cipher(RC4) with static key

Encryption Method : WPA

- WPA: Wi-Fi Protected Access, also based on RC4

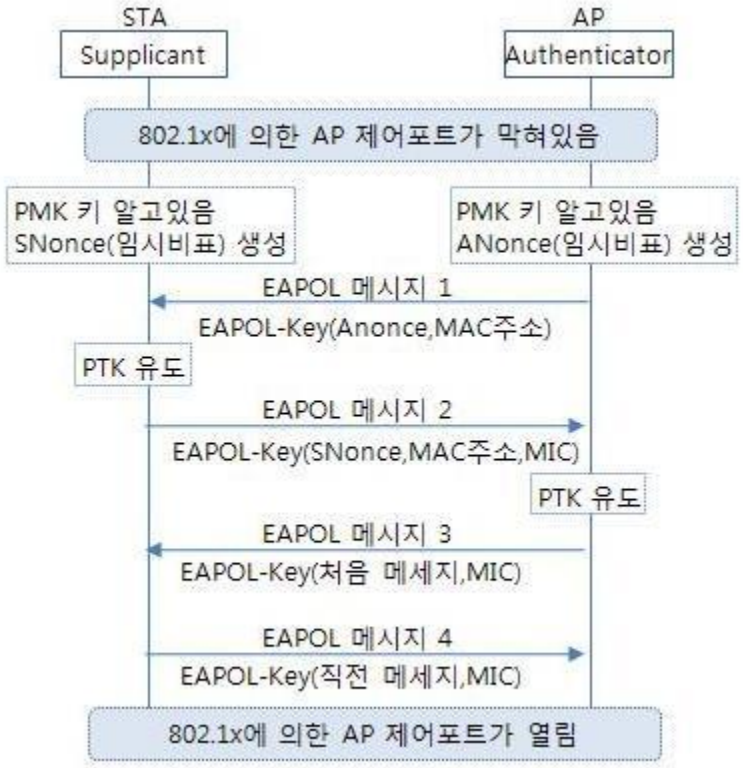
- WPA implements TKIP(Temporal Key Integrity Protocol)
  - key mixing function
  - Sequence counter
  - Message Integrity Check (replaces CRC)

- Weak security: Stream Cipher(TKIP)



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: 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 Key Nonce: 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 Key Nonce: 15adf473164f43a34f211ebc34495b588af5b915c0dd4478f5fbc89d2f7bd0fa
    Key IV: 00000000000000000000000000000000
    WPA Key RSC: 0000000000000000
    WPA Key ID: 0000000000000000
    WPA Key MIC: e481fe9d4a2e0a53dd1119fb36104330
    WPA Key Data Length: 56
    WPA Key Data: b43c7737faedbf17306b5ea1d5059fd5379d0145fa6ddac1e08d460de93cd72c103a7f
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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
- Wifi-vulnerability: 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)