

# Wi-Fi 6 and Routers

A Learn-in-30

OPCUG & PATACS

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# Outline

- Wi-Fi—what it is
- Routers—what they do
- The standard Wi-Fi 6 (aka 802.11ax)
- A bit about wireless security



# What is Wi-Fi?

- A wireless technology used to link computers, tablets, smartphones, cameras, refrigerators, IoT
  - ✓ These devices are called clients which are “attached” to a router
  - ✓ Usually there is also a connection to the Internet
- Wi-Fi are standards developed by the IEEE\*
- There are currently six (?) Wi-Fi standards designated in the 802.11 family

\* Institute of Electrical and Electronics Engineers  ← Active link



# Generations of Wi-Fi


Generation	IEEE Standard	Maximum Linkrate (Mbit/s)	Adopted	Radio Frequency (GHz)
Wi-Fi 6E	802.11ax	600 to 9608	2020	2.4/5 <u>and</u> 6
Wi-Fi 6			2019	2.4/5
Wi-Fi 5	802.11ac	433 to 6933	2014	5
Wi-Fi 4	802.11n	72 to 600	2008	2.4/5
<i>(Wi-Fi 3*)</i>	802.11g	6 to 54	2003	2.4
<i>(Wi-Fi 2*)</i>	802.11a	6 to 54	1999	5
<i>(Wi-Fi 1*)</i>	802.11b	1 to 11	1999	2.4
<i>(Wi-Fi 0*)</i>	802.11	1 to 2	1997	2.4



\* Wi-Fi 0, 1, 2, 3 are unbranded common usage

From *Wikipedia* 

# Wi-Fi 6

- What's new compared to Wi-Fi 5?
  - ✓ Less interference between networks in crowded areas
  - ✓ Faster speed
  - ✓ Lower latency
  - ✓ Introduction of a third additional band, 6 GHz (6E only)
  - ✓ MU-MIMO, OFDMA, BSS, TWT... blah, blah, blah
- Few Wi-Fi 6E routers available
- Very few Wi-Fi 6E client devices to be had\*
- Wi-Fi 6 is backward compatible
- For more information see 

\* At this time Apple products do not support Wi-Fi 6E



# Some Nitty Gritty Details


	WiFi 6E	WiFi 6	WiFi 5
Release date	2020	2018	2014
Maximum data rate	9.6 Gbps		3.5 Gbps
Operating frequency	6GHz 5GHz 2.4GHz	5GHz 2.4GHz	5GHz 2.4GHz
Number of 160 MHz channels	7 (on 6GHz band)* 2 (on 5GHz band)	2 (on 5GHz band)	2 (on 5GHz band)
Modulation	1024QAM	1024QAM	256QAM
Features	<ul style="list-style-type: none"> <li>• 6GHz band dedicated to WiFi 6E client devices</li> <li>• 160MHz channels in 6GHz band are not operating on DFS</li> </ul>	<ul style="list-style-type: none"> <li>• OFDMA &amp; MU-MIMO</li> <li>• Target Wake Time</li> </ul>	<ul style="list-style-type: none"> <li>• Introducing 5GHz band</li> </ul>
Benefit	<ul style="list-style-type: none"> <li>• Massive capacity, lower latency</li> <li>• Least congestion for WiFi 6E clients</li> <li>• Zero-wait connection on 6GHz 160MHz channels</li> </ul>	<ul style="list-style-type: none"> <li>• 4X lower latency</li> <li>• 1.25X faster</li> <li>• 7X energy efficiency</li> <li>• 1.25X longer range compared to WiFi 5</li> </ul>	<ul style="list-style-type: none"> <li>• Faster WiFi from 5GHz band</li> </ul>

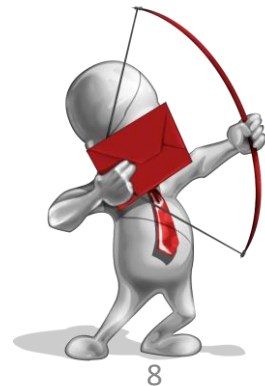
\*Subject to regulatory limitations, and co-existence with 5GHz WiFi. Number of channels may be less than 7.

FREE WIFE  
ZONE



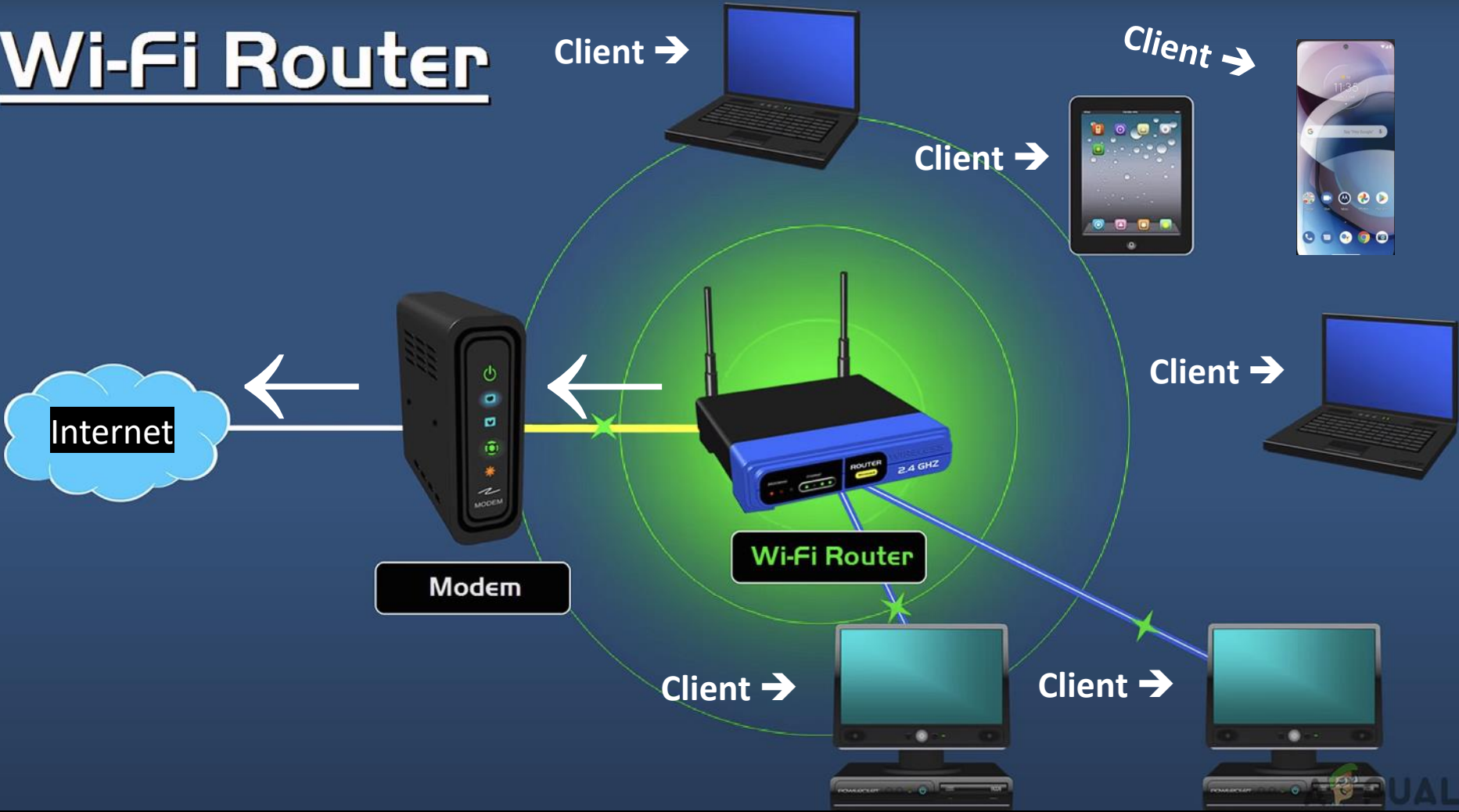
# What Is a Router?

- A device that forwards data packets between devices (clients) in a computer network
  - ✓ LAN (your home network)
  - ✓ Connection to the Internet
- Routers forward data to a modem that passes data to the Internet
- Routers can be wired or wireless
- For more information see 















# Wi-Fi Router




# Examples of ASUS Wi-Fi Routers\*

Family	Model	Price	See	Reference
AX1800	RT-AX1800S	\$100		
AX1800	RT-AX55	\$130		
AX3000	RT-AX3000	\$180		
AX6100	RT-AX92U	\$230		
AX5700	RT-AX86U	\$280		

\* ASUS currently has 14 families of Wi-Fi routers






# Mesh Routers

- Mesh routers use two or more connected devices to distribute the Wi-Fi signal more broadly—resulting in extending coverage
- Most manufacturers of routers also make mesh routers
- For more information see 



# Router Brands and Where to Buy

## Brands

- ASUS 
- D-Link 
- Linksys 
- Netgear 
- TP-Link 

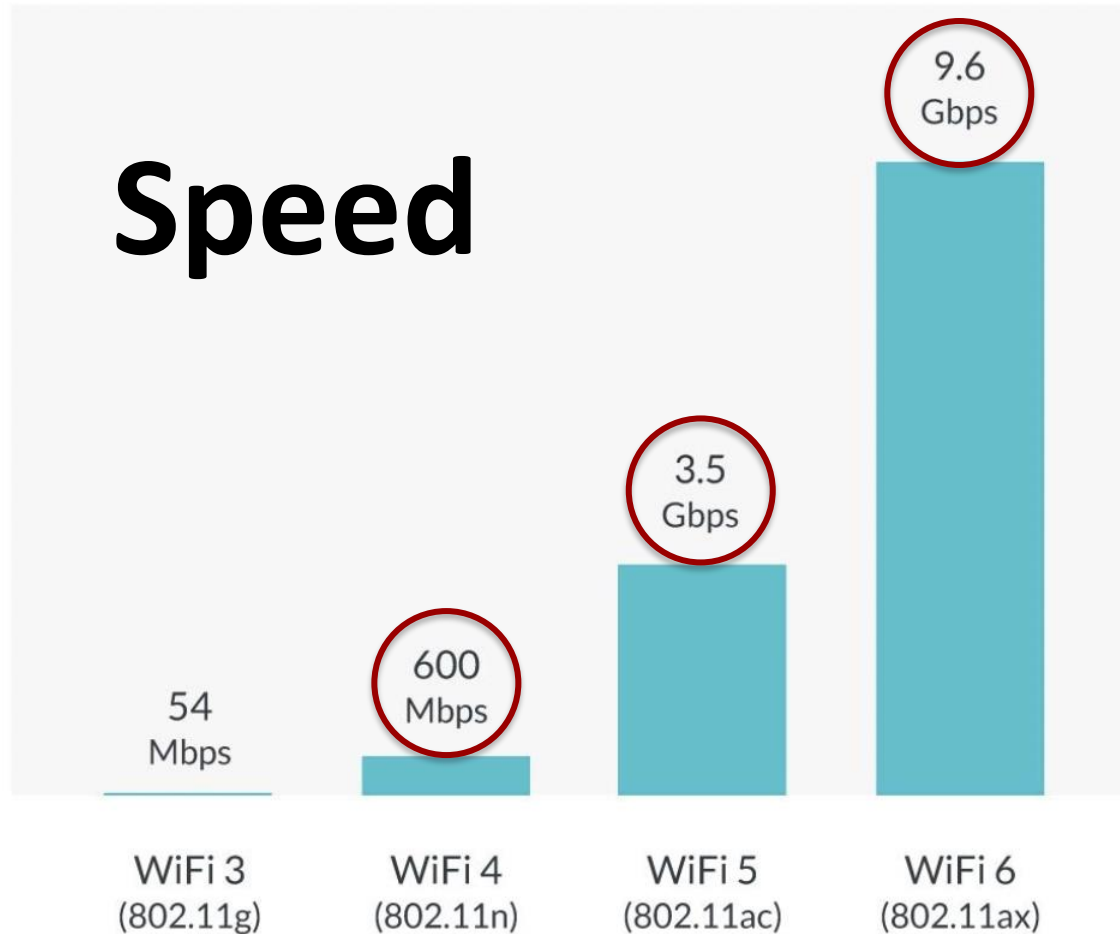
## Where to Buy

- Amazon 
- Best Buy 
- Costco Wholesale 
- Micro Center 
- Newegg 
- TigerDirect 






# One Compelling Reason to Upgrade

IEEE Standard maximum throughput speeds




From 

## 2<sup>nd</sup> Reason to Upgrade—Better Security









<b>Brand</b>	<b>Enhanced Protection</b>	<b>References</b>
ASUS	AiProtection	
D-Link	None?	_____
Linksys	None?	_____
Netgear	Armor	
TP-Link	HomeCare HomeShield	

# When Should You Replace Your Router?

- When mfg. declares your router obsolete
- Firmware can no longer be updated
- Your LAN becomes progressively slower
- A new IEEE 802.11 standard comes out
- When you're renting your router from your ISP
- When you are experiencing connection issues
- Common wisdom—every three to five years
- For more information see 



# Manufacturers' End-of-Life Products

- ASUS 
- D-Link 
- Linksys    
- Netgear 
- TP-Link 





# wi-Fi 6

**IEEE 802.11ax**

# New & Enhanced Tech in Wi-Fi 6

- Improved performance with (a) accommodating more simultaneous users and (b) many more clients
- Faster speed: Wi-Fi 5 (3.5 Gbps) Wi-Fi 6 (9.6 Gbps)
- OFDMA
- MU-MIMO
- Beamforming
- BSS
- TWT security
- WPA3 security

**Explanations to follow...**



# OFDMA... Huh?

- OFDMA = **O**rthogonal **F**requency **D**ivision **M**ultiple **A**ccess
- The effect?
  - ✓ More devices can connect to your LAN (up to 74) and are served simultaneously
  - ✓ Lower latency by delivering multiple pieces of data to multiple clients simultaneously

- For more information see 



# MU-MINO... You're kidding!

- MU-MINO = **M**ultiple **U**ser—**M**ultiple **I**ntput—**M**ultiple **O**utput
- The effect?



Previously data were streamed sequentially to clients

- For more information see 



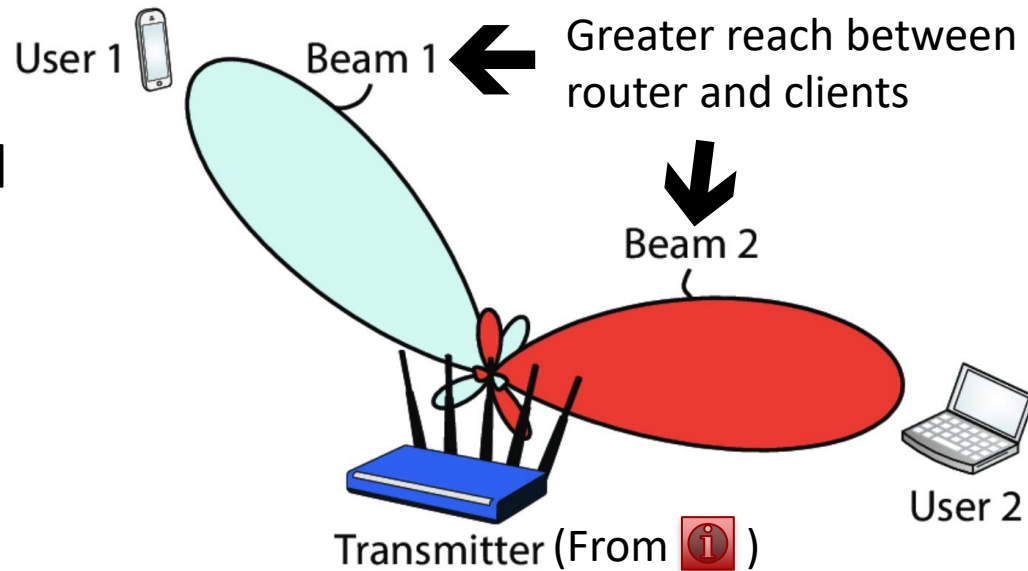
# Beamforming



# Beamforming


- Focusing radio transmission from router to clients

- The effect?
  - ✓ Higher speed




- For more information see ⓘ ⓘ ⓘ

# BSS Coloring... Wot?

- BSS = **B**asic **S**ervice **S**et
- The effect?
  - ✓ Reduces interference between Wi-Fi clients... especially helpful in Wi-Fi congested areas
  - ✓ Consequently, improved performance
- For more information see 



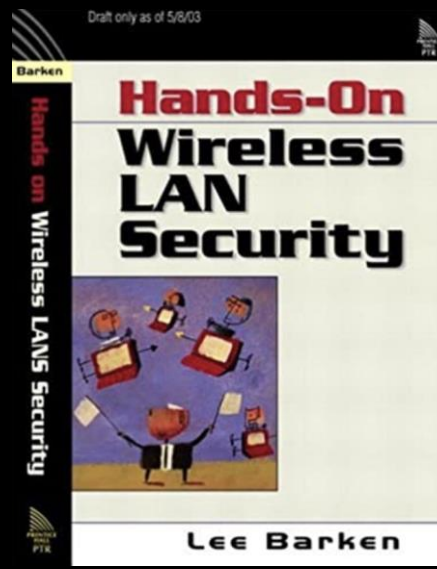
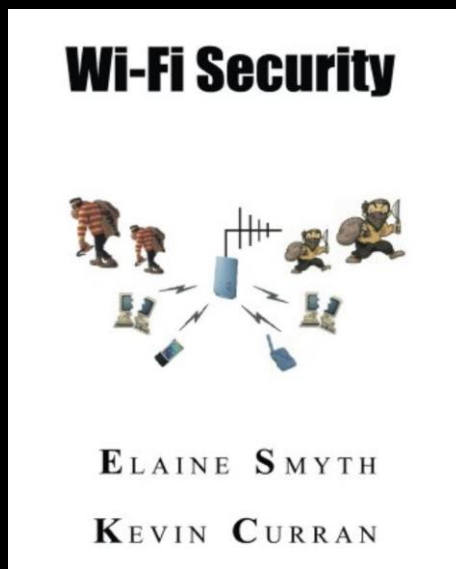
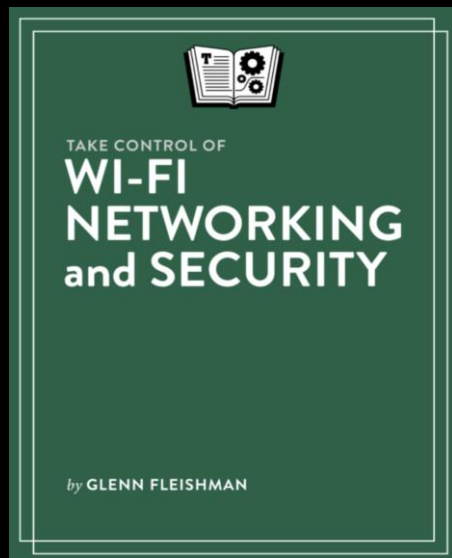
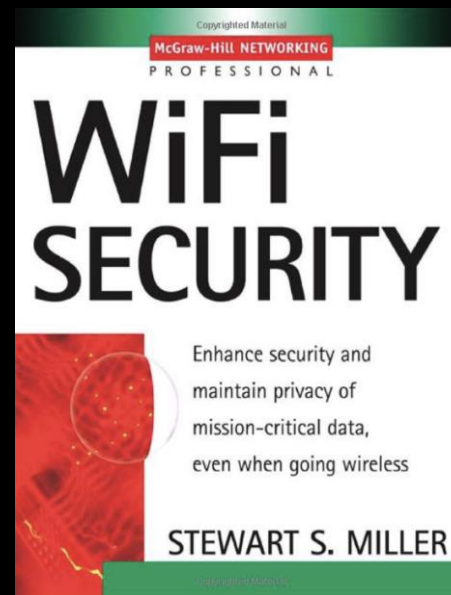
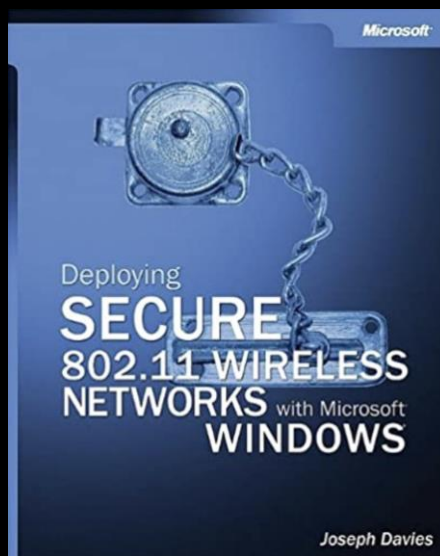
# TWT... not Twit

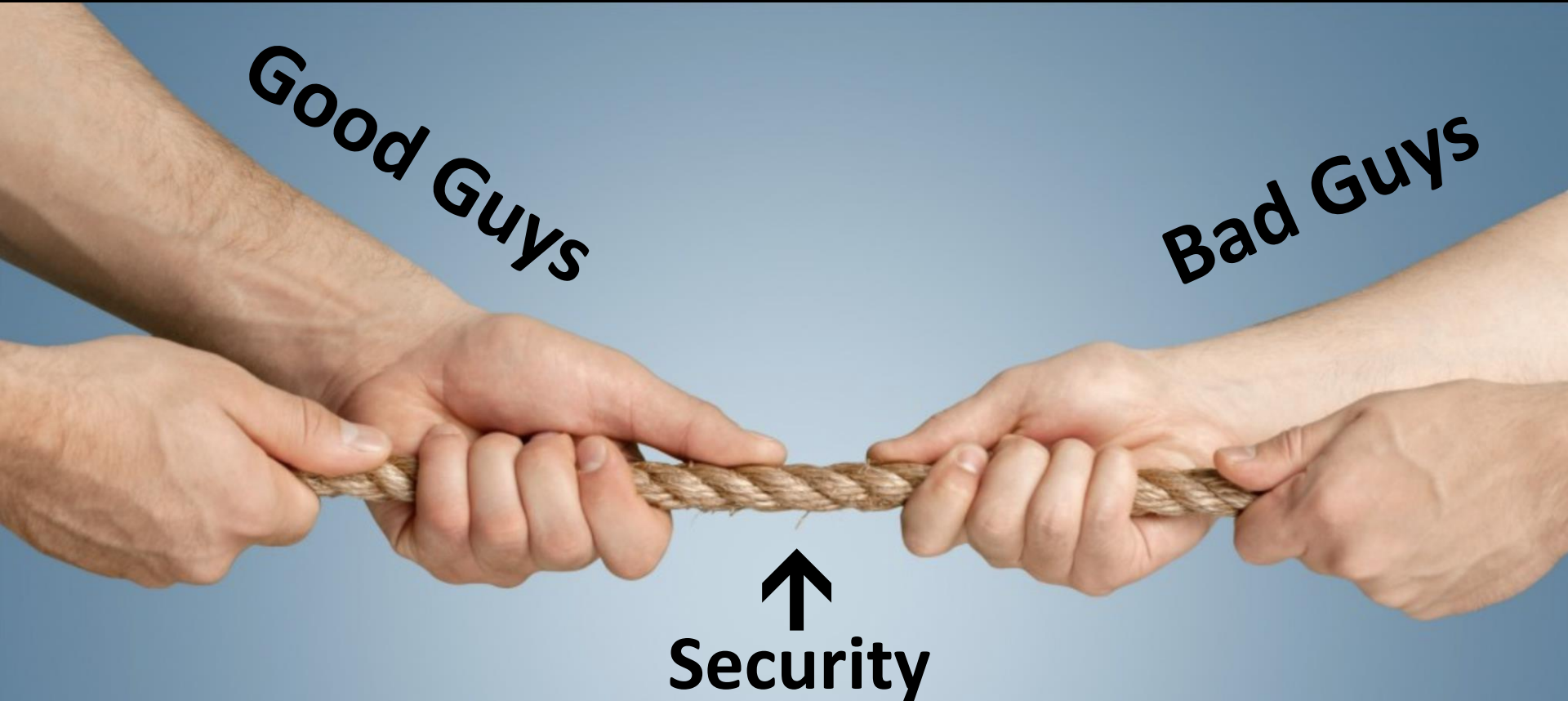
- TWT = **T**arget **W**ait **T**ime
- Effect?
  - ✓ Enables the router to negotiate with clients (IoT) to establish when and how often the client will wake up and send or receive data
  - ✓ Extends battery life of IoT devices
- For more information 





# Router Security is **Complicated**













**Good Guys**

**Bad Guys**





**↑  
Security**

**“No technology that’s connected to the Internet is unhackable”  
Abhijit Naskar**

# Setting Up a Router

- Process varies widely depending on manufacturer and router model
- Before setting up a router, make an effort to become educated...
  - ✓ Web sources      
  - ✓ Videos  
  - ✓ Search the Web for your specific make and model router
- Carefully read the router's documentation before starting to set up
- Alternatively, get a knowledgeable friend or expert (a child?) to help or **do it for you!**

# Wireless Security

- ***Immediately*** change the admin password
  - ✓ User = “admin”
  - ✓ Password = "S0meth1ng-Rea11y-G00d"
- There are numerous factors to consider
- Which encryption protocol to use? WEP or WPA or WPA2 or WPA3 (  )?
- For information on wireless security see   



Getting a router up and running  
is usually straightforward  
Implementing security is not



# Wireless Security Protocols

	<u>WEP</u>	<u>WPA</u>	<u>WPA 2</u>	<u>WPA 3</u>
Stands For	Wired Equivalent Privacy	Wi-Fi Protected Access	Wi-Fi Protected Access 2	Wi-Fi Protected Access 3
Developed	1997	2003	2004	2018
Security Level	Very Low	Low	High	Very High
Encryption	RC4	TKIP with RC4	AES-CCMP	AES-CCMP AES-GCMP
Key Size	64 bit 128 bit	128 bit	128 bit	128 bit 256 bit
Authentication	Open System & Shared Key	Pre Shared Key & 802.1x with EAP	Pre Shared Key & 802.1x with EAP	AES-CCMP AES-GCMP
Integrity	CRC-32	64 Bit MIC	CCMP with AES	SHA-2

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# Where Security Gets Complicated

ASUS RT-AC68U Logout Reboot English

Operation Mode: Wireless router Firmware Version: 9.0.0.4.384.9309  
SSID: 123\_68U 123\_68U\_5G

Quick Internet Setup

General

Network Map

Guest Network

**AiProtection**

Adaptive QoS

Traffic Analyzer

USB Application

AiCloud 2.0

Advanced Settings

Network Protection Malicious Sites Blocking Two-Way IPS Infected Device Prevention and Blocking Parental Controls

**AiProtection**

*AiProtection with Trend Micro provides real-time network monitoring to detect malware, viruses, and intrusions before they can reach your PC or device. Parental Controls let you schedule times that a connected device is able to access the Internet. You can also restrict unwanted websites and apps.*

[AiProtection FAQ](#)

TREND MICRO™ SMART HOME NETWORK

1 2 3

AiProtection ON ← Turn on AiProtection

For ASUS RT-AX86U router

Recommendations from ASUS



# Where Security Gets Complicated (cont.)

The screenshot displays the 'Advanced Settings' interface of a router. The left sidebar contains navigation options: Wireless, LAN, WAN, IPv6, VPN, Firewall, Administration (highlighted), System Log, and Network Tools. The main content area is divided into several sections:

- Time Zone:** (GMT+08:00) Beijing, Hong Kong
- NTP Server:** pool.ntp.org (with a link to NTP Link)
- Network Monitoring:**  DNS Query  Ping
- Auto Logout:** 30 minute(s) (Disable : 0)
- Enable WAN down browser redirect notice:**  Yes  No
- Enable Reboot Scheduler:**  Yes  No

**Service**

- Enable Telnet:**  Yes  No
- Enable SSH:** No
- Idle Timeout:** 20 minute(s) (Disable : 0)

**Local Access Config**

- Authentication Method:** HTTPS
- HTTPS LAN port:** 8443 (Access setting page via <https://router.asus.com:8443>)

**Remote Access Config**

- Enable Web Access from WAN:**  Yes  No ← Disable access from WAN
- Enable Access Restrictions:**  Yes  No

# Where Security Gets Complicated (cont.)

The screenshot displays a network configuration interface with a sidebar on the left and a main configuration area on the right. The sidebar contains the following menu items: VPN, Firewall, Administration (highlighted), System Log, and Network Tools. The main configuration area is divided into three sections: Service, Local Access Config, and Remote Access Config.

**Service Section:**

Enable Telnet	<input checked="" type="radio"/> Yes <input type="radio"/> No
Enable SSH	No ▼
Idle Timeout	20 minute(s) (Disable : 0)

**Local Access Config Section:**

Authentication Method	HTTP ▼
-----------------------	--------

**Remote Access Config Section:**

Enable Web Access from WAN	<input type="radio"/> Yes <input checked="" type="radio"/> No
Enable Access Restrictions	<input type="radio"/> Yes <input checked="" type="radio"/> No

An **Apply** button is located at the bottom of the configuration area. A red box highlights the 'Enable Telnet' and 'Enable SSH' rows in the Service section. A yellow callout box with a black arrow points to these rows, containing the text "Disable Telnet and SSH".



# Where Security Gets Complicated (cont.)

ASUS RT-AC68U    Logout    Reboot    English

Operation Mode: **Wireless router**    Firmware Version: **9.0.0.4.384.9309**  
SSID: **123\_68U** **123\_68U\_5G**    App    [User Icon]    [Home Icon]    [Refresh Icon]

Internet Connection    Dual WAN    Port Trigger    Virtual Server / Port Forwarding    **DMZ**    DDNS    NAT Passthrough

### WAN - DMZ

Virtual DMZ allows you to expose one computer to the Internet, so that all the inbounds packets will be redirected to the computer you set. It is useful while you run some applications that use uncertain incoming ports. Please use it carefully.

Special Applications:

- Some applications require special handler against NAT. These special handlers are disabled in default.
- Please add a rule to port forwarding list for USB Disk access properly on FTP service.

[DMZ\\_FAQ](#)

Enable DMZ     Yes     No    **← Do not enable DMZ**

Apply

# Where Security Gets Complicated (cont.)

The screenshot displays the 'Advanced Settings' page of an ASUSWRT router. The left sidebar contains navigation options: Wireless, LAN, WAN, IPv6, VPN, Firewall, Administration (highlighted), System Log, and Network Tools. The main content area is divided into several sections:

- Time Zone:** (GMT+08:00) Beijing, Hong Kong
- NTP Server:** pool.ntp.org (with an NTP Link button)
- Network Monitoring:** DNS Query and Ping checkboxes.
- Auto Logout:** 30 minute(s) (Disable : 0)
- Enable WAN down browser redirect notice:** Radio buttons for Yes and No.
- Enable Reboot Scheduler:** Radio buttons for Yes and No.
- Service Section:**
  - Enable Telnet:** Radio buttons for Yes and No.
  - Enable SSH:** No (dropdown menu)
  - Idle Timeout:** 20 minute(s) (Disable : 0)
- Local Access Config Section (highlighted with a red box):**
  - Authentication Method:** HTTPS (dropdown menu) with a yellow callout: **← Enable https to log in ASUSWRT**
  - HTTPS LAN port:** 8443 (with a note: Access setting page via <https://router.asus.com:8443>)

# ASUS RT-AX86U—Admin Portal



## Router Security Assessment

Default router login username and password changed -	Yes
Wireless password strength check -	Strong
Wireless encryption enabled -	Strong
WPS Disabled -	Yes
UPnP service disabled -	No
Web access from WAN disabled -	No
PING from WAN disabled -	Yes
DMZ disabled -	Yes
Port trigger disabled -	Yes
Port forwarding disabled -	Yes
Anonymous login to FTP share disabled -	Yes
Disable guest login for Network Place Share -	Yes
Malicious Website Blocking enabled -	Yes
Vulnerability Protection enabled -	Yes
Infected Device Prevention and Blocking -	Yes

**Thanks for  
Listening!**

