

Wireless Networks



Wired Network



Wireless Network

➤ In a **wired network**, any two devices that need to communicate with each other must be connected by a wire and data must travel over this wire.

➤ In a **wireless network**, any two devices that need to communicate with each other do not need to be connected by a wire and data can travel through free space.

➤ In a **wired network**, a device connected to a wire can not move around very easily or very far.

➤ In a **wireless network**, a device can move around very easily or very far.

➤ An **Ethernet network** is an example of a wired network.

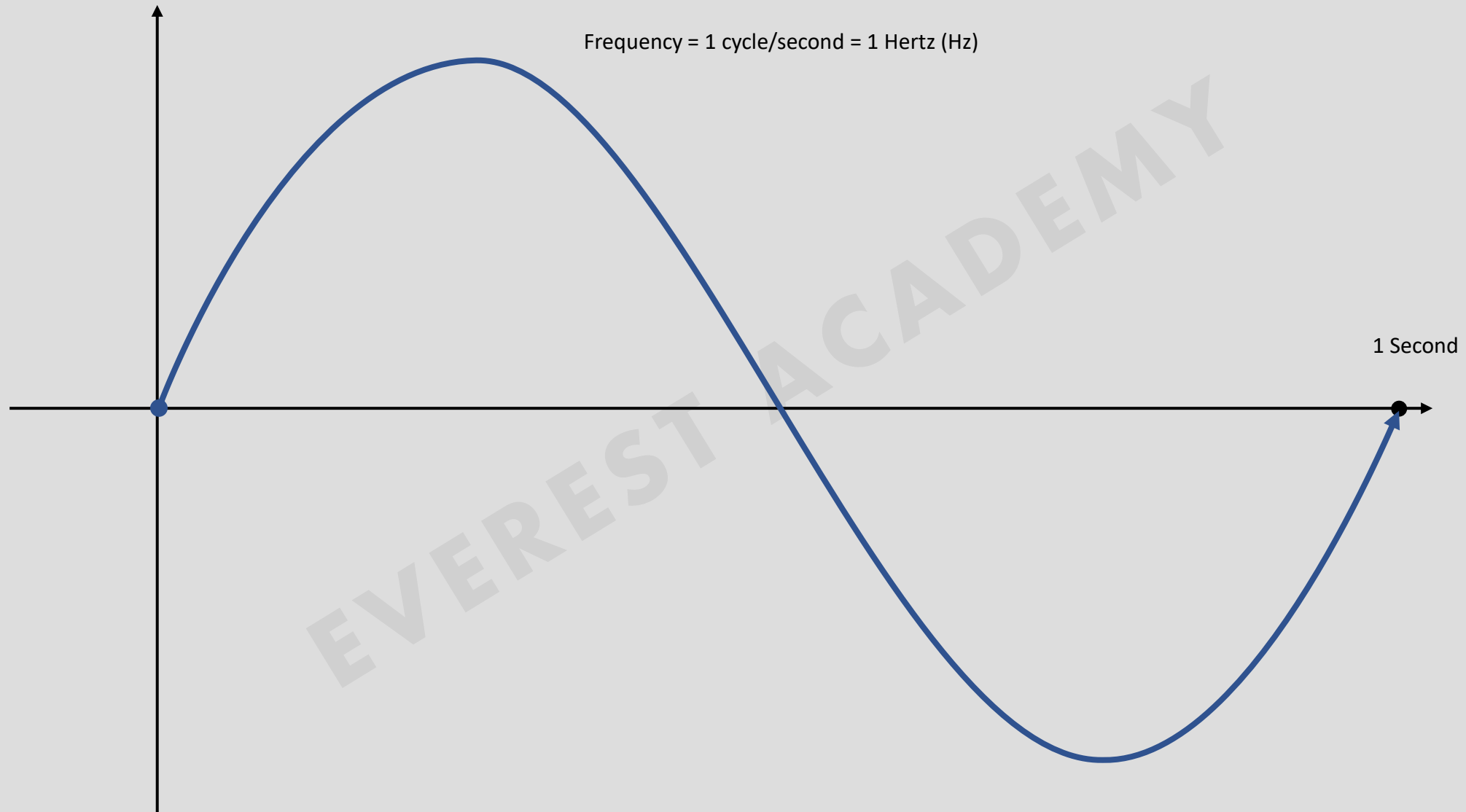
➤ A **Wireless Local Area Network (WLAN)** is an example of a wireless network.

➤ The **IEEE 802.3 set of standards** defines the guidelines for the **Ethernet**.

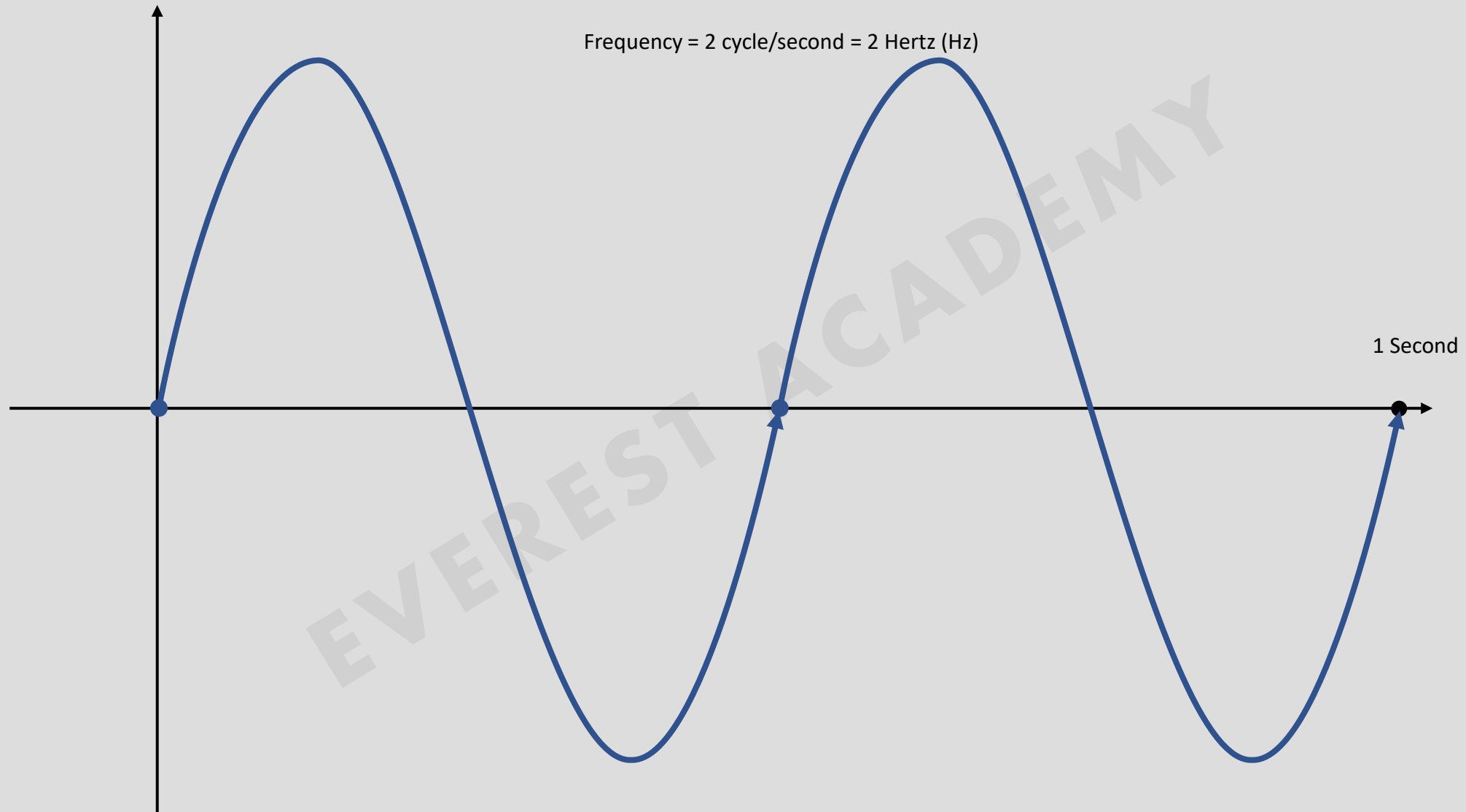
➤ The **IEEE 802.11 set of standards** defines the guidelines for the **WLAN**.



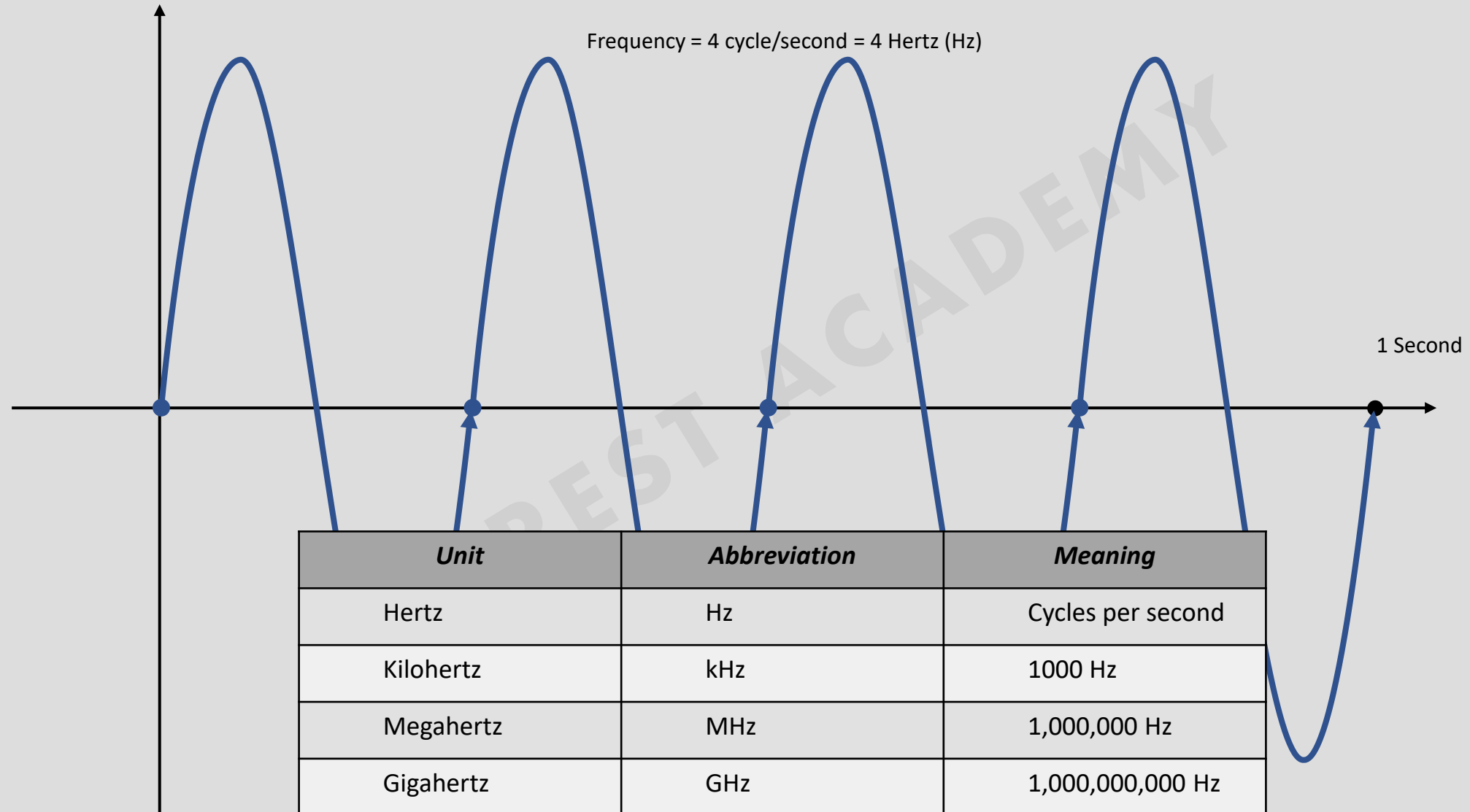
Frequency



Frequency



Frequency



Wireless Bands

Frequency (Hz)	Frequency Notation
10^{10}	10 GHz
10^9	1 GHz
10^8	100 MHz
10^7	10 MHz
10^6	1 MHz
10^5	100 KHz
10^4	10 KHz
10^3	1 KHz
10^2	100 Hz
10^1	10 Hz
0	0 Hz

Microwave and Radar

Wi-Fi Frequency Bands
(Wireless LAN) (WLAN)

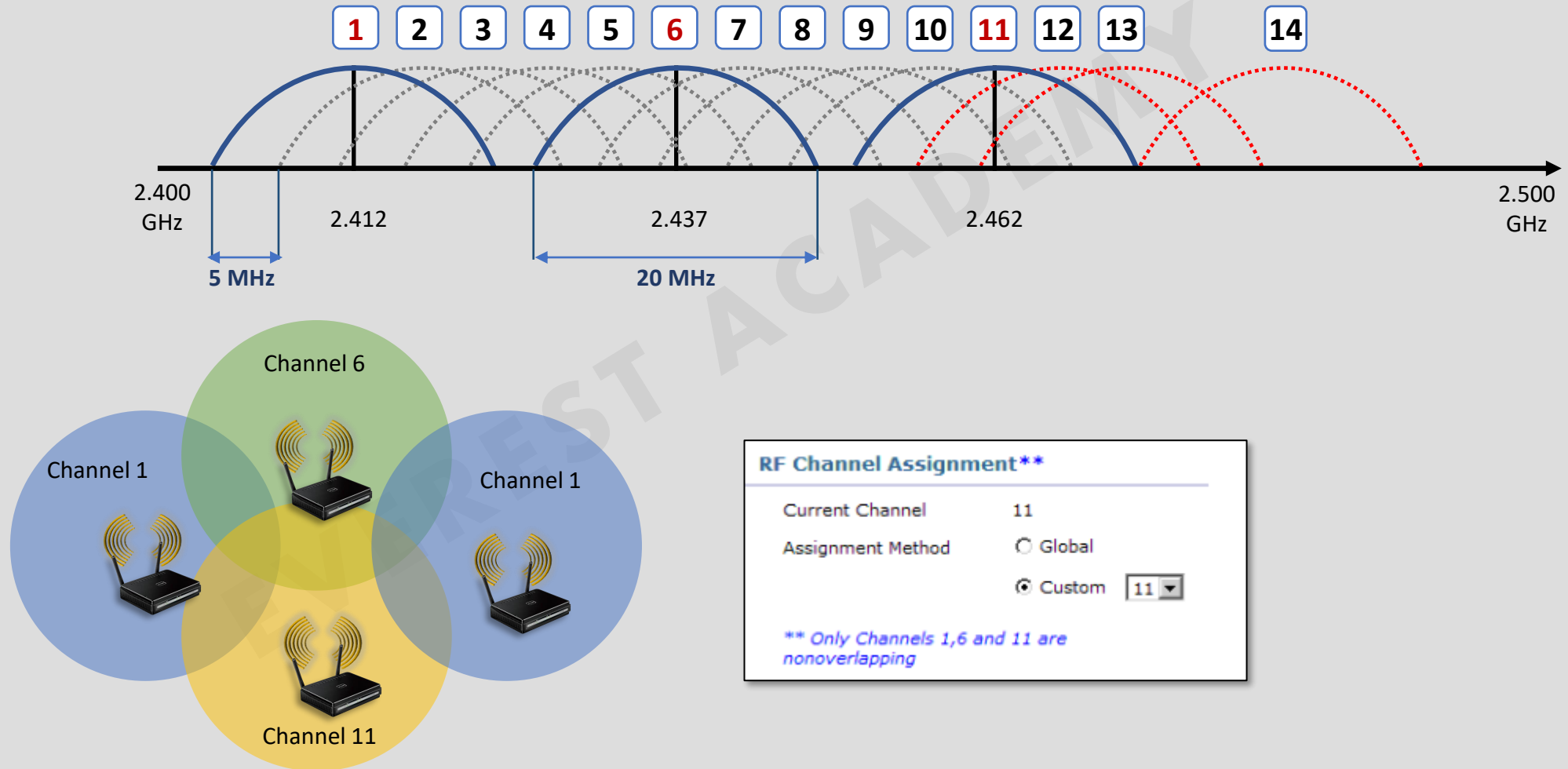
- 5 GHz Wireless
- 2.4 GHz Wireless

802.11 Standard

802.11 Standard	2.4 GHz	5 GHz	Data Rate	Year
802.11	yes	NO	2 Mbps	1997
802.11a	No	Yes	54 Mbps	1999
802.11b	Yes	No	11 Mbps	1999
802.11g	Yes	No	54 Mbps	2003
802.11n	Yes	Yes	600 Mbps	2009
802.11ac	No	Yes	6.93 Gbps	2013
802.11ax	Yes	Yes	4x 802.11ac	2021

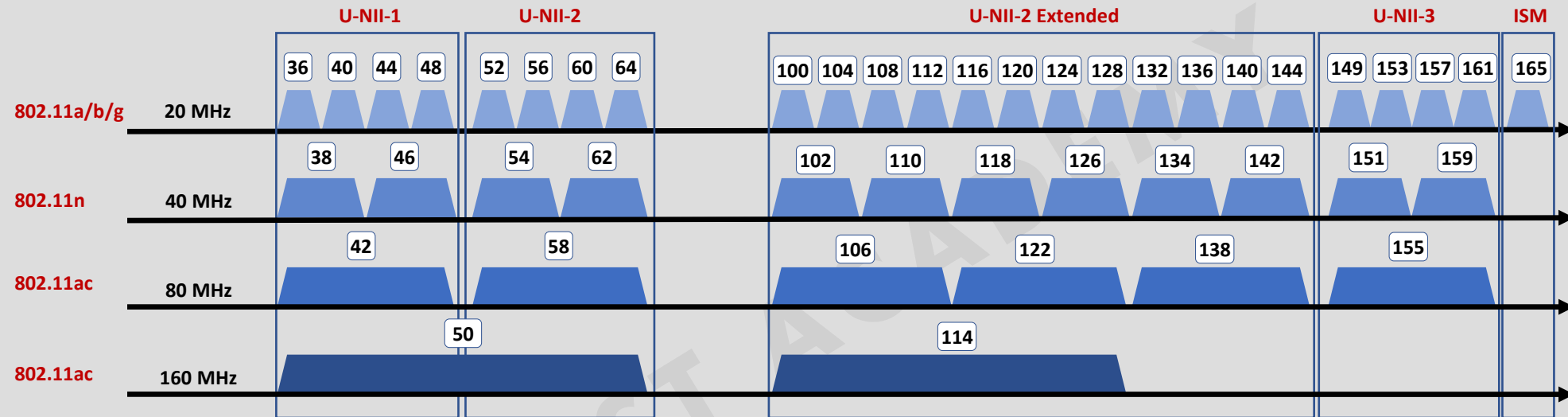
2.4 GHz Wireless Band

2.4 GHz Band (Overlapping Channels)



5 GHz Wireless Band

5 GHz Band (Nonoverlapping Channels)



* U-NII (Unlicensed National Information Infrastructure).



* ISM (industrial, scientific and medical) .

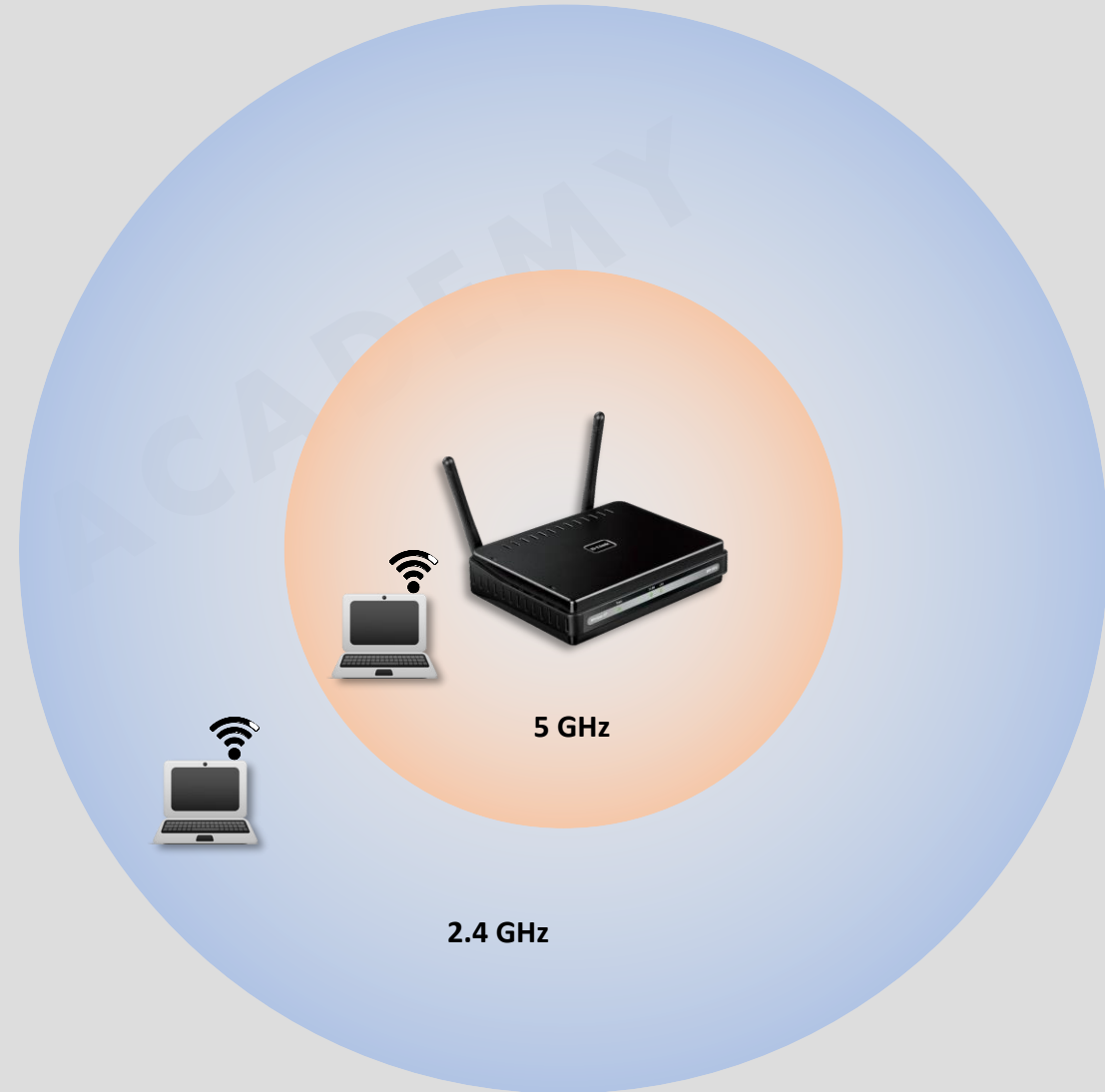
DCA Channel List

DCA Channels

36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144, 149, 153, 157, 161

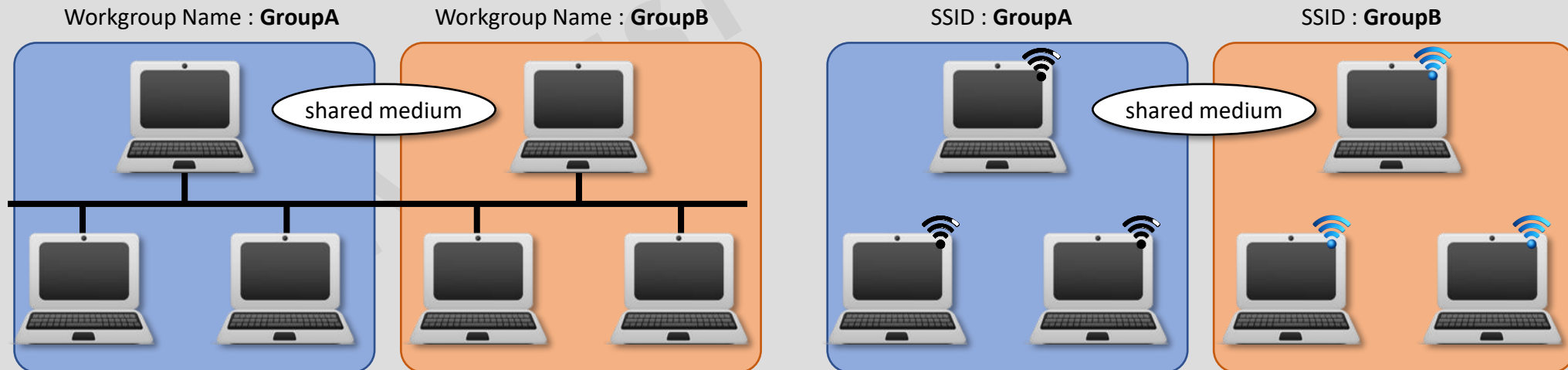
2.4 GHz and 5 GHz Comparison

 2.4 GHz	 5 GHz
➤ 802.11 b, g, n, ax	➤ 802.11 a, n, ac, ax
➤ Slower Speed	➤ Faster Speed
➤ Longer Range	➤ Shorter Range
➤ More Radio Interference	➤ Less Radio Interference
➤ 3 non-overlapping	➤ 25 non-overlapping at 20 MHz wide ➤ 12 non-overlapping at 40 MHz wide ➤ 6 non-overlapping at 80 MHz wide ➤ 2 non-overlapping at 160 MHz wide



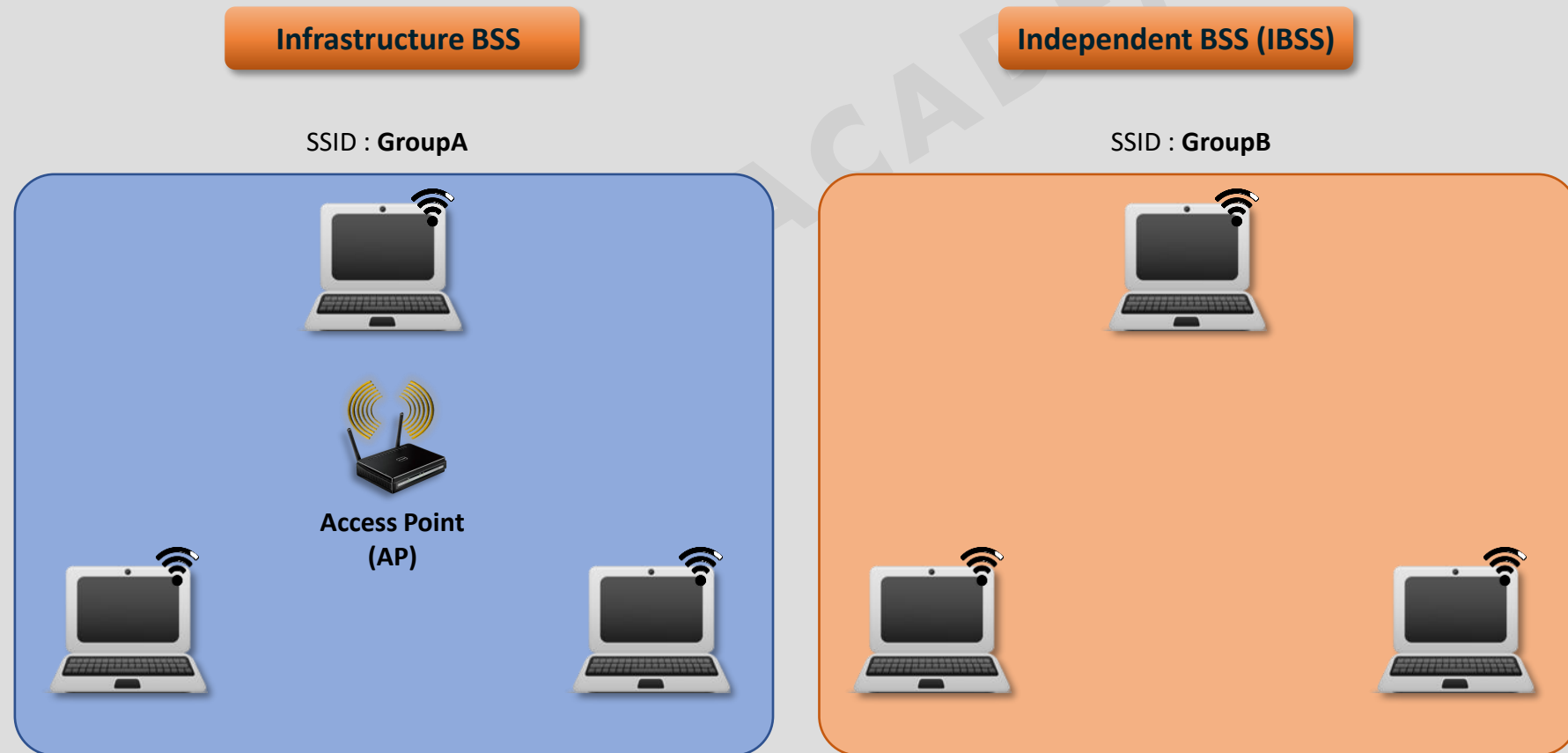
Service set (802.11 Network)

- A **service set** is a group of wireless network devices which share a **service set identifier (SSID)** .
- A **service set identifier (SSID)** is the network name (a 32-character unique identifier) used to logically identify the wireless network .
- A **service set forms** a logical network segment of nodes operating in a shared medium at the link-layer.
- A **service set is either a basic service set (BSS) or an extended service set (ESS)** .



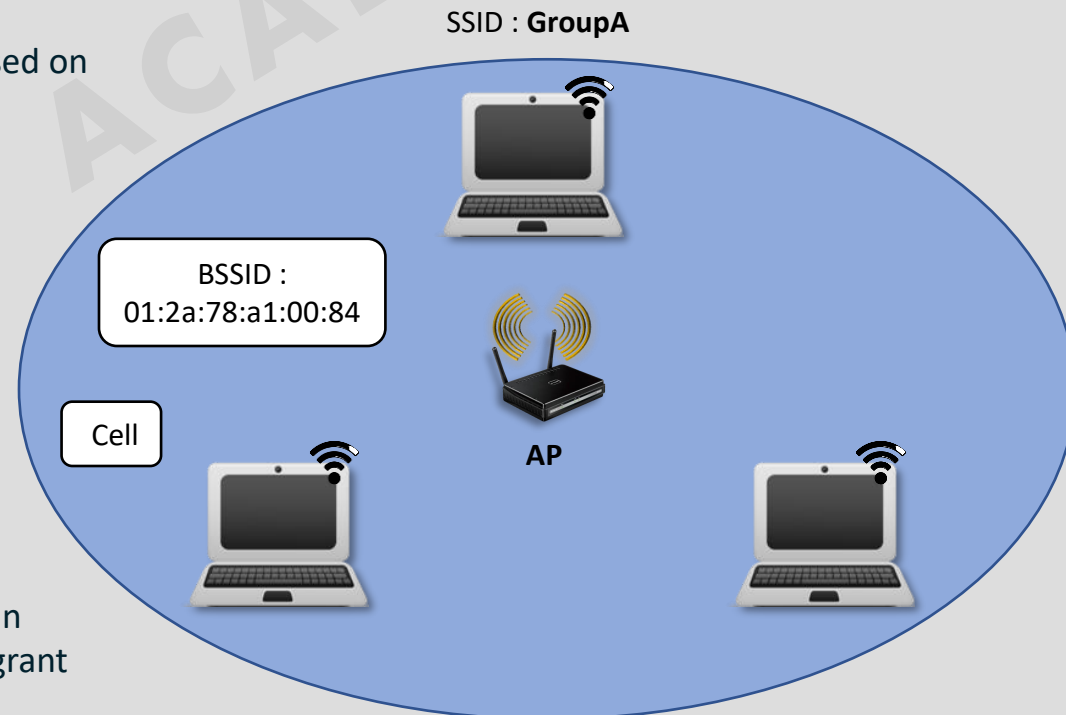
Basic Service Set (BSS)

- A **Basic Service Set (BSS)** is a subgroup, within a service set, of devices that share physical-layer medium access characteristics (e.g. radio frequency, modulation scheme, security settings).
- There are **two types** of the basic service set(BSS) :



Basic Service Set (BSS) : Infrastructure Mode

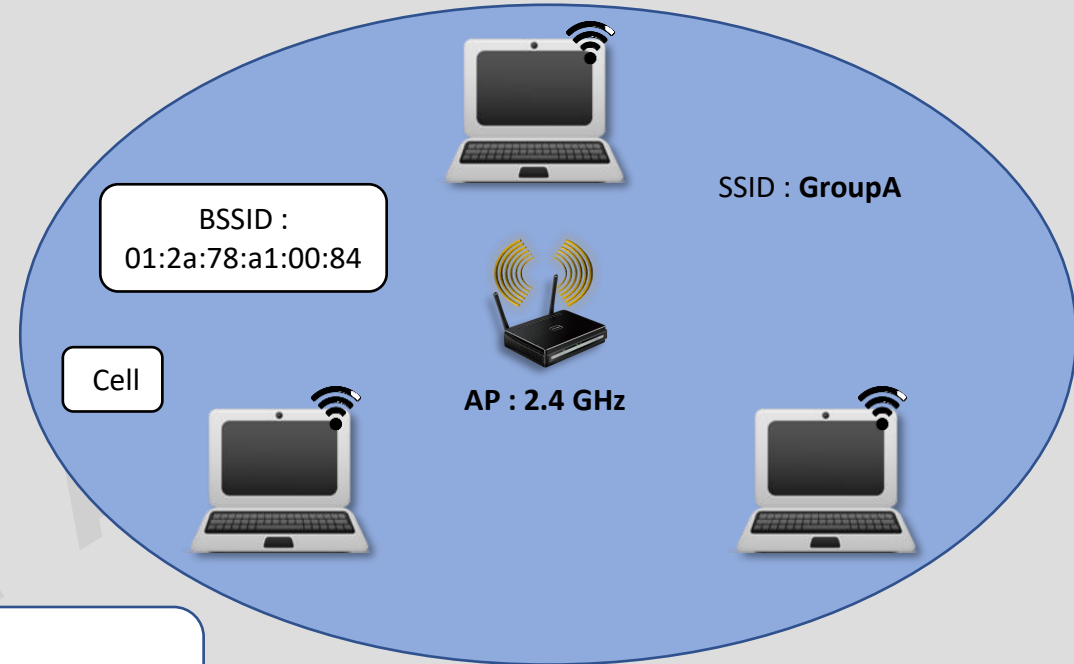
- In **infrastructure mode**, the access point (AP) offers the services that are necessary to form the infrastructure of a wireless network.
- In **infrastructure mode**, the AP also establishes its BSS over a single wireless channel, which means that the AP and the members of the BSS must all use the same channel to communicate properly.
- **The AP** serves as a single point of contact for every device that wants to use the BSS. It advertises the existence of the BSS so that devices can find it and try to join
- **The AP** uses a unique **BSS identifier (BSSID)** that is based on the AP's own radio MAC address.
- **The AP** use the MAC address of the wireless network interface as the BSSID.
- In **infrastructure mode** , the BSS is bounded by the area where the AP's signal is usable. This is known as the basic service area (BSA) or cell.
- In **infrastructure mode** the AP advertises the wireless network with a Service Set Identifier (SSID).
- In **infrastructure mode** , a wireless device must send an association request to the AP and the AP must either grant or deny the request.



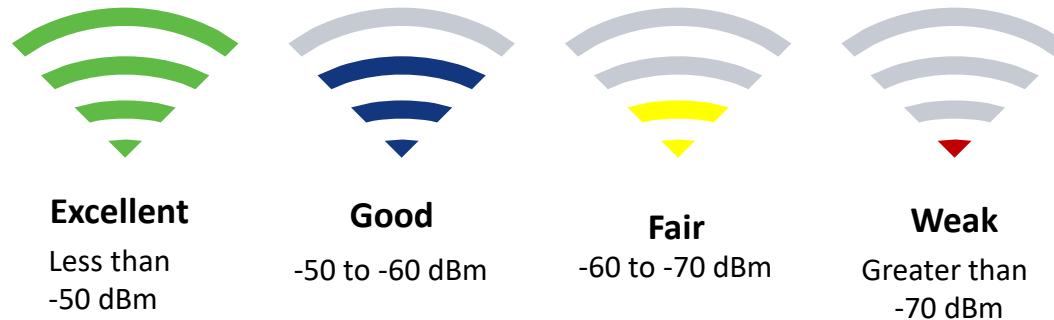
Basic Service Set (BSS) : Infrastructure Mode

```
C:\>netsh wlan show networks mode=bssid
```

Interface name : Wi-Fi
SSID 1 : GroupA
Network type : Infrastructure
Authentication : WPA2-Personal
Encryption : CCMP
BSSID 1 : 01:2a:78:a1:00:84
Signal : 100%
Radio type : 802.11n
Channel : 8
Basic rates (Mbps) : 1 2 5.5 11
Other rates (Mbps) : 6 9 12 18 24 36 48 54



Wi-Fi Signal Strength

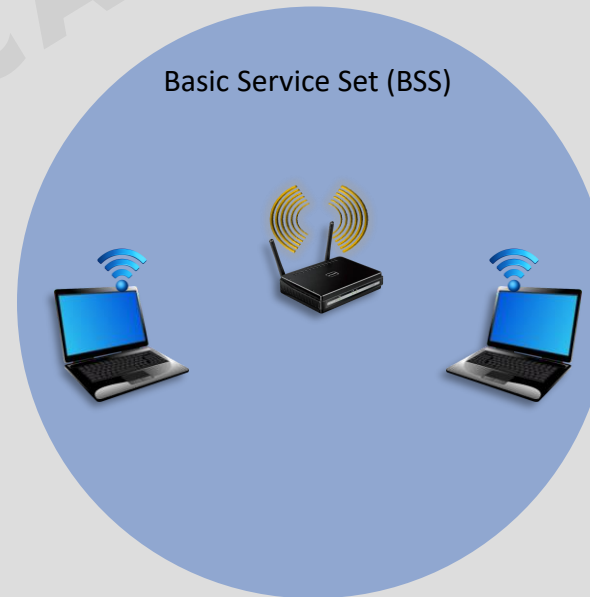


* dBm (decibel milliwatts).



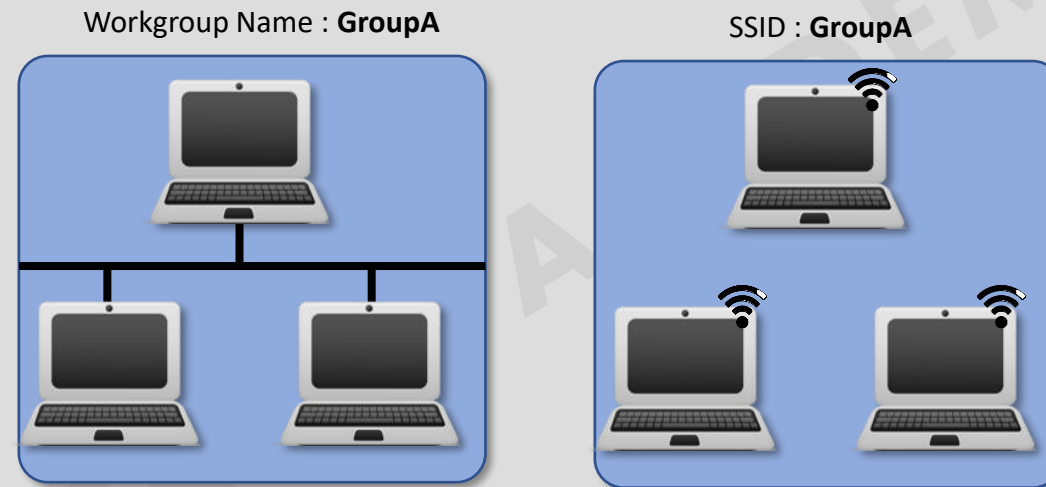
Service set (802.11 network)

- A **service set** is a group of wireless network devices which share a **service set identifier (SSID)**.
- A **service set identifier (SSID)** is the network name (a 32-character unique identifier) used to logically identify the wireless network.
- The **Basic Service Set (BSS)** is a term used to describe the collection of Stations which may communicate together within an 802.11 network using an access point (AP).
- The **AP** serves as a single point of contact for every device that wants to use the **BSS**. It advertises a unique **Service Set Identifier (SSID)** that is based on the AP's own radio MAC address.



Wireless LAN Topologies

- The **802.11-2016 standard** defines multiple 802.11 topologies, known as **service sets**, which describe how group of wireless devices communicate with each other.
- A **service set identifier (SSID)** is the network name (a 32-character unique identifier) used to logically identify the wireless network.

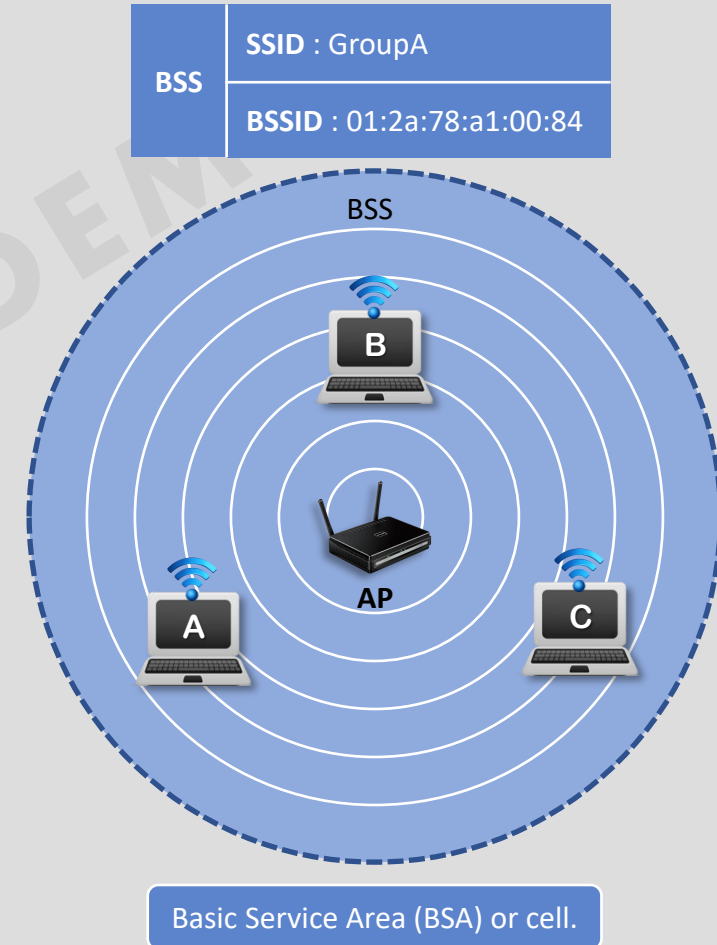


Service Sets	
<i>Ad-hoc mode</i>	<i>Infrastructure mode</i>
<ul style="list-style-type: none"> Independent Basic Service Set (IBSS) 	<ul style="list-style-type: none"> Basic Service Set (BSS)
	<ul style="list-style-type: none"> <ul style="list-style-type: none"> Distribution System (DS)
	<ul style="list-style-type: none"> Extended Service Set (ESS)



Basic Service Set (BSS)

- **Basic Service Set (BSS)** is a wireless network topology that allows wireless devices to communicate with each other through an access point (AP) and share the same medium access characteristics (e.g. **radio frequency (RF), modulation scheme, security settings**).
- **The basic service set (BSS)** is defined **by a basic service set identifier (BSSID)** shared by all devices within it. The BSSID is a 48-bit (6-Byte) label that conform to MAC-48 conventions.
- **The AP** use the MAC address of **the wireless network interface** as the BSSID.
- **The access point (AP)** serves as a **single point of contact** for every device that wants to use the BSS. It advertises the existence of the BSS using the Service Set Identifier (SSID). so that devices can find it and try to join.
- A wireless device must send an **association request** to the AP and the AP must either grant or deny the request.
- **The basic service set (BSS)** is bounded by the area where the AP's signal is usable. This is known as the **basic service area (BSA) or cell**.

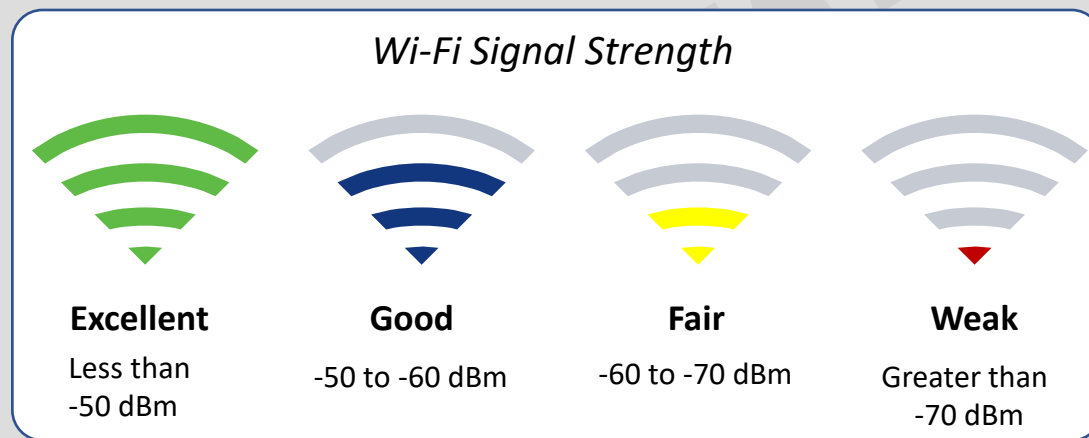


Traffic Flows Within a BSS and Signal Strength

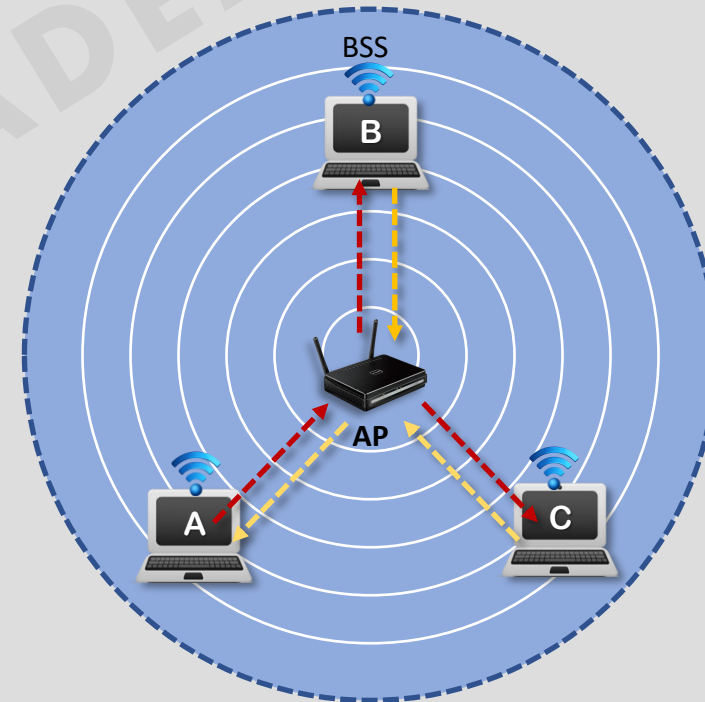
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BSS	SSID : GroupA
	BSSID : 01:2a:78:a1:00:84

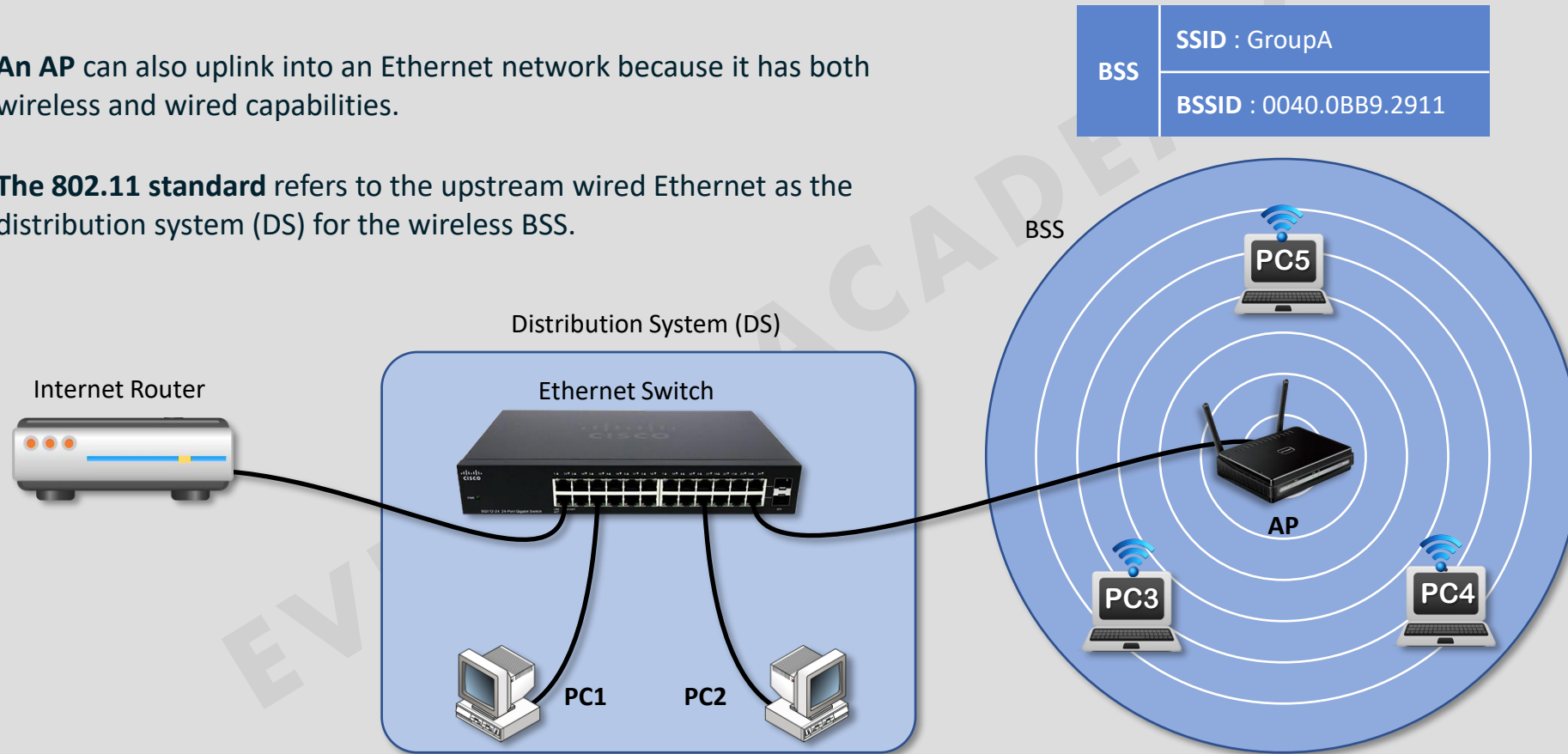


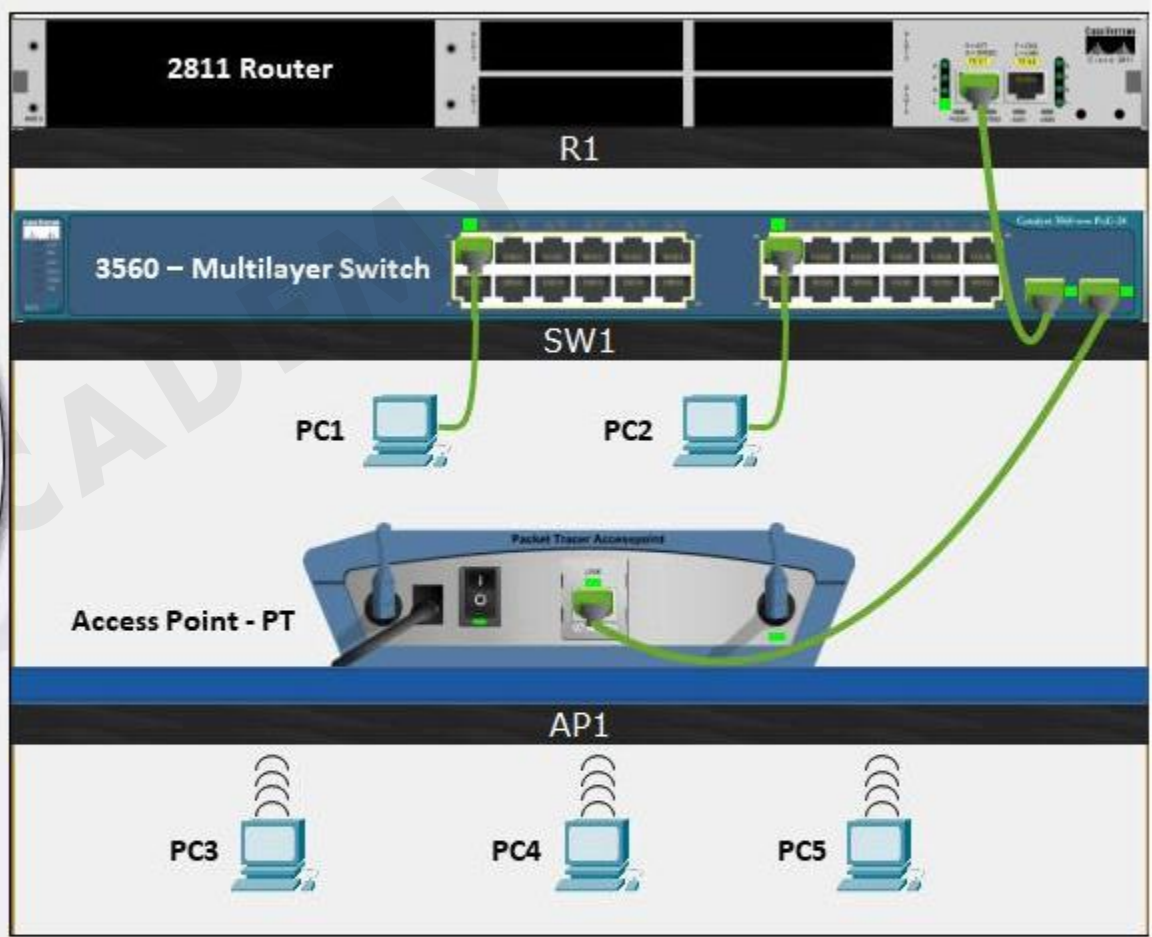
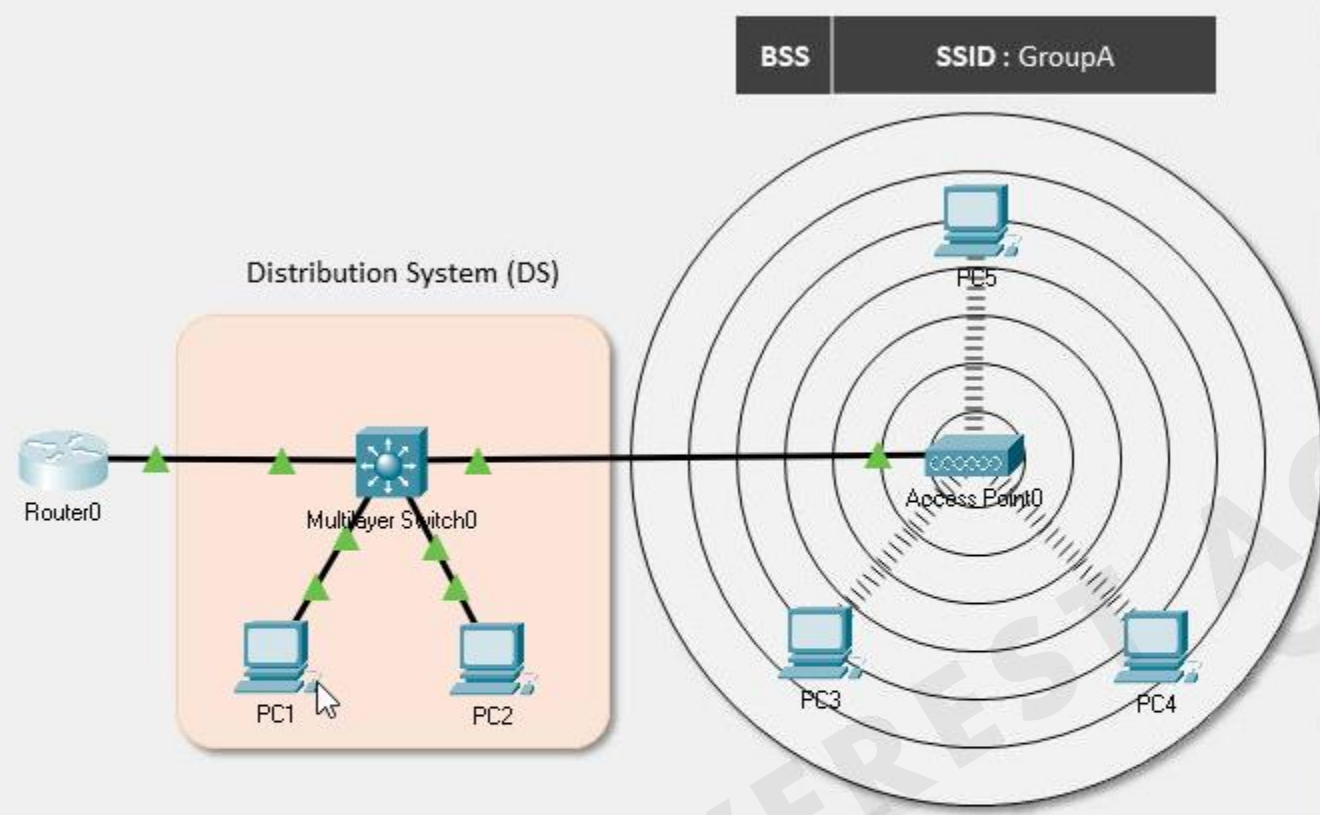
* dBm (decibel milliwatts).



Distribution System (DS)

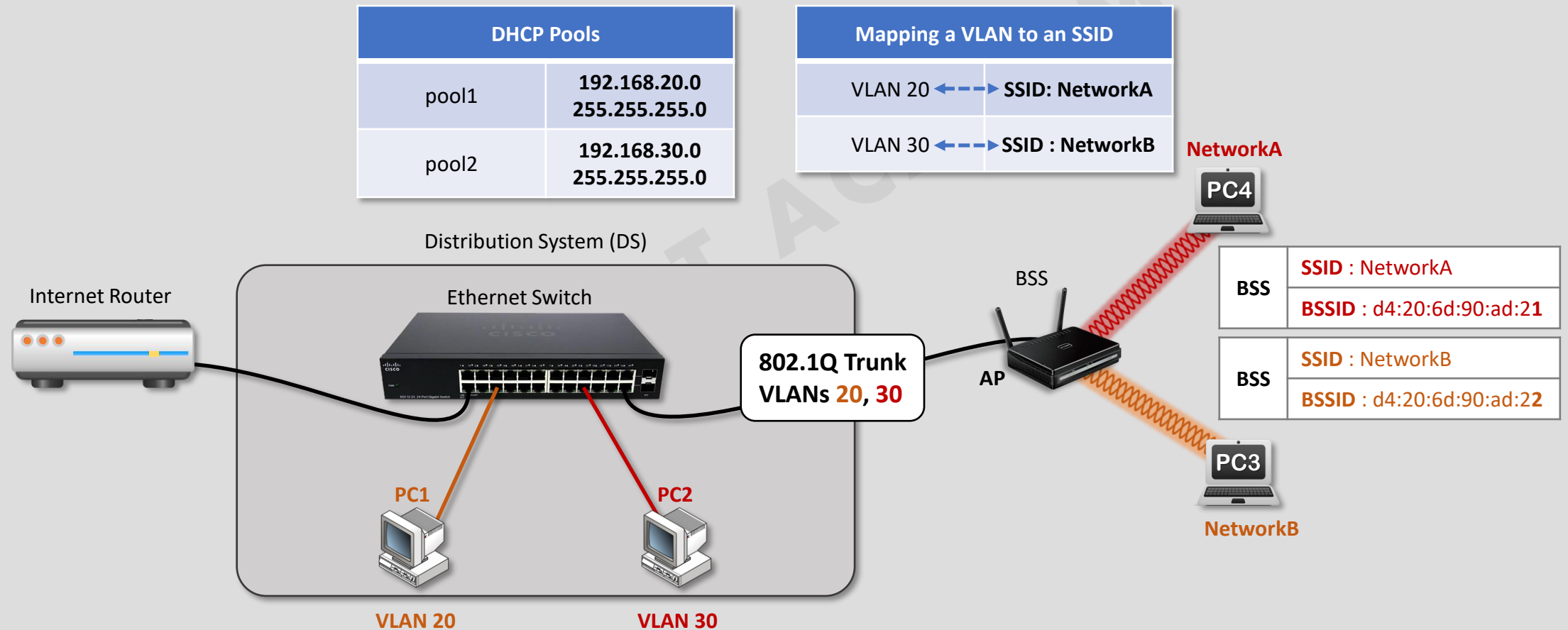
- In **Basic Service Set (BSS)** the AP and its associated clients make up a standalone network.
- An **AP** can also uplink into an Ethernet network because it has both wireless and wired capabilities.
- The **802.11 standard** refers to the upstream wired Ethernet as the distribution system (DS) for the wireless BSS.






Distribution System (DS)

Mapping a VLAN to an SSID



Distribution System (DS)



Cisco Aironet 1240AG Series Access Point

HOME

EXPRESS SET-UP

EXPRESS SECURITY

NETWORK MAP +

ASSOCIATION +

NETWORK INTERFACES +

SECURITY

Admin Access

Encryption Manager

SSID Manager

Server Manager

AP Authentication

Intrusion Detection

Local RADIUS Server

Advanced Security

SERVICES +

WIRELESS SERVICES +

SYSTEM SOFTWARE +

EVENT LOG +

Hostname AP1242AG

AP1242AG uptime is 2 weeks, 4 days, 20 hours, 40 minutes

Security: Global SSID Manager

SSID Properties

Current SSID List

< NEW >

Delete

SSID:

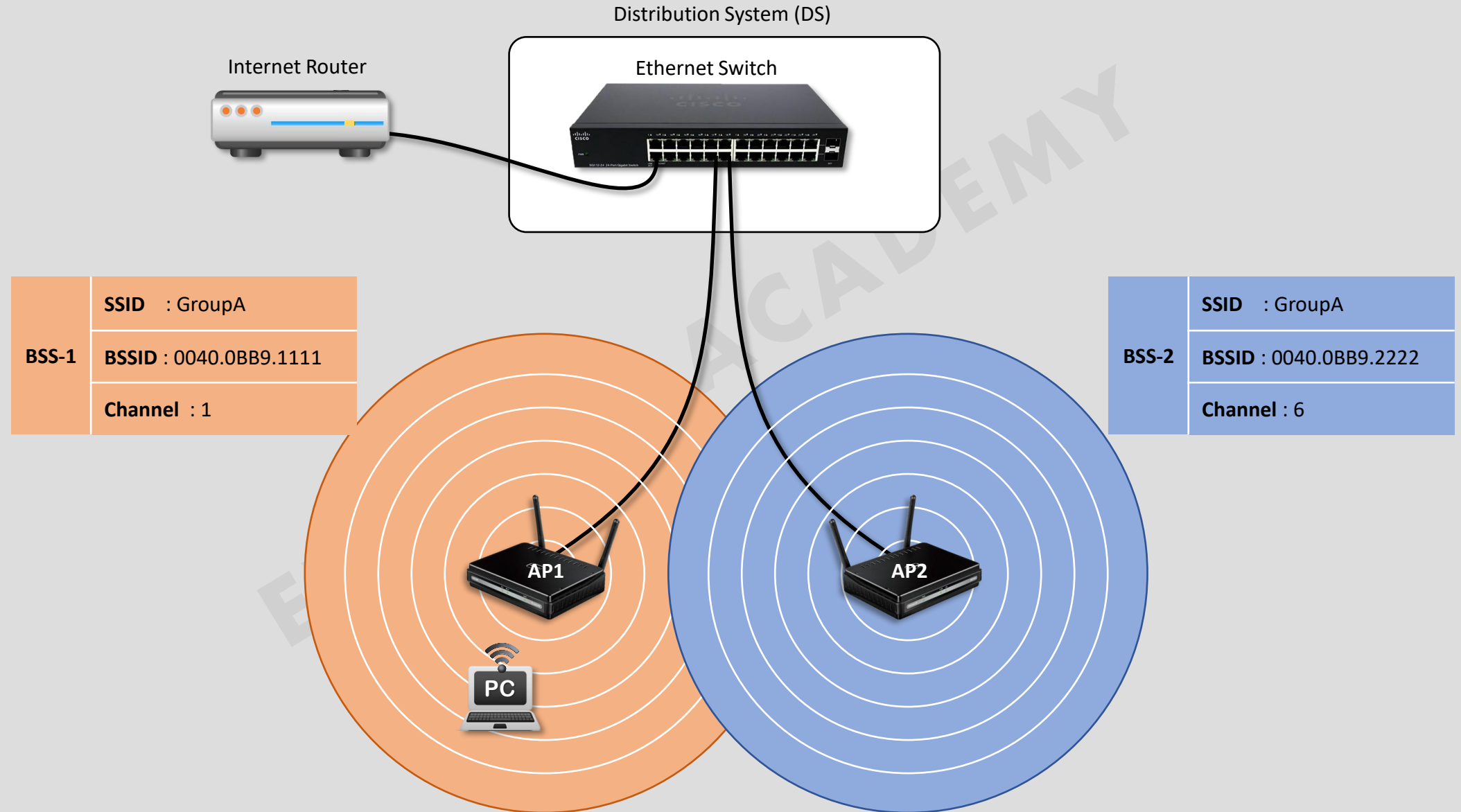
VLAN: [Define VLANs](#)

Interface: ☐ Radio0-802.11G ☐ Radio1-802.11A

Network ID: (0-4096)



Extended Service Set (ESS)



Independent Basic Service Set (IBSS)

Ad Hoc



Windows Settings

**System**Display, sound, notifications,
power**Devices**

Bluetooth, printers, mouse

**Phone**

Link your Android, iPhone

**Network & Internet**

Wi-Fi, airplane mode, VPN

**Personalization**

Background, lock screen, colors

**Apps**Uninstall, defaults, optional
features**Accounts**Your accounts, email, sync,
work, family**Time & Language**

Speech, region, date

**Gaming**Game bar, captures,
broadcasting, Game Mode**Ease of Access**Narrator, magnifier, high
contrast**Search**

Find my files, permissions

**Cortana**Cortana language, permissions,
notifications**Privacy**

Location, camera, microphone

**Update & Security**Windows Update, recovery,
backup

Home

Find a setting



Network & Internet

Status

Wi-Fi

Ethernet

Dial-up

VPN

Airplane mode

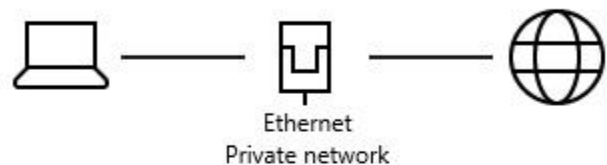
Mobile hotspot

Data usage

Proxy

Status

Network status



You're connected to the Internet

If you have a limited data plan, you can make this network a metered connection or change other properties.

[Change connection properties](#)[Show available networks](#)

Change your network settings



Change adapter options

View network adapters and change connection settings.



Sharing options

For the networks you connect to, decide what you want to share.



Network troubleshooter

Diagnose and fix network problems.

[View your network properties](#)

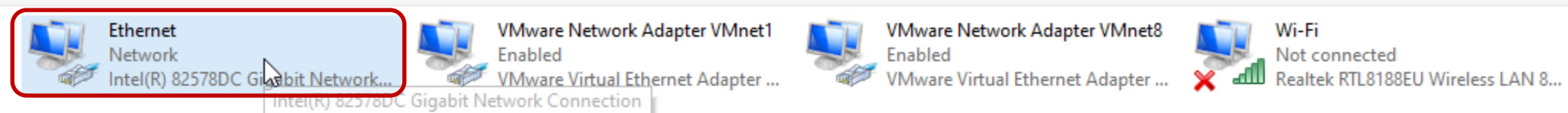
Have a question?

[Finding my IP address](#)[Troubleshooting network connection issues](#)[Updating network adapter or driver](#)[Get help](#)

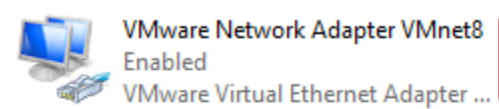
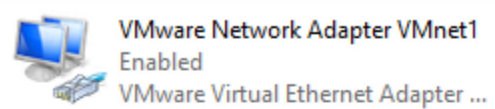
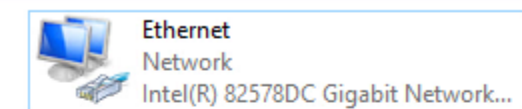
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Organize ▾



Organize ▾



Settings

Home

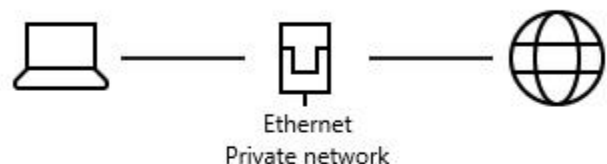
Find a setting

Network & Internet

- Status
- Wi-Fi
- Ethernet
- Dial-up
- VPN
- Airplane mode
- Mobile hotspot**
- Data usage
- Proxy

Status

Network status






You're connected to the Internet

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[Change connection properties](#)

[Show available networks](#)

Change your network settings

-  **Change adapter options**
View network adapters and change connection settings.
-  **Sharing options**
For the networks you connect to, decide what you want to share.
-  **Network troubleshooter**
Diagnose and fix network problems.

[View your network properties](#)

Have a question?

[Finding my IP address](#)

[Troubleshooting network connection issues](#)

[Updating network adapter or driver](#)

[Get help](#)

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Network & Internet

- Status
- Wi-Fi
- Ethernet
- Dial-up
- VPN
- Airplane mode
- Mobile hotspot
- Data usage
- Proxy

Mobile hotspot

Share my Internet connection with other devices



Share my Internet connection from

Network

Network name: Network
Network password: 1234567864

Edit

Turn on remotely

Allow another device to turn on mobile hotspot. Both devices must have Bluetooth turned on and be paired.



Related settings

[Change adapter options](#)

[Network and Sharing Center](#)

[Windows Firewall](#)

Have a question?

[Setting up mobile hotspot](#)

[Get help](#)

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Network & Internet

Status

Wi-Fi

Ethernet

Dial-up

VPN

Airplane mode

Mobile hotspot

Data usage

Proxy

Mobile hotspot

Share my Internet connection with other devices



On

Share my Internet connection from

Network

Network name: Network

Network password: 1234567864

Edit

Devices connected: 0 of 8

Power saving

When no devices are connected, automatically turn off mobile hotspot.



On

Related settings

[Change adapter options](#)

[Network and Sharing Center](#)

[Windows Firewall](#)

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Network & Internet

- Status
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- Proxy

Mobile hotspot

Share my Internet connection with other devices

☒ On

Share my Internet connection from

Network

Network name: Network

Network password: 1234567864

Edit

Devices connected: 0 of 8

Power saving

When no devices are connected, automatically turn off mobile hotspot.

☒ On

Related settings

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[Network and Sharing Center](#)

[Windows Firewall](#)

Have a question?

[Setting up mobile hotspot](#)

[Get help](#)

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Mobile hotspot

Share my Internet connection with other devices

☒ On

Related settings

[Change adapter options](#)

[Network and Sharing Center](#)

Edit network info

Change the network name and password that other people use for your shared connection.

Network name

NetworkA



Network password (at least 8 characters)

1234567864

Save

Cancel

Mobile hotspot

Share my Internet connection with other devices

☒ On

Related settings

[Change adapter options](#)

[Network and Sharing Center](#)

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Cancel

Mobile hotspot

Share my Internet connection with other devices

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[Network and Sharing Center](#)

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Save Cancel

Network & Internet

Status

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Share my Internet connection with other devices

☒ On

Share my Internet connection from

Network

Network name: NetworkA

Network password: 12345678

Edit

Devices connected: 0 of 8

Power saving

When no devices are connected, automatically turn off mobile hotspot.

☒ On

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Network & Internet

Status

Wi-Fi

Ethernet

Dial-up

VPN

Airplane mode

Mobile hotspot

Data usage

Proxy

Mobile hotspot

Share my Internet connection with other devices

☒ On

Share my Internet connection from

Network

Network name: NetworkA

Network password: 12345678

Edit

Devices connected: 1 of 8

Device name	IP address	Physical address (MAC)
	192.168.137.88	

Power saving

When no devices are connected, automatically turn off mobile hotspot.

☒ On

Related settings

[Change adapter options](#)

[Network and Sharing Center](#)

[Windows Firewall](#)

Have a question?

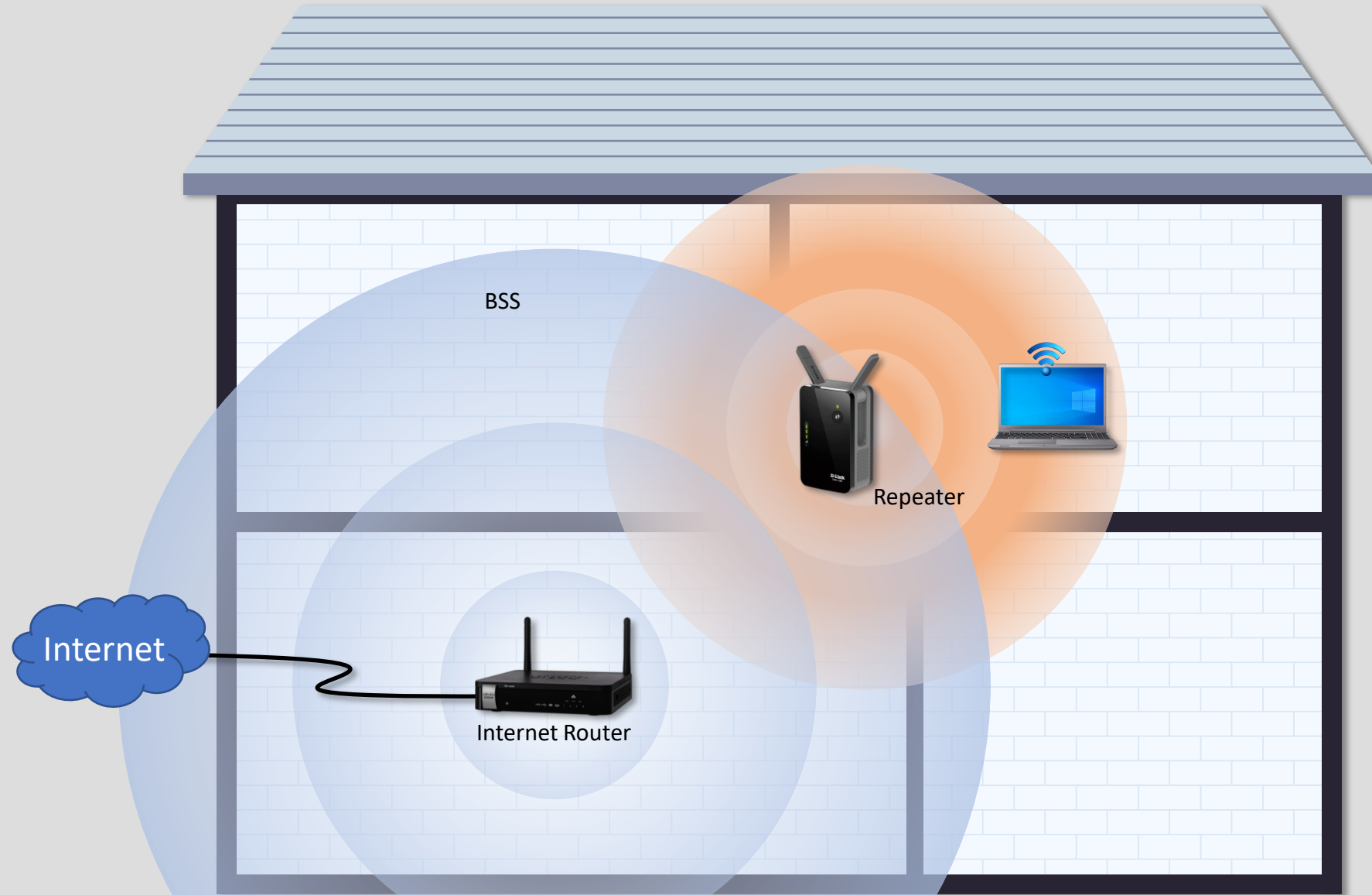
[Setting up mobile hotspot](#)

[Get help](#)

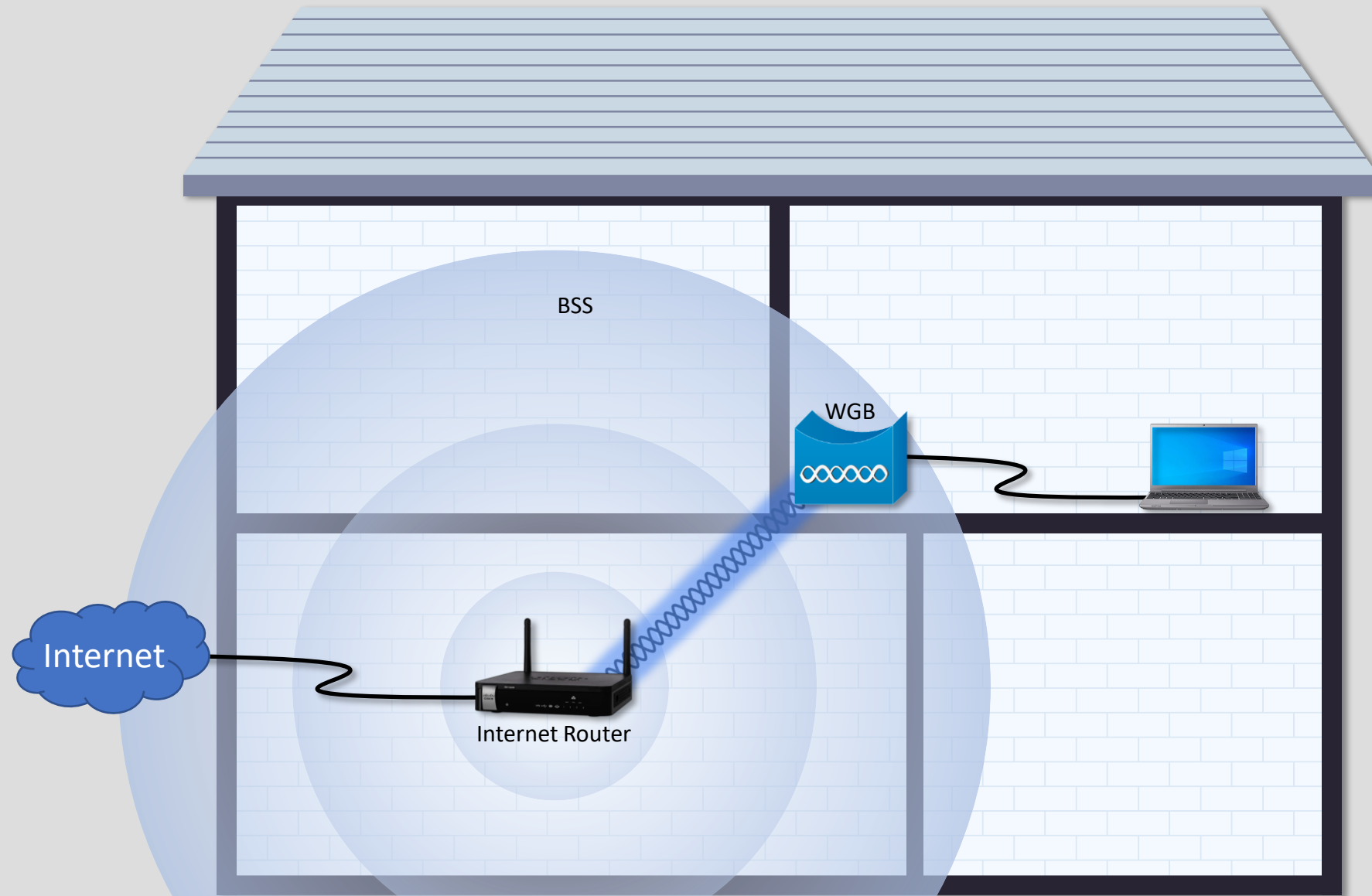
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Repeater (Range Extender)



Workgroup Bridge (WGB)



Outdoor Bridge (Point-to-Point)

