

Wi-Fi Direct to Hell

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Whoami

Interests and expertise include network security, reverse engineering, and privacy. I enjoy playing with IEEE 802.11 security.

What?

Wi-Fi Direct specification defines the architecture and protocols to facilitate device-to-device connectivity based on the IEEE 802.11 infrastructure mode.

- Wi-Fi Direct can be use by an attacker to access a device.
- Devices supporting the protocol extends the IEEE 802.11 attack surface.

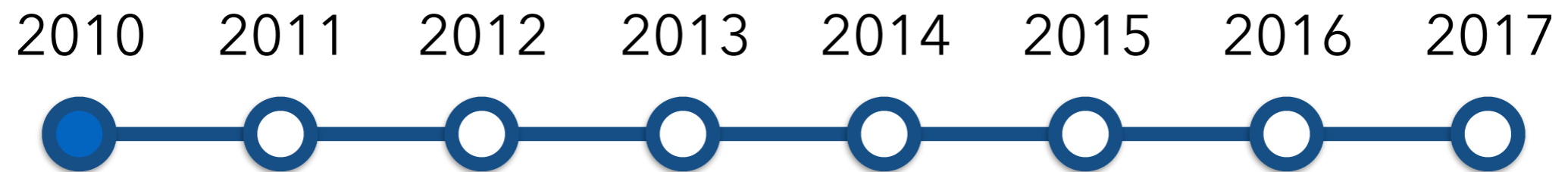
Why?

- There are several vendors that have implemented the protocol in an insecure way.

Wi-Fi Alliance

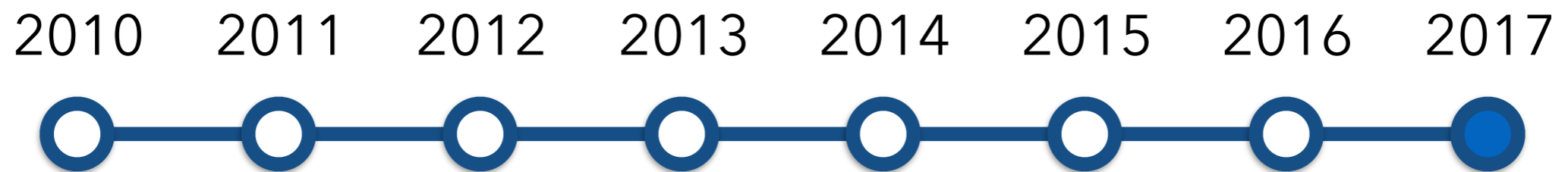
- WPS (Wi-Fi Protected Setup)
- Wi-Fi Display
- Wi-Fi Direct
- Hotspot 2.0

Wi-Fi Direct



First public release of the technical specification

Wi-Fi Direct

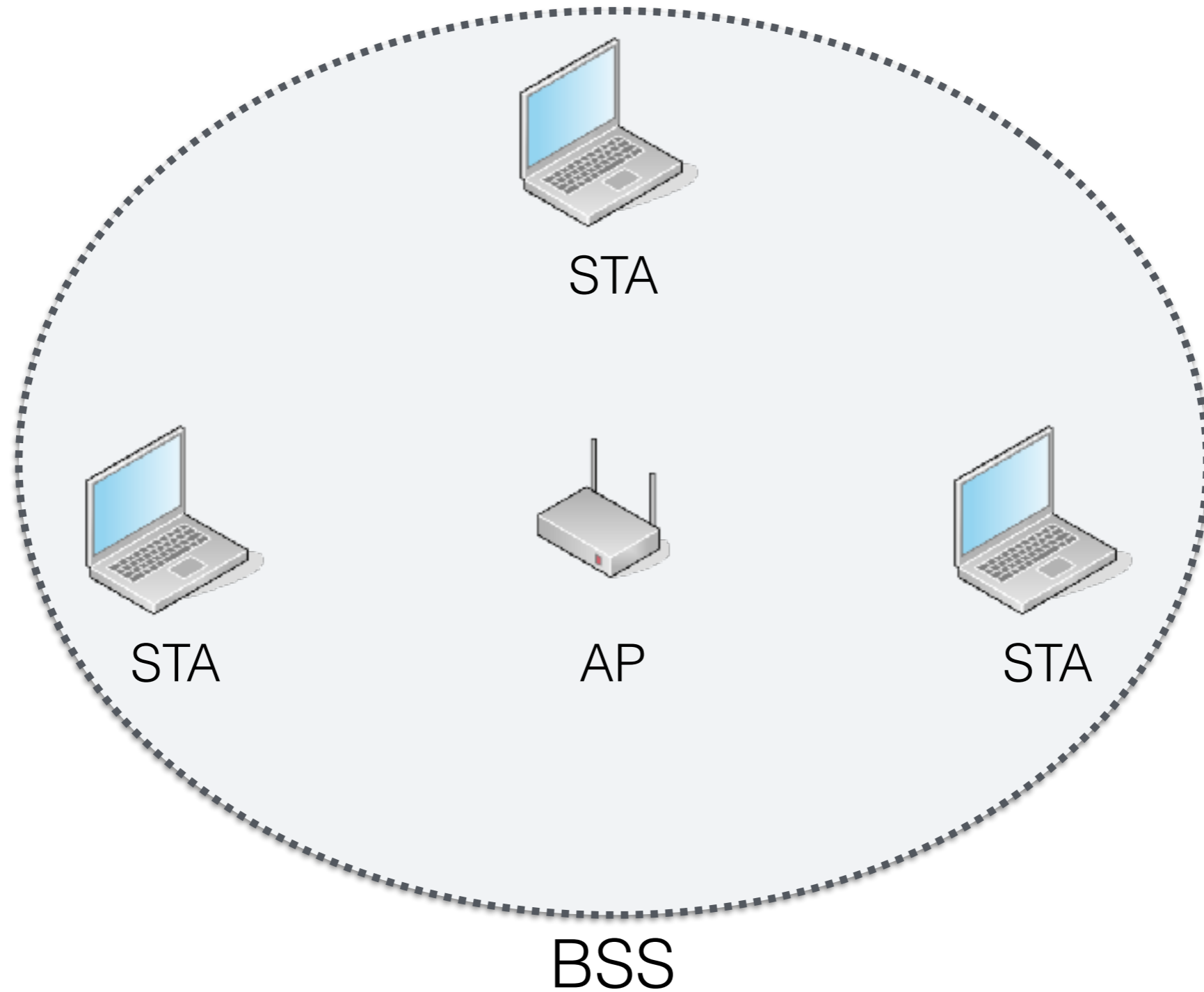


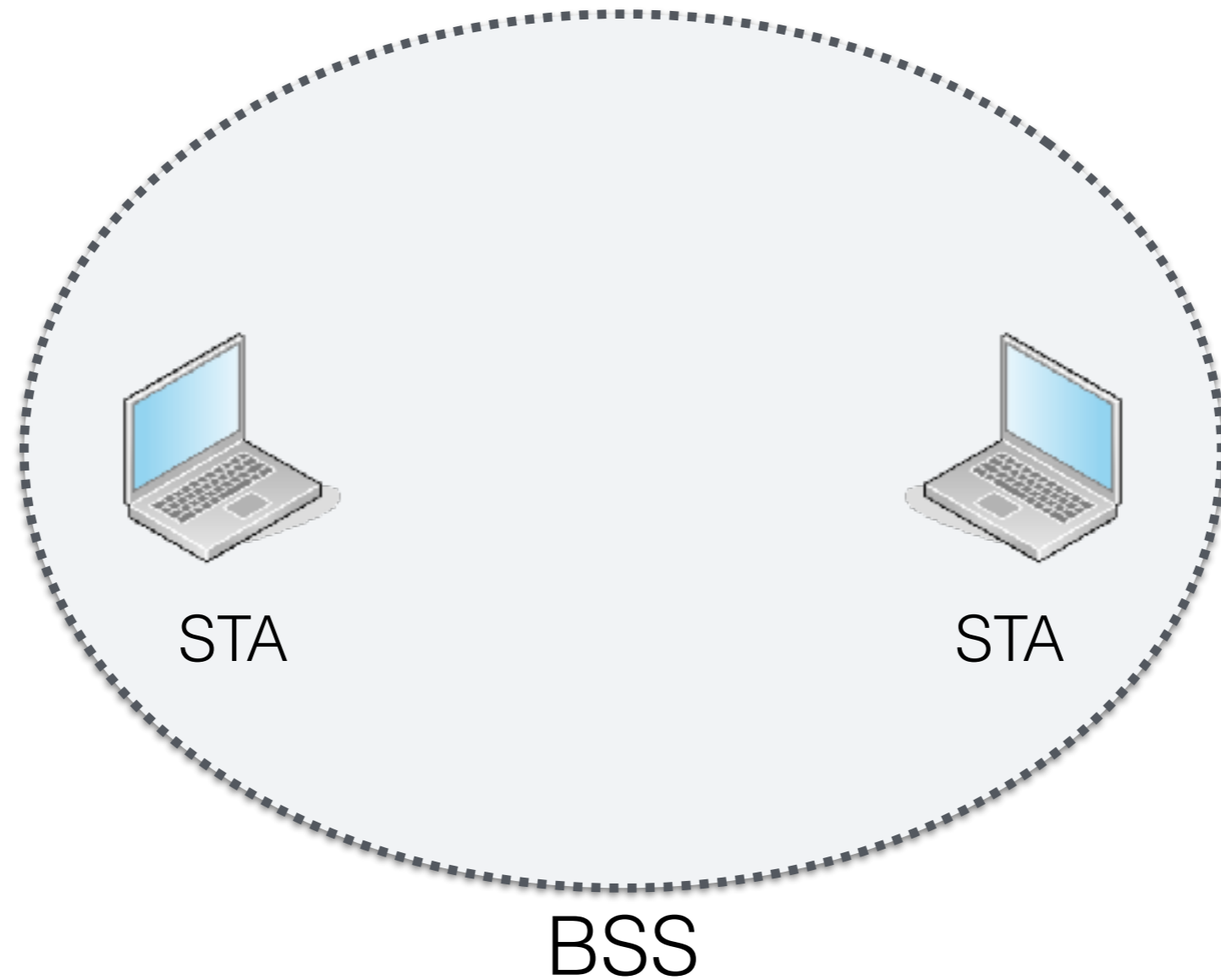
13280 Wi-Fi Direct certified products

Wi-Fi Direct

- P2P Discovery
- P2P Group Operations
- P2P Legacy Support

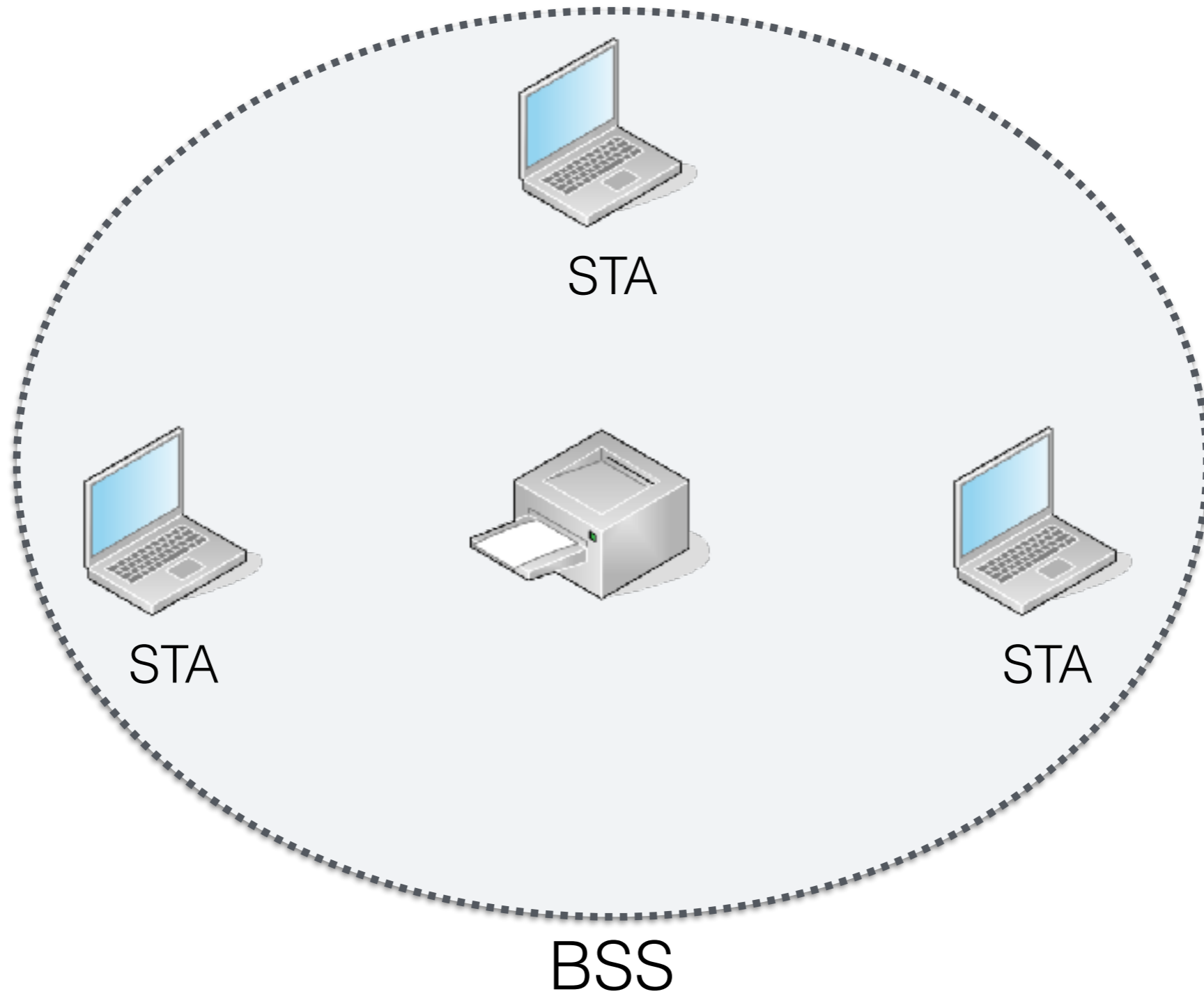
Infrastructure Mode



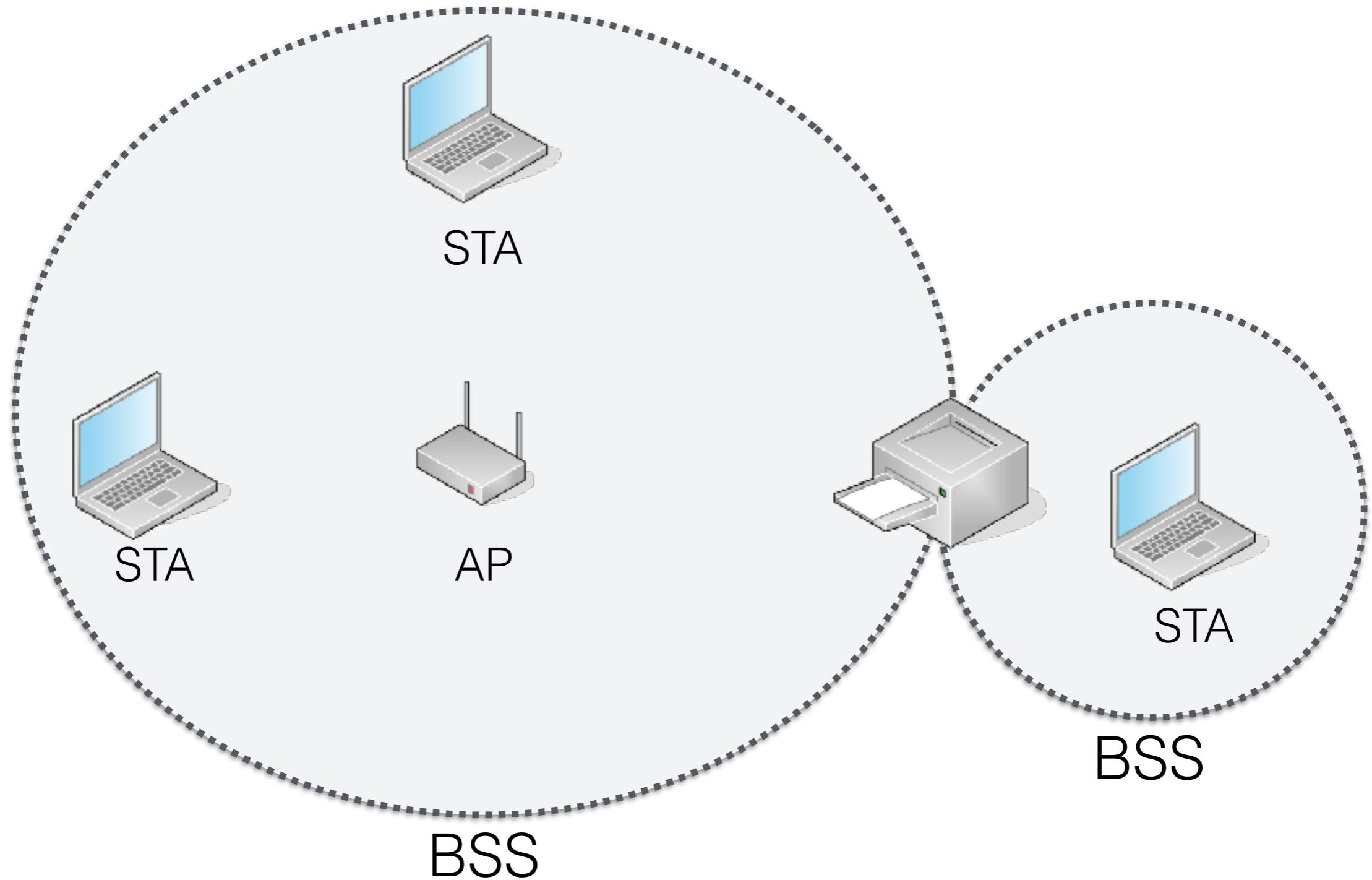


Ad Hoc Mode

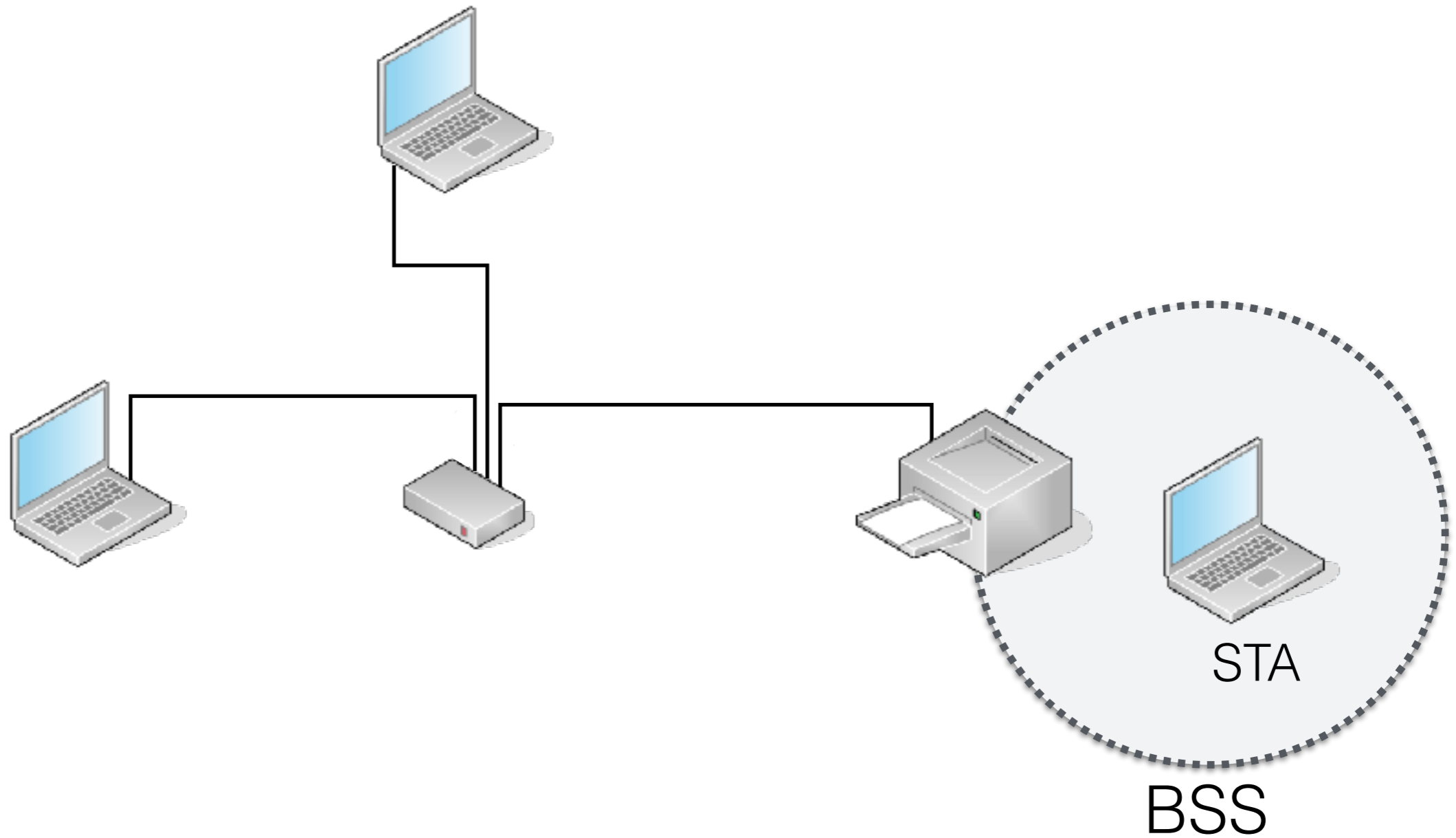
Wi-Fi Direct



Wi-Fi Direct



Wi-Fi Direct



802.11 Discovery



AP



Beacon frame



STA





AP

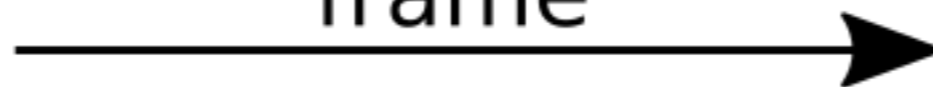


STA



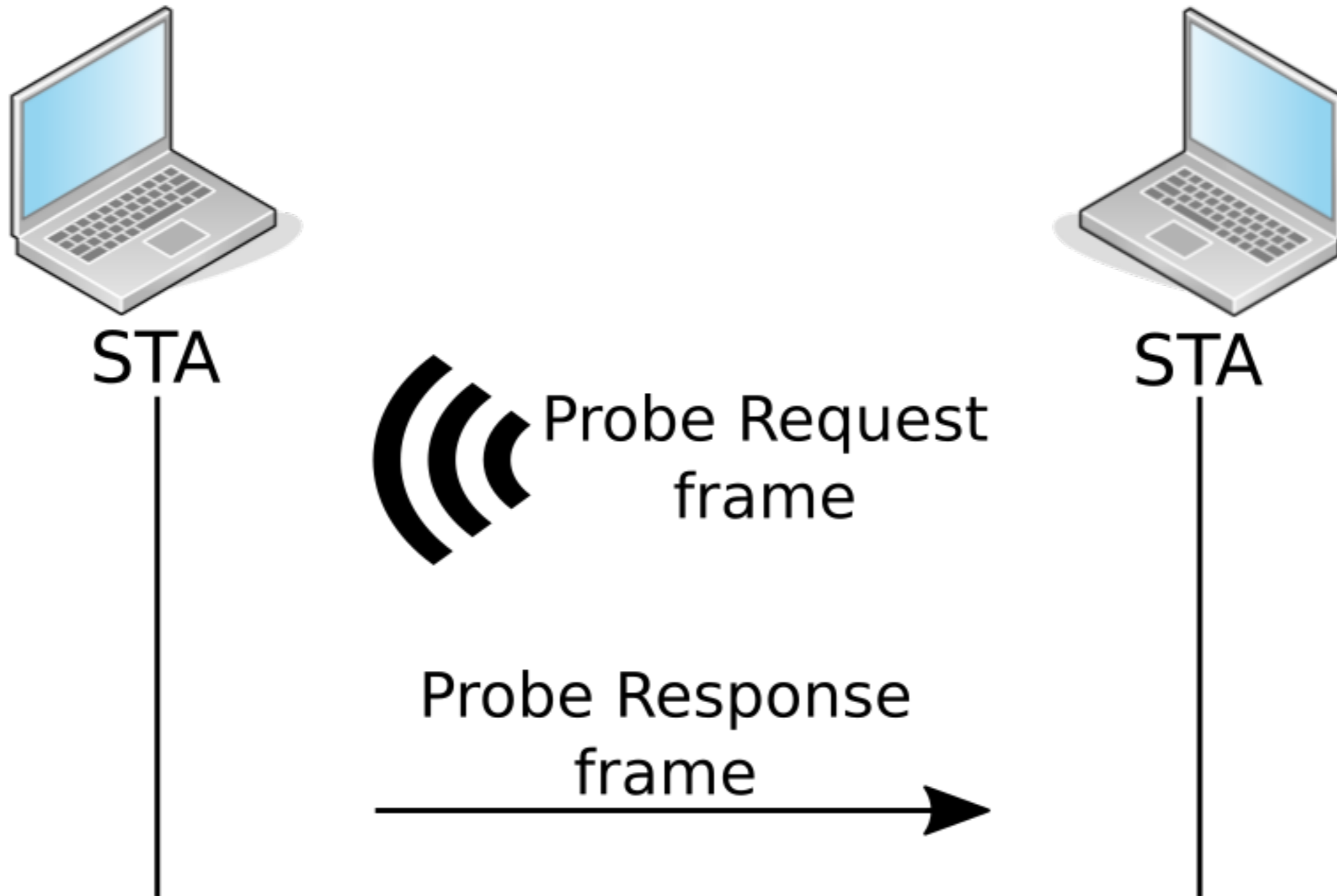
Probe Request
frame

Probe Response
frame



802.11 Discovery

P2P Discovery



- ▶ Radiotap Header v0, Length 36
- ▶ 802.11 radio information
- ▼ IEEE 802.11 Probe Request, Flags:C
 - Type/Subtype: Probe Request (0x0004)
 - ▶ Frame Control Field: 0x4000
 - .000 0000 0000 0000 = Duration: 0 microseconds
 - Receiver address: ff:ff:ff:ff:ff:ff
 - Destination address: ff:ff:ff:ff:ff:ff
 - Transmitter address: 8a:28: [REDACTED]
 - Source address: 8a:28: [REDACTED]
 - BSS Id: ff:ff:ff:ff:ff:ff
 - 0000 = Fragment number: 0
 - 0011 0101 1011 = Sequence number: 859
 - Frame check sequence: 0x272d3650 [correct]
 - [FCS Status: Good]
- ▼ IEEE 802.11 wireless LAN management frame
 - ▼ Tagged parameters (253 bytes)
 - ▶ Tag: SSID parameter set: DIRECT-
 - ▶ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
 - ▶ Tag: DS Parameter set: Current Channel: 6
 - ▶ Tag: HT Capabilities (802.11n D1.10)
 - ▶ Tag: Extended Capabilities (8 octets)
 - ▶ Tag: VHT Capabilities (IEEE Std 802.11ac/D3.1)
 - ▶ Tag: Vendor Specific: 00:50:f2: WPS
 - ▶ Tag: Vendor Specific: 50:6f:9a: P2P

P2P Discovery

```
▶ Radiotap Header v0, Length 36
▶ 802.11 radio information
▶ IEEE 802.11 Probe Response, Flags: .....C
▼ IEEE 802.11 wireless LAN management frame
  ▶ Fixed parameters (12 bytes)
  ▼ Tagged parameters (235 bytes)
    ▶ Tag: SSID parameter set: DIRECT-
    ▶ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    ▶ Tag: DS Parameter set: Current Channel: 3
    ▶ Tag: Vendor Specific: 00:50:f2: WPS
    ▶ Tag: Vendor Specific: 50:6f:9a: Wi-Fi Display
    ▼ Tag: Vendor Specific: 50:6f:9a: P2P
      Tag Number: Vendor Specific (221)
      Tag length: 47
      OUI: 50-6f-9a (Wi-FiAll)
      Vendor Specific OUI Type: 9
      ▶ P2P Capability: Device 0x25 Group 0x80
      ▼ P2P Device Info
        Attribute Type: P2P Device Info (13)
        Attribute Length: 35
        P2P Device address: 00:b1:10:f4:b7:f5
```

P2P Discovery

```
Device Name attribute type: 0x1011
Device Name attribute length: 14
Device Name: [TV] UN32J5500
```

- ▶ Radiotap Header v0, Length 36
- ▶ 802.11 radio information
- ▶ IEEE 802.11 Action, Flags:C
- ▼ IEEE 802.11 wireless LAN management frame

▼ Fixed parameters

Category code: Public Action (4)
 Public Action: GAS Initial Request (0x0a)
 Dialog token: 0x00
 Tag Number: Advertisement Protocol (108)
 Tag length: 2

P2P Discovery

OUI: 50-6f-9a (Wi-FiAll)
 ANQP WFA Subtype: P2P (9)
 Service Update Indicator: 0

▼ Service TLV (Transaction ID: 1 Type: UPnP)

Length: 54
 Service Protocol Type: UPnP (2)
 Service Transaction ID: 1

Query Data: 1075726e3a736368656d61732d75706e702d6f72673a6465...

```

0000  00 00 24 00 2f 40 00 a0 20 08 00 00 00 00 00 00  ..$./@..
0010  8e 87 36 7c 02 00 00 00 10 0c 76 09 c0 00 ec 00  ..6|....v....
0020  00 00 ec 00 d0 00 3c 00 10 c8 04 0a 00 6c 10  ..<.....1
0030  02 00 00 42 00 dd dd 3e 00 50 6f 9a 09 00 00 36  ...B...>.Po...6
0040  00 02 01 10 75 72 6e 3a 73 63 68 65 6d 61 73 2d  ...urn:schemas-
0050  75 70 6e 70 2d 6f 72 67 3a 64 65 76 69 63 65 3a  upnp-org:device:
0060  49 6e 74 65 72 6e 65 74 47 61 74 65 77 61 79 44  Internet GatewayD
0070  65 76 69 63 65 3a 31 1c f6 22 39  evice:1. ."9
0080
  
```

```

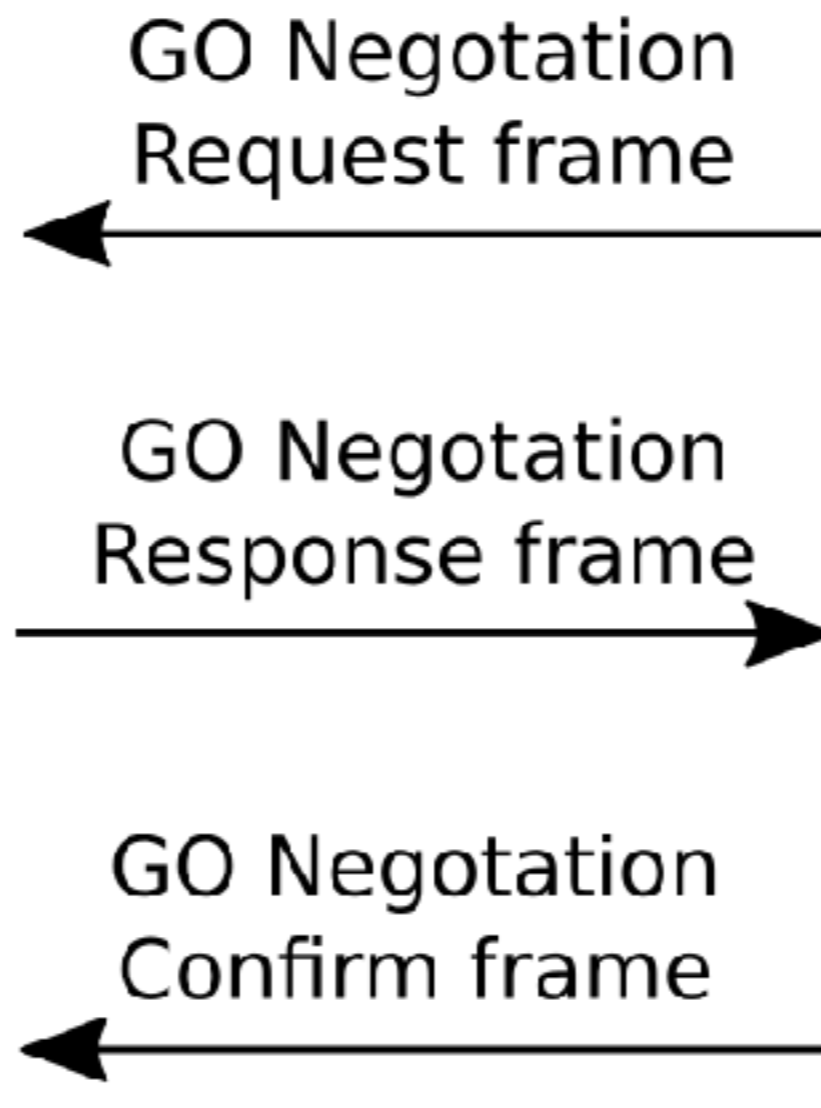
..$./@..
..6|....v....
.....<.....1
...B...>.Po...6
...urn:schemas-
upnp-org:device:
Internet GatewayD
evice:1. ."9
  
```



STA

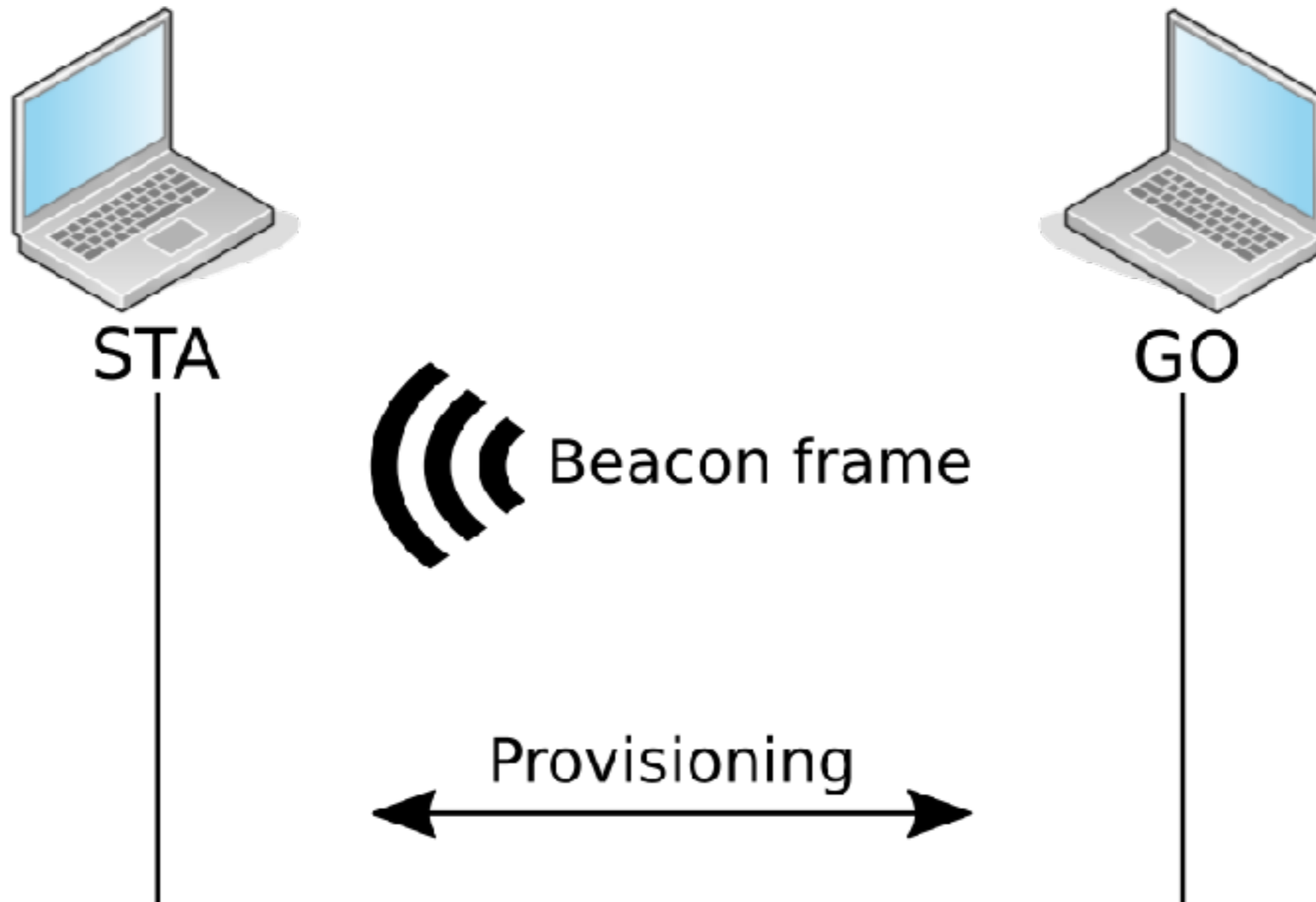


STA



P2P Group Formation

P2P Group Formation





TL-WN722N

```
$ iw phy
wiphy phy0
  max # scan SSIDs: 4
  max scan IEs length: 2257 bytes
  Retry short limit: 7
  Retry long limit: 4
  Coverage class: 0 (up to 0m)
  Device supports RSN-IBSS.
  Device supports AP-side u-APSD.
  Device supports T-DLS.
  Supported Ciphers:
    * WEP40 (00-0f-ac:1)
    * WEP104 (00-0f-ac:5)
    * TKIP (00-0f-ac:2)
```

Interface Requirements

```
  * 00-0f-ac:13
  * 00-0f-ac:11
  * 00-0f-ac:12
  Available Antennas: TX 0x1 RX 0x3
  Configured Antennas: TX 0x1 RX 0x3
  Supported interface modes:
    * IBSS
    * managed
    * AP
    * AP/VLAN
    * WDS
    * monitor
    * mesh point
    * P2P-client
    * P2P-GO
```

wpa_cli v2.5

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See README for more details.

Selected interface 'wlp2s0'

Interactive mode

> p2p_find 5

OK

<3>CTRL-EVENT-SCAN-STARTED

<3>P2P-DEVICE-FOUND 70:5a: p2p_dev_addr=72:5a: pri_dev_type=3-0050F204-1
'DIRECT-66-HP OfficeJet Pro 8710' config_methods=0x5a88 dev_capab=0x4 group_capab=0x1 vendor_e
new=1

<3>P2P-DEVICE-FOUND 32:cd: p2p_dev_addr=32:cd: pri_dev_type=3-0050F204-5
'DIRECT-KIM283x Series' config_methods=0x98 dev_capab=0x4 group_capab=0x9 vendor_elems=1 new=1

<3>P2P-DEVICE-FOUND ce:b1: p2p_dev_addr=ce:b1: pri_dev_type=7-0050F204-1
'[TV] UN32J5500' config_methods=0x188 dev_capab=0x25 group_capab=0x80 new=1

<3>CTRL-EVENT-SCAN-STARTED

wpa_cli

<3>CTRL-EVENT-SCAN-STARTED

<3>CTRL-EVENT-SCAN-STARTED

<3>CTRL-EVENT-SCAN-STARTED

<3>P2P-FIND-STOPPED

<3>P2P-DEVICE-LOST p2p_dev_addr=ce:b1:

<3>P2P-DEVICE-LOST p2p_dev_addr=32:cd:

<3>P2P-DEVICE-LOST p2p_dev_addr=72:5a:

Settings

SEARCHING...

RENAME DEVICE



My Pixel

Peer devices

DIRECT-66-HP OfficeJet Pro 8710
Available



DIRECT-KIM283x Series
Available



Remembered groups

android

Search:

Name	Type	Phy	Signal	Channel	Last Seen	Data	Packets
[redacted]	Wi-Fi AP	IEEE802.11	-94	11	Oct 22 2017 20:01:26	0 B	[bar chart]
E4:C8:[redacted]	Wi-Fi Client	IEEE802.11	-75	2.462 GHz	Oct 22 2017 20:01:20	0 B	[bar chart]
E0:AC:[redacted]	Wi-Fi Client	IEEE802.11	-80	2.437 GHz	Oct 22 2017 20:01:26	124 B	[bar chart]
DIRECT-KIM283x Series	Wi-Fi AP	IEEE802.11	-41	8	Oct 22 2017 20:01:26	0 B	[bar chart]
DIRECT-66-HP OfficeJet Pro 8710	Wi-Fi AP	IEEE802.11	-75	8	Oct 22 2017 20:01:26	0 B	[bar chart]
DC:CF:[redacted]	Wi-Fi Bridged Device	IEEE802.11	-89	2.437 GHz	Oct 22 2017 20:00:02	178 B	[bar chart]
D0:66:[redacted]	Wi-Fi Bridged Device	IEEE802.11	-81	2.427 GHz	Oct 22 2017 20:00:49	210 B	[bar chart]

kismet

Oct 22 2017 20:01:23	Detected new 802.11 Wi-Fi device 16:98:[redacted] packet 9976
Oct 22 2017 20:01:23	Detected new 802.11 Wi-Fi device 68:27:[redacted] packet 9957
Oct 22 2017 20:01:21	Detected new 802.11 Wi-Fi device 48:F7:[redacted] packet 9316
Oct 22 2017 20:01:17	Detected new 802.11 Wi-Fi device F8:1A:[redacted] packet 8677
Oct 22 2017 20:01:09	Detected new 802.11 Wi-Fi device 4A:F7:[redacted] packet 7532
Oct 22 2017 20:01:09	Detected new 802.11 Wi-Fi device 54:A0:[redacted] packet 7450
Oct 22 2017 20:00:59	Detected new 802.11 Wi-Fi device 90:5F:[redacted] packet 6315

CH 3][Elapsed: 0 s][2017-10-22 19:40

BSSID	PWR	Beacons	#Data, #/s	CH	MB	ENC	CIPHER	AUTH	ESSID
78:45:	-68	3	0 0	6	54e.	WPA2	CCMP	PSK	
A0:E4:	-87	2	0 0	11	54e	WPA2	CCMP	PSK	
18:1E:	-86	2	0 0	11	54e	WPA2	CCMP	PSK	
FA:8F:	-76	6	0 0	11	54e.	OPN			
A0:8E:	-86	4	0 0	11	54e	WPA2	CCMP	PSK	
54:DC:	-79	2	0 0	4	54e	WPA2	CCMP	PSK	
78:45:	-78	3	0 0	6	54e.	WPA2	CCMP	PSK	
70:5A:	-51	6	0 0	8	54e	WPA2	CCMP	PSK	DIRECT-66-HP OfficeJet Pro
32:CD:	-39	5	0 0	8	54e	WPA2	CCMP	PSK	DIRECT-KIM283x Series
60:14:	-64	10	3 1	11	54e.	WPA2	CCMP	PSK	
84:00:	-63	11	0 0	11	54e	WPA2	CCMP	PSK	
84:00:	-77	8	0 0	6	54e	WPA2	CCMP	PSK	
FA:8F:	-83	5	0 0	6	54e.	OPN			
20:25:	-77	2	0 0	6	54e	WPA2	CCMP	PSK	
60:14:	-45	14	0 0	6	54e.	WPA2	CCMP	PSK	
78:45:	-25	17	0 0	8	54e.	WPA2	CCMP	PSK	
60:14:	-61	13	0 0	6	54e.	WPA2	CCMP	PSK	
E0:69:	-90	2	0 0	1	54e	WPA	TKIP	PSK	
C4:04:	-47	22	0 0	3	54e	WPA2	CCMP	PSK	

airodump-ng

BSSID	STATION	PWR	Rate	Lost	Frames	Probe
1C:49:		-79		0 0	1 54e	WPA CCMP PSK
54:DC:	60:A4:	-82	0 - 1	0	1	
(not associated)	A4:77:	-81	0 - 1	0	2	
60:14:	E4:C8:	-82	0e- 1	34	6	

█

Device Capabilities: service discovery, concurrent operation, p2p invitation procedure
- Group Capabilities: ip address allocation
P2p Device Info:
P2P Device address: fa:77:...

wig

MAC Address: ae:37:...

WPS Information:

Device Name: My Pixel
Primary Device Type: Telephone
Response Type: '\x00'
Model Number: Pixel
Vendor Extension: '\x007*\x00\x01 '
Serial Number: FA71S0...
Version: 1.0
Model Name: Pixel
Wifi Protected Setup State: Not-Configured
Config Methods: Display, Push Button, Keypad
Uuid E: 2C48E129BEFF566FAFCAF5670562E4E6
Manufacturer: Google

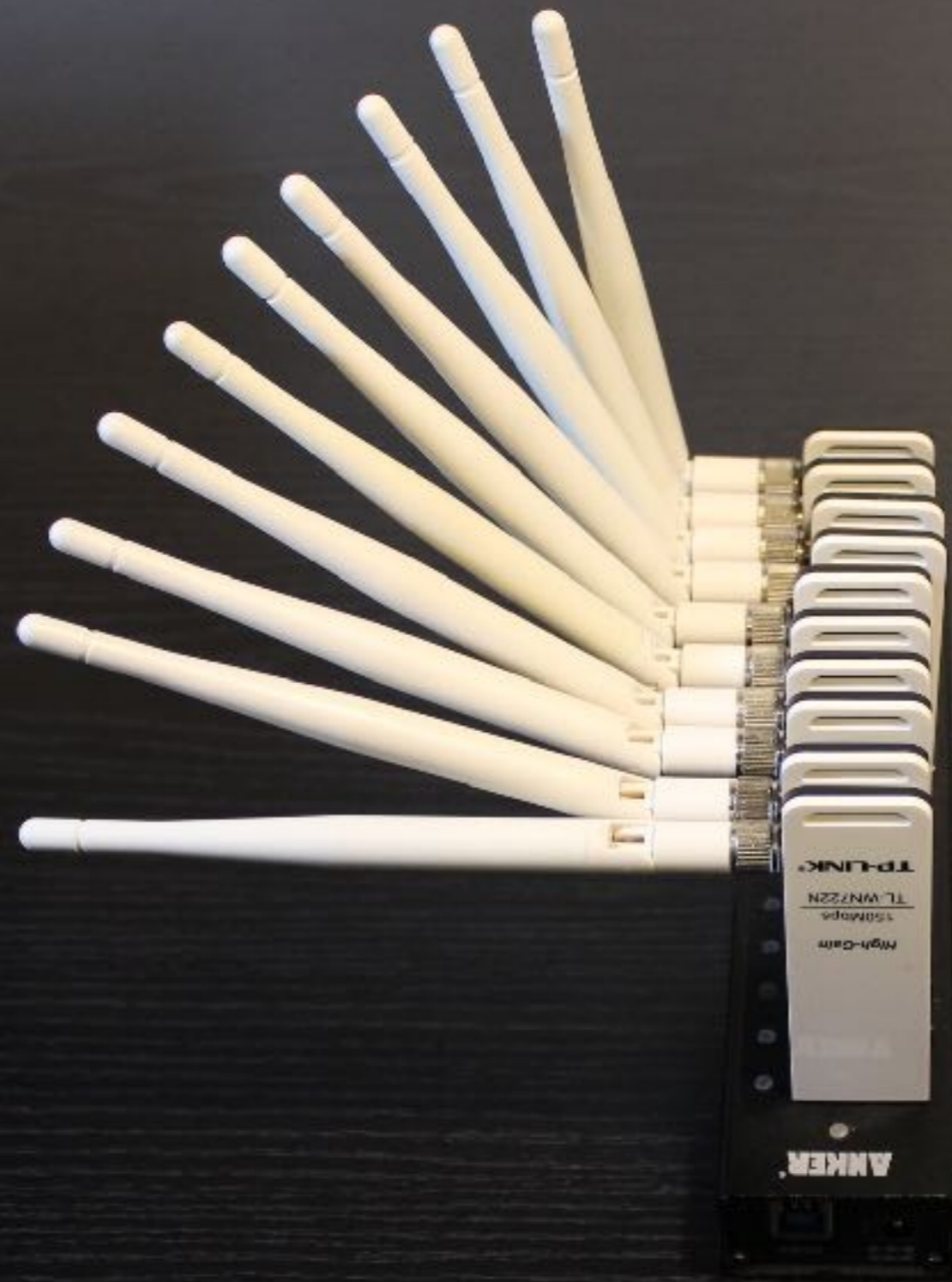
Wi-Fi Direct Information:

P2p Capability:

- Device Capabilities: service discovery, concurrent operation, p2p invitation procedure
- Group Capabilities:

P2p Device Info:

- P2P Device address: ae:37:...
- Config Methods: Display, Push Button, Keypad
- Primary Device Type: Telephone
- Number of Secondary Device Types: 0
- Device Name: My Pixel



Monitor P2P Devices



HP Printers



HP OfficeJet Pro 8710

Embedded Web Server

- Home
- Scan
- Fax
- Web Services
- Network**
- Tools
- Settings

NETWORK

- + General
- + Wired (802.3)
- + Wireless (802.11)
- **Wi-Fi Direct**
 - Status
- + AirPrint™

Wi-Fi Direct

Status

Wi-Fi Direct Settings

Change the Wi-Fi Direct settings, and then click Apply.

Status

Wi-Fi Direct Name DIRECT-66-HP

Connection Method

Wi-Fi Direct Password

English

HP Printers



HP OfficeJet Pro 8710

Embedded Web Server

- Home
- Scan
- Fax
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- Tools
- Settings

NETWORK

- + General
- + Wired (802.3)
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- **Wi-Fi Direct**
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Wi-Fi Direct

Status

Wi-Fi Direct Settings

Change the Wi-Fi Direct settings, and then click Apply.

Status

Wi-Fi Direct Name DIRECT-66-HP

Connection Method

Wi-Fi Direct Password

HP Printers

English

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Samsung Printers

Settings

Network Settings

- General
- TCP/IPv4
- TCP/IPv6
- Raw TCP/IP, LPR, IPP
- AirPrint
- Samsung Cloud Print
- Google Cloud Print
- WSD
- SLP
- UPnP
- mDNS
- SNMP
 - SNMPv1/v2
 - SNMPv3
- HTTP
- Proxy
- Wi-Fi
 - Wi-Fi
 - Wi-Fi Direct™**
- Restore Default

Wi-Fi Direct™

Apply Undo

Wi-Fi Direct™

Wi-Fi Direct™:	On
Device Name:	M283x Series
IP Address:	192.168.3.1
Group Owner:	Activate
Network Key:	24767897
	<input type="checkbox"/> Hide Network Key

Wi-Fi Direct™ Status

Current Role:	Group Owner
Current SSID:	DIRECT-KIM283x Series
Current Status:	Connected (0)

Information Desk

Recent Links

- [Wi-Fi Direct™](#)
- [General](#)
- [SNMPv3](#)
- [Home](#)

Samsung Printers



Samsung Printers

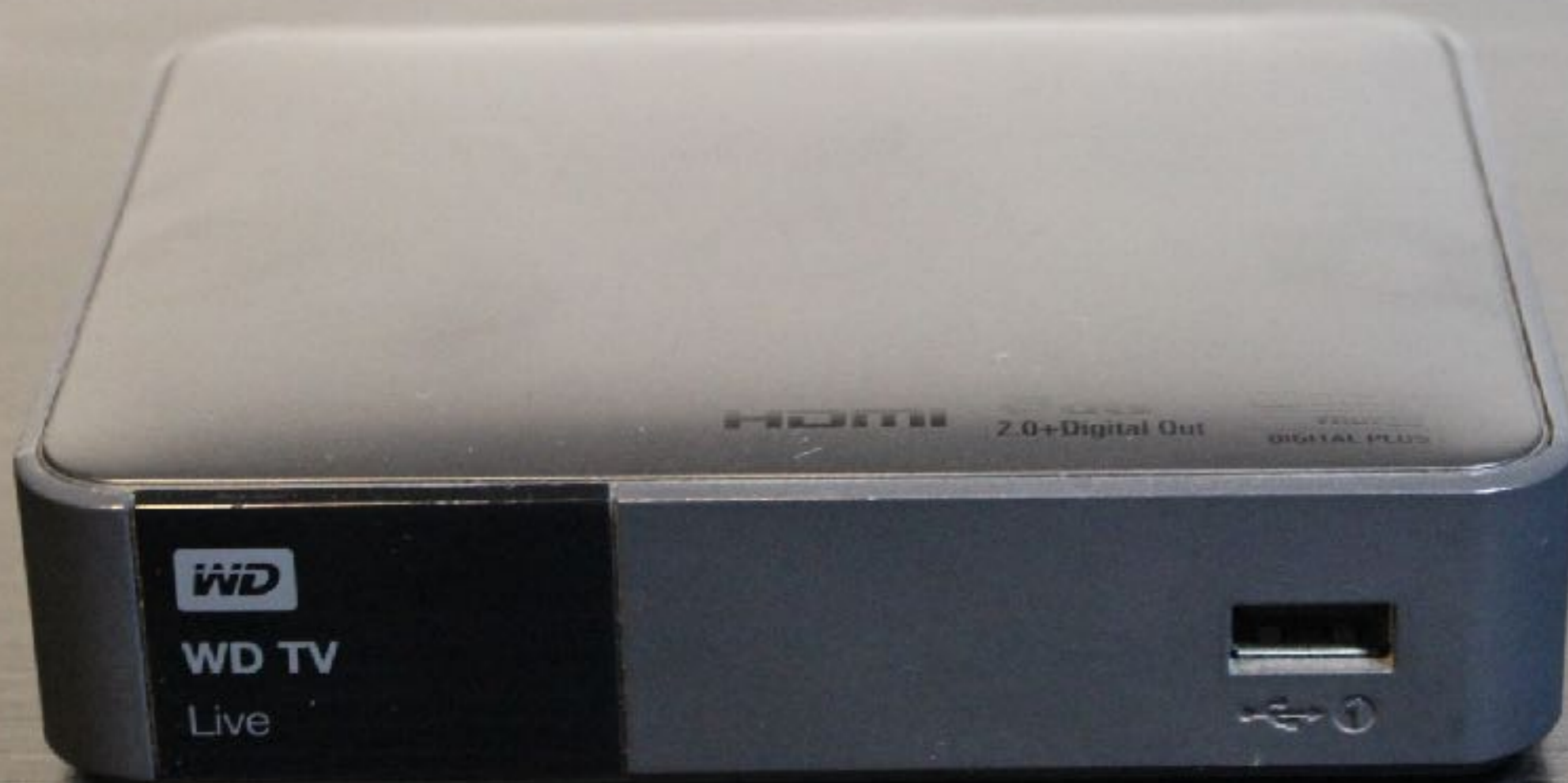


Samsung Smart TV



```
▶ Radiotap Header v0, Length 36
▶ 802.11 radio information
▼ IEEE 802.11 Action, Flags: .....C
  Type/Subtype: Action (0x000d)
  ▶ Frame Control Field: 0xd000
    .000 0000 0011 1100 = Duration: 60 microseconds
  Receiver address: ae:37:
  Destination address: ae:37:
  Transmitter address: ce:b1:
  Source address: ce:b1:
  BSS Id: ae:37:
    .... 0000 = Fragment number: 0
    1000 1010 0100 .... = Sequence number: 2212
  Frame check sequence: 0x94f60964 [correct]
  [FCS Status: Good]
▼ IEEE 802.11 wireless LAN management frame
  ▼ Fixed parameters
    Category code: Public Action (4)
    Public Action: Vendor Specific (0x09)
    OUI: 50-6f-9a (Wi-FiAll)
    WFA Subtype: 9
    P2P Public Action Subtype: GO Negotiation Confirmation (2)
    P2P Public Action Dialog Token: 1
  ▶ Tagged parameters (126 bytes)
```

Samsung Smart TV



WD TV Live

```
Completed SYN Stealth Scan at 22:04, 4.61s elapsed (1000 total ports)
Initiating Service scan at 22:04
Scanning 5 services on 192.168.69.61
Completed Service scan at 22:04, 26.03s elapsed (5 services on 1 host)
Initiating OS detection (try #1) against 192.168.69.61
```

WD TV Live

```
Completed NSE at 22:05, 0.00s elapsed
Nmap scan report for 192.168.69.61
Host is up (0.0033s latency).
Not shown: 995 closed ports
```

PORT	STATE	SERVICE	VERSION
80/tcp	open	http	Apache httpd (PHP 5.2.17)
139/tcp	open	netbios-ssn	Samba smbd 3.X (workgroup: WORKGROUP)
443/tcp	open	ssl/http	Apache httpd (PHP 5.2.17)
445/tcp	open	netbios-ssn	Samba smbd 3.X (workgroup: WORKGROUP)
30000/tcp	open	unknown	

```
MAC Address: 02:90:A9:67:7B:7E (Unknown)
```

```
OS fingerprint not ideal because: Didn't receive UDP response. Please try again with -
```

```
No OS matches for host
```

```
Network Distance: 1 hop
```

TRACEROUTE

HOP	RTT	ADDRESS
1	3.34 ms	192.168.69.61

```
NSE: Script Post-scanning.
```

```
Initiating NSE at 22:05
```

```
Completed NSE at 22:05, 0.00s elapsed
```

```
Initiating NSE at 22:05
```

```
Completed NSE at 22:05, 0.00s elapsed
```

WD TV Live

Login

Password

Language

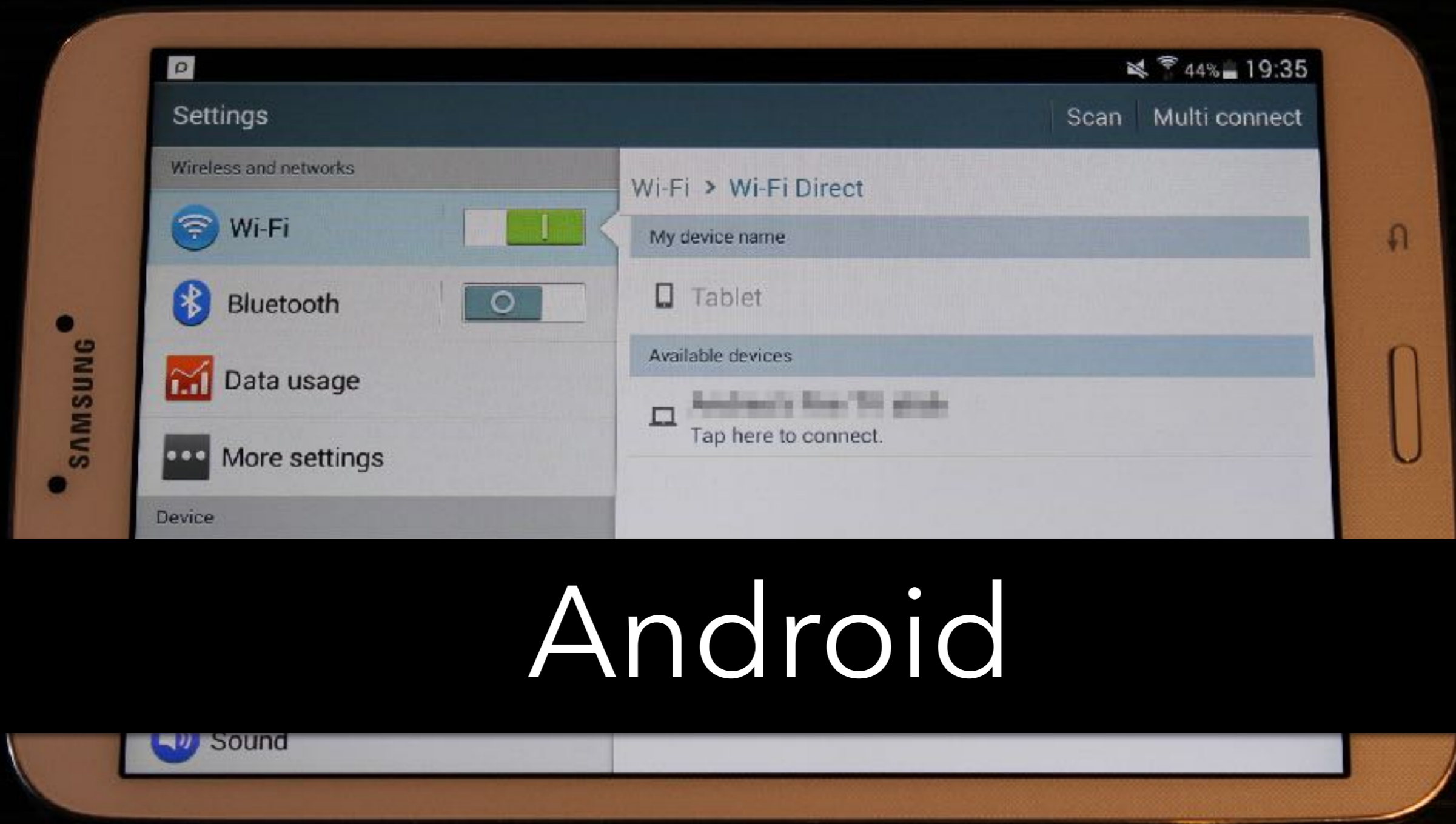
 

I accept [END USER LICENSE AGREEMENT](#)

Keep me signed in

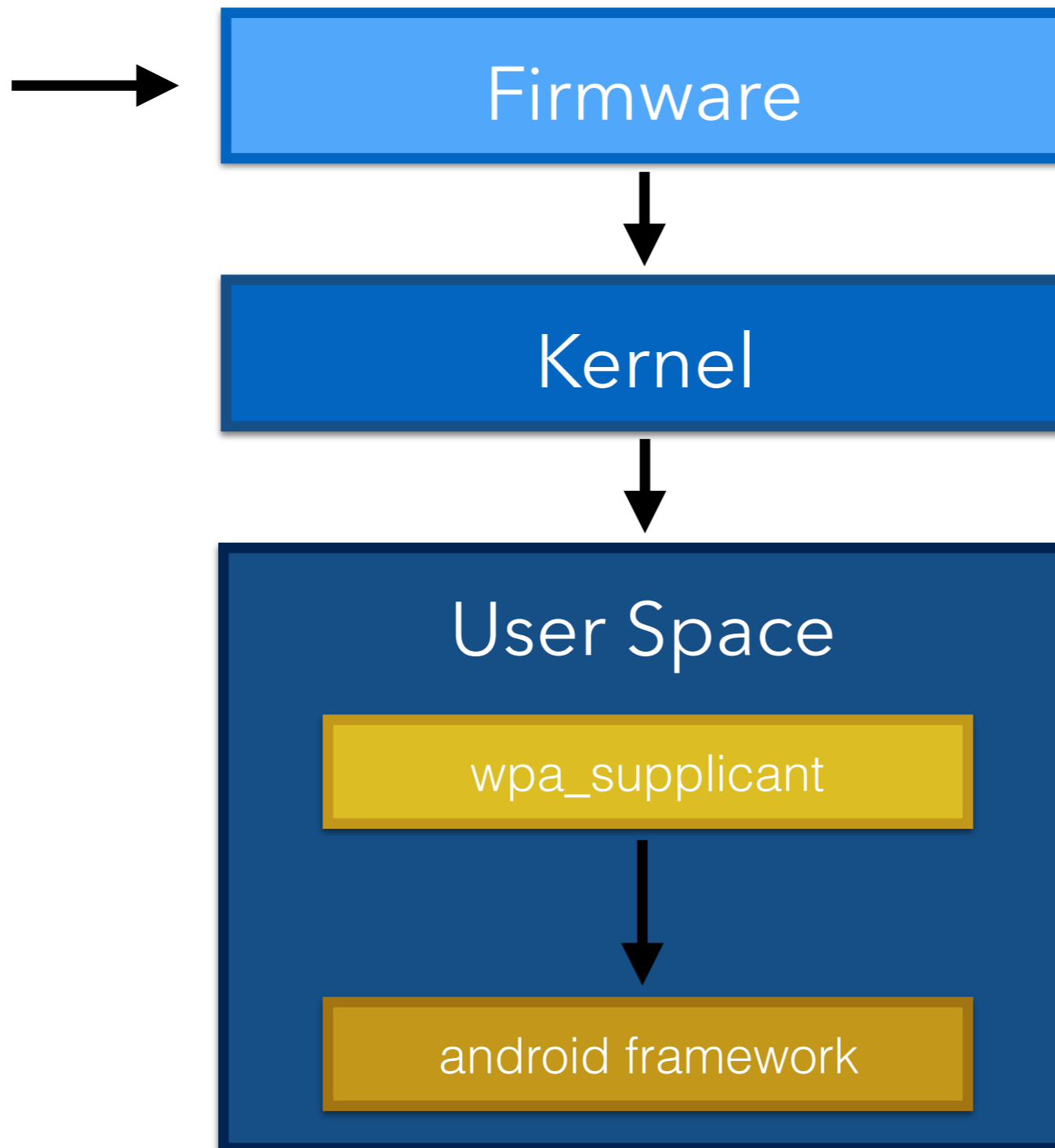
Login





Android

Android



```

private static final Pattern detailedDevicePattern = Pattern.compile(
    "(?:[0-9a-f]{2}:){5}[0-9a-f]{2}) " +
    "(\\d+ )?" +
    "p2p_dev_addr=(?:[0-9a-f]{2}:){5}[0-9a-f]{2}) " +
    "pri_dev_type=(\\d+-[0-9a-fA-F]+-\\d+) " +
    "name='(.*)' " +
    "config_methods=(0x[0-9a-fA-F]+) " +
    "dev_capab=(0x[0-9a-fA-F]+) " +
    "group_capab=(0x[0-9a-fA-F]+) " +
    "( wfd_dev_info=0x000006([0-9a-fA-F]{12}))?"
);

```

Android

```

/**
 * @param string formats supported include
 * P2P-DEVICE-FOUND fa:7b:7a:42:02:13 p2p_dev_addr=fa:7b:7a:42:02:13
 * pri_dev_type=1-0050F204-1 name='p2p-TEST1' config_methods=0x188 dev_capab=0x27
 * group_capab=0x0 wfd_dev_info=000006015d022a0032
 *
 * P2P-DEVICE-LOST p2p_dev_addr=fa:7b:7a:42:02:13
 *
 * AP-STA-CONNECTED 42:fc:89:a8:96:09 [p2p_dev_addr=02:90:4c:a0:92:54]
 *
 * AP-STA-DISCONNECTED 42:fc:89:a8:96:09 [p2p_dev_addr=02:90:4c:a0:92:54]
 *
 * fa:7b:7a:42:02:13
 *
 * Note: The events formats can be looked up in the wpa_supplicant code
 * @hide
 */
public WifiP2pDevice(String string) throws IllegalArgumentException {
    String[] tokens = string.split("[ \\n]");
    Matcher match;

    if (tokens.length < 1) {
        throw new IllegalArgumentException("Malformed supplicant event");
    }
}

```

```
D/TCMD ( 519): Listening for incoming client connection request
I/wpa_supplicant( 3482): P2P-DEVICE-FOUND 70:5a:0f:16:ed:54 p2p_dev_addr=72:5a:0f:16:b4:66 pri_dev
name='DIRECT-66-HP OfficeJet Pro 8710' config_methods=0x5a88 dev_capab=0x4 group_capab=0x1 level=
I/wpa_supplicant( 3482): P2P-DEVICE-FOUND 00:de:ad:fa:fa:fa p2p_dev_addr=00:de:ad:fa:fa:fa pri_dev
5 name='fafa<FA><FA>' config_methods=0x188 dev_capab=0x21 group_capab=0x0 level=-27
D/MDMCTBK ( 267): reply_len: 40 reply is = <3>P2P-DEVICE-FOUND 70:5a:0f:16:ed:54 p2
D/MDMCTBK ( 267): Event received = P2P-DEVICE-FOUND 70:5a:0f:16:ed:54 p2
D/MDMCTBK ( 267): reply_len: 40 reply is = <3>P2P-DEVICE-FOUND 00:de:ad:fa:fa:fa p2
D/MDMCTBK ( 267): Event received = P2P-DEVICE-FOUND 00:de:ad:fa:fa:fa p2
D/WifiP2pService( 1024): InactiveState{ when=-1ms what=147477 obj=Device: DIRECT-66-HP OfficeJet P
D/WifiP2pService( 1024): deviceAddress: 72:5a:0f:16:b4:66
D/WifiP2pService( 1024): primary type: 3-0050F204-1
```

Android

```
D/WifiP2pService( 1024): level: -49 target=com.android.internal.util.StateMachine$SmHandler }
D/WifiP2pService( 1024): P2pEnabledState{ when=-1ms what=147477 obj=Device: DIRECT-66-HP OfficeJet
D/WifiP2pService( 1024): deviceAddress: 72:5a:0f:16:b4:66
D/WifiP2pService( 1024): primary type: 3-0050F204-1
D/WifiP2pService( 1024): secondary type: null
D/WifiP2pService( 1024): wps: 23176
D/WifiP2pService( 1024): grpcapab: 1
D/WifiP2pService( 1024): devcapab: 4
D/WifiP2pService( 1024): status: 3
D/WifiP2pService( 1024): wfdInfo: null
D/WifiP2pService( 1024): level: -49 target=com.android.internal.util.StateMachine$SmHandler }
W/dalvikvm( 1024): threadid=71: thread exiting with uncaught exception (group=0x4171bd40)
E/AndroidRuntime( 1024): *** FATAL EXCEPTION IN SYSTEM PROCESS: WifiMonitor
E/AndroidRuntime( 1024): java.lang.IllegalArgumentException: Malformed supplicant event
E/AndroidRuntime( 1024):     at android.net.wifi.p2p.WifiP2pDevice.<init>(WifiP2pDevice.java:21)
E/AndroidRuntime( 1024):     at android.net.wifi.WifiMonitor$MonitorThread.handleP2pEvents(Wifi
E/AndroidRuntime( 1024):     at android.net.wifi.WifiMonitor$MonitorThread.dispatchEvent(WifiMo
E/AndroidRuntime( 1024):     at android.net.wifi.WifiMonitor$MonitorThread.run(WifiMonitor.java
I/Process ( 1024): Sending signal. PID: 1024 SIG: 9
I/ServiceManager( 255): service 'package' died
I/ServiceManager( 255): service 'sensor-service' died
```

While sitting here (and enjoying the free Wi-Fi)

Kevin made notes for the meeting. Jane emailed the office. Pete had a stare-off with a squirrel. Claire published the changes. Rohan amended the contract. Stuart didn't see the football in time.

Many unique needs
one solution

Kevin finally made eye contact with the guy from finance.
Raj edited the proposal.
Michelle started the powerpoint.

Las updated the presentation.
Phya edited the proposal.
Helen heroically polished off a triple club sandwich.

Availability



Confusion

Weakest Link



Bridge



Attack Surface



Questions

<https://github.com/6e726d/BHEU17>

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