

WiFi: Emulating Degraded Stations

Goal: Create a scenario where WiFi stations send out corrupted packets that can cause handshake and authentication failures. Learn techniques to capture and inspect packets to view corruption and scan log files to find indications of LANforge corruption injections.

We will learn to use some WiFi packet corruption features to emulate malfunctioning station equipment. This consists of enabling the corruption features and looking for errors when stations attempt to associate. Part of this will include capturing packets and inspecting them. This scenario requires LANforge version 5.3.6, and a two-radio LANforge system with one radio set in monitor mode.

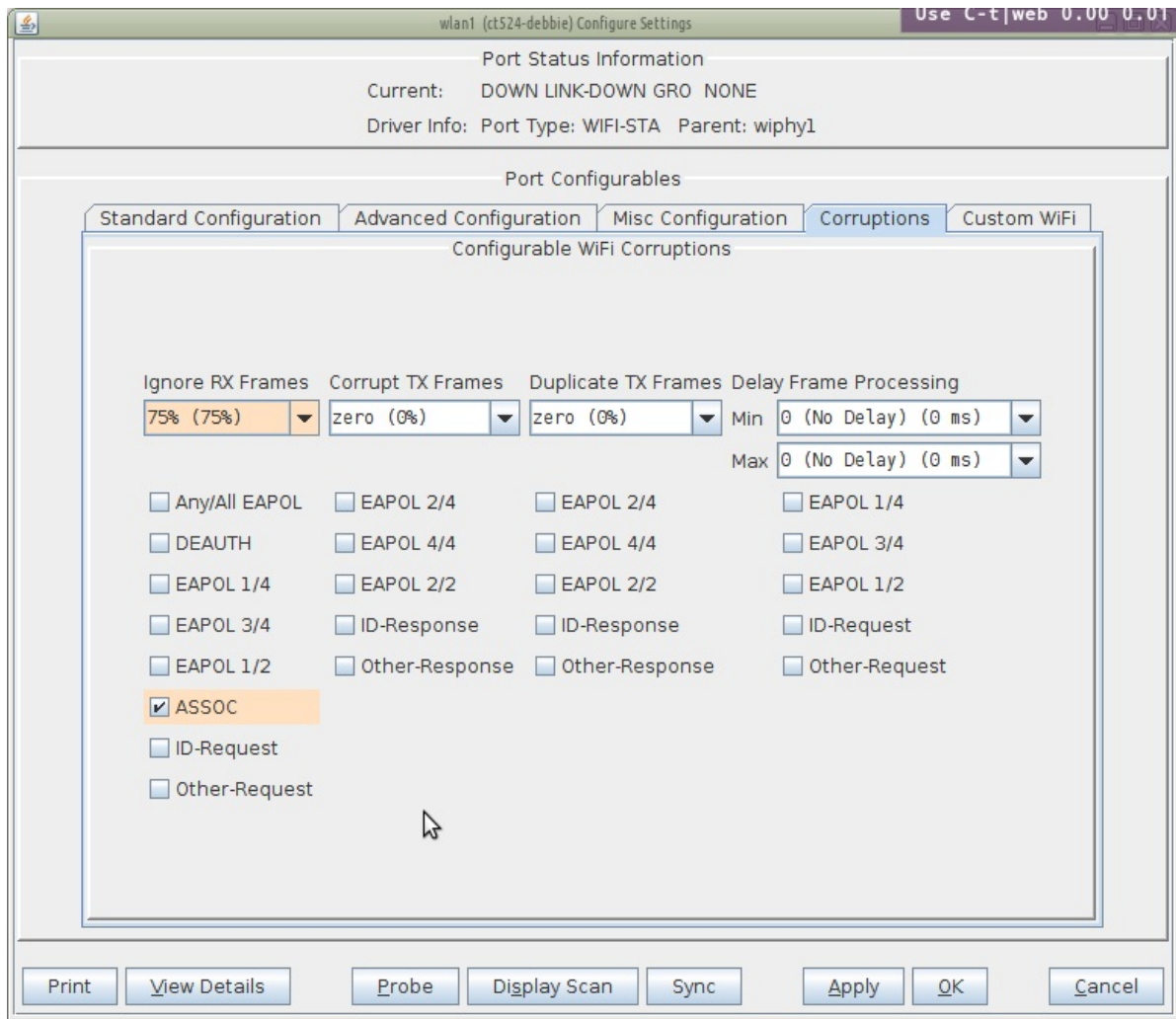


Open Authentication Test Scenario

We will begin with a basic open authentication test scenario with a single virtual station on a LANforge system connecting to an AP. (See Also: [Generating Traffic for WLAN Testing](#)) This test scenario also works for Captive Portal testing.

Create a Station with Corruptions

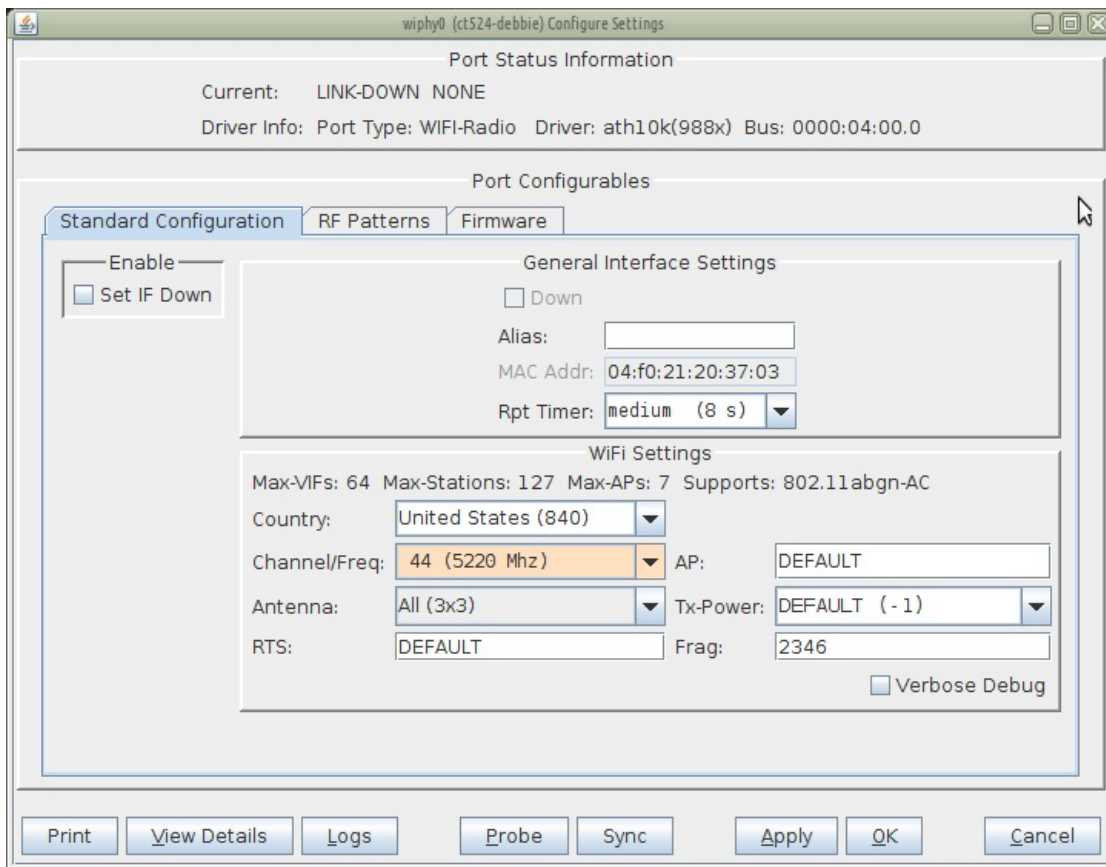
We will use the simplest form of corruption, ignored frames. Select the Port → Corruptions tab, and set Ignore RX Frames very high, like **75%**. To limit this to association frames, select **ASSOC**.



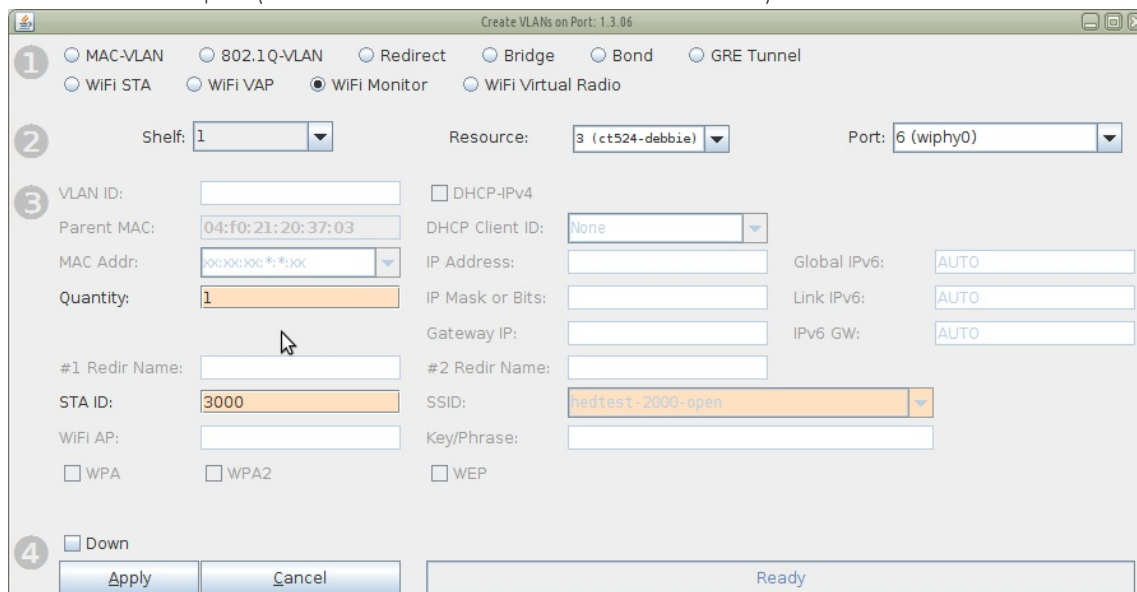
Associate a Station with Corruptions

Introducing corruptions is simple. Watching the effects takes some effort. With aggressive association corruptions, the basic effect will appear as if your station takes an unreasonably long time to associate. Let's set up Wireshark at different interfaces to understand better the kinds of traffic at play.

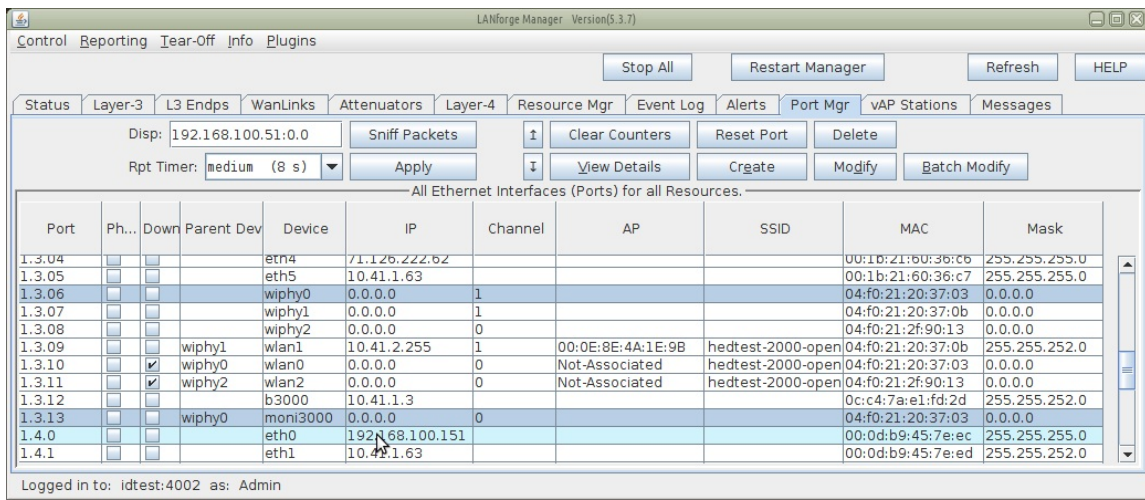
1. Select a radio for monitoring and set its channel to match the AP channel. If your AP is on channel 44, modify your LANforge wiphy monitor radio to also listen on channel 44. Our test AP is named hedtest-2000-open



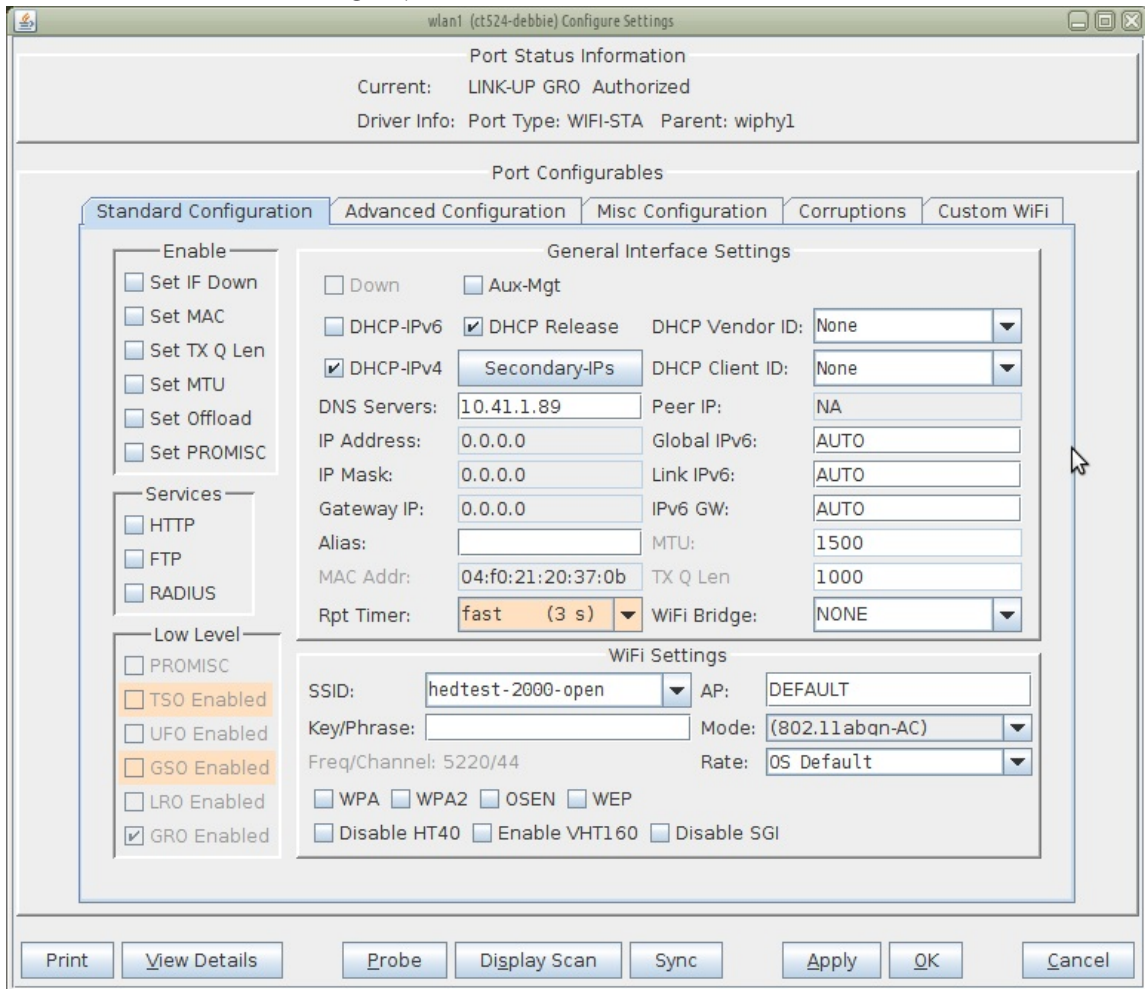
2. Create a **monitor** port (Port tab → Select Radio → Create → Monitor)



You will see the **moni 3000** port below. The channel number will not display.



3. Create a station (wiphy1 → wlan1 will work) and associate it with hedtest-2000-open. Highlight the station in the Ports tab and bring it up.



Watch Traffic

With 75% ignore the chances of the station actually associating are very port. On our monitor interface, we see that there are multiple discover and request packets.

*moni3000 [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: wlan.addr == 04:f0:21:20:37:0b Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
798	15:50:37.604074540	Sparklan 4a:1e:9b (00:CompeXPt_20:37:0b (04:802.11	ff02::2	ICMPv6	136	Router Solicitation from 04:f0:21:20:37:0b
819	15:50:41.185927522	10.41.2.255	10.41.1.89	DHCP	413	DHCP Release - Transaction ID 0x2477fc00
820	15:50:41.185979038	Sparklan 4a:1e:9b (00:CompeXPt_20:37:0b (04:802.11	ff02::2	ICMPv6	136	Router Solicitation from 04:f0:21:20:37:0b
821	15:50:41.189296093	10.41.2.255	10.41.1.89	DHCP	408	DHCP Release - Transaction ID 0x2477fc00
829	15:50:42.150757131	10.41.2.255	255.255.255.255	DHCP	408	DHCP Discover - Transaction ID 0x2477fc00
830	15:50:42.150764826	10.41.1.89	10.41.2.255	DHCP	422	DHCP Offer - Transaction ID 0x2477fc00
832	15:50:42.151282665	10.41.2.255	255.255.255.255	DHCP	413	DHCP Request - Transaction ID 0x2477fc00
833	15:50:42.151287980	Sparklan 4a:1e:9b (00:CompeXPt_20:37:0b (04:802.11	ff02::2	ICMPv6	136	Router Solicitation from 04:f0:21:20:37:0b
834	15:50:42.154495230	10.41.2.255	255.255.255.255	DHCP	408	DHCP Request - Transaction ID 0x2477fc00
835	15:50:42.151287980	10.41.1.89	10.41.2.255	DHCP	422	DHCP ACK - Transaction ID 0x2477fc00
864	15:50:47.367511641	Silicom 19:c9:dc	CompeXPt_20:37:0b	ARP	131	Who has 10.41.2.255? Tell 10.41.1.89
866	15:50:47.36759247	CompeXPt_20:37:0b	Silicom 19:c9:dc	ARP	113	10.41.2.255 is at 04:f0:21:20:37:0b
867	15:50:47.367810430	Sparklan 4a:1e:9b (00:CompeXPt_20:37:0b (04:802.11	ff02::2	ICMPv6	136	Router Solicitation from 04:f0:21:20:37:0b

Frame 829: 408 bytes on wire (3264 bits), 408 bytes captured (3264 bits) on interface 0

- Radiotap Header v0, Length 48
- 802.11 radio information
- IEEE 802.11 Data, Flags:F.
- Logical-Link Control
- Internet Protocol Version 4, Src: 10.41.2.255, Dst: 255.255.255.255
- User Datagram Protocol, Src Port: 68, Dst Port: 67
- Bootstrap Protocol (Discover)

```

0000 00 00 30 00 2f 40 00 a0 20 08 00 a0 20 08 00 a0 ..0./@. ...
0010 20 08 00 00 00 00 00 00 14 fa 11 0d 00 00 00 00 .....
0020 00 02 6c 09 a0 00 c5 00 00 00 bf 00 c0 01 c0 02 ..l.....
0030 08 02 00 00 ff ff ff ff ff ff 00 0e 8e 4a 1e 9b .....J..
0040 04 f0 21 20 37 0b 80 59 aa aa 03 00 00 00 08 00 ..!7..Y
0050 45 10 01 48 00 00 00 00 80 11 2c 6e 0a 29 02 ff E..H....,n..

```

On our station interface (wlan1), we see a different number of DHCP requests.

*wlan1 [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	15:50:29.845257423	10.41.1.89	224.0.0.251	MDNS	87	Standard query 0x0000 PTR _ipps.tcp.local,
2	15:50:29.846360437	fe80::2e0:edff:fe19:c9dc	ff02::fb	MDNS	107	Standard query 0x0000 PTR _ipps.tcp.local,
3	15:50:37.603676577	fe80::6f0:21ff:fe20:370b	ff02::2	ICMPv6	70	Router Solicitation from 04:f0:21:20:37:0b
4	15:50:41.185646447	10.41.2.255	10.41.1.89	DHCP	342	DHCP Release - Transaction ID 0x2477fc00
5	15:50:42.146967571	10.41.2.255	255.255.255.255	DHCP	342	DHCP Discover - Transaction ID 0x2477fc00
6	15:50:42.150757374	10.41.1.89	10.41.2.255	DHCP	351	DHCP Offer - Transaction ID 0x2477fc00
7	15:50:42.150862602	10.41.2.255	255.255.255.255	DHCP	342	DHCP Request - Transaction ID 0x2477fc00
8	15:50:42.180569682	10.41.1.89	10.41.2.255	DHCP	351	DHCP ACK - Transaction ID 0x2477fc00
9	15:50:47.367515151	Silicom 19:c9:dc	CompeXPt_20:37:0b	ARP	60	Who has 10.41.2.255? Tell 10.41.1.89
10	15:50:47.367541031	CompeXPt_20:37:0b	Silicom 19:c9:dc	ARP	42	10.41.2.255 is at 04:f0:21:20:37:0b

Frame 5: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits) on interface 0

- Ethernet II, Src: CompeXPt_20:37:0b (04:f0:21:20:37:0b), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 - Destination: Broadcast (ff:ff:ff:ff:ff:ff)
 - Source: CompeXPt_20:37:0b (04:f0:21:20:37:0b)
 - Type: IPv4 (0x0800)
 - Internet Protocol Version 4, Src: 10.41.2.255, Dst: 255.255.255.255
 - User Datagram Protocol, Src Port: 68, Dst Port: 67
 - Bootstrap Protocol (Discover)
 - Message type: Boot Request (1)
 - Hardware type: Ethernet (0x01)
 - Hardware address length: 6
 - Hops: 0
 - Transaction ID: 0x2477fc00
 - Seconds elapsed: 0
 - Bootp flags: 0x0000 (Unicast)
 - Client IP address: 0.0.0.0
 - Your (client) IP address: 0.0.0.0
 - Next server IP address: 0.0.0.0
 - Relay agent IP address: 0.0.0.0
 - Client MAC address: CompeXPt_20:37:0b (04:f0:21:20:37:0b)

```

0000 ff ff ff ff ff ff 04 f0 21 20 37 0b 80 00 45 10 .....!7...E.
0010 01 48 00 00 00 00 00 11 2c 6e 0a 29 02 ff ff ff ..H.....,n)...
0020 ff ff 00 44 00 43 01 34 0d bf 01 01 06 00 24 77 ..D.C.4 .....$w
0030 fc 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0040 00 00 00 00 00 00 04 f0 21 20 37 0b 80 00 00 00 .....!7...
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0060 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....

```

At our AP, we see repeated attempts.

***vap2000 [Wireshark 2.2.8 (wireshark-2.2.8)]**

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: `eth.addr == 04:f0:21:20:37:0b` Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
35	15:50:37.606829353	fe80::6f0:21ff:fe20:37	ff02::2	ICMPv6	70	Router Solicitation from 04:f0:21:20:37:0b
36	15:50:41.188713983	10.41.2.255	10.41.1.89	DHCP	342	DHCP Release - Transaction ID 0x2477fc00
37	15:50:41.188783549	10.41.2.255	10.41.1.89	DHCP	342	DHCP Release - Transaction ID 0x2477fc00
38	15:50:42.150048868	10.41.2.255	255.255.255.255	DHCP	342	DHCP Discover - Transaction ID 0x2477fc00
39	15:50:42.150126797	10.41.2.255	255.255.255.255	DHCP	342	DHCP Discover - Transaction ID 0x2477fc00
40	15:50:42.151060639	10.41.1.89	10.41.2.255	DHCP	351	DHCP Offer - Transaction ID 0x2477fc00
41	15:50:42.153822350	10.41.2.255	255.255.255.255	DHCP	342	DHCP Request - Transaction ID 0x2477fc00
42	15:50:42.153832743	10.41.2.255	255.255.255.255	DHCP	342	DHCP Request - Transaction ID 0x2477fc00
43	15:50:42.182995793	10.41.1.89	10.41.2.255	DHCP	351	DHCP ACK - Transaction ID 0x2477fc00
44	15:50:47.368350608	NewLink 19:c9:dc	CompexPt 20:37:0b	ARP	60	Who has 10.41.2.255? Tell 10.41.1.89
45	15:50:47.370494497	CompexPt 20:37:0b	NewLink 19:c9:dc	ARP	42	10.41.2.255 is at 04:f0:21:20:37:0b

▶ Frame 39: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits) on interface 0
 ▶ Ethernet II, Src: CompexPt 20:37:0b (04:f0:21:20:37:0b), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 ▶ Internet Protocol Version 4, Src: 10.41.2.255, Dst: 255.255.255.255
 ▶ User Datagram Protocol, Src Port: 68, Dst Port: 67
 ▶ Bootstrap Protocol (Discover)
 Message type: Boot Request (1)
 Hardware type: Ethernet (0x01)
 Hardware address length: 6
 Hops: 0
 Transaction ID: 0x2477fc00
 Seconds elapsed: 0
 ▶ Bootp flags: 0x0000 (Unicast)
 Client IP address: 0.0.0.0
 Your (client) IP address: 0.0.0.0
 Next server IP address: 0.0.0.0
 Relay agent IP address: 0.0.0.0
 Client MAC address: CompexPt 20:37:0b (04:f0:21:20:37:0b)
 Client hardware address padding: 00000000000000000000
 Server host name not given

```

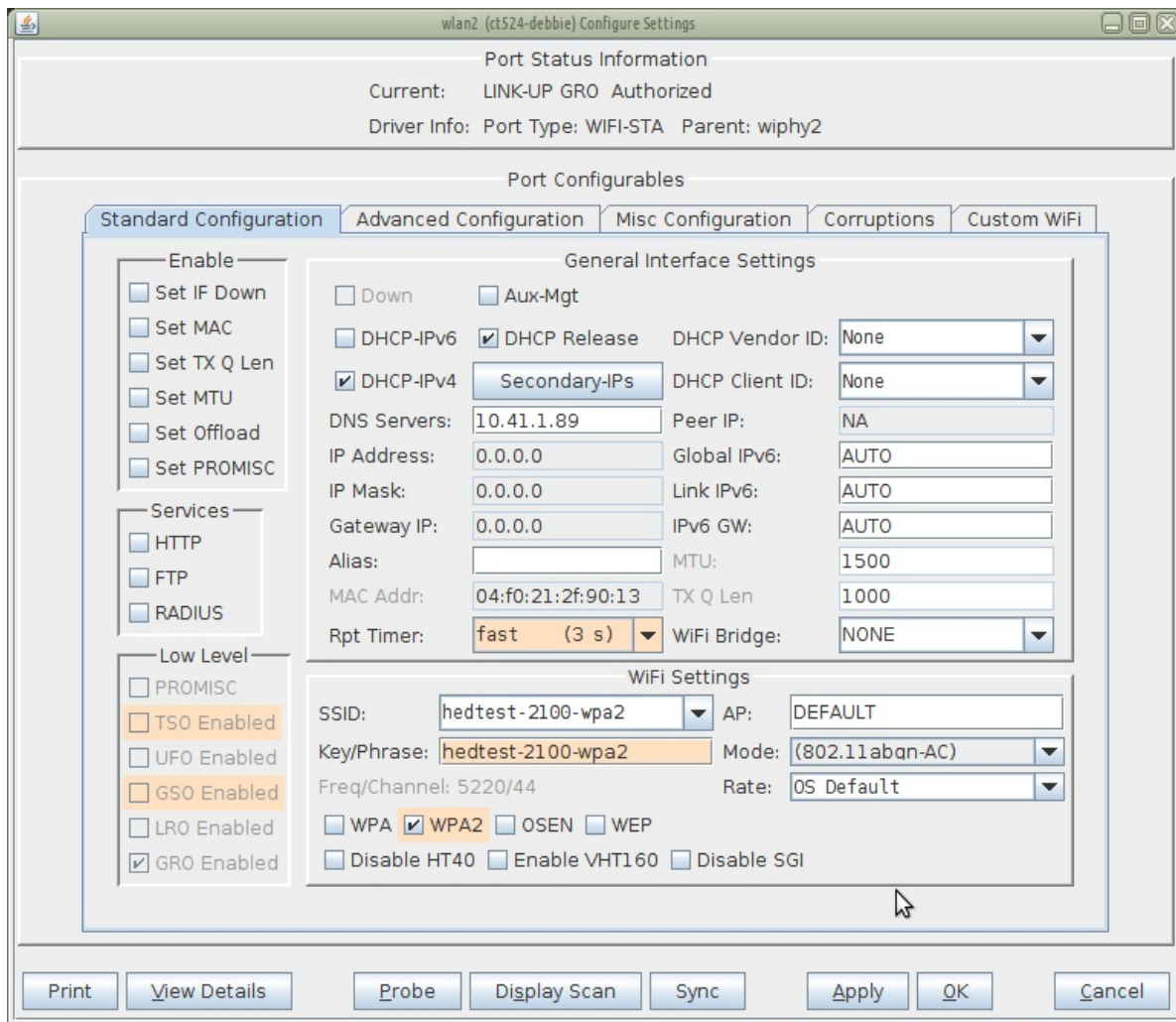
0000  ff ff ff ff ff ff 04 f0 21 20 37 0b 08 00 45 10  ....!7...E.
0010  01 48 00 00 00 00 80 11 2c 6e 0a 29 02 ff ff ff  .H.....,n)....
0020  ff ff 00 44 00 43 01 34 0d bf 01 01 06 00 24 77  ...D.C.4 .....$w
0030  fc 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ....
0040  00 00 00 00 00 00 04 f0 21 20 37 0b 00 00 00 00  ....!7....
0050  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ....
  
```

WPA2 Authentication Test Scenario

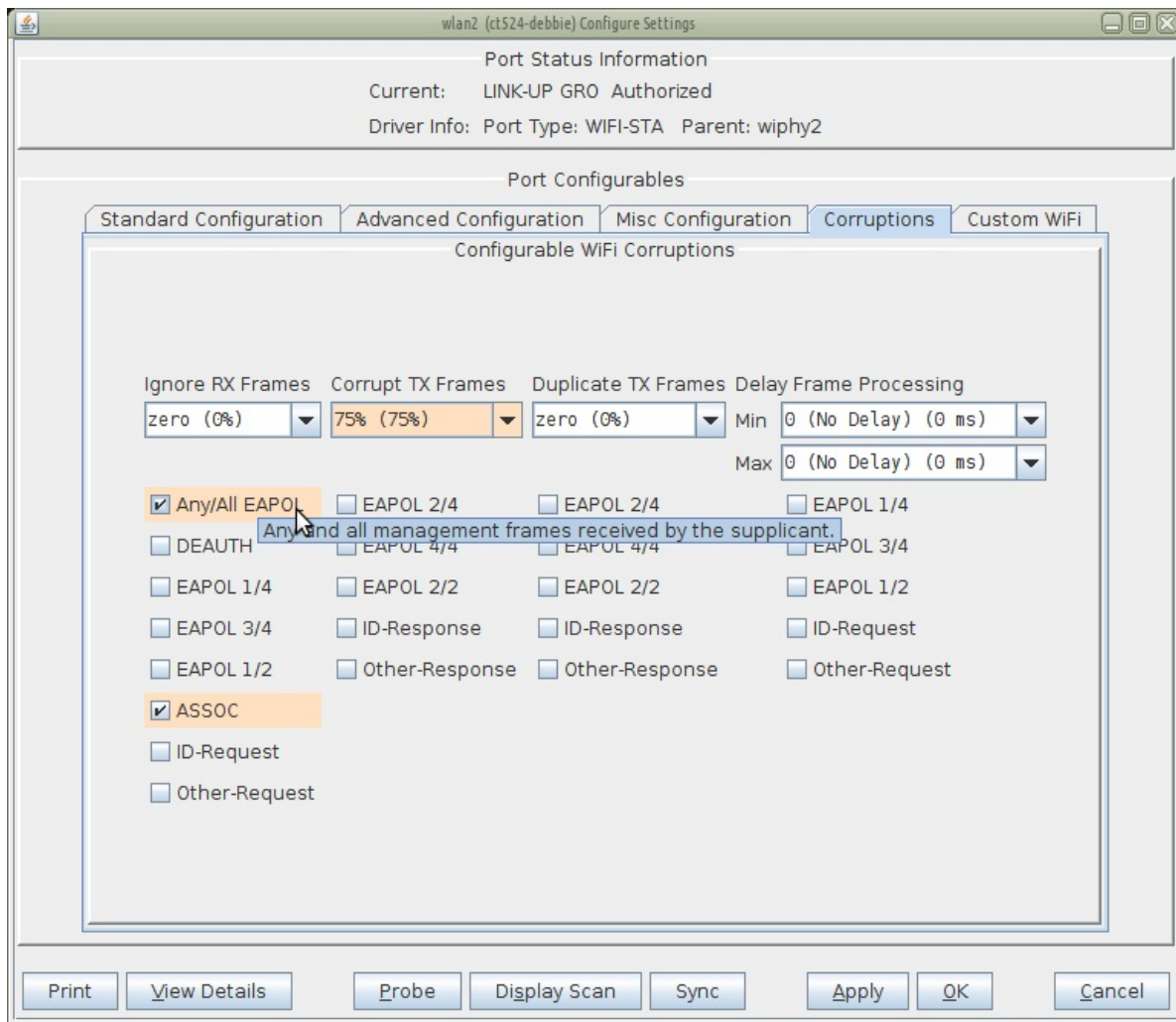
We will configure a station with WPA2 PSK encryption. We will also use Wireshark to decrypt the packets in order to see that they are corrupt.

Configure the Station

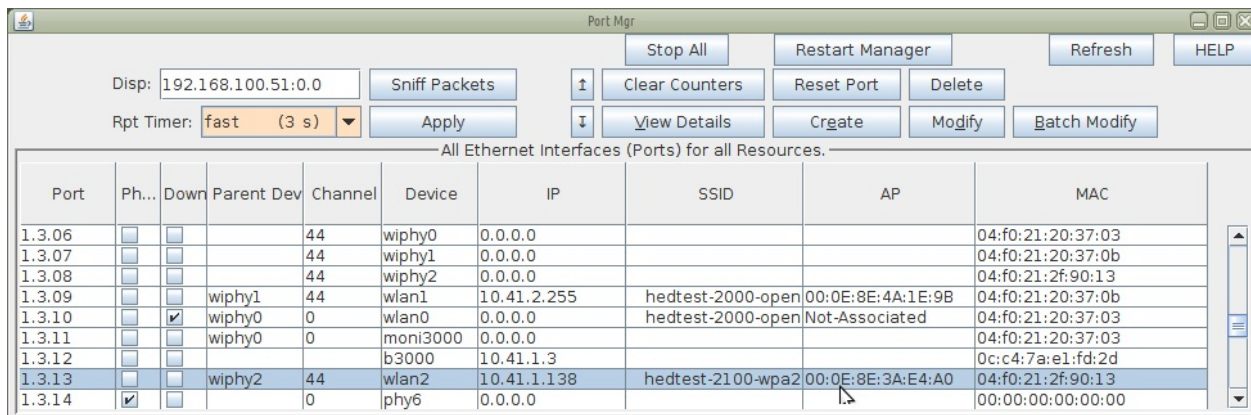
Configure station with WPA2 (See also: [Test WiFi station upload throughput](#))



On the Corruptions tab, you can set stations:



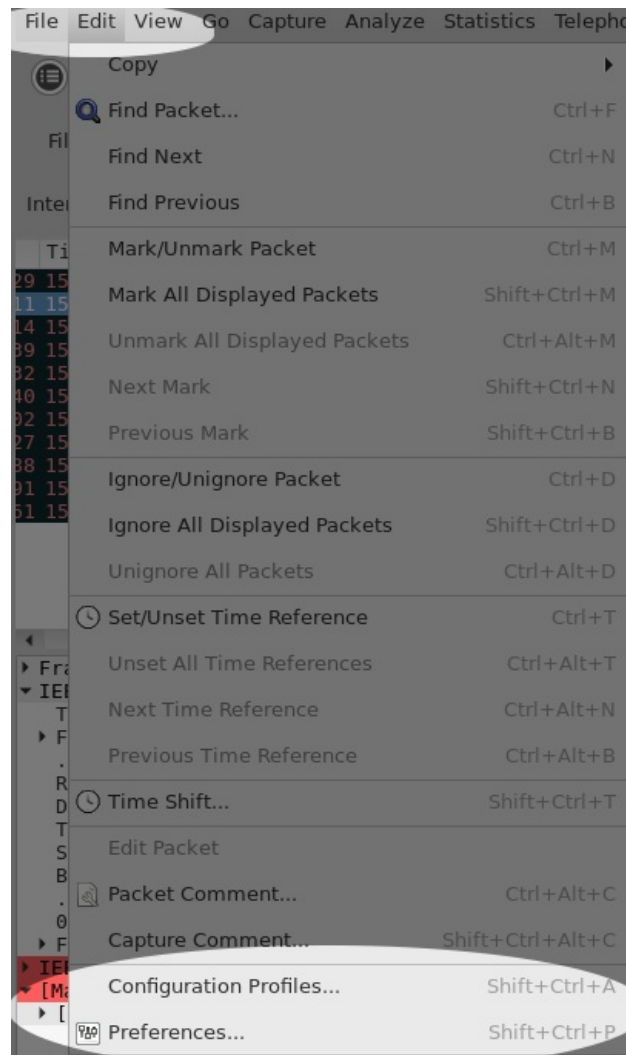
Highlight and activate the station:



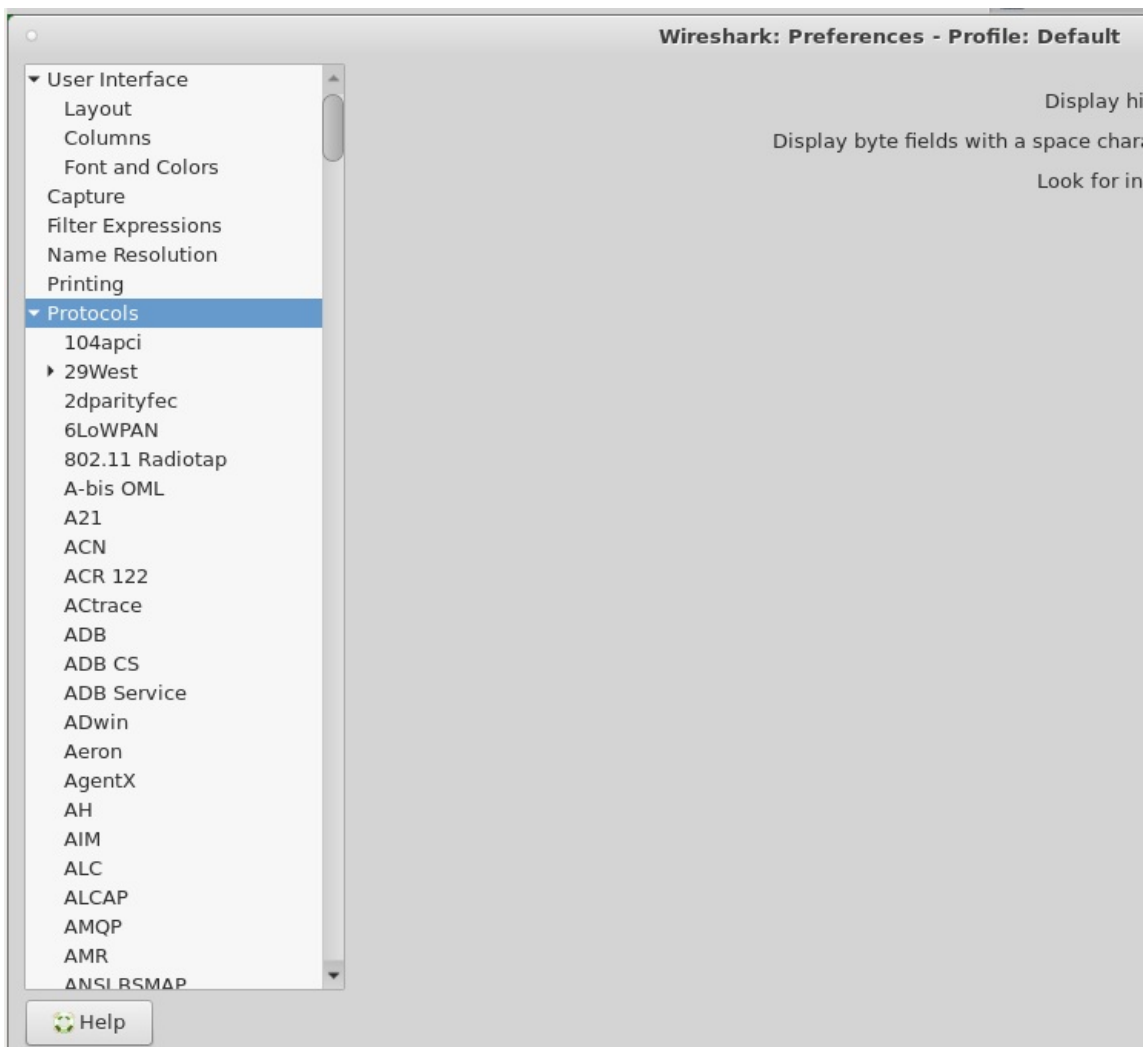
Setup Packet Decryption

We will not be able to inspect packets unless we configure Wireshark to decrypt the packets from this capture. Follow these steps:

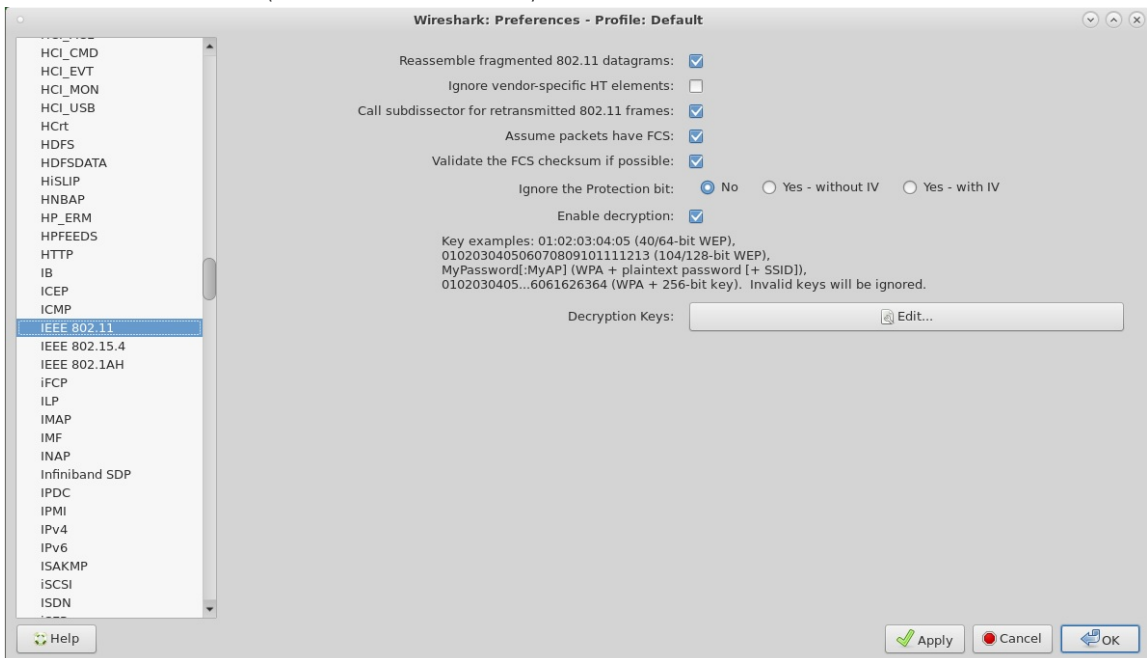
1. Wireshark Preferences (Edit → Preferences)



2. Protocol Preferences (Preferences → Protocols)



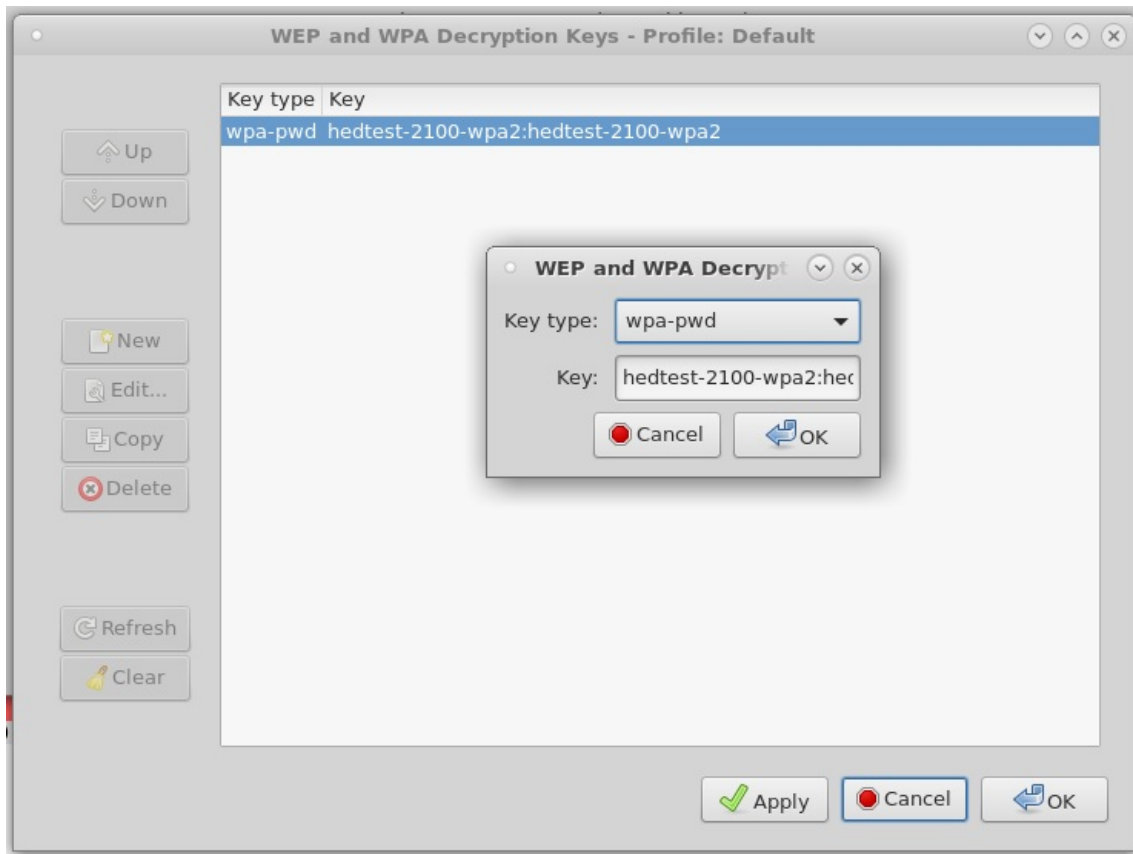
3. IEEE 802.11 Preferences (Protocols → IEEE 802.11)



- Select **Reassemble Fragmented 802.11 datagrams**
- Select **Call subdissector for retransmitted 802.11 frames**
- Select **Assume Packets have FCS**
- Select **Validate the FCS Checksum if possible**
- Select **No** for Ignore the Protection bit
- Select **Enable Decryption**

Add the SSID and password to the list of Decryption Keys. Select **wpa-pwd:** and type in the string **\$SSID: \$PSK** to match your password from your AP:

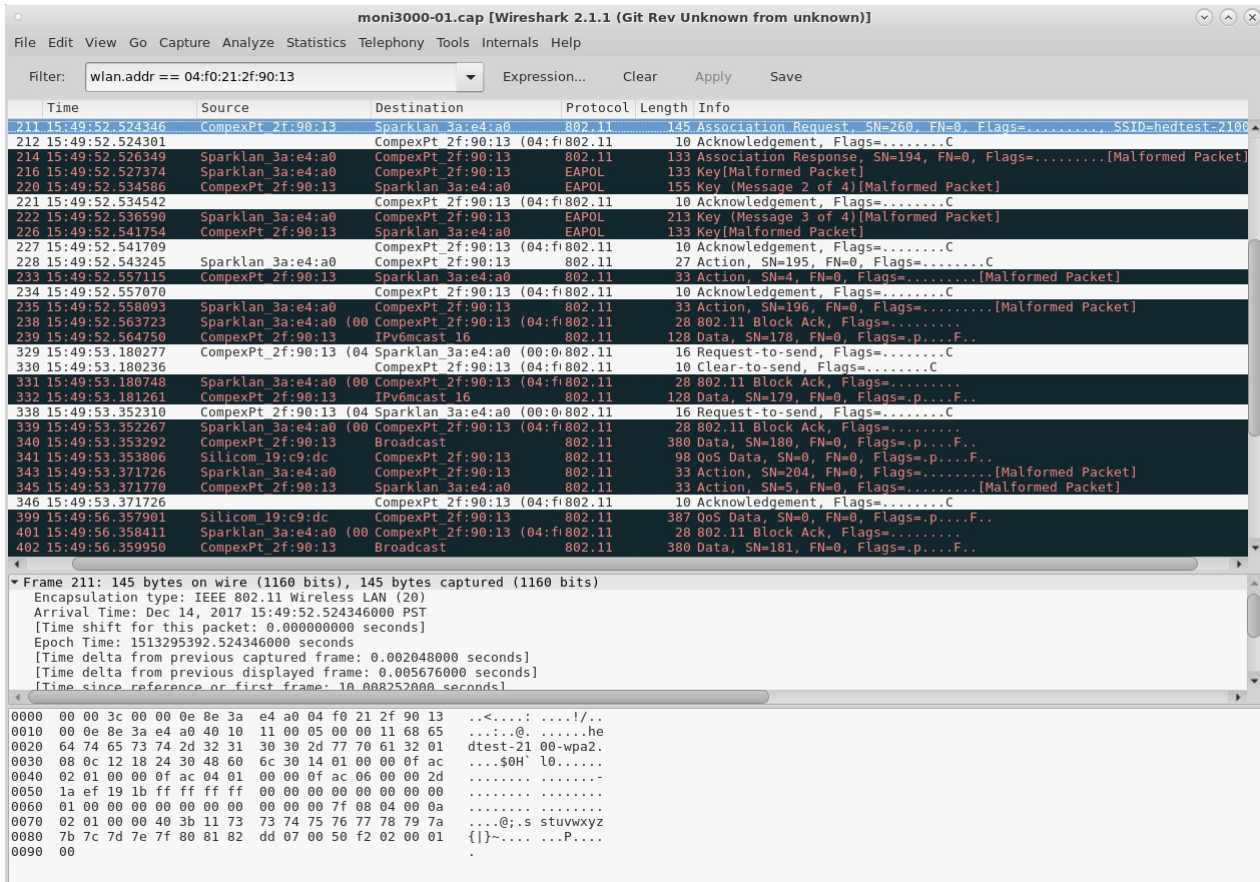
```
hedtest-2100-wpa2:hedtest-2100-wpa2
```



With our decryption enabled we can now inspect the captured packets:

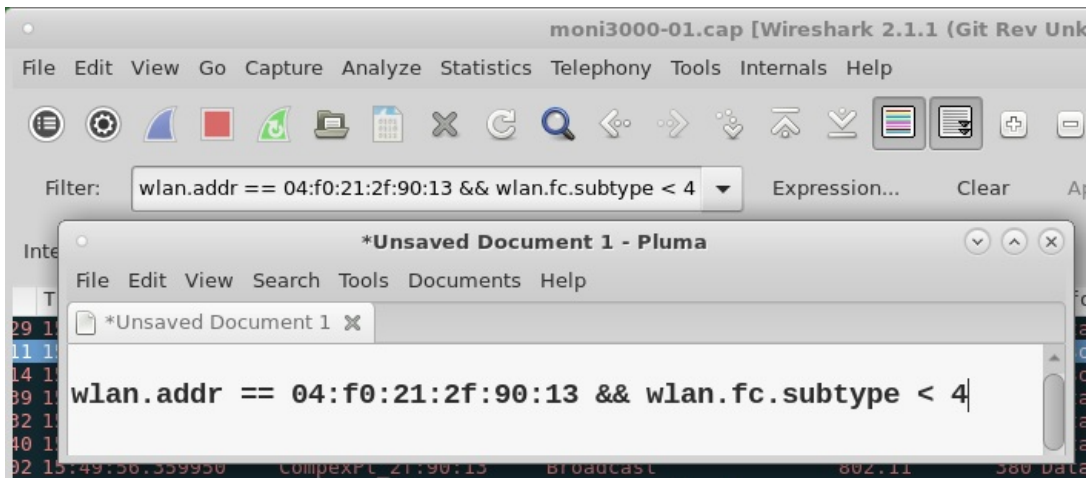
Packets from `moni3000` are filtered to show the station of interest using the display filter:

```
wlan.addr == 04:f0:21:2f:90:31
```



We can focus into the association by using a display filter:

wlan.addr == 04:f0:21:2f:90:13 && wlan.fc.subtype < 4



And the packets that form the association:

moni3000-01.cap [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

Filter: wlan.addr == 04:f0:21:2f:90:13 && wlan.fc.subtype < 4

Time	Source	Destination	Protocol	Length	Info
129	15:49:48.037389	CompexPt 2f:90:13	Broadcast	802.11	380 Data, SN=177, FN=0, Flags=p...F..
211	15:49:52.524346	CompexPt 2f:90:13	Sparklan 3a:e4:a0	802.11	145 Association Request, SN=260, FN=0, Flags=..... SSID=hedtest-2100-
214	15:49:52.526349	Sparklan 3a:e4:a0	CompexPt 2f:90:13	802.11	133 Association Response, SN=194, FN=0, Flags=..... [Malformed Packet]
239	15:49:52.564750	CompexPt 2f:90:13	IPv6mcast 16	802.11	128 Data, SN=178, FN=0, Flags=p...F..
332	15:49:53.181261	CompexPt 2f:90:13	IPv6mcast 16	802.11	128 Data, SN=179, FN=0, Flags=p...F..
340	15:49:53.353292	CompexPt 2f:90:13	Broadcast	802.11	380 Data, SN=180, FN=0, Flags=p...F..
402	15:49:56.359950	CompexPt 2f:90:13	Broadcast	802.11	380 Data, SN=181, FN=0, Flags=p...F..
427	15:49:57.087053	CompexPt 2f:90:13	IPv6mcast ff:2f:90:13	802.11	124 Data, SN=182, FN=0, Flags=p...F..
488	15:50:00.092175	CompexPt 2f:90:13	IPv6mcast 16	802.11	128 Data, SN=183, FN=0, Flags=p...F..
491	15:50:00.094735	CompexPt 2f:90:13	IPv6mcast 02	802.11	108 Data, SN=184, FN=0, Flags=p...F..
561	15:50:00.861199	CompexPt 2f:90:13	IPv6mcast 16	802.11	128 Data, SN=185, FN=0, Flags=p...F..

Frame 211: 145 bytes on wire (1160 bits), 145 bytes captured (1160 bits)

IEEE 802.11 Association Request, Flags:

Type/Subtype: Association Request (0x0000)

Frame Control Field: 0x0000

.000 0000 0011 1100 = Duration: 60 microseconds

Receiver address: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0)

Destination address: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0)

Transmitter address: CompexPt 2f:90:13 (04:f0:21:2f:90:13)

Source address: CompexPt 2f:90:13 (04:f0:21:2f:90:13)

BSS Id: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0)

.... .. 0000 = Fragment number: 0

0001 0000 0100 = Sequence number: 260

Frame check sequence: 0x00010002 [incorrect, should be 0x4d3f9908]

IEEE 802.11 wireless LAN management frame

[Malformed Packet: IEEE 802.11]

[Expert Info (Error/Malformed): Malformed Packet (Exception occurred)]

[Malformed Packet (Exception occurred)]

[Severity level: Error]

[Group: Malformed]

```

0000 00 00 3c 00 00 0e 8e 3a e4 a0 04 f0 21 2f 90 13 ..<.....!/.
0010 00 0e 8e 3a e4 a0 40 10 11 00 05 00 00 11 68 65 .....@.....he
0020 64 74 65 73 74 2d 32 31 30 30 2d 77 70 61 32 01 dtest-21 00-wpa2.
0030 08 0c 12 18 24 30 48 60 6c 30 14 01 00 00 0f ac ...$0H l0.....
0040 02 01 00 00 0f ac 04 01 00 00 0f ac 06 00 00 2d .....
0050 1a ef 19 1b ff ff ff ff 00 00 00 00 00 00 00 .....
0060 01 00 00 00 00 00 00 00 00 00 00 7f 08 04 00 0a .....
0070 02 01 00 00 40 3b 11 73 73 74 75 76 77 78 79 7a ...@:;s tuvwxyz
0080 7b 7c 7d 7e 7f 80 81 82 dd 07 00 50 f2 02 00 01 {}~.....P....
0090 00

```

Notice how the AP only really gets the uncorrupted packets. What we hope will happen is that our WiFi drivers will discard corrupted packets before passing them up to userspace.

We did not need to decrypt packets from our AP (only possible if monitoring inside the AP) **vap2100:**

*vap2100 [Wireshark 2.2.8 (wireshark-2.2.8)]

Filter: eth.addr == 04:f0:21:2f:90:13

No.	Time	Source	Destination	Protocol	Length	Info
1	15:49:48.033013778	10.41.1.138	10.41.1.89	DHCP	342	DHCP Release - Transaction ID 0x8afe7235
2	15:49:48.033095066	10.41.1.138	10.41.1.89	DHCP	342	DHCP Release - Transaction ID 0x8afe7235
3	15:49:51.422388481	CompexPt 2f:90:13	Broadcast	XID	20	Basic Format; Type 1 LLC (Class 1 LLC); Window Size 0
4	15:49:52.523945142	Sparklan 3a:e4:a0	CompexPt 2f:90:13	EAPOL	113	Key (Message 1 of 4)
5	15:49:52.532270418	CompexPt 2f:90:13	Sparklan 3a:e4:a0	EAPOL	135	Key (Message 2 of 4)
6	15:49:52.532961236	Sparklan 3a:e4:a0	CompexPt 2f:90:13	EAPOL	193	Key (Message 3 of 4)
7	15:49:52.539284251	CompexPt 2f:90:13	Sparklan 3a:e4:a0	EAPOL	113	Key (Message 4 of 4)
8	15:49:52.560890797	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
9	15:49:52.560973325	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
10	15:49:53.177475124	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
11	15:49:53.177574187	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
12	15:49:53.349441609	0.0.0.0	255.255.255.255	DHCP	342	DHCP Discover - Transaction ID 0x9f26eb08
13	15:49:53.349528422	0.0.0.0	255.255.255.255	DHCP	342	DHCP Discover - Transaction ID 0x9f26eb08
14	15:49:53.350698431	10.41.1.89	10.41.1.138	ICMP	62	Echo (ping) request id=0x73b2, seq=0/0, ttl=64 (no res
15	15:49:56.354280127	10.41.1.89	10.41.1.138	DHCP	351	DHCP Offer - Transaction ID 0x9f26eb08

Frame 4: 113 bytes on wire (904 bits), 113 bytes captured (904 bits) on interface 0

Ethernet II, Src: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0), Dst: CompexPt 2f:90:13 (04:f0:21:2f:90:13)

Destination: CompexPt 2f:90:13 (04:f0:21:2f:90:13)

Address: CompexPt 2f:90:13 (04:f0:21:2f:90:13)

.... .0 = LG bit: Globally unique address (factory default)

.... .0 = IG bit: Individual address (unicast)

Source: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0)

Address: Sparklan 3a:e4:a0 (00:0e:8e:3a:e4:a0)

.... .0 = LG bit: Globally unique address (factory default)

.... .0 = IG bit: Individual address (unicast)

Type: 802.1X Authentication (0x888e)

802.1X Authentication

Version: 802.1X-2004 (2)

Type: Key (3)

Length: 95

Key Descriptor Type: EAPOL RSN Key (2)

Key Information: 0x008b

Key Length: 16

Replay Counter: 1

WPA Key Nonce: 60514571cffb43fcc63805a9805032b07df12f7d75b242b4...

Key IV: 00000000000000000000000000000000

WPA Key RSC: 0000000000000000

WPA Key ID: 0000000000000000

WPA Key MIC: 00000000000000000000000000000000

WPA Key Data Length: 0

```

0000 04 f0 21 2f 90 13 00 0e 8e 3a e4 a0 88 8e 02 03 ..!/....
0010 00 5f 02 00 8b 00 10 00 00 00 00 00 00 01 60 .....
0020 51 45 71 cf fb 43 fc c6 38 05 a9 80 50 32 b0 7d OEq..C.. 8...P2.}
0030 f1 2f 7d 75 b2 42 b4 5b 2d 18 b2 8e 5f 50 56 00 ./}u.B.[ -...PV.
0040 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....

```