SharkFest'25 EUROPE

Wireless with Wireshark

Scanning wireless to find devices with Wireshark

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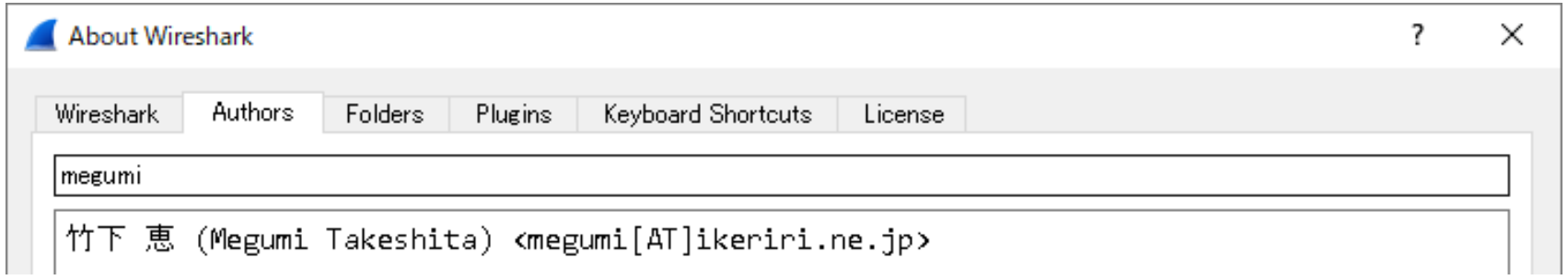
please download the trace files and scripts at
https://www.ikeriri.ne.jp/sharkfest/ikeriri25eu.zip

Megumi Takeshita, Packet Otaku, ikeriri network service

- Worked SE/IS at BayNetwork, Nortel
- Reseller of CACE technologies in 2008
- Founder, ikeriri network service co., ltd
  Reseller of packet capture / wireless-tools
- Wrote 10+ books about Wireshark in Japanese
- Instruct Wireshark to JSDF etc.
- Lecturer of CHUO University
- One of the contributors to Wireshark
  Translate Wireshark into Japanese



Session Overview

Wireshark is a tool for analyzing both wireless and wired networks. In this session, Megumi will show you how to find devices on your wireless network. With various scanning tools, we can explore different standards of WiFi networks and Bluetooth using Wireshark. Additionally, tshark and other Wireshark command-line interface (CLI) tools are helpful in collecting and summarize device information. Use Wireshark to manage your wireless environment and enhance your security!!

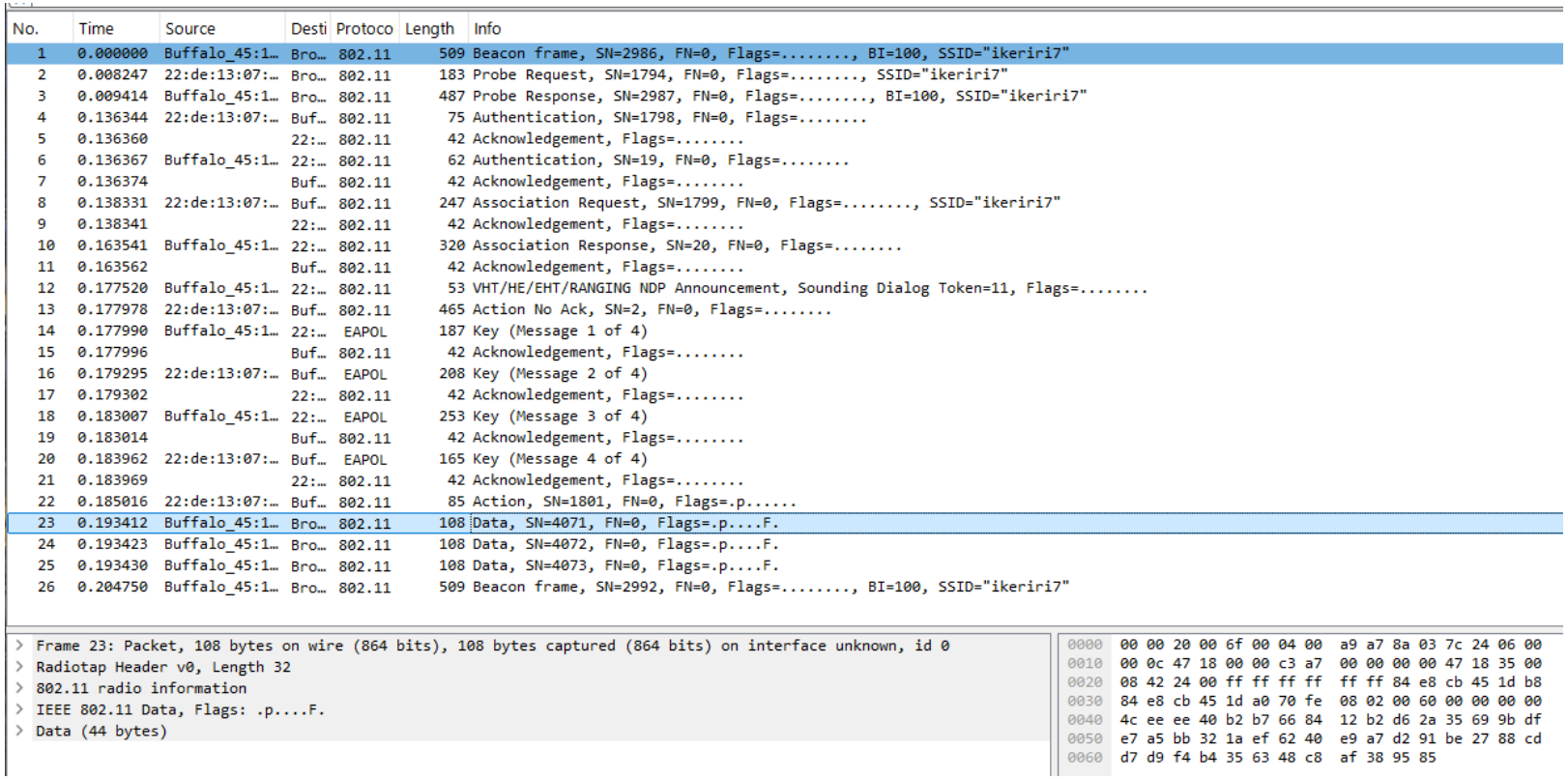
Customize Wireshark for Wireless

Set Aliases, Columns, Display Filter buttons, Coloring Rules

#sf25eu

Wireless with Wireshark

- Open trace file wifi7.pcapng
- It is the typical wifi7 connection sequence between Buffalo AP and iphone16 Pro STA
- Let's start Wireless analysis with Wireshark



No.	Time	Source	Desti	Protoco	Length	Info
1	0.000000	Buffalo_45:1…	Bro…	802.11	509	Beacon frame, SN=2986, FN=0, Flags=........, BI=100, SSID="ikeriri7"
2	0.008247	22:de:13:07:…	Bro…	802.11	183	Probe Request, SN=1794, FN=0, Flags=........, SSID="ikeriri7"
3	0.009414	Buffalo_45:1…	Bro…	802.11	487	Probe Response, SN=2987, FN=0, Flags=........, BI=100, SSID="ikeriri7"
4	0.136344	22:de:13:07:…	Buf…	802.11	75	Authentication, SN=1798, FN=0, Flags=........
5	0.136360		22:…	802.11	42	Acknowledgement, Flags=........
6	0.136367	Buffalo_45:1…	22:…	802.11	62	Authentication, SN=19, FN=0, Flags=........
7	0.136374		Buf…	802.11	42	Acknowledgement, Flags=........
8	0.138331	22:de:13:07:…	Buf…	802.11	247	Association Request, SN=1799, FN=0, Flags=........, SSID="ikeriri7"
9	0.138341		22:…	802.11	42	Acknowledgement, Flags=........
10	0.163541	Buffalo_45:1…	22:…	802.11	320	Association Response, SN=20, FN=0, Flags=........
11	0.163562		Buf…	802.11	42	Acknowledgement, Flags=........
12	0.177520	Buffalo_45:1…	22:…	802.11	53	VHT/HE/EHT/RANGING NDP Announcement, Sounding Dialog Token=11, Flags=........
13	0.177978	22:de:13:07:…	Buf…	802.11	465	Action No Ack, SN=2, FN=0, Flags=........
14	0.177990	Buffalo_45:1…	22:…	EAPOL	187	Key (Message 1 of 4)
15	0.177996		Buf…	802.11	42	Acknowledgement, Flags=........
16	0.179295	22:de:13:07:…	Buf…	EAPOL	208	Key (Message 2 of 4)
17	0.179302		22:…	802.11	42	Acknowledgement, Flags=........
18	0.183007	Buffalo_45:1…	22:…	EAPOL	253	Key (Message 3 of 4)
19	0.183014		Buf…	802.11	42	Acknowledgement, Flags=........
20	0.183962	22:de:13:07:…	Buf…	EAPOL	165	Key (Message 4 of 4)
21	0.183969		22:…	802.11	42	Acknowledgement, Flags=........
22	0.185016	22:de:13:07:…	Buf…	802.11	85	Action, SN=1801, FN=0, Flags=.p.....
23	0.193412	Buffalo_45:1…	Bro…	802.11	108	Data, SN=4071, FN=0, Flags=.p....F.
24	0.193423	Buffalo_45:1…	Bro…	802.11	108	Data, SN=4072, FN=0, Flags=.p....F.
25	0.193430	Buffalo_45:1…	Bro…	802.11	108	Data, SN=4073, FN=0, Flags=.p....F.
26	0.204750	Buffalo_45:1…	Bro…	802.11	509	Beacon frame, SN=2992, FN=0, Flags=........, BI=100, SSID="ikeriri7"

```
> Frame 23: Packet, 108 bytes on wire (864 bits), 108 bytes captured (864 bits) on interface unknown, id 0
> Radiotap Header v0, Length 32
> 802.11 radio information
> IEEE 802.11 Data, Flags: .p....F.
> Data (44 bytes)
```

```
0000  00 00 20 00 6f 00 04 00  a9 a7 8a 03 7c 24 06 00
0010  00 0c 47 18 00 00 c3 a7  00 00 00 00 47 18 35 00
0020  08 42 24 00 ff ff ff ff  ff ff 84 e8 cb 45 1d b8
0030  84 e8 cb 45 1d a0 70 fe  08 02 00 60 00 00 00 00
0040  4c ee ee 40 b2 b7 66 84  12 b2 d6 2a 35 69 9b df
0050  e7 a5 bb 32 1a ef 62 40  e9 a7 d2 91 be 27 88 cd
0060  d7 d9 f4 b4 35 63 48 c8  af 38 95 85
```

Add alias name on ethers

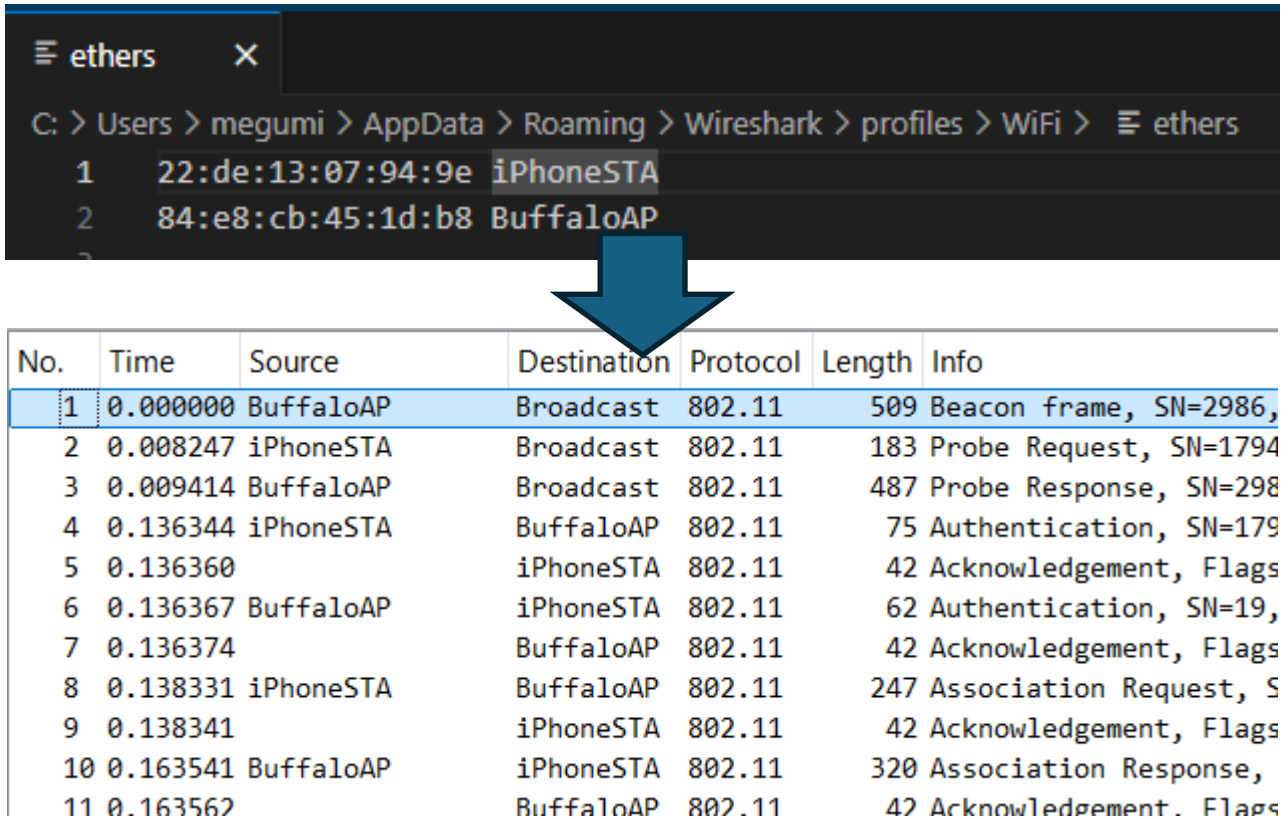
In wireless analysis, you need to work with MAC addresses rather than IP addresses.

Adding an alias to the ethers file in your profile is essential.

Aliases help you easily identify your known Aps and STAs.

Edit ethers on your Wireshark profile directory
Help>About Wireshark
Select the Folders tab and look for personal configuration

We can use alias names in display filter, Endpoints, Conversations, I/O Graph, Flow diagram and so on



Add columns on Packet List

No.	Time	PHY type	CH	Freq.	Signal	MCS	Rate	Retry	Type/Subtype	Source	Destination	SSID	BSSID	STA	Length	Info
1	0.000000	802.11a (OFD…	53	6215M…	-62 d…		6		Beacon frame	Buffalo_45:…	Broadcast	"ikeri…	Buffalo_45:1d:…		509	Beacon frame, SN
2	0.008247	802.11a (OFD…	53	6215M…	-58 d…		6		Probe Reque…	22:de:13:07…	Broadcast	"ikeri…	Buffalo_45:1d:…		183	Probe Request, S
3	0.009414	802.11a (OFD…	53	6215M…	-62 d…		6		Probe Respo…	Buffalo_45:…	Broadcast	"ikeri…	Buffalo_45:1d:…		487	Probe Response,

Displayed	Title	Type	Custom Expression
☑	No.	Number	
☑	Time	Time (format as specified)	
☑	PHY type	Custom	wlan_radio.phy
☑	CH	Custom	wlan_radio.channel
☑	Freq.	Custom	wlan_radio.frequency
☑	Signal	Custom	radiotap.dbm_antsignal
☑	MCS	Custom	radiotap.mcs.index
☑	Rate	Custom	radiotap.datarate
☑	Retry	Custom	wlan.fc.retry.expert
☑	Type/Subtype	Custom	wlan.fc.type_subtype
☑	Source	Source address	
☑	Destination	Destination address	
☑	Length	Packet length (bytes)	
☑	STA	Custom	wlan.staa
☑	BSSID	Custom	wlan.bssid
☑	SSID	Custom	wlan.ssid
☑	Info	Information	

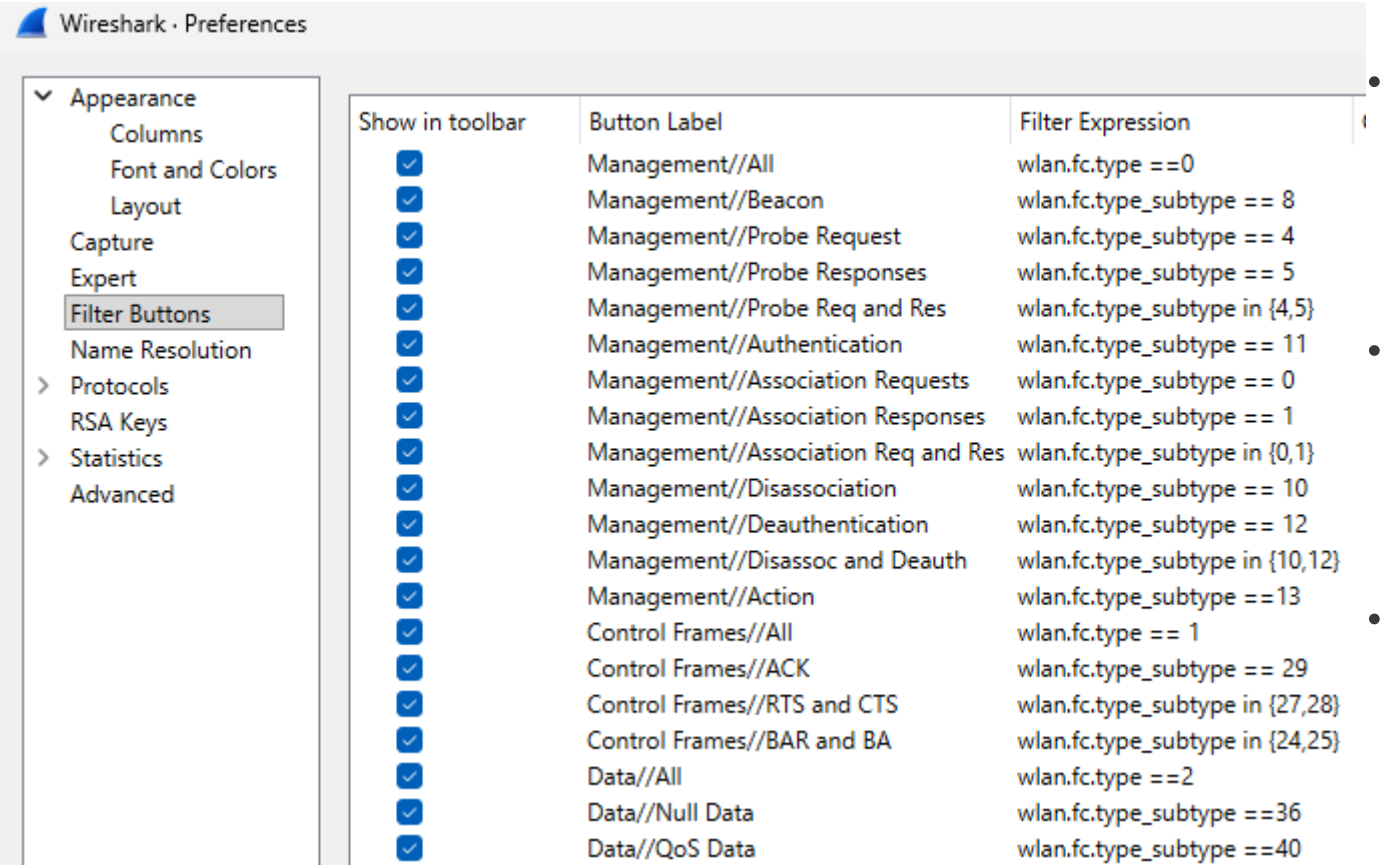
- Add columns to your Packet List
- You can drag and drop the field into Column tabs directly, or select Edit > Preferences > Appearance > Columns
- Add columns for WiFi analysis. Recommended fields are PHY type, CH, Freq, Signal, MCS, Rate, Retry, Type/Subtype, STA, BSSID and SSID
- We do not need the Packet length, so check out the Displayed checkbox

IEEE802.11 frame type/subtype

Type	Type and Subtype	
Management wlan.fc.type==0	Used by management of WiFi network	Beacon wlan.fc.type_subtype==8
		Probe Request wlan.fc.type_subtype==4
		Probe Response wlan.fc.type_subtype==5
		Authentication wlan.fc.type_subtype==11
		Deauthentication wlan.fc.type_subtype==12
		Association Request wlan.fc.type_subtype==0
		Asociation Response wlan.fc.type_subtype==1
		Disassociation wlan.fc.type_subtype==10
		Action wlan.fc.type_subtype==13
Control wlan.fc.type==1	Used by control of data communication	RTS (Request To Send) wlan.fc.type_subtype==27
		CTS (Clear To Send) wlan.fc.type_subtype==28
		ACK (ACKnowledge) wlan.fc.type_subtype==29
		BAR (Block ACK Request) wlan.fc.type_subtype==24
		BA(Block ACK) wlan.fc.type_subtype==25
Data wlan.fc.type==2	Data(with ACK) wlan.fc.type_subtype==20 Null Data(No data) wlan.fc.type_subtype==36 QoS Data(with BlockACK) wlan.fc.type_subtype==40	

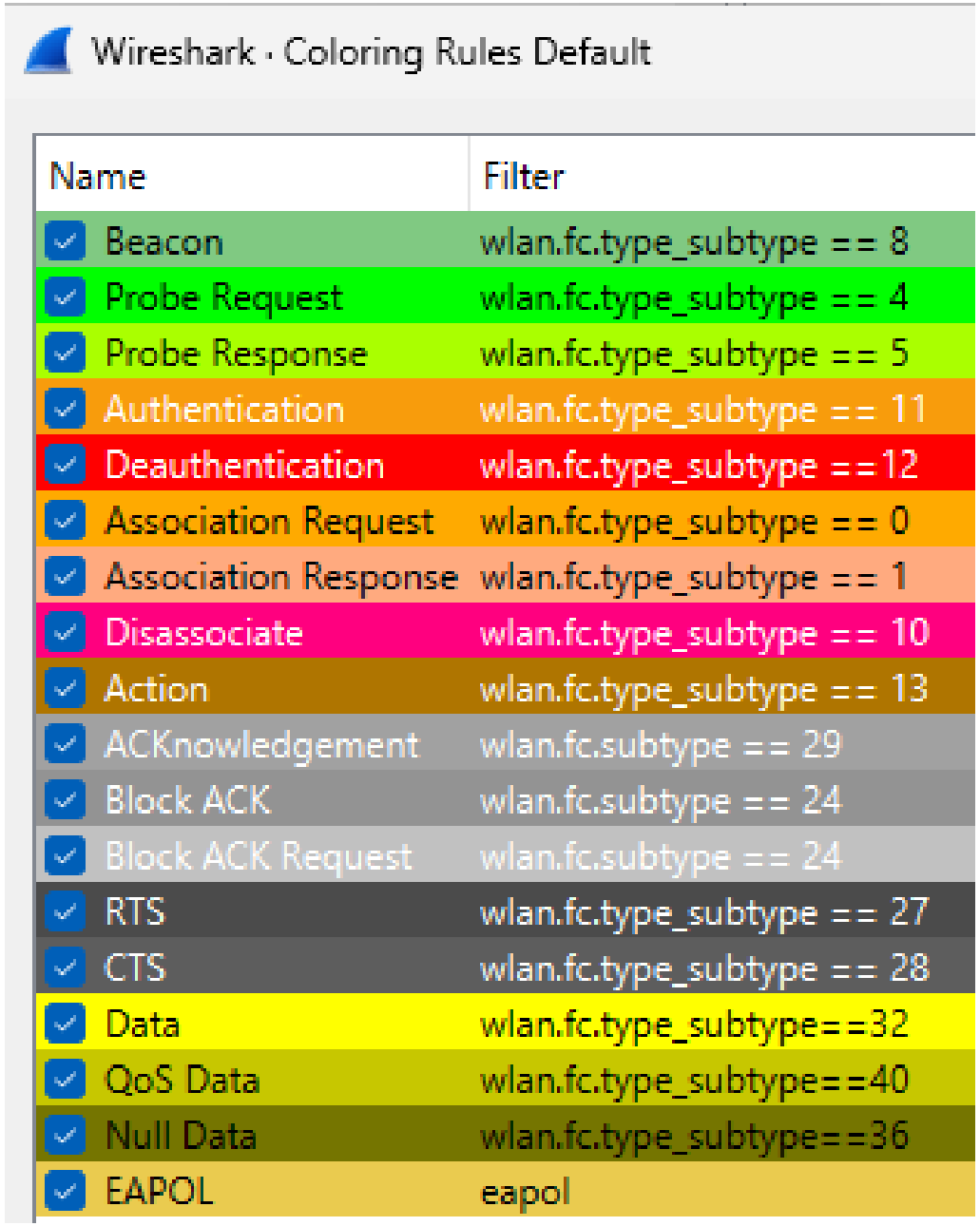
- First, we need to know frame types and subtypes of the IEEE802.11 frame
- Here are the common types and subtypes of WiFi.

Add Filter Buttons



- Choose Edit -> Preference, select Appearance -> Filter Buttons.
- Create Parent Item // Children Items and set Filter Expression on each Items
- You can filter multiple WiFi type/subtypes like wlan.fc.type_subtype in { 4,5 }
- The filter button helps you to distinguish frames and understand the WiFi sequence easily

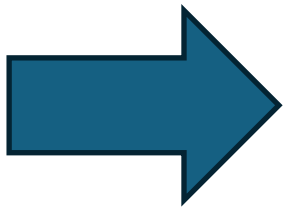
Add coloring Rules for WiFi analysis

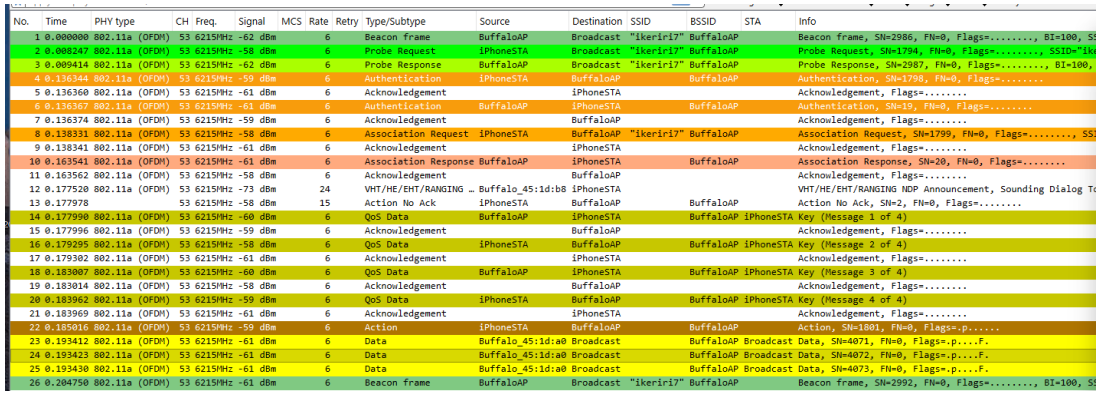


- View>Coloring Rules
- Set different colors by frame types and subtype
  Beacon, Probe Request Probe Authentication, Deauthentication, Association Request, Association Response, Disassociate, Action, ACKnoledgement, Block ACK, Block ACK Request, RTS, CTS, EAPOL, Data, QoS Data and Null Data
- It helps to understand the sequence of the WiFi connection easily

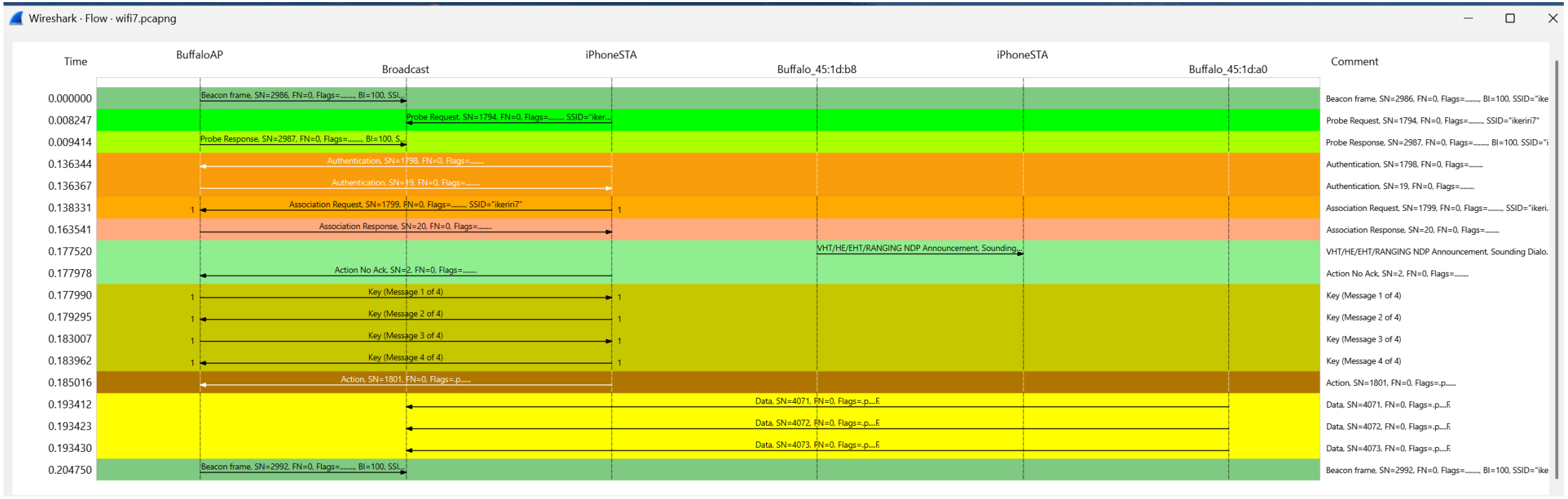
Add coloring Rules for WiFi analysis

No.	Time	PHY type	CH	Freq.	Signal	MCS	Rate	Retry	Type/Subtype	Source	Destination	SSID	BSSID	STA	Info
1	0.000000	802.11a (OFDM)	53	6215MHz	-62 dBm		6		Beacon frame	BuffaloAP	Broadcast	"ikeriri7"	BuffaloAP		Beacon frame, SN=2986, FN=0, Flags=........, BI=100, S
2	0.008247	802.11a (OFDM)	53	6215MHz	-58 dBm		6		Probe Request	iPhoneSTA	Broadcast	"ikeriri7"	BuffaloAP		Probe Request, SN=1794, FN=0, Flags=........, SSID="ik
3	0.009414	802.11a (OFDM)	53	6215MHz	-62 dBm		6		Probe Response	BuffaloAP	Broadcast	"ikeriri7"	BuffaloAP		Probe Response, SN=2987, FN=0, Flags=........, BI=100,
4	0.136344	802.11a (OFDM)	53	6215MHz	-59 dBm		6		Authentication	iPhoneSTA	BuffaloAP		BuffaloAP		Authentication, SN=1798, FN=0, Flags=........
5	0.136360	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Acknowledgement		iPhoneSTA				Acknowledgement, Flags=........
6	0.136367	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Authentication	BuffaloAP	iPhoneSTA		BuffaloAP		Authentication, SN=19, FN=0, Flags=........
7	0.136374	802.11a (OFDM)	53	6215MHz	-59 dBm		6		Acknowledgement		BuffaloAP				Acknowledgement, Flags=........
8	0.138331	802.11a (OFDM)	53	6215MHz	-58 dBm		6		Association Request	iPhoneSTA	BuffaloAP	"ikeriri7"	BuffaloAP		Association Request, SN=1799, FN=0, Flags=........, SS
9	0.138341	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Acknowledgement		iPhoneSTA				Acknowledgement, Flags=........
10	0.163541	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Association Response	BuffaloAP	iPhoneSTA		BuffaloAP		Association Response, SN=20, FN=0, Flags=........
11	0.163562	802.11a (OFDM)	53	6215MHz	-58 dBm		6		Acknowledgement		BuffaloAP				Acknowledgement, Flags=........
12	0.177520	802.11a (OFDM)	53	6215MHz	-73 dBm		24		VHT/HE/EHT/RANGING …	Buffalo_45:1d:b8	iPhoneSTA				VHT/HE/EHT/RANGING NDP Announcement, Sounding Dialog T
13	0.177978		53	6215MHz	-58 dBm		15		Action No Ack	iPhoneSTA	BuffaloAP		BuffaloAP		Action No Ack, SN=2, FN=0, Flags=........
14	0.177990	802.11a (OFDM)	53	6215MHz	-60 dBm		6		QoS Data	BuffaloAP	iPhoneSTA		BuffaloAP	iPhoneSTA	Key (Message 1 of 4)
15	0.177996	802.11a (OFDM)	53	6215MHz	-59 dBm		6		Acknowledgement		BuffaloAP				Acknowledgement, Flags=........
16	0.179295	802.11a (OFDM)	53	6215MHz	-58 dBm		6		QoS Data	iPhoneSTA	BuffaloAP		BuffaloAP	iPhoneSTA	Key (Message 2 of 4)
17	0.179302	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Acknowledgement		iPhoneSTA				Acknowledgement, Flags=........
18	0.183007	802.11a (OFDM)	53	6215MHz	-60 dBm		6		QoS Data	BuffaloAP	iPhoneSTA		BuffaloAP	iPhoneSTA	Key (Message 3 of 4)
19	0.183014	802.11a (OFDM)	53	6215MHz	-58 dBm		6		Acknowledgement		BuffaloAP				Acknowledgement, Flags=........
20	0.183962	802.11a (OFDM)	53	6215MHz	-59 dBm		6		QoS Data	iPhoneSTA	BuffaloAP		BuffaloAP	iPhoneSTA	Key (Message 4 of 4)
21	0.183969	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Acknowledgement		iPhoneSTA				Acknowledgement, Flags=........
22	0.185016	802.11a (OFDM)	53	6215MHz	-59 dBm		6		Action	iPhoneSTA	BuffaloAP		BuffaloAP		Action, SN=1801, FN=0, Flags=.p.....
23	0.193412	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Data	Buffalo_45:1d:a0	Broadcast		BuffaloAP	Broadcast	Data, SN=4071, FN=0, Flags=.p....F.
24	0.193423	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Data	Buffalo_45:1d:a0	Broadcast		BuffaloAP	Broadcast	Data, SN=4072, FN=0, Flags=.p....F.
25	0.193430	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Data	Buffalo_45:1d:a0	Broadcast		BuffaloAP	Broadcast	Data, SN=4073, FN=0, Flags=.p....F.
26	0.204750	802.11a (OFDM)	53	6215MHz	-61 dBm		6		Beacon frame	BuffaloAP	Broadcast	"ikeriri7"	BuffaloAP		Beacon frame, SN=2992, FN=0, Flags=........, BI=100, S

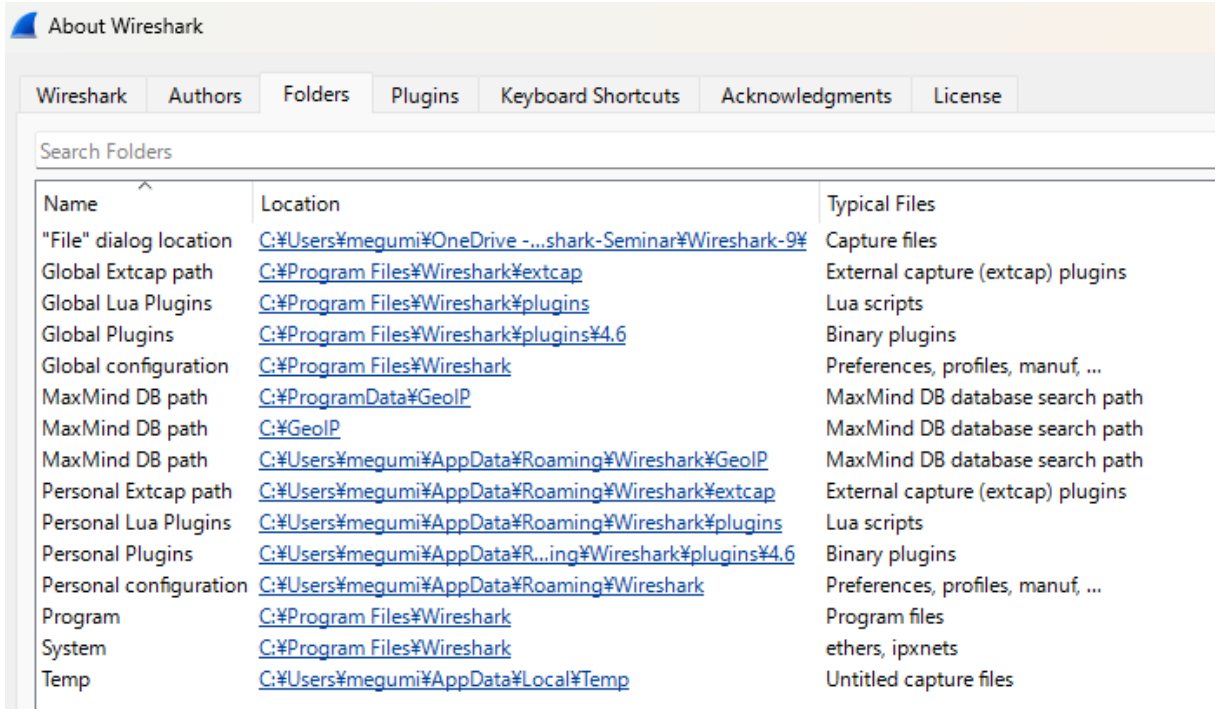


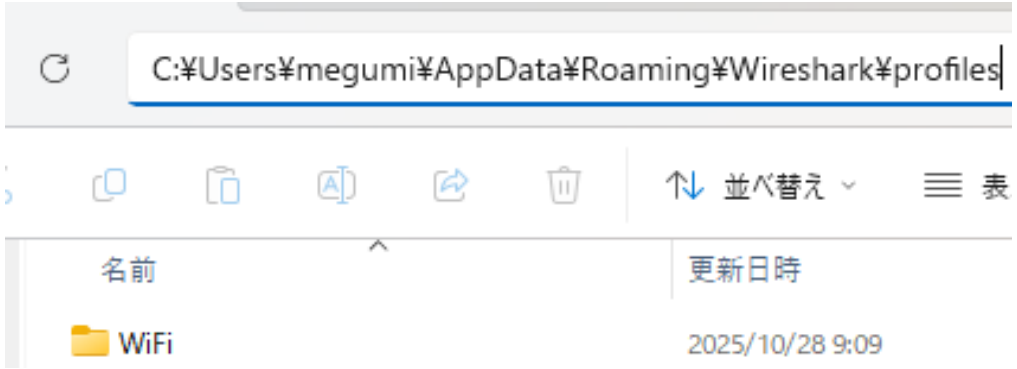


- Check on Colorize button and Statistics -> Flow Graph



Copy the profile into your environment



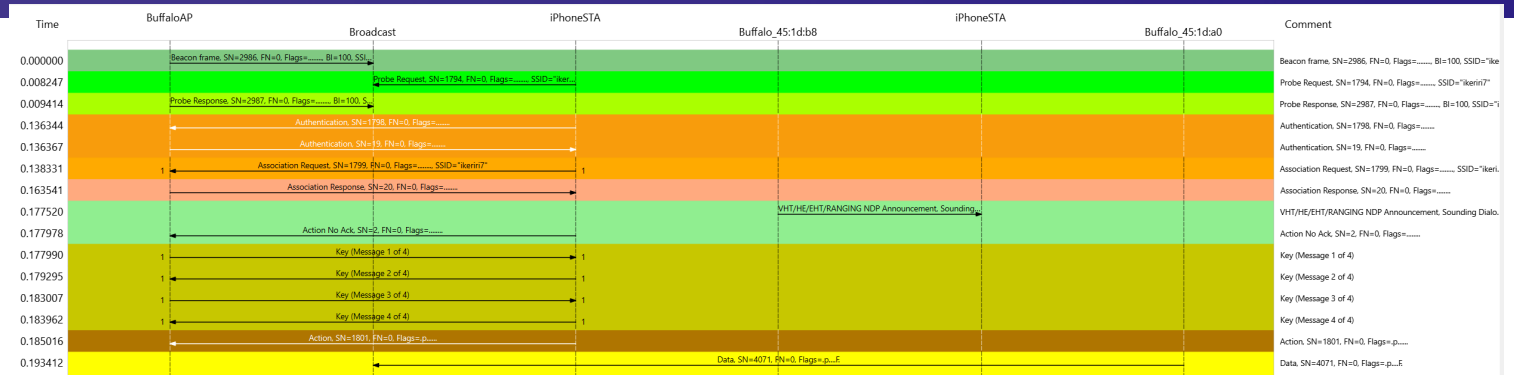


- Help -> About Wireshark -> Folders to find your personal configuration location
- Copy WiFi folder (extract from WiFi.zip) into your profile directory (for example, copy into C:¥Users¥username¥AppData¥Roaming¥Wireshark¥profiles if you use Wireshark in Windows)
- Change your Wireshark profile, click the right bottom Profile button and change it from Default to WiFi

Basic Connection sequence

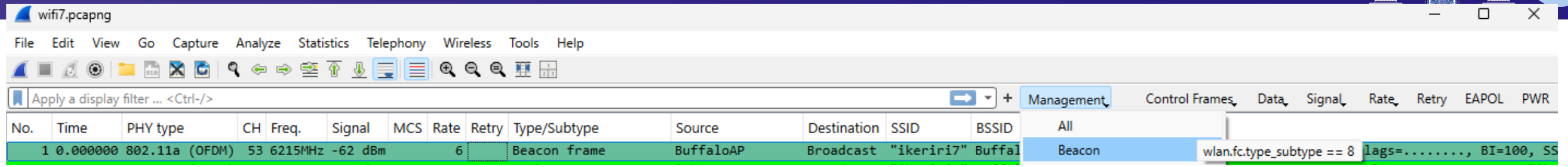
Beacons, Probes, Authentications, Associations and 4-way Handshake

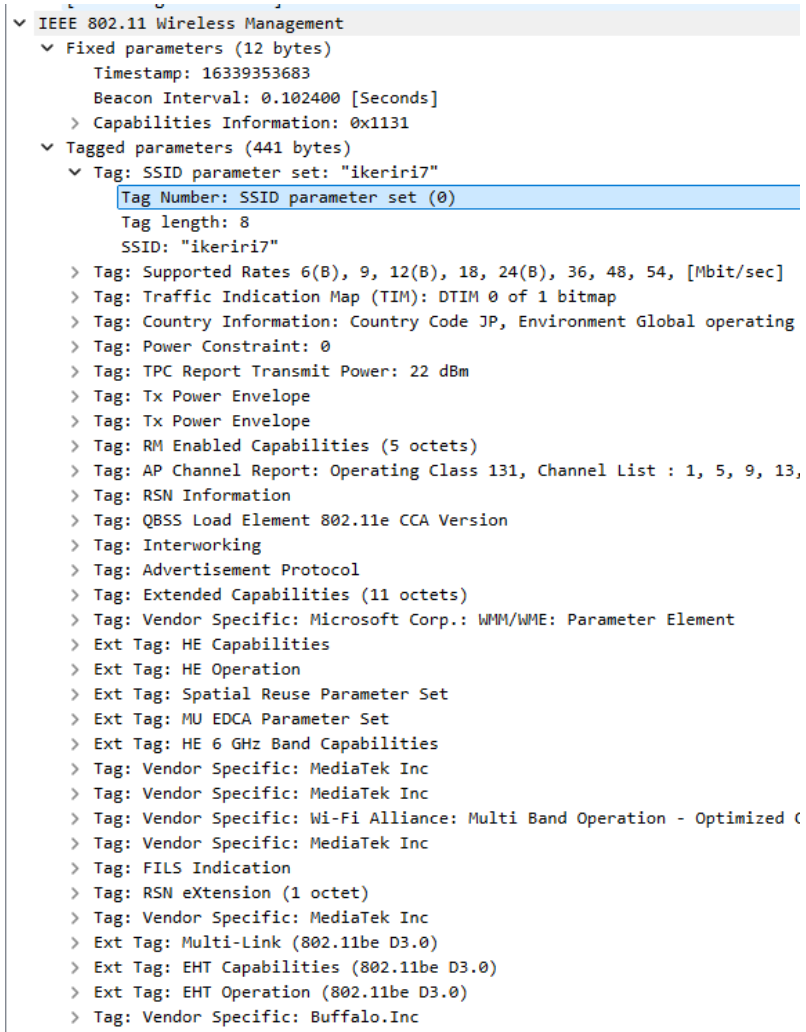
Basic Connection sequence



- APs send Beacons periodically (every 100ms in usual)
- STA sends Probe Requests to determine the best AP, AP sends back Probe Response including AP specifications.
- STA and AP exchange Authentication frames (WPA2: Basic Authentication, WPA3: Simultaneous Authentication of Equals)
- STA sends Association Request and AP sends back Association Response to negotiate exchange Association frames, including the actual connection settings between STA and AP
- STA and AP start EAPOL 4-way handshake to create PTK for unicast, AP sends GTK for multicast, broadcast.

Beacon frame



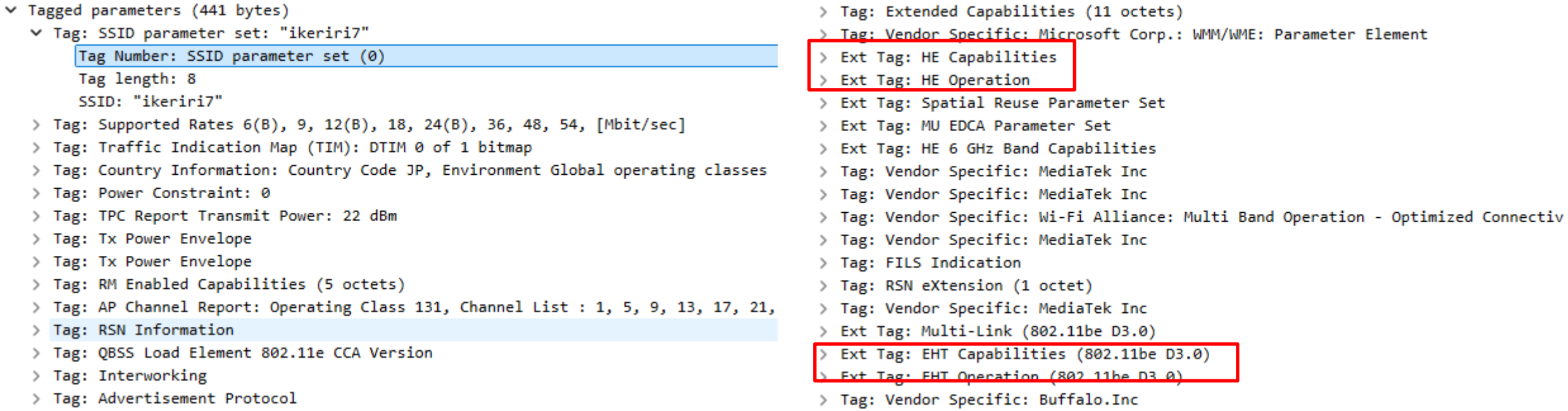


- Choose Display Filter button, Management -> Beacon and click one of Beacon frames.
- Beacon frame is broadcast by AP periodically, including Wireless specs.
- Open IEEE802.11 Wireless Management -> Tagged parameters.
- You can find SSID in Tag: SSID parameter set if AP is not set in stealth mode.
- There are many Tags, including AP's specs, such as HT(.11n WiFi4), VHT(.11ac WiFi5), HE(.11ax WiFi6) and EHT(.11be WiFi7)

WiFi generation

Generation	Name	band	Wireless LAN Management fields
4 (IEEE802.11n)	HT	2.4/5GHz	HT Capabilities, HT Operations
5 (IEEE802.11ac)	VHT	5GHz	VHT Capabilities, VHT Operations
6/6E (IEEE802.11ax)	HE	2.4/5GHz	HE Capabilities, HE Operations
7 (IEEE802.11be)	EHT	2.4/5/6GHz	HT Capabilities, HT Operations

- We can find supported generations by Wireless LAN Management fields.



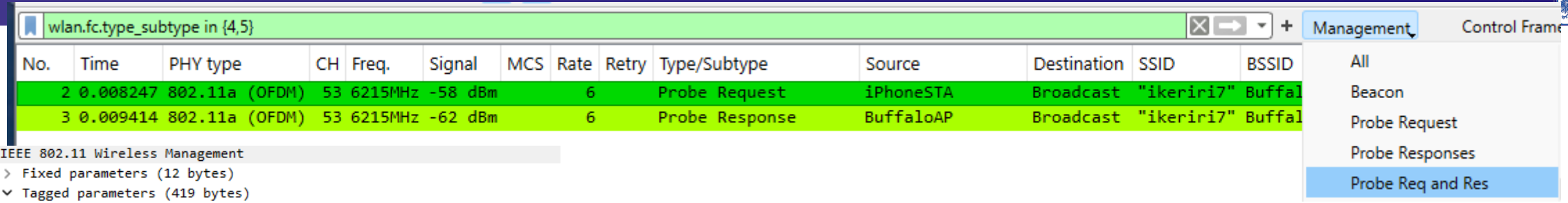
Finding WiFi generations from Beacon

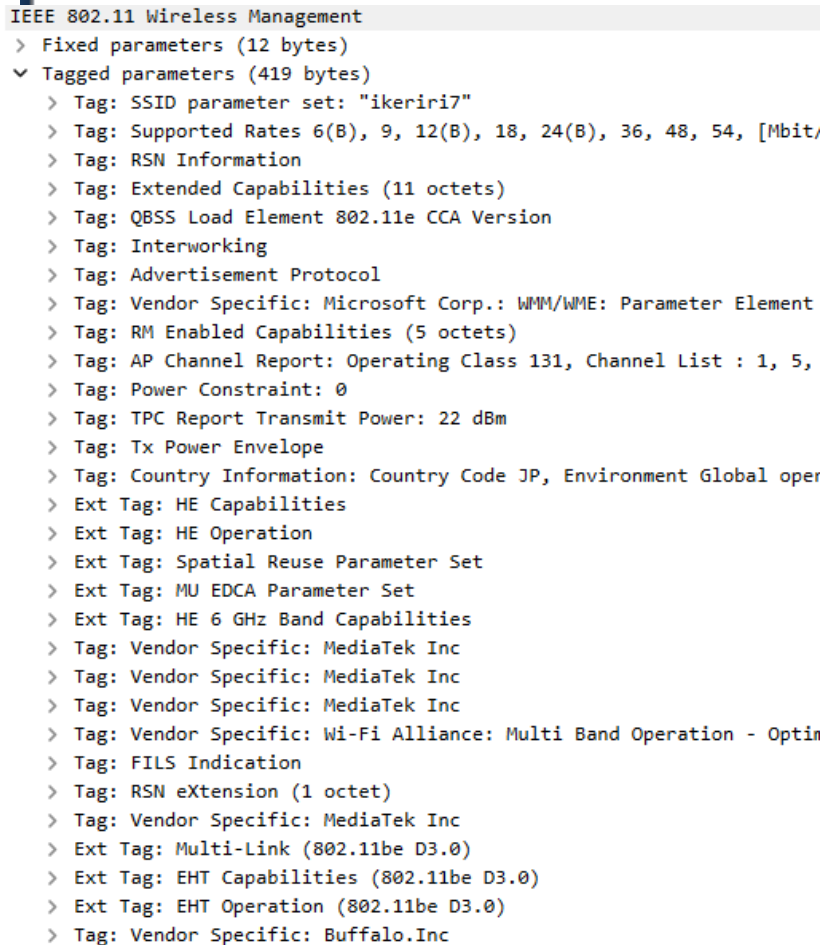
- Andy-san (Andrew Walding, famous for Wireshark Profiles Repository, founder of CELLSTREAM) submits Wireshark Discord

Standards	Display Filter
Pre-WiFi 4 Legacy	wlan.fc.type_subtype == 0x0008 and wlan.tag.number == 1 and not ((wlan.tag.number == 61) or (wlan.tag.number == 45) or (wlan.tag.number == 191) or (wlan.ext_tag.number == 192) or (wlan.ext_tag.number == 255) or (wlan.ext_tag.number == 108))
WiFi4 11n	wlan.fc.type_subtype == 0x0008 and ((wlan.tag.number == 61) or (wlan.tag.number == 45)) and not ((wlan.tag.number == 191) or (wlan.tag.number == 192) or (wlan.ext_tag.number == 255) or (wlan.ext_tag.number == 108))
WiFi5 11ac	wlan.fc.type_subtype == 0x0008 and ((wlan.tag.number == 191 or (wlan.tag.number == 192)) and not ((wlan.ext_tag.number == 255 or wlan.ext_tag.number == 108)))
WiFi6 11ax	wlan.fc.type_subtype == 0x0008 and wlan.tag.number == 255 and not wlan.ext_tag.number == 108
WiFi7 11be	wlan.fc.type_subtype == 0x0008 and wlan.ext_tag.number == 108

We can find WiFi generations from tags on Beacon from AP

Probe Request and Probe Response





- Choose the Display Filter button, Management -> Probe Req and Res
- Ctrl + [Up], Ctrl + [Down] to compare IEEE802.11 Wireless Management Header
- STA sends SSID, HE, EHT and Vendor information by Probe Request, and AP sends back Probe Response with SSID, QBSS, HE, Multi-Link (Aggregating 2.4/5/6 GHz connections) and Vendor information

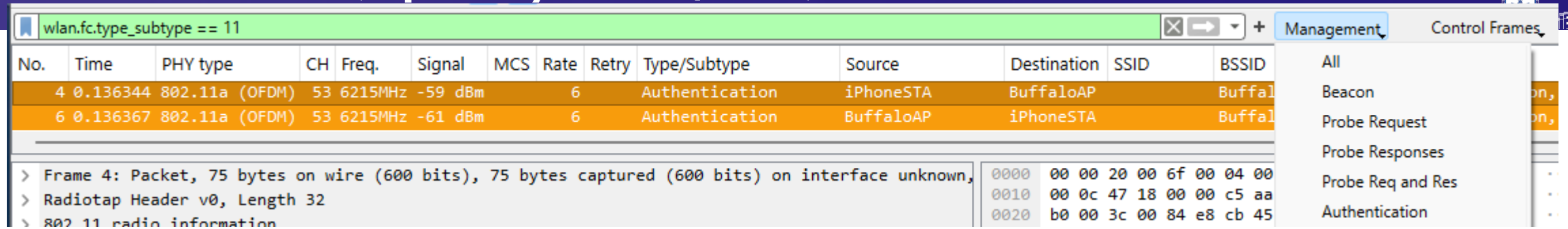
QBSS Load Element 802.11e CCA

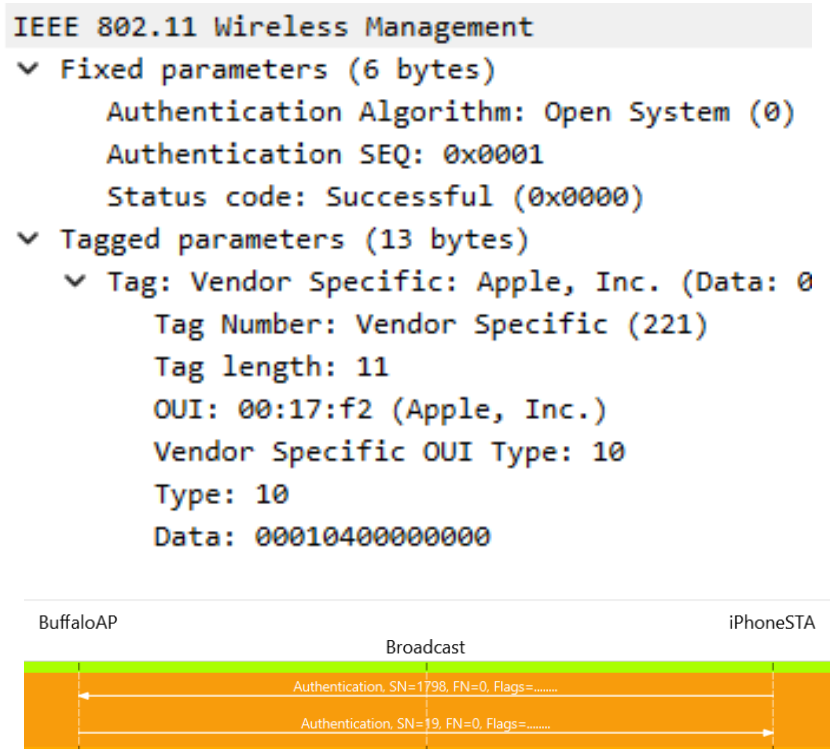

```
Tag: QBSS Load Element 802.11e CCA Version
    Tag Number: QBSS Load Element (11)
    Tag length: 5
    QBSS Version: 2
    Station Count: 0
    Channel Utilization: 6 (2%)
    Available Admission Capacity: 31250 (1000000 us/s)
```

Field name	Contents
Station Count	Number of Stations associated with the BSS
Channel Utilization	Percentage of the channel was sensed as busy
Available Admission Capacity	Remaining capacity available for new QoS

- QBSS(QoS Basic Service Set) Load Element is defined by IEEE802.11e
- CCA (Clear Channel Assessment) is the PHY-layer mechanism used to determine whether WiFi is busy.
- QBSS Load Element 802.11 CCA Version contains network load information: Station Count, Channel Utilization and Available Admission Capacity in Probe Response by AP
- STA determine which AP is the best from the QBSS Load Element
- Some Beacons may contain QBSS Load Element 802.11e CCA

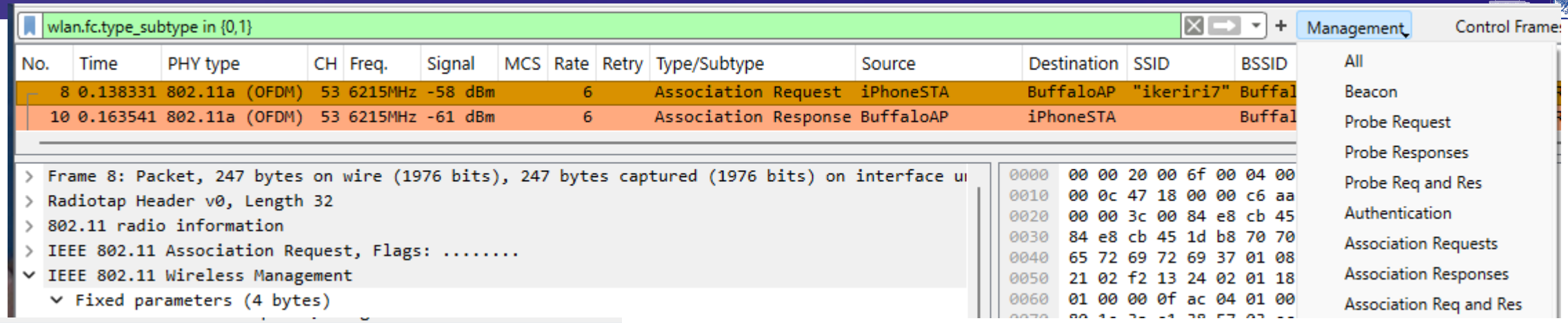
Authentication (Open Systems/SAE)

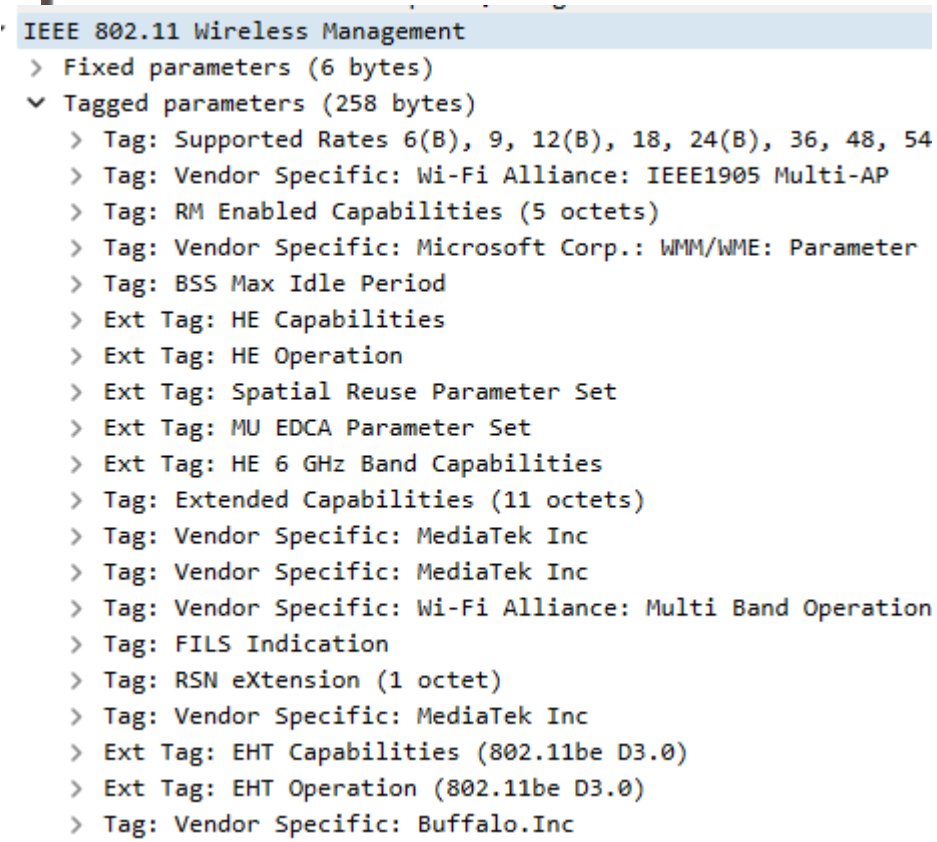




- Choose the Display Filter button, Management -> Authentication
- Ctrl + [Up], Ctrl + [Down] to compare IEEE802.11 Wireless Management Header
- This datalink uses Open System, STA and AP exchange Authentication frame, confirms SSID name for authentication.
- If you find Open System, this connection uses WEP/TKIP/WPA2, we may decrypt if you captured the complete 4-way handshake and we knew PSK.
- If you find SAE, it uses WPA3

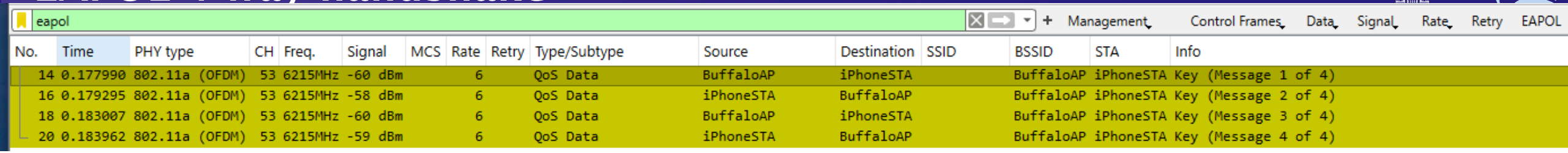
Asssociation Request and Association Response

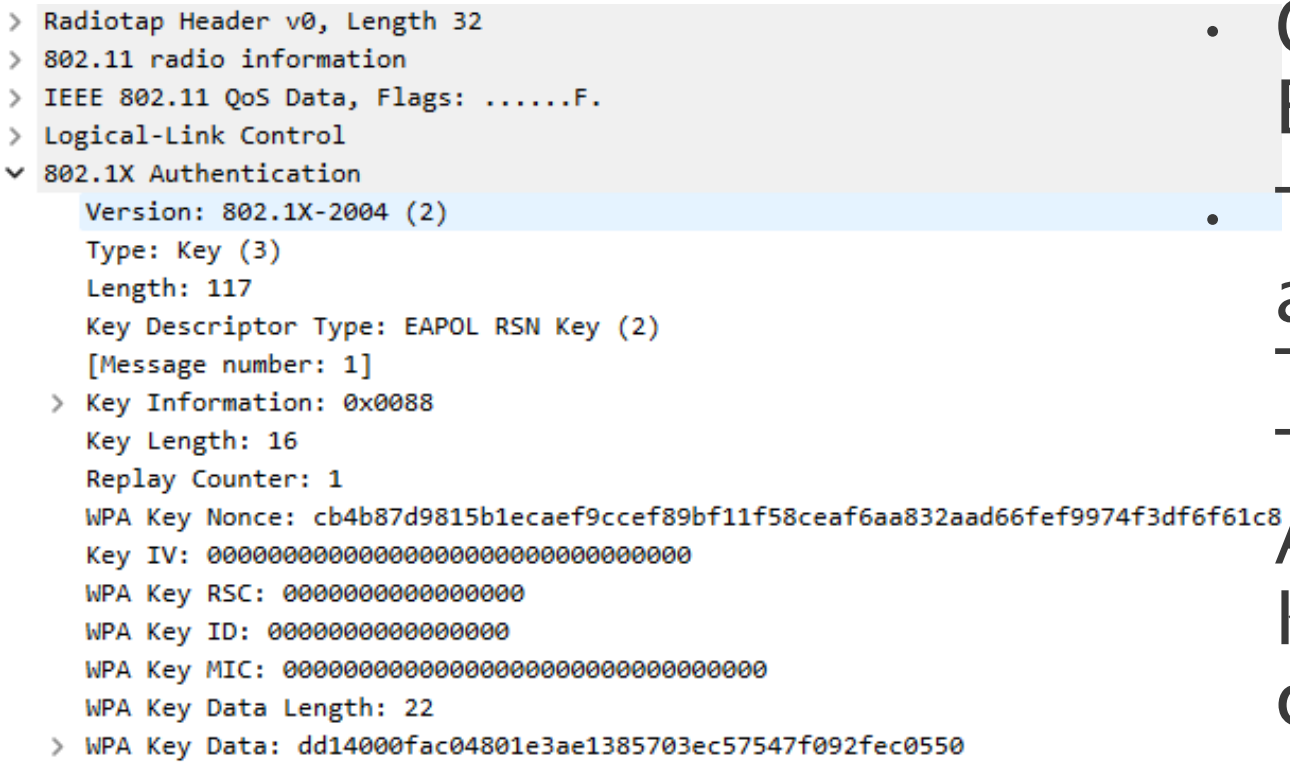




- Choose the Display Filter button, Management -> Association Req and Res
- Ctrl + [Up], Ctrl + [Down] to compare IEEE802.11 Wireless Management Header
- WiFi datalink is created between STA and AP, exchanging actual connect specs.
- This connection uses WiFi7 and MLO (we can find EHT, IEEE1905 Multi-AP, Multi Band Operation tags.

EAPOL 4 way handshake

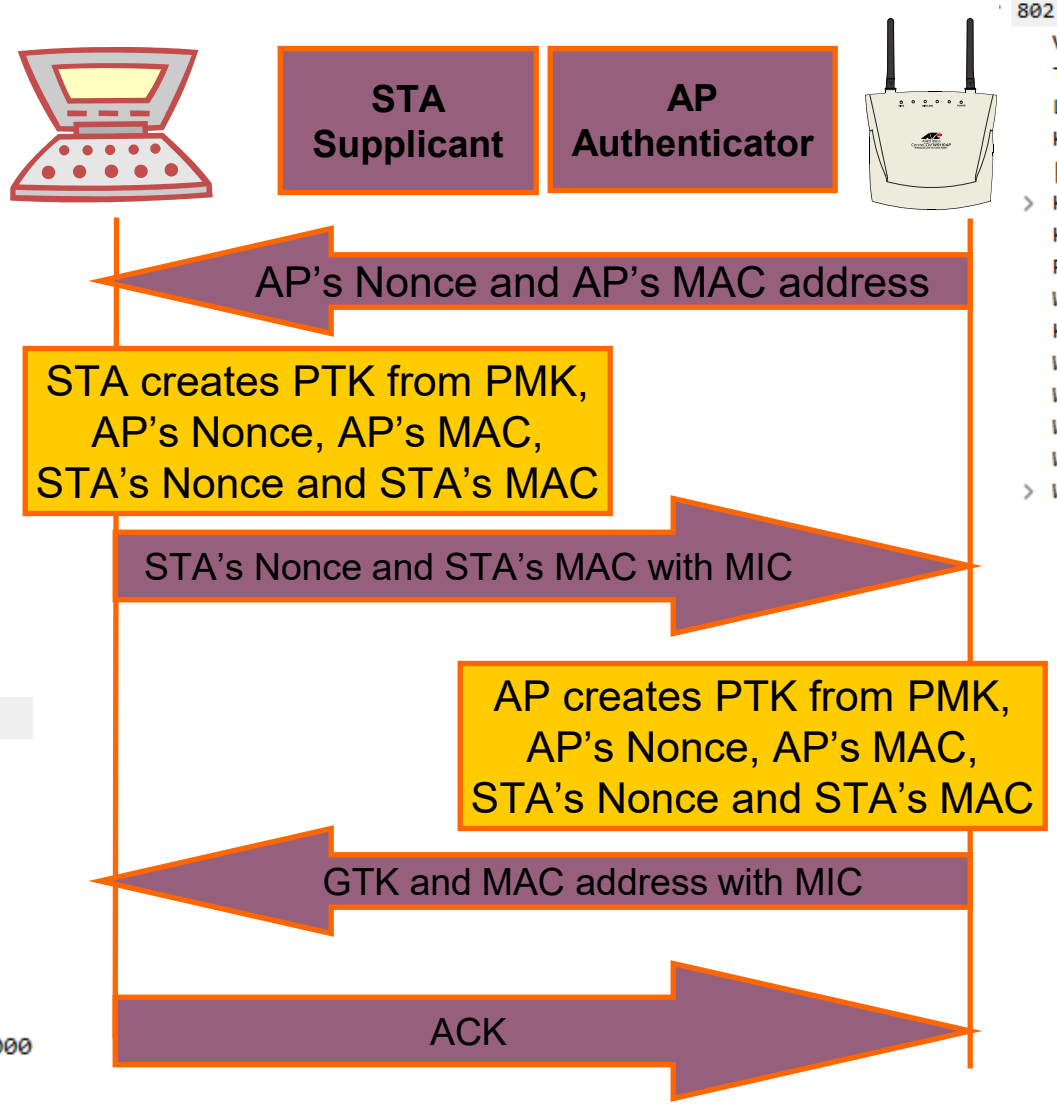




- Choose the Display Filter button, EAPOL, to filter 4-way handshake
- There are 4 packets between AP and STA to create a PTK (Pairwise Transient Key) keyring, including TK(Temporal Key) for the session, AP sends GTK (Group Temporal Key) for broadcast and multicast communication

- Message 1 from AP contains source MAC and AP's Nonce
- Message 2 from STA contains source MAC and STA's Nonce
- Message 3 and 4 are encrypted (Message3 contains GTK)

#14 #16 #18 #20 4 way handshake of EAPOL




```
802.1X Authentication
    Version: 802.1X-2001 (1)
    Type: Key (3)
    Length: 138
    Key Descriptor Type: EAPOL RSN Key (2)
    [Message number: 2]
  > Key Information: 0x0108
    Key Length: 0
    Replay Counter: 1
    WPA Key Nonce: 588a0a47e032159122d43a76d98593ab5
    Key IV: 00000000000000000000000000000000
    WPA Key RSC: 0000000000000000
    WPA Key ID: 0000000000000000
    WPA Key MIC: cdf56f1f2ed869fdcbb4ce91969ad699
    WPA Key Data Length: 43
  > WPA Key Data: 30260100000fac040100000fac04010000
```

```
802.1X Authentication
    Version: 802.1X-2001 (1)
    Type: Key (3)
    Length: 95
    Key Descriptor Type: EAPOL RSN Key (2)
    [Message number: 4]
  > Key Information: 0x0308
    Key Length: 0
    Replay Counter: 2
    WPA Key Nonce: 00000000000000000000000000000000
    Key IV: 00000000000000000000000000000000
    WPA Key RSC: 0000000000000000
    WPA Key ID: 0000000000000000
    WPA Key MIC: 0fb45bc999e2c0e8ca4320a6427ca91a
    WPA Key Data Length: 0
```

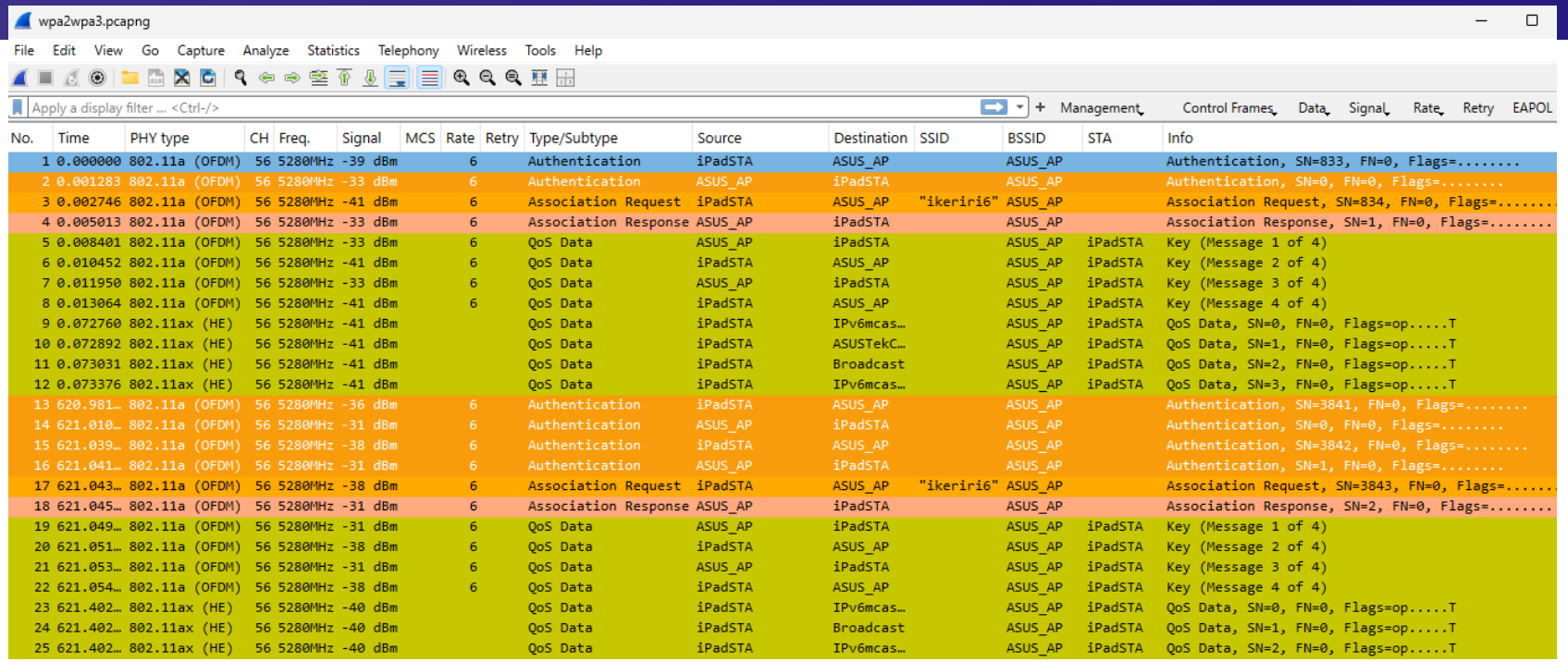
```
802.1X Authentication
    Version: 802.1X-2004 (2)
    Type: Key (3)
    Length: 117
    Key Descriptor Type: EAPOL RSN Key (2)
    [Message number: 1]
  > Key Information: 0x0088
    Key Length: 16
    Replay Counter: 1
    WPA Key Nonce: cb4b87d9815b1ecaef9ccef89bf11f58ceaf6aa832aa
    Key IV: 00000000000000000000000000000000
    WPA Key RSC: 0000000000000000
    WPA Key ID: 0000000000000000
    WPA Key MIC: 00000000000000000000000000000000
    WPA Key Data Length: 22
  > WPA Key Data: dd14000fac04801e3ae1385703ec57547f092fec0550
```

```
802.1X Authentication
    Version: 802.1X-2004 (2)
    Type: Key (3)
    Length: 183
    Key Descriptor Type: EAPOL RSN Key (2)
    [Message number: 3]
  > Key Information: 0x13c8
    Key Length: 16
    Replay Counter: 2
    WPA Key Nonce: cb4b87d9815b1ecaef9ccef89bf11f58c
    Key IV: 00000000000000000000000000000000
    WPA Key RSC: 0000000000000000
    WPA Key ID: 0000000000000000
    WPA Key MIC: b3483369e6d859a57cacac3337e37636
    WPA Key Data Length: 88
    WPA Key Data: aaa9777ad55f4f133366827adc01a2e0f3
```

Decrypting WPA2 PSK

Use Pre Shared Key : SSID to decrypt WPA2-PSK

Wireless with Wireshark



No.	Time	PHY type	CH	Freq.	Signal	MCS	Rate	Retry	Type/Subtype	Source	Destination	SSID	BSSID	STA	Info
1	0.000000	802.11a (OFDM)	56	5280MHz	-39 dBm		6		Authentication	iPadSTA	ASUS_AP		ASUS_AP		Authentication, SN=833, FN=0, Flags=........
2	0.001283	802.11a (OFDM)	56	5280MHz	-33 dBm		6		Authentication	ASUS_AP	iPadSTA		ASUS_AP		Authentication, SN=0, FN=0, Flags=........
3	0.002746	802.11a (OFDM)	56	5280MHz	-41 dBm		6		Association Request	iPadSTA	ASUS_AP	"ikeriri6"	ASUS_AP		Association Request, SN=834, FN=0, Flags=........
4	0.005013	802.11a (OFDM)	56	5280MHz	-33 dBm		6		Association Response	ASUS_AP	iPadSTA		ASUS_AP		Association Response, SN=1, FN=0, Flags=........
5	0.008401	802.11a (OFDM)	56	5280MHz	-33 dBm		6		QoS Data	ASUS_AP	iPadSTA		ASUS_AP	iPadSTA	Key (Message 1 of 4)
6	0.010452	802.11a (OFDM)	56	5280MHz	-41 dBm		6		QoS Data	iPadSTA	ASUS_AP		ASUS_AP	iPadSTA	Key (Message 2 of 4)
7	0.011950	802.11a (OFDM)	56	5280MHz	-33 dBm		6		QoS Data	ASUS_AP	iPadSTA		ASUS_AP	iPadSTA	Key (Message 3 of 4)
8	0.013064	802.11a (OFDM)	56	5280MHz	-41 dBm		6		QoS Data	iPadSTA	ASUS_AP		ASUS_AP	iPadSTA	Key (Message 4 of 4)
9	0.072760	802.11ax (HE)	56	5280MHz	-41 dBm				QoS Data	iPadSTA	IPv6mcas…		ASUS_AP	iPadSTA	QoS Data, SN=0, FN=0, Flags=op.....T
10	0.072892	802.11ax (HE)	56	5280MHz	-41 dBm				QoS Data	iPadSTA	ASUSTekC…		ASUS_AP	iPadSTA	QoS Data, SN=1, FN=0, Flags=op.....T
11	0.073031	802.11ax (HE)	56	5280MHz	-41 dBm				QoS Data	iPadSTA	Broadcast		ASUS_AP	iPadSTA	QoS Data, SN=2, FN=0, Flags=op.....T
12	0.073376	802.11ax (HE)	56	5280MHz	-41 dBm				QoS Data	iPadSTA	IPv6mcas…		ASUS_AP	iPadSTA	QoS Data, SN=3, FN=0, Flags=op.....T
13	620.981…	802.11a (OFDM)	56	5280MHz	-36 dBm		6		Authentication	iPadSTA	ASUS_AP		ASUS_AP		Authentication, SN=3841, FN=0, Flags=........
14	621.010…	802.11a (OFDM)	56	5280MHz	-31 dBm		6		Authentication	ASUS_AP	iPadSTA		ASUS_AP		Authentication, SN=0, FN=0, Flags=........
15	621.039…	802.11a (OFDM)	56	5280MHz	-38 dBm		6		Authentication	iPadSTA	ASUS_AP		ASUS_AP		Authentication, SN=3842, FN=0, Flags=........
16	621.041…	802.11a (OFDM)	56	5280MHz	-31 dBm		6		Authentication	ASUS_AP	iPadSTA		ASUS_AP		Authentication, SN=1, FN=0, Flags=........
17	621.043…	802.11a (OFDM)	56	5280MHz	-38 dBm		6		Association Request	iPadSTA	ASUS_AP	"ikeriri6"	ASUS_AP		Association Request, SN=3843, FN=0, Flags=........
18	621.045…	802.11a (OFDM)	56	5280MHz	-31 dBm		6		Association Response	ASUS_AP	iPadSTA		ASUS_AP		Association Response, SN=2, FN=0, Flags=........
19	621.049…	802.11a (OFDM)	56	5280MHz	-31 dBm		6		QoS Data	ASUS_AP	iPadSTA		ASUS_AP	iPadSTA	Key (Message 1 of 4)
20	621.051…	802.11a (OFDM)	56	5280MHz	-38 dBm		6		QoS Data	iPadSTA	ASUS_AP		ASUS_AP	iPadSTA	Key (Message 2 of 4)
21	621.053…	802.11a (OFDM)	56	5280MHz	-31 dBm		6		QoS Data	ASUS_AP	iPadSTA		ASUS_AP	iPadSTA	Key (Message 3 of 4)
22	621.054…	802.11a (OFDM)	56	5280MHz	-38 dBm		6		QoS Data	iPadSTA	ASUS_AP		ASUS_AP	iPadSTA	Key (Message 4 of 4)
23	621.402…	802.11ax (HE)	56	5280MHz	-40 dBm				QoS Data	iPadSTA	IPv6mcas…		ASUS_AP	iPadSTA	QoS Data, SN=0, FN=0, Flags=op.....T
24	621.402…	802.11ax (HE)	56	5280MHz	-40 dBm				QoS Data	iPadSTA	Broadcast		ASUS_AP	iPadSTA	QoS Data, SN=1, FN=0, Flags=op.....T
25	621.402…	802.11ax (HE)	56	5280MHz	-40 dBm				QoS Data	iPadSTA	IPv6mcas…		ASUS_AP	iPadSTA	QoS Data, SN=2, FN=0, Flags=op.....T

- Open the trace wpa2wpa3.pcapng
- There are two WiFi connections by same STA (e2:da:1e:a8:92:8f) as iPadSTA and same AP (f0:2f:74:c4:f5:c4) as ASUS_AP
- Both connection use same SSID: ikeriri6 and pass phrase: wireshark
- The first connection from #1 to #13 is WPA2 PSK
- The next connection from #14 to #27 is WPA3 PSK

Compare Authentication

- Compare Open System of WPA2 and SAE (Simultaneous Authentication of Equals)
- Use Display Filter buttons to select Management -> Authentication, Ctrl + [Up], Ctrl + [Down] to compare 802.11 Wireless Management Header
- Open System confirms SSID, exchange Status Code: Successful
- Each AP and STA sends Scalar and Finite Field Element value, SAE Message Type: Commit
- Then AP and STA exchange Confirm Value, SAE Message Type: Confirm

```
IEEE 802.11 Wireless Management
  Fixed parameters (6 bytes)
      Authentication Algorithm: Open System (0)
      Authentication SEQ: 0x0001
      Status code: Successful (0x0000)
  Tagged parameters (35 bytes)
```

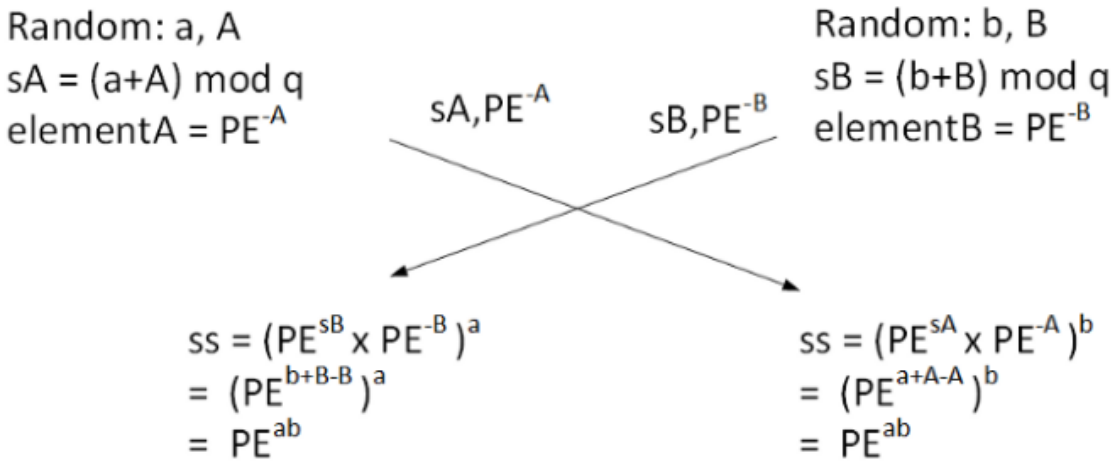
```
IEEE 802.11 Wireless Management
  Fixed parameters (104 bytes)
      Authentication Algorithm: Simultaneous Authentication of Equals (SAE) (3)
      Authentication SEQ: 0x0001
      Status code: Successful (0x0000)
      SAE Message Type: Commit (1)
      Group Id: 256-bit random ECP group (19)
      Scalar: c67801ac5941d1e0fad412b255567e53c885a0d12a22439a3e021c7d633f37e7
      Finite Field Element: f4b7c34e9f0d5444381e1dde353e54dcc838435b372a3933b7cc
```

```
IEEE 802.11 Wireless Management
  Fixed parameters (40 bytes)
      Authentication Algorithm: Simultaneous Authentication of Equals (SAE) (3)
      Authentication SEQ: 0x0002
      Status code: Successful (0x0000)
      SAE Message Type: Confirm (2)
      Send-Confirm: 1
      Confirm: e05e00747ffce2d04a55d7d7d32296c5b8ffa07e5777d2dfa3f7a8e74fce2343
```

SAE（Simultaneous Authentication of Equals) Handshake

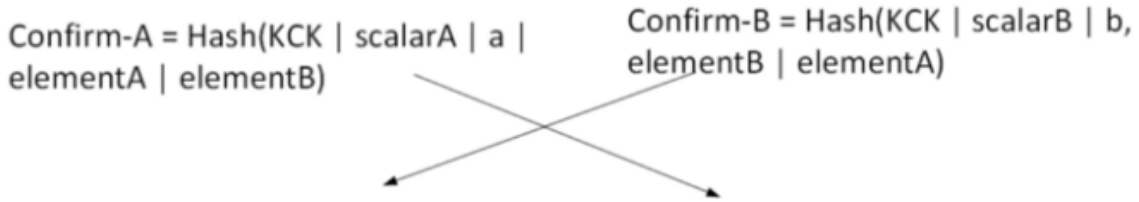
- SAE（Simultaneous Authentication of Equals) is known for Dragonfly key exchange in RFC7664 https://www.rfc-editor.org/info/rfc7664

Auth-Commit



- AP and STA calculate their own and the other side Scalar and Finite field element to create and share PE(Password Equivalent) value using Elliptic Curve cryptography

Auth-Confirm



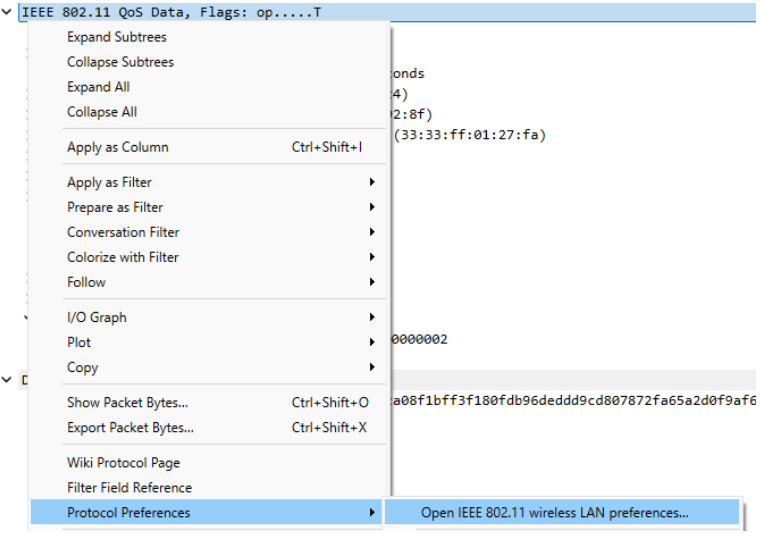
- Each Alice(STA) and Bob(AP) can verify the packet's Confirm value with the calculated Confirm value
- K=rB · (sA · P+eA) tr=(sB,eB,sA,eA) cB=HMAC(Hash(K),tr)
- If the calculated Confirm value is the same as the packet, we can share PE(Password Equivalent) value

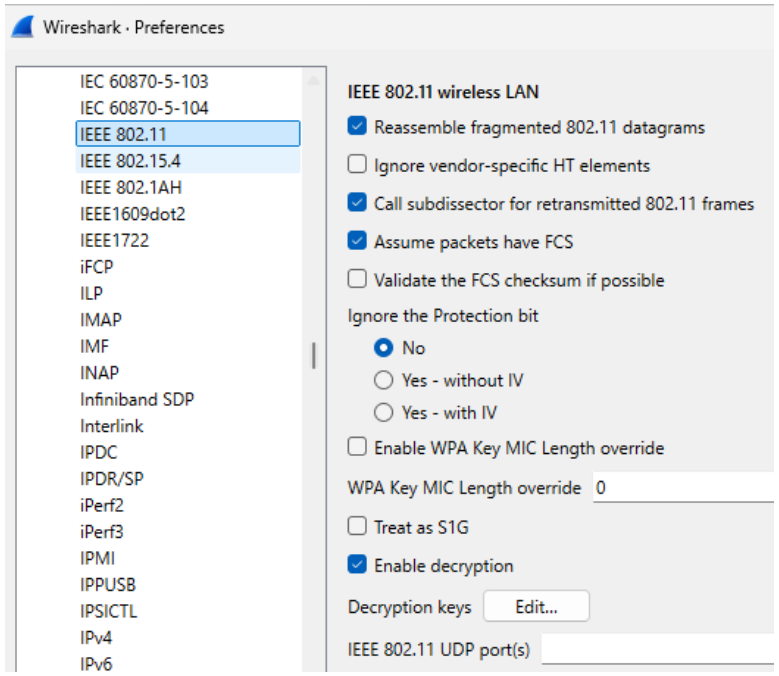
Confirm Data frames are encrypted


```
IEEE 802.11 QoS Data, Flags: op.....T
    Type/Subtype: QoS Data (0x0028)
  > Frame Control Field: 0x88c1
    .000 0000 0010 1100 = Duration: 44 microseconds
  > Receiver address: ASUS_AP (f0:2f:74:c4:f5:c4)
  > Transmitter address: iPadSTA (e2:da:1e:a8:92:8f)
  > Destination address: IPv6mcast_ff:01:27:fa (33:33:ff:01:27:fa)
  > Source address: iPadSTA (e2:da:1e:a8:92:8f)
  > BSS Id: ASUS_AP (f0:2f:74:c4:f5:c4)
  > STA address: iPadSTA (e2:da:1e:a8:92:8f)
    .... .... .... 0000 = Fragment number: 0
    0000 0000 0000 .... = Sequence number: 0
    [WLAN Flags: op.....T]
  > Qos Control: 0x3016
  > HT Control (+HTC): 0x0000b20f
  v CCMP parameters
      CCMP Ext. Initialization Vector: 0x000000000002
      Key Index: 0
v Data (88 bytes)
    Data: df24237032516733724bf86184cfb9531849ca08f1bff3f180fdb96d
    [Length: 88]
```

- Check data frame #9, #10, #11, #12 encrypted by WPA2 and #23, #24, #25 by WPA3
- Open IEEE802.11 QoS Data -> CCMP parameters header, these frames contain CCMP Ext. Initialization Vector as a packet counter to protect against Replay Attack, AP and STA drops frames with old IVs

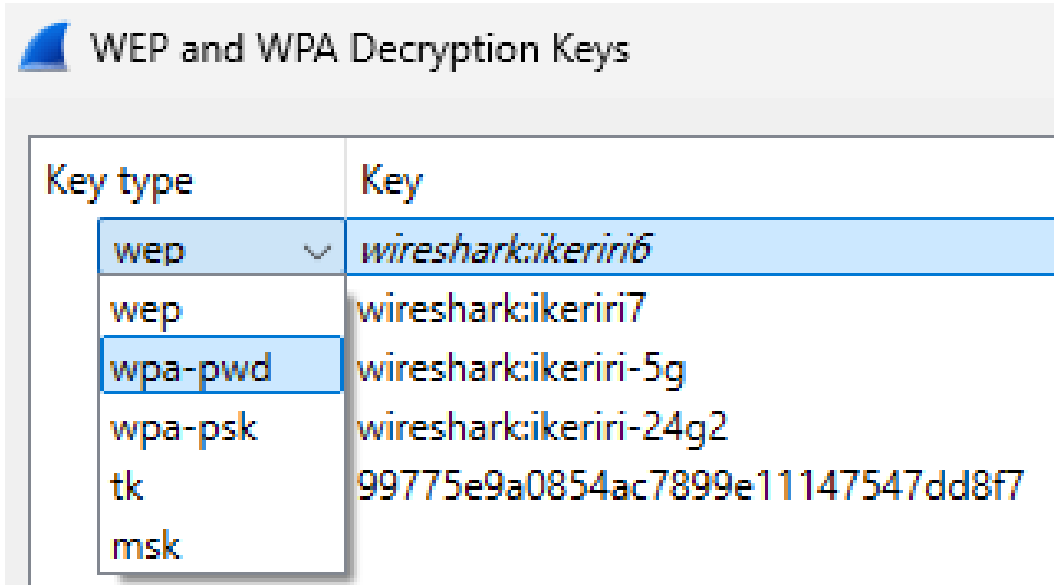
IEEE802.11 decryption

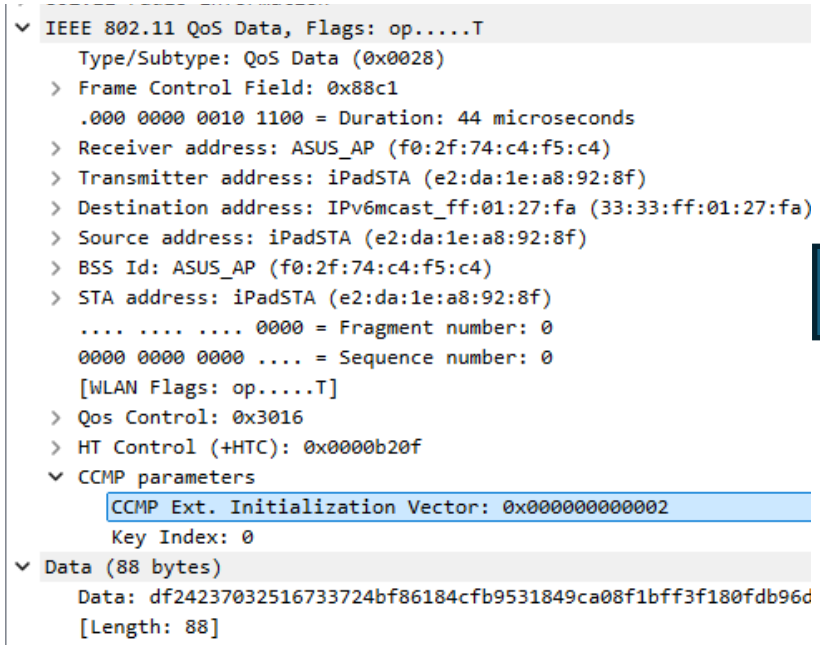




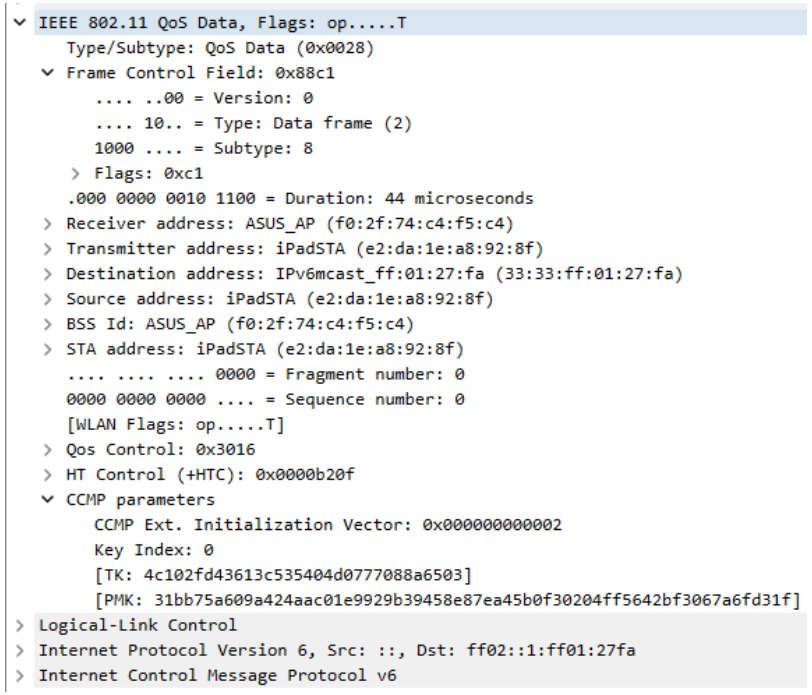
- Wireshark supports WEP, WPA1/2 decryption and doesn't support WPA3
- Wireshark also supports TK(Temporal Key) as a session key and MSK(Master Session Key) style decryption too.
- Right-click the IEEE 802.11 header, select Protocol Preferences -> Open IEEE 802.11 wireless LAN preferences.
- Confirm “Enable decryption” is checked, Open the “Edit…” button of Decryption keys.
- Note: you need to capture complete 4 packets of EAPOL 4-way handshake and you need to know SSID and pre shared key.

WEP and WPA Decryption Keys

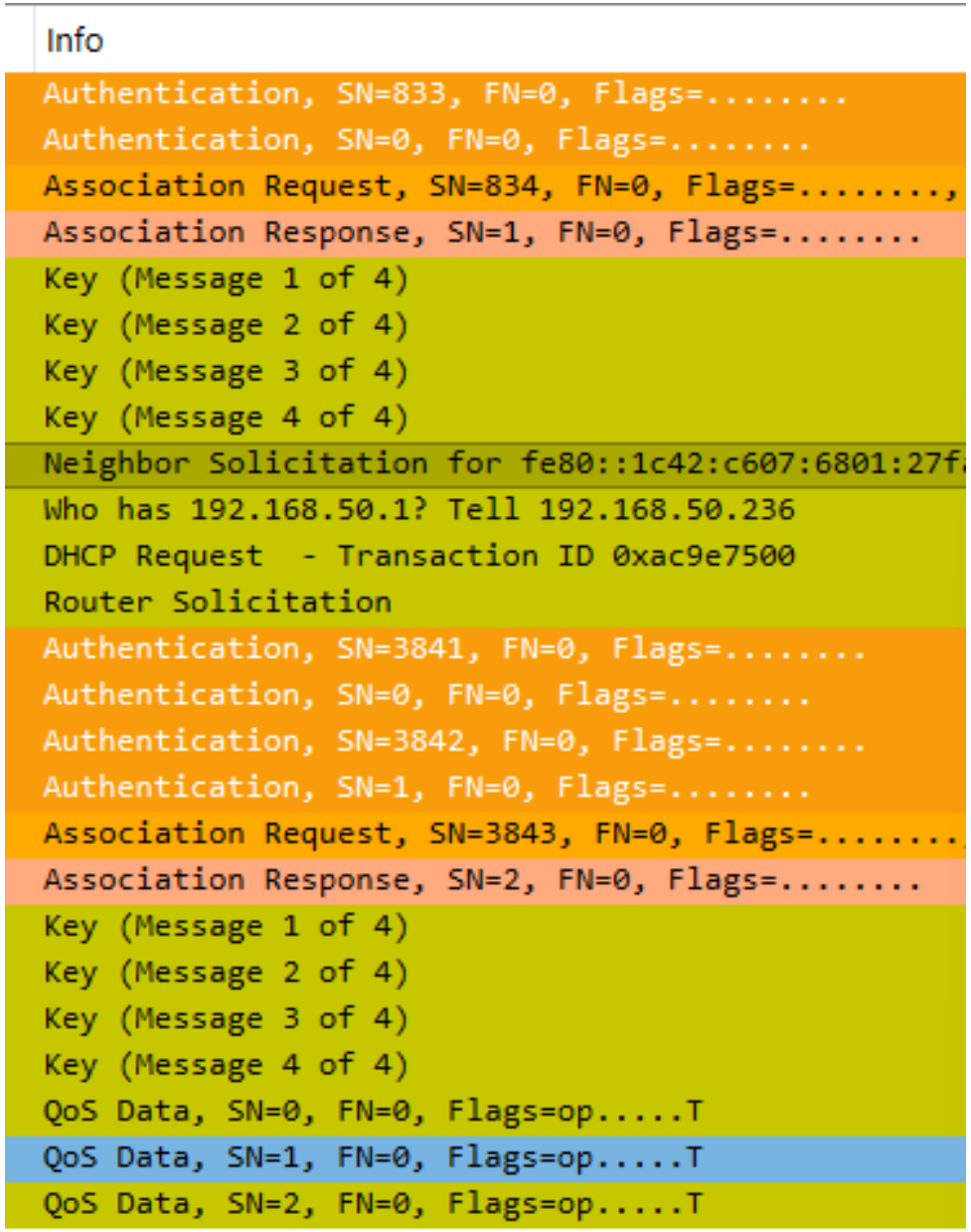




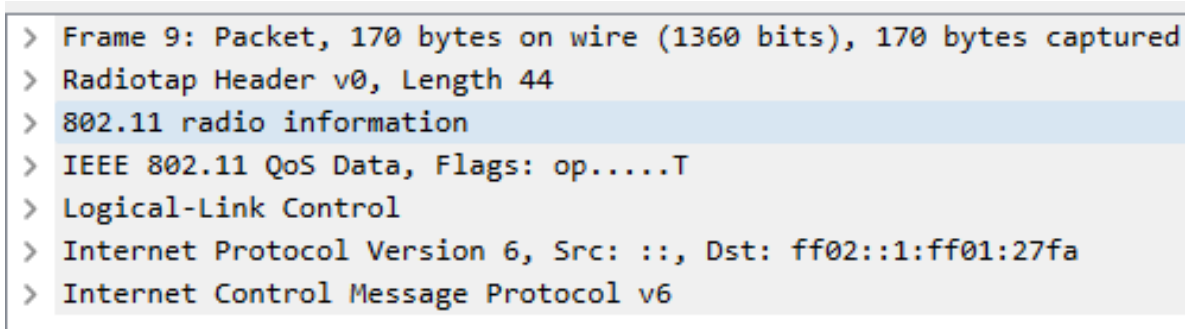
- You can set multiple WEP and WPA decryption Keys in preference.
- Select Key type as wpa-pwd and set Key as [Pre shared key:SSID] style
- Select “wpa-pwd” from the list box and set “wireshark:ikeriri6”



WEP and WPA Decryption Keys



- We can find plaintext data frames such as Neighbour Solicitation of IPv6(#9), ARP Requests(#10), DHCP Request(#11) and Router Solicitation of IPv6(#12) as the result of decryption of WPA2-PSK
- But We still can not decrypt WPA3 if we use the same SSID and Pass phrase, and if we have the complete set of SAE Authentications and 4-way handshake.



SharkFest'25 EUROPE

Wireless in Live Action

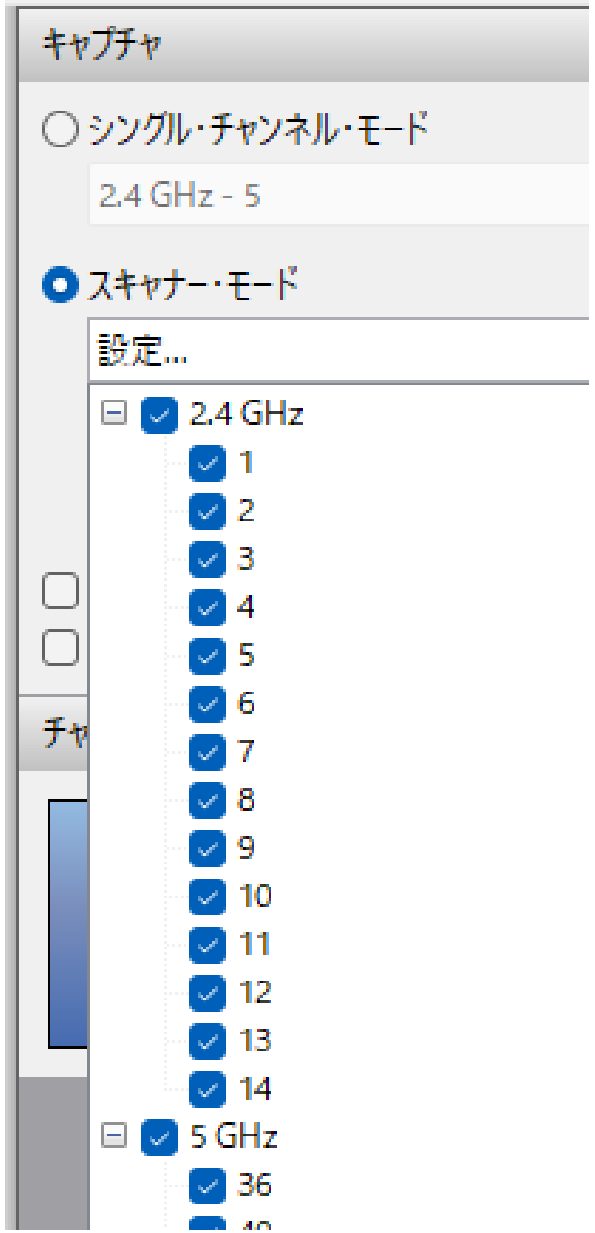
Actual use case of Wireless packet capturing

WiFi capturing in Live Actions

- We can capture the complete set of 4-way handshake and connection sequence between AP and STA, if we test in the Anechoic Chamber or in the shield box.
- But wireless packet analysis in live actions is far different, we merely capture the complete sets of 4-way handshakes, nor connection sequences.

- WPA3 and PMF(Protected Management Frame) is common now.
- But we still get the various information about the Wireless environment from the trace file.
- WiFi SIGINT is WiFi Signal Intelligence, get Important Information like finding the needle in a haystack of the WiFi trace file

WiFi SIGINT (WiFi Signal Intelligence)

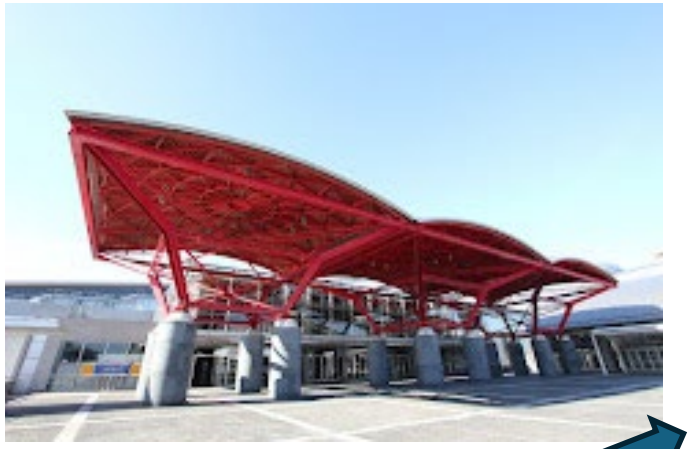


- It is inevitable to drop many wireless packets, and we need a huge amount of time and money to get all frames, and it may be impossible. We do not have to pursue full capturing.
- We do not have to lock in fixed WiFi channel, but switching channel in short interval, scanning wireless environment.
- 200ms/CH is good parameter of WiFi scanning, because 100ms is usual time of Beacon interval of the AP
- For example, set your WiFi capture equipment to scanner mode, set all 2.4/5/6GHz channels, capture WiFi packets at 200ms/CH

WiFi SIGINT (WiFi Signal Intelligence)

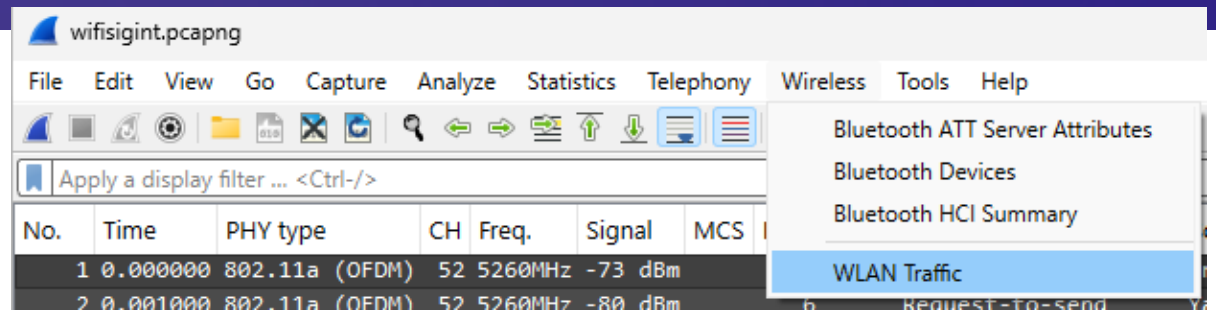
- We have smart devices everywhere and every time, and all devices have WiFi and their MAC address.
- When you visit your favorite cafe, you bring your MAC address and your information.
- We can map the network, identify devices and access points, detect unknown STAs, rogue APs, attackers and so on

WiFi SIGINT (WiFi Signal Intelligence)



- CEATEC 2025 is one of the biggest IT conference events in Japan.
- Ikeriri booth is located at Hall 6 in the 75,000㎡ square feet of Makuhari Messe, Chiba prefecture.
- Open wifisigint.pcapng, 11MB trace file at 15:25:21 to 15:25:41 (79 seconds) in 14th, October, the first day of the conference
- Choose Statistics -> Capture File Properties to confirm the number of packets (53809), size of the trace file

Wireless LAN Statistics



- Choose Wireless -> WLAN Traffic to display Wireless LAN Statistics

Wireshark · Wireless LAN Statistics · wifisigint.pcapng

BSSID	Channel	SSID	Percent Packets	Percent Retry	Retry	Beacons	Data Pkts	Probe Reqs	Probe Resp	Auths	Deauths	Other	Protection
		<Broadcast>	0.0	0.0	0	0	2	0	0	0	0	0	
00:00:00:00:00:00		<Broadcast>	0.0	0.0	0	0	0	0	0	0	0	2	
00:09:b4:71:01:18	132	0000softbank	0.1	38.5	5	4	3	0	6	0	0	0	Unknown
00:09:b4:71:07:8c	112	0002softbank	0.0	33.3	1	0	0	1	2	0	0	0	
00:09:b4:71:0a:c0	124	0000softbank	0.0	75.0	3	0	0	0	4	0	0	0	
00:09:b4:71:13:48	116	ABCeatec_EXT	0.1	6.3	1	1	0	11	4	0	0	0	
00:09:b4:71:15:2f	11	0000softbank	0.0	0.0	0	2	0	0	0	0	0	0	
00:09:b4:71:15:30	140	0000softbank	0.1	25.0	3	3	0	0	9	0	0	0	
00:25:00:ff:94:73		<Broadcast>	0.5	14.9	10	0	4	0	0	0	0	63	
00:2b:f5:5b:85:2e	1	<Broadcast>	0.0	0.0	0	1	0	0	0	0	0	0	
00:2b:f5:5b:85:30	128	Buffalo-5G-8520	0.1	0.0	0	2	0	0	11	0	0	0	

Display filter: Enter a display filter ... Apply

Copy Save as... Close Help

- We can sort, extract and right-click to filter BSSID, Channel, SSID, Percent Packets, Percent Retry, Retry, Beacons, Data Pkts, Probe Reqs, Probe Resps, Auths, Deauths, Other and Protection Columns

Counting the transmitter of wireless traffic

- tshark is a good tool for counting APs and STAs
- Let's list Transmitter address (wlan.ta) of the wifisigint.pcapng
- Use -T fields -e wlan.ta options to pick up Transmitter Address

```
C:\Users\megumi\Desktop>tshark -T fields -e wlan.ta -r wifisigint.pcapng
d0:65:78:17:f8:22
f5:d5:80:1d:01:e0
```

- Redirect the result as TA.txt and cat TA.txt | sort | uniq | wc -l to count up the unique MAC address of the transmitter.

```
C:\Users\megumi\Desktop>tshark -T fields -e wlan.ta -r wifisigint.pcapng >>TA.txt

C:\Users\megumi\Desktop>bash
┌──(user㉿area51)-[/mnt/c/Users/megumi/Desktop]
└─$ cat TA.txt | sort | uniq | wc -l
1344
```

Counting the number of AP and STA

- AP sends Beacons, so counting unique AP by using –Y wlan.fc.type_subtype==8 and redirect as AP.txt

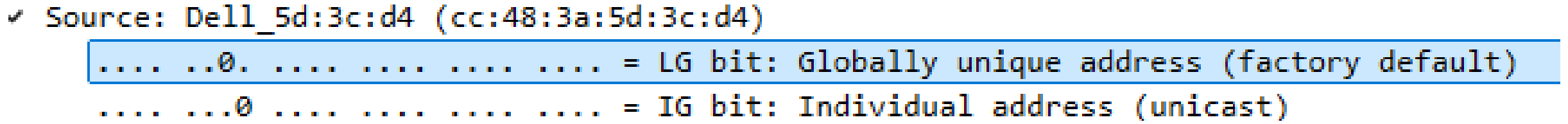
```
C:\Users\megumi\Desktop>tshark -T fields -e wlan.ta -r wifisigint.pcapng -Y wlan.fc.type_subtype==8 >>AP.txt

C:\Users\megumi\Desktop>bash
┌──(user㉿area51)-[/mnt/c/Users/megumi/Desktop]
└─$ cat AP.txt | sort | uniq | wc -l
215
```

- Counting AP using sort, uniq and wc –l
  There are 215 Aps in this trace file
- All MAC addresses 1344 - AP's MAC address 215 = 1129 STAs

Privete MAC Address

- A private MAC Address is a locally administered MAC address, a hardware address that is not globally assigned by a manufacturer (OUI) but instead generated by the device or operating system
- Smart devices such as iOS and Android OS use a Private MAC address as the default.



- Private MAC addresses' LG bit (Specifies if this is a locally administrated or globally unique (IEEE assigned) is true, that means the 7th bit of the first byte of the MAC Address is 1
- For example, Private MAC address starts with x2, x6, xA, xE, etc.
- We can filter Private MAC address as Display Filter Expression as eth.src.lg==1 in the Wired network

Privete MAC Address in Wireless network

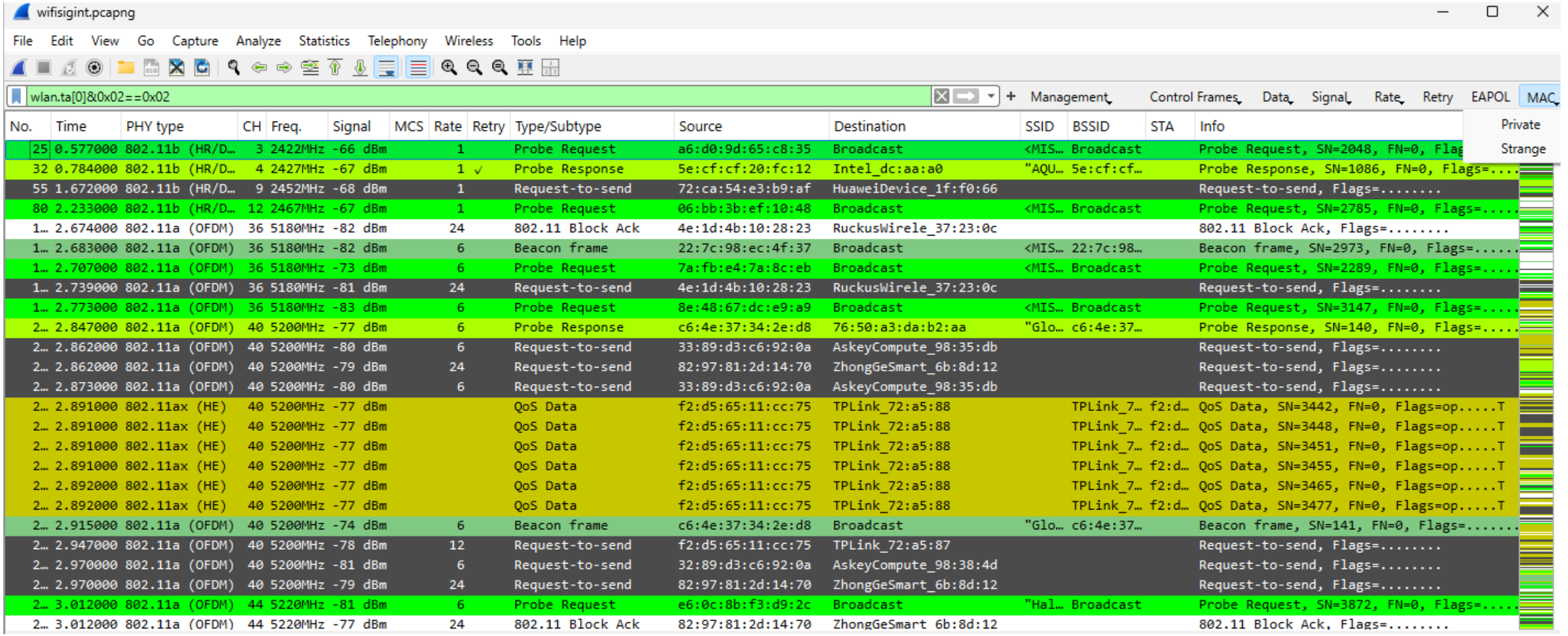
- If we want to filter the Private MAC Address in a Wireless network, we can filter as Wireshark Display Filter syntax as wlan.ta[0]&0x02==0x02
  wlan.ta[0] means the first byte of the transmitter address
  & means bit-based AND calculation
  0x02 is the mask pattern matched for the 7th bit of the first byte
- Using tshark to filter the transmitter MAC address that is private

```
C:\Users\megumi\Desktop>tshark -T fields -e wlan.ta -r wifisigint.pcapng -Y "wlan.ta[0]&0x02==0x02" >>private.txt

C:\Users\megumi\Desktop>bash
┌──(user㉿area51)-[/mnt/c/Users/megumi/Desktop]
└─$ cat private.txt | sort | uniq | wc -l
812
```

- Using cat, sort, uniq, and wc commands to count the private MAC
  Private MAC STAs: 812, all STAs: 1344
  so two-thirds(about 66%) of STAs are smart devices.

Try Display filter as “wlan.ta[0]&0x02==0x02”



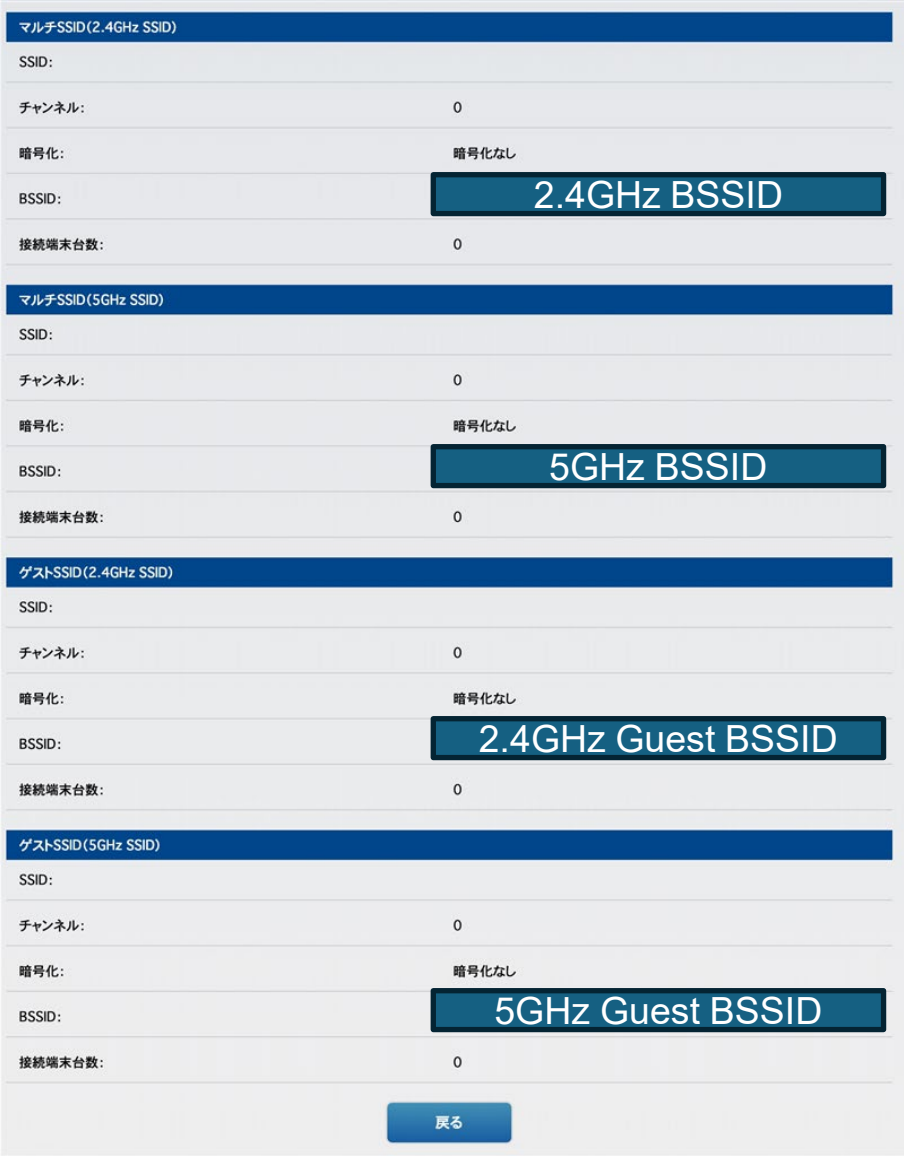
- Two-thirds of the STAs are Private MAC addresses in the conference center

Important hint of iOS's Private MAC Address

- iPhone and iPad use a Private MAC address by default, iOS uses randomized MAC address in different locations.
- But iOS has interesting characteristics, iPhone and iPad use the same Private MAC address in the exact locations every time.
- That helps us identify the devices, for example, you watched some Private MAC address on Monday, and you find the same Private MAC address on Tuesday. The device is the same!!


```
Transmitter address: e2:ea:bc:1d:45:f7 (e2:ea:bc:1d:45:f7)
    .... ..1. .... .... .... .... = LG bit: Locally administered address (this is NOT the factory default)
    .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
```

Common pattern of MAC address



- We experienced the interesting pattern of BSSID in the same AP.
- AP uses a sequential MAC address for different bands' BSSID, for example
  B0:BE:76:12:34:56 for 2.4GHz band
  B0:BE:76:12:34:57 for 5GHz band
  B0:BE:76:12:34:58 for 6GHz band
- Sometimes an AP uses multiple SSIDs with similar BSSIDs
  B0:BE:76:12:ab:cd for main SSID
  B0:BE:76:12:ab:ce for guest SSID
- First 3 bytes are the same -> same OUI
- First 4 bytes are the same -> same AP

Interesting MAC Address

wlan.ta in {00-00-00-00-00-00, 11-22-33-44-55-66, de-ad-be-ef-00-00}

Management | Control Frames | Data | Signal | Rate | Retry | EAPOL | PWR

No.	Time	PHY type	CH	Freq.	Signal	MCS	Rate	Retry	Type/Subtype	Source	Destination	SSID	BSSID	STA	Info
2…	63.4880…	802.11a (OFDM)	1…	5580MHz	-66 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3785, FN=0, Flags=........[Malformed Packet]
2…	64.2440…	802.11a (OFDM)	1…	5580MHz	-67 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3799, FN=0, Flags=........[Malformed Packet]
2…	65.4070…	802.11a (OFDM)	1…	5580MHz	-75 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3445, FN=0, Flags=........[Malformed Packet]
3…	66.7310…	802.11a (OFDM)	1…	5580MHz	-76 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3482, FN=0, Flags=........[Malformed Packet]
3…	69.1370…	802.11a (OFDM)	1…	5580MHz	-63 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3903, FN=0, Flags=........[Malformed Packet]
3…	70.4610…	802.11a (OFDM)	1…	5580MHz	-63 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3933, FN=0, Flags=........[Malformed Packet]
4…	71.8880…	802.11a (OFDM)	1…	5580MHz	-75 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3562, FN=0, Flags=........[Malformed Packet]
4…	72.4130…	802.11a (OFDM)	1…	5580MHz	-74 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3571, FN=0, Flags=........[Malformed Packet]
4…	73.2350…	802.11a (OFDM)	1…	5580MHz	-67 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3982, FN=0, Flags=........[Malformed Packet]
5…	77.0330…	802.11a (OFDM)	1…	5580MHz	-65 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=4047, FN=0, Flags=........[Malformed Packet]
5…	77.5470…	802.11a (OFDM)	1…	5580MHz	-75 dBm		6		Association Request	00:00:00_…	00:00:00…		00:00:00…		Association Request, SN=3676, FN=0, Flags=........[Malformed Packet]

- Sometimes an attacker uses interesting MAC addresses,
  00:11:22:33:44:55 for debugging/testing
  DE:AD:BE:EF:00:00 for joking
  AA:BB:CC:DD:EE:FF is the default value of the attack tool
  00:00:00:00:00:00 is seen when the packet is broken
  If you find these MAC addresses on your network, someone is measuring, attacking your WiFi, or packets are broken.
- For example, try display filter as wlan.ta in {00-00-00-00-00-00, 11-22-33-44-55-66, de-ad-be-ef-00-00, aa-bb-cc-dd-ee-ff}

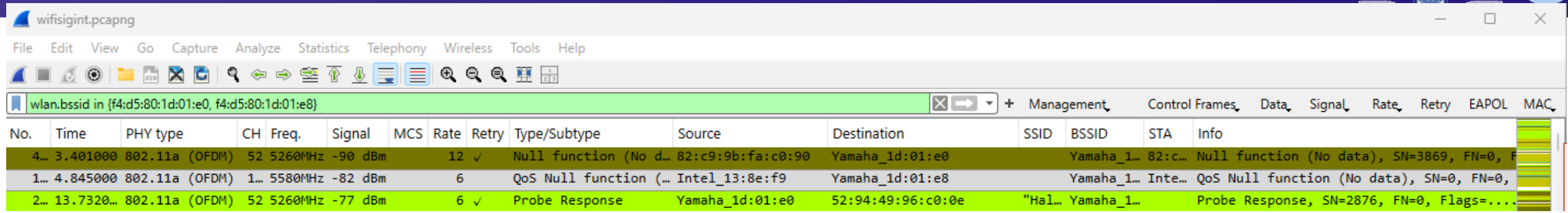
Pick up the certain SSID

- The capture point is Ikeriri's booth at Hall 6
- Working Lounge is located at Hall 5, about 100 meters away from the capture point.
- Wireless -> WLAN traffic, sort the SSID column, and pick up "Hall5_Working_Lounge_Space" that BSSID is f4:d5:80:1d:01:e0 and f4:d5:80:1d:01:e8

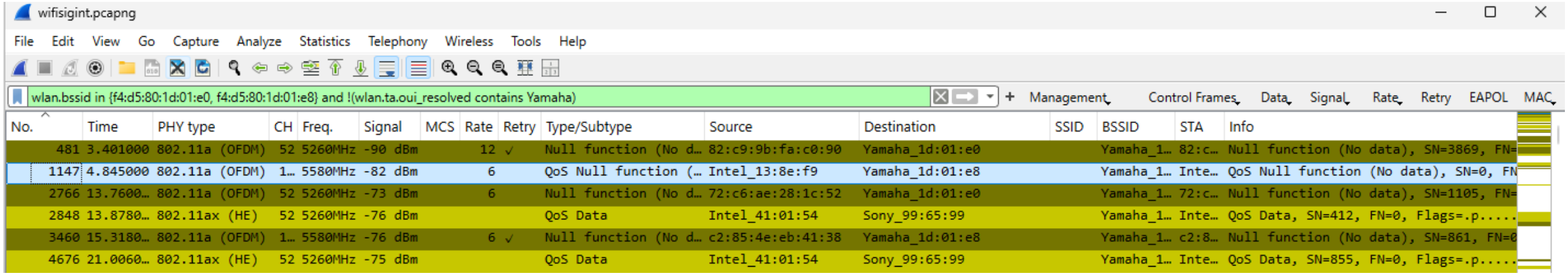
Wireshark · Wireless LAN Statistics · wifisigint.pcapng

BSSID	Channel	SSID	Percent Packets	Percent Retry	Retry	Beacons	Data Pkts	Probe Reqs	Probe Resp	Auths	Deauths	Other	Protection
f4:d5:80:1d:01:e0	52	Hall5_Working_Lounge_Space	2.3	65.6	221	16	215	0	95	2	0	9	Unknown
f4:d5:80:1d:01:e8	116	Hall5_Working_Lounge_Space	4.9	51.9	379	80	404	0	184	34	5	23	Unknown

“Hall5_Working_Lounge_Space”



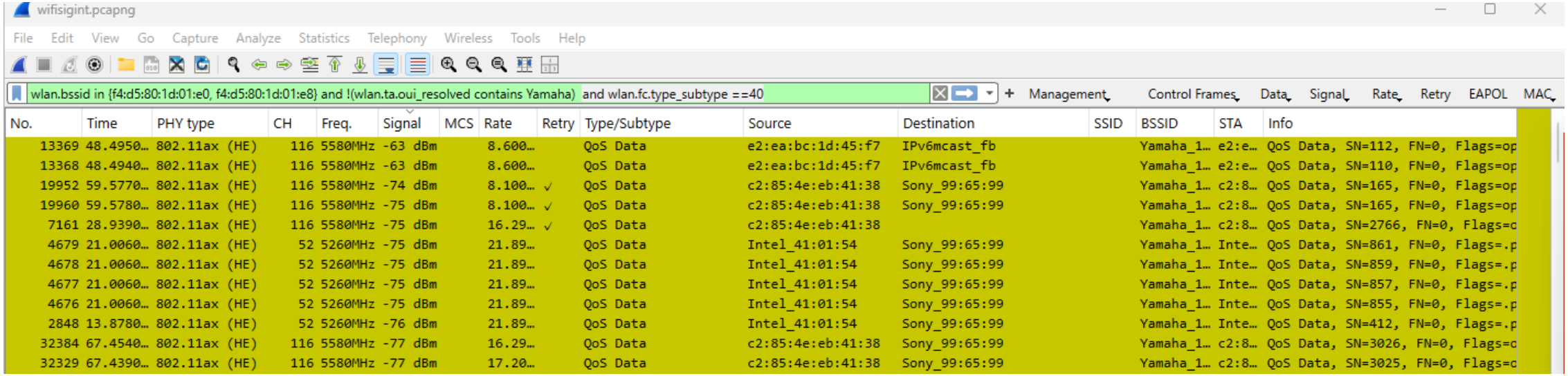
- Set Display Filter as wlan.bssid in {f4:d5:80:1d:01:e0, f4:d5:80:1d:01:e8} to filter “Hall5_Working_Lounge_Space” SSID
- This SSID is operated by two Yamaha APs, so pick up STAs as wlan.bssid in {f4:d5:80:1d:01:e0, f4:d5:80:1d:01:e8} and !(wlan.ta.oui_resolved contains Yamaha)



- Let’s think about the Signal Strength of this SSID

“Hall5_Working_Lounge_Space”

- We need to add a filter for the frames Type/Subtype is QoS Data, set Display Filter as wlan.bssid in {f4:d5:80:1d:01:e0, f4:d5:80:1d:01:e8} and and wlan.fc.type_subtype ==40
- Sort the Signal Column descending, from strong to weak signal

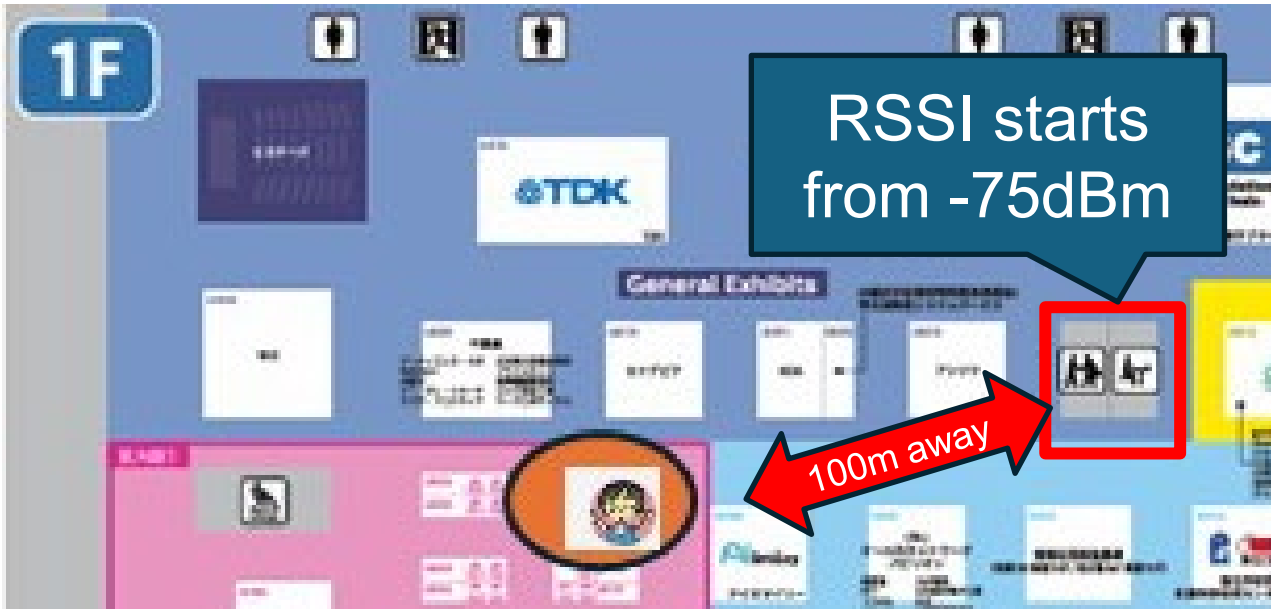


No.	Time	PHY type	CH	Freq.	Signal	MCS	Rate	Retry	Type/Subtype	Source	Destination	SSID	BSSID	STA	Info
13369	48.4950…	802.11ax (HE)	116	5580MHz	-63 dBm		8.600…		QoS Data	e2:ea:bc:1d:45:f7	IPv6mcast_fb		Yamaha_1…	e2:e…	QoS Data, SN=112, FN=0, Flags=op
13368	48.4940…	802.11ax (HE)	116	5580MHz	-63 dBm		8.600…		QoS Data	e2:ea:bc:1d:45:f7	IPv6mcast_fb		Yamaha_1…	e2:e…	QoS Data, SN=110, FN=0, Flags=op
19952	59.5770…	802.11ax (HE)	116	5580MHz	-74 dBm		8.100…	✓	QoS Data	c2:85:4e:eb:41:38	Sony_99:65:99		Yamaha_1…	c2:8…	QoS Data, SN=165, FN=0, Flags=op
19960	59.5780…	802.11ax (HE)	116	5580MHz	-75 dBm		8.100…	✓	QoS Data	c2:85:4e:eb:41:38	Sony_99:65:99		Yamaha_1…	c2:8…	QoS Data, SN=165, FN=0, Flags=op
7161	28.9390…	802.11ax (HE)	116	5580MHz	-75 dBm		16.29…	✓	QoS Data	c2:85:4e:eb:41:38			Yamaha_1…	c2:8…	QoS Data, SN=2766, FN=0, Flags=o
4679	21.0060…	802.11ax (HE)	52	5260MHz	-75 dBm		21.89…		QoS Data	Intel_41:01:54	Sony_99:65:99		Yamaha_1…	Inte…	QoS Data, SN=861, FN=0, Flags=.p
4678	21.0060…	802.11ax (HE)	52	5260MHz	-75 dBm		21.89…		QoS Data	Intel_41:01:54	Sony_99:65:99		Yamaha_1…	Inte…	QoS Data, SN=859, FN=0, Flags=.p
4677	21.0060…	802.11ax (HE)	52	5260MHz	-75 dBm		21.89…		QoS Data	Intel_41:01:54	Sony_99:65:99		Yamaha_1…	Inte…	QoS Data, SN=857, FN=0, Flags=.p
4676	21.0060…	802.11ax (HE)	52	5260MHz	-75 dBm		21.89…		QoS Data	Intel_41:01:54	Sony_99:65:99		Yamaha_1…	Inte…	QoS Data, SN=855, FN=0, Flags=.p
2848	13.8780…	802.11ax (HE)	52	5260MHz	-76 dBm		21.89…		QoS Data	Intel_41:01:54	Sony_99:65:99		Yamaha_1…	Inte…	QoS Data, SN=412, FN=0, Flags=.p
32384	67.4540…	802.11ax (HE)	116	5580MHz	-77 dBm		16.29…		QoS Data	c2:85:4e:eb:41:38	Sony_99:65:99		Yamaha_1…	c2:8…	QoS Data, SN=3026, FN=0, Flags=o
32329	67.4390…	802.11ax (HE)	116	5580MHz	-77 dBm		17.20…		QoS Data	c2:85:4e:eb:41:38	Sony_99:65:99		Yamaha_1…	c2:8…	QoS Data, SN=3025, FN=0, Flags=o

- Strongest two packets’s Signal Strength(dBm) are -63dBm, But the others start from -74dBm to -92dBm
- 100 meters away’s signal starts from -75dBm?

RSSI investigation in WiFi SIGINT

- This trace is captured at a huge conference site, like a stadium, A big open space, and many people visit the booth



- If we touch the wireless capture card with the devices, we get -30dBm in Japan (in Japanese radio law condition)
- Noise floor, the lowest signal is measured from -95dBm to -105 dBm in usual
- How about the office, the office floor is covered by many glass and gypsum board partitions.
- These materials have different attenuation values (in dB) and reflection percentages of 2.4/5/6GHz signal

Attenuation in dB and Reflection rate of 2.4/5GHz signal

- In general, attenuations and reflection rates of 2.4/5GHz signal

Materials	2.4GHz attenuation	5GHz attenuation	Reflection Rate
Glass partition	About 2-4dB	About 3-6dB	About 15-20%
Gypsum board	About 3dB	About 4-5dB	About 3-5%
Metal Door	About 16dB	About 28dB	About 100%
20cm concrete	About 20-30dB	About 25-45dB	About 15-25%

- These parameter helps us to determine the device is on site or off site, if you capture signals at -30dBm, the device locates in just a few meters away, if you captured at -31 to -50, the device may be in the same room, if you capture at -51 to -60, the device may locates in the same floor, if you capture at -61 to -79, the devices may be in the same building…

Signal threshold examples

- Usual threshold of WiFi RSSI(Receive Signal Strength Indicator)

RSSI(dBm)	Location	Details
From 0 to -30Bm	Same room	A few meters away
From -31 to -50dBm	Same room or next room	In the same room or next room divided with thin wall
From -51 to -60dBm	Same floor or same building	In the same floor or same building of next floor
From -61 to -70dBm	Same building	Reflected signals from 2-3 floors away
From -71 to -80dBm	Same building or outside	Reflected signals from outside or concrete wall
From -81 to -90dBm	Outside	The lowest signal for data

Create Display Filter button

- Edit -> Preferences and Choose Filter Buttons

Signal//Same room	radiotap.dbm_antsignal <=-0 and radiotap.dbm_antsignal >=-30
Signal//Same | Next room	radiotap.dbm_antsignal <=-31 and radiotap.dbm_antsignal >=-50
Signal//Same floor | Same building	radiotap.dbm_antsignal <=-51 and radiotap.dbm_antsignal >=-60
Signal//Same building	radiotap.dbm_antsignal <=-61 and radiotap.dbm_antsignal >=-70
Signal//Same bld | Outside	radiotap.dbm_antsignal <=-71 and radiotap.dbm_antsignal >=-80
Signal//Outside	radiotap.dbm_antsignal <=-81 and radiotap.dbm_antsignal >=-90

- Let's start a live demonstration
  Part1: Collect WiFi scan packets with CommView for WiFi
  Collect WiFi scan packets with Metageek Apps
  Part2: Save and merge traces as a pcapng trace file
  Start WiFi SIGINT analysis with Wireshark!!

USE WIRESHARK

Thank you for your participation.

Please complete the survey

trace files and Wireshark profiles are here:
https://www.ikeriri.ne.jp/sharkfest/wifi7_sf24eu.zip

ikeriri network service
http://www.ikeriri.ne.jp