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

* **I**nstitute of **E**lectrical and **E**lectronics **E**ngineers

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 and 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
(Wi-Fi 3*)	802.11g	6 to 54	2003	2.4
(Wi-Fi 2*)	802.11a	6 to 54	1999	5
(Wi-Fi 1*)	802.11b	1 to 11	1999	2.4
(Wi-Fi 0*)	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

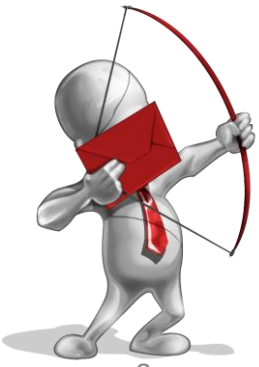
	WiFi 6E	WiFi 6	WiFi 5
Release date	2020	2018	2014
Maximum data rate	9.6 Gbps		3.5 Gbps
Operating frequency	6GHz 5GHz 2.4GHz	5GHz 2.4GHz	5GHz 2.4GHz
Number of 160 MHz channels	7 (on 6GHz band)* 2 (on 5GHz band)	2 (on 5GHz band)	2 (on 5GHz band)
Modulation	1024QAM	1024QAM	256QAM
Features	• 6GHz band dedicated to WiFi 6E client devices • 160MHz channels in 6GHz band are not operating on DFS	• OFDMA & MU-MIMO • Target Wake Time	• Introducing 5GHz band
Benefit	• Massive capacity, lower latency • Least congestion for WiFi 6E clients • Zero-wait connection on 6GHz 160MHz channels	• 4X lower latency • 1.25X faster • 7X energy efficiency • 1.25X longer range compared to WiFi 5	• Faster WiFi from 5GHz band

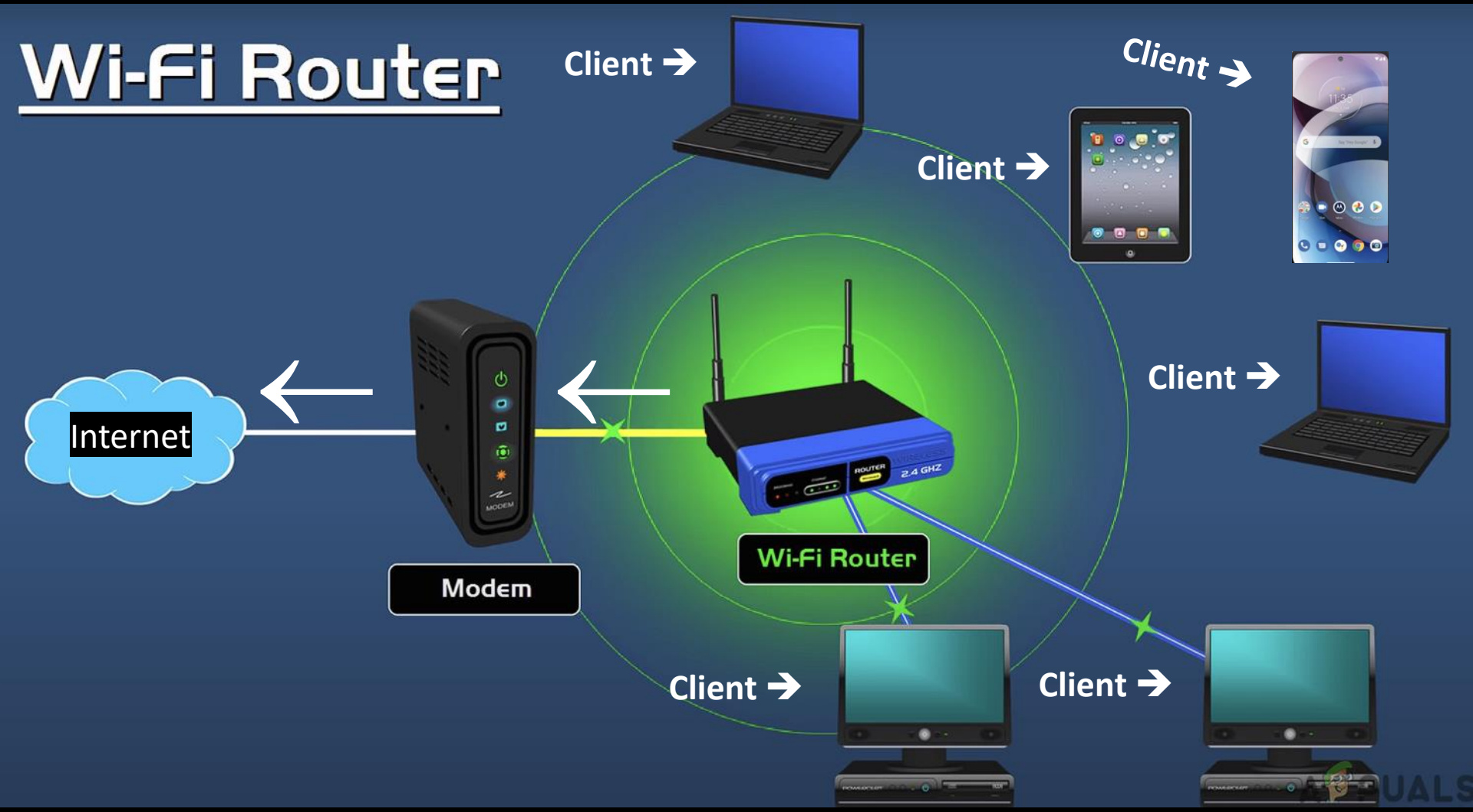
*Subject to regulatory limitations, and co-existence with 5GHz WiFi. Number of channels may be less than 7.

From
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 care be wired or wireless
- For more information see




Wi-Fi Router
Client
Client
Client
Client
Client
Client
Internet
Modem
Wi-Fi Router
2.4 GHZ

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

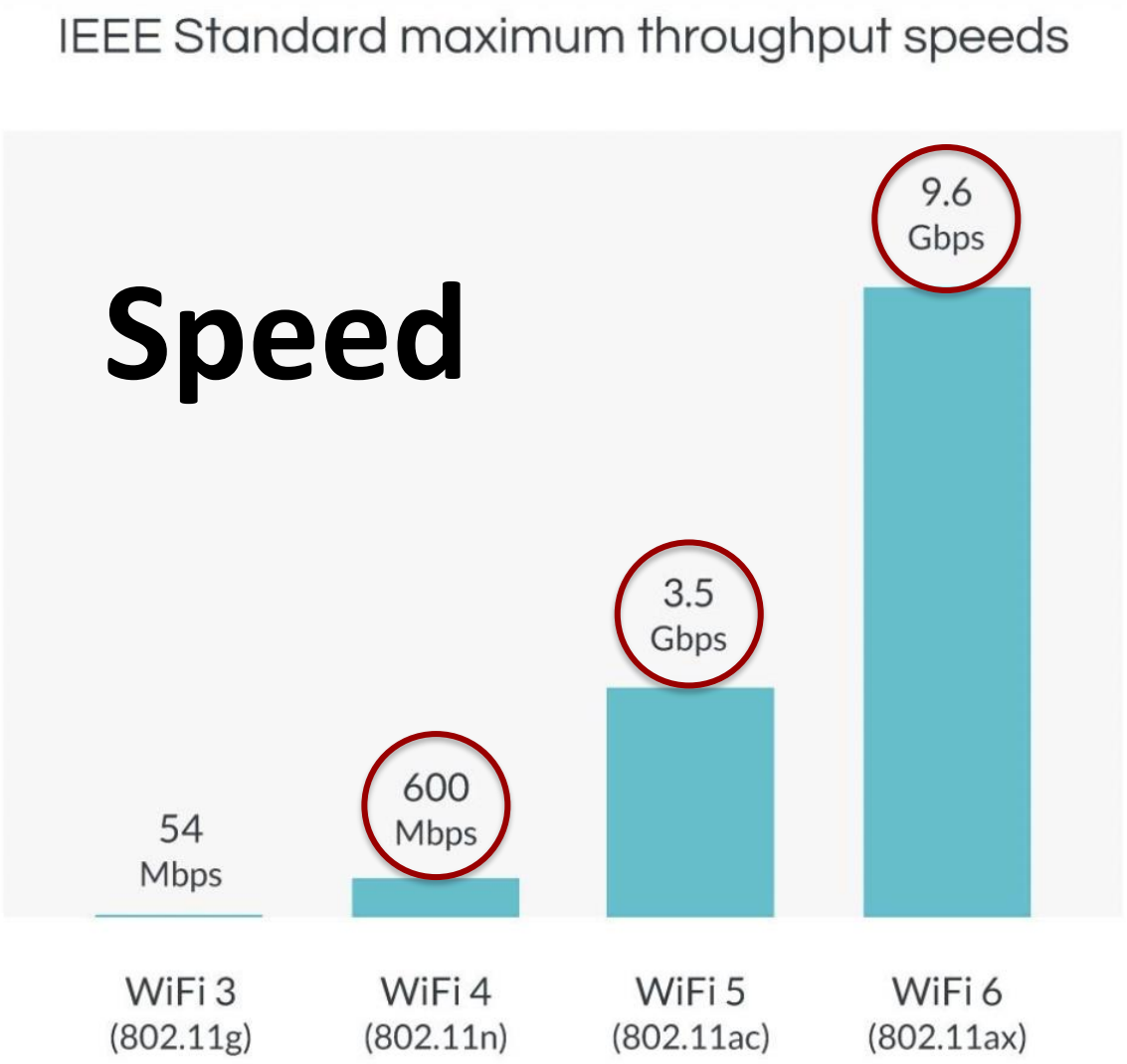
Brands

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

Where to Buy

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

One Compelling Reason to Upgrade



From

2nd Reason to Upgrade—Better Security

Brand	Enhanced Protection	References
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

Manufactures' 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-MINO
- 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**nput—**M**ultiple **O**utput
- The effect?

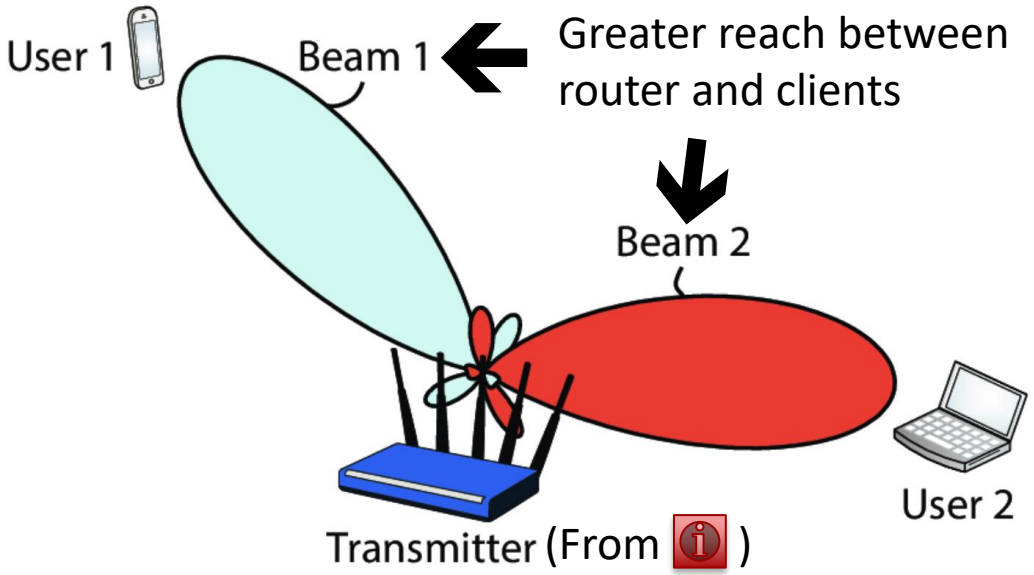
Previously data were streamed sequentially to clients

- For more information see

Beamforming

Beamforming

- Focusing radio transmission from router to clients
- The effect?
  - ✓ Higher speed



- For more information see

BSS Coloring… Wot?

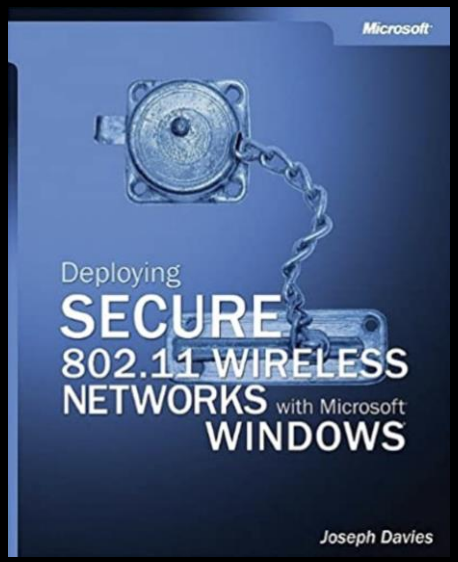
- BSS = **B**asic **S**ervice **S**et
- The effect?
  - ✓Reduces interference between Wi-Fi clients… especially helpful in Wi-Fi congested areas
  - ✓Consequently, improved performance
- For more information see

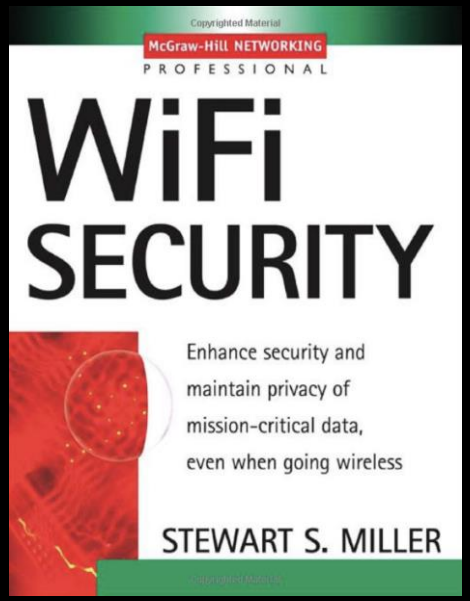
TWT… not Twit

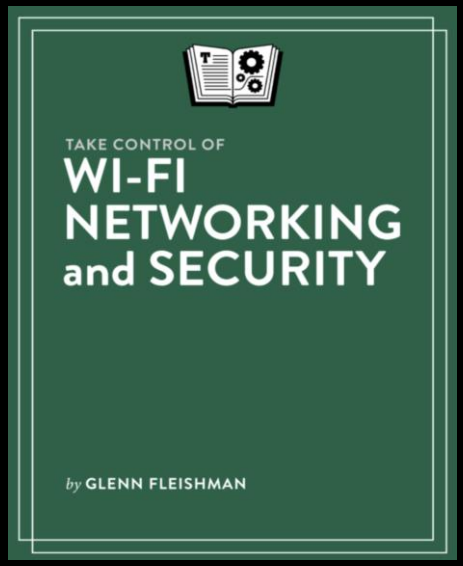
- TWT = **T**arget **W**ait **T**ime
- Effect?
  - ✓Enables the router to negotiate with clients (IoT) to establish when and how often the client will wake up and send or receive data
  - ✓Extends battery life of IoT devices

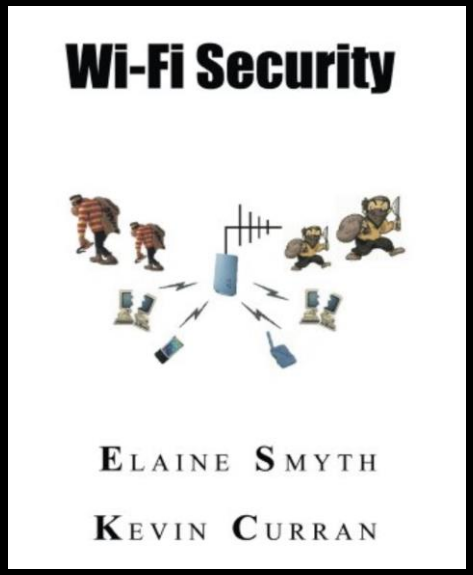
- For more information

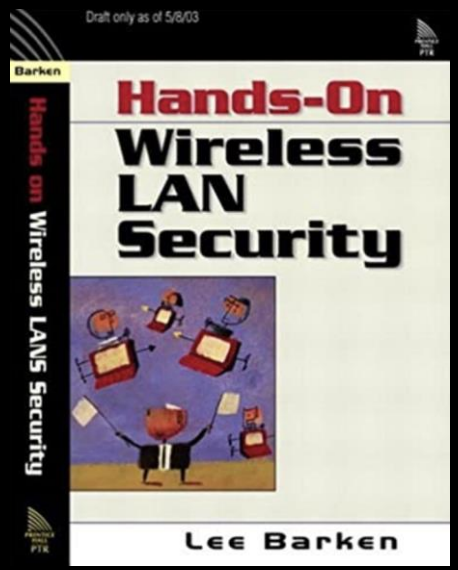
Router Security is Complicated

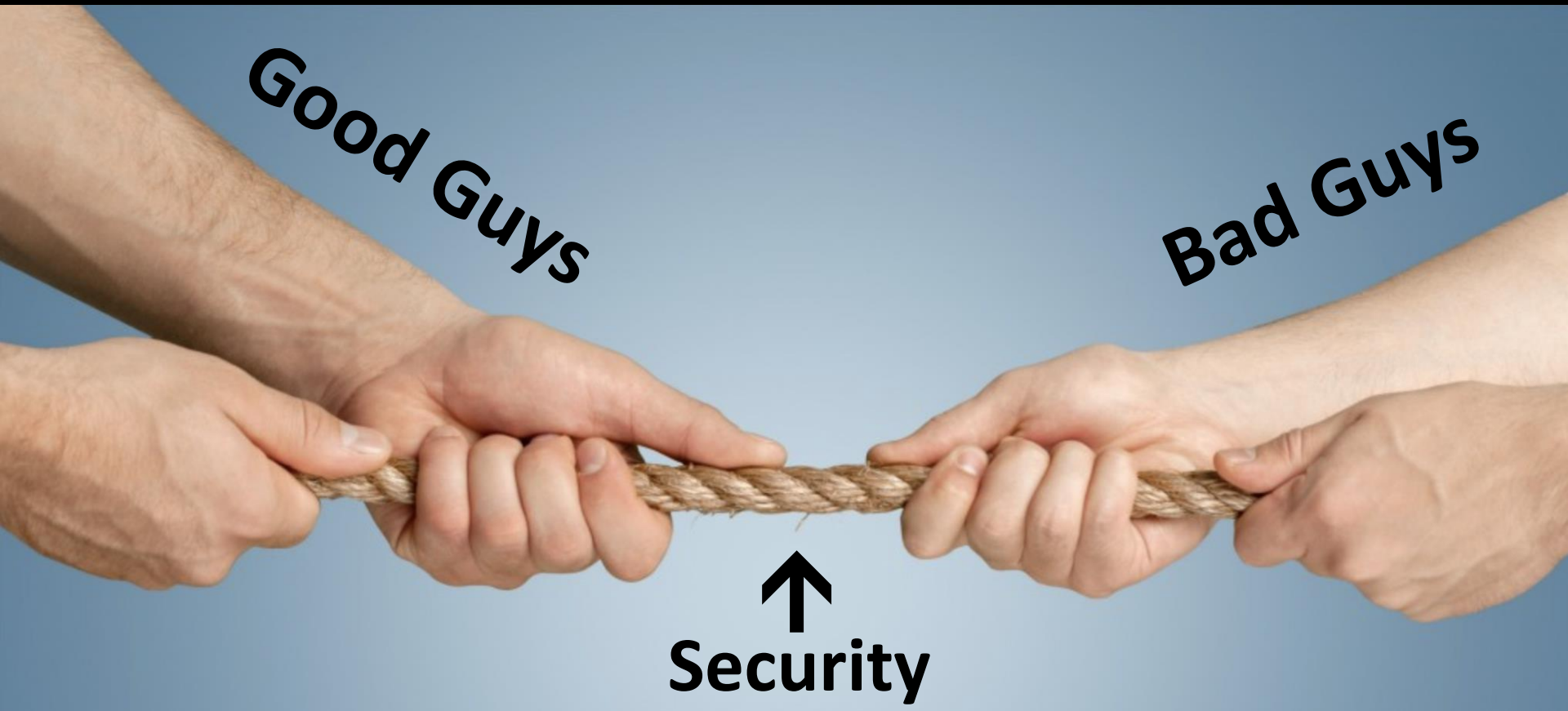












“No technology that’s connected to the Internet is unhackable”

Abhijit Naskar

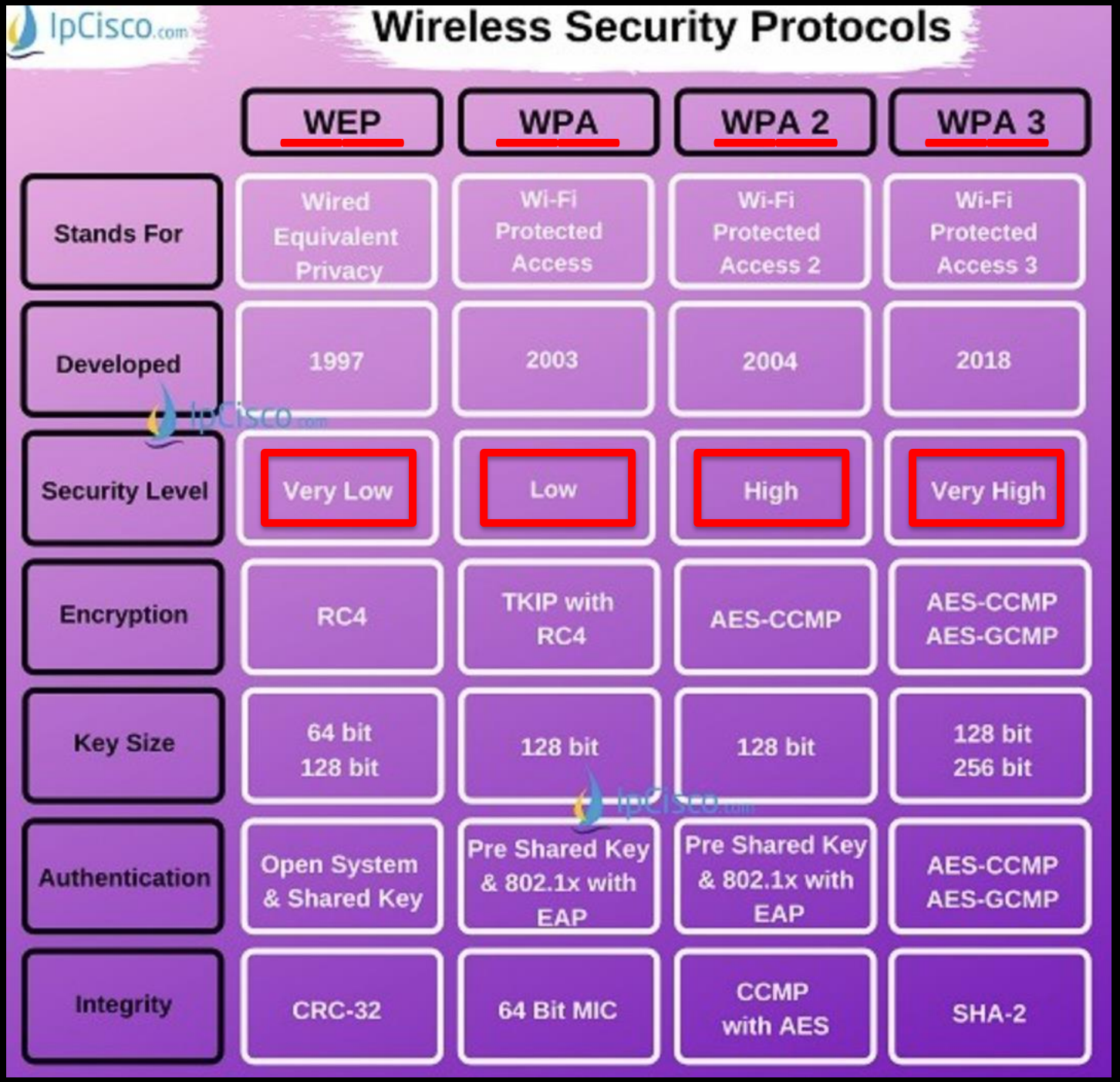
Setting Up a Router

- 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!**

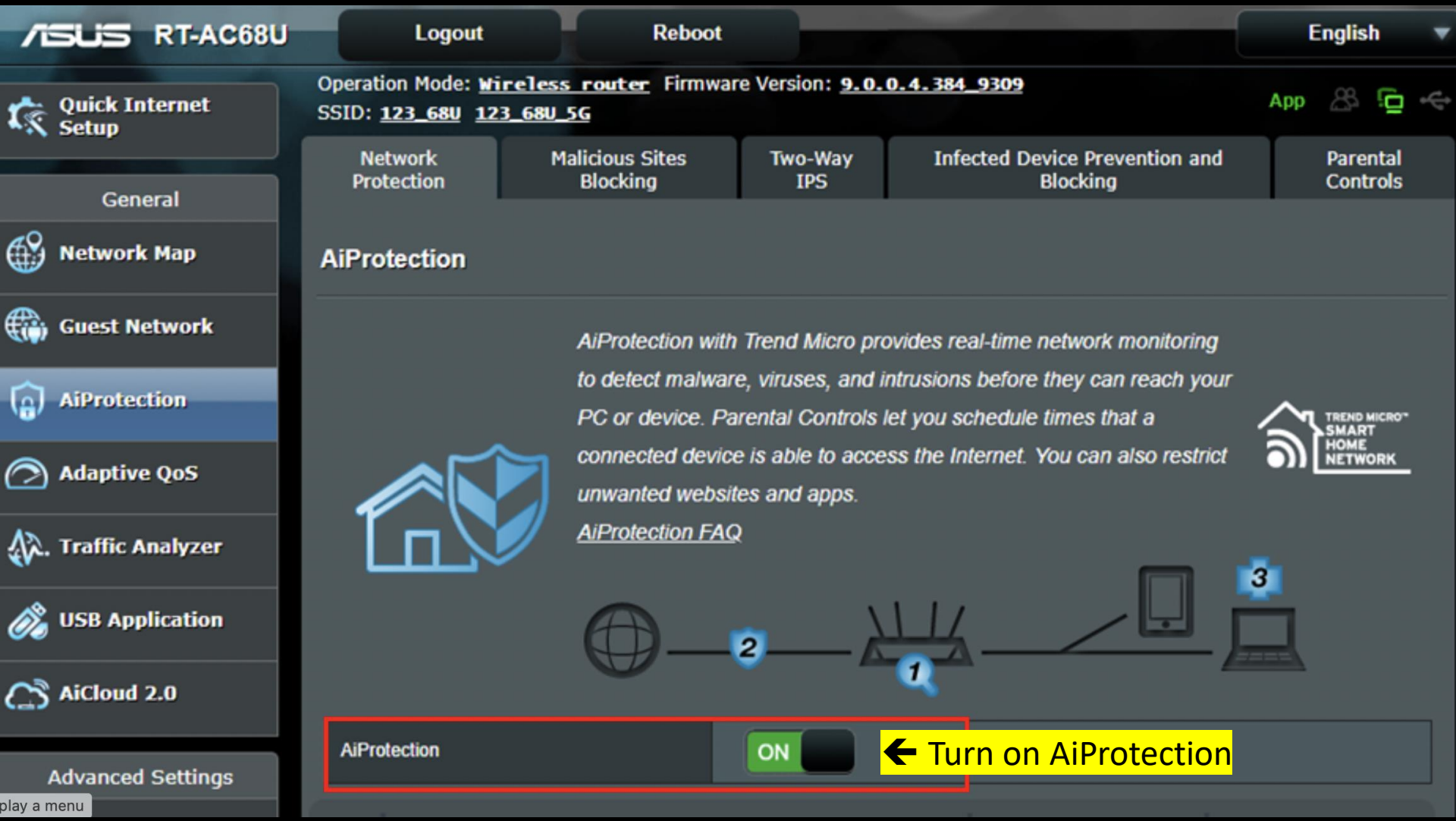
Wireless Security

- ***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


IpCisco.com
Wireless Security Protocols
WEP
WPA
WPA 2
WPA 3
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

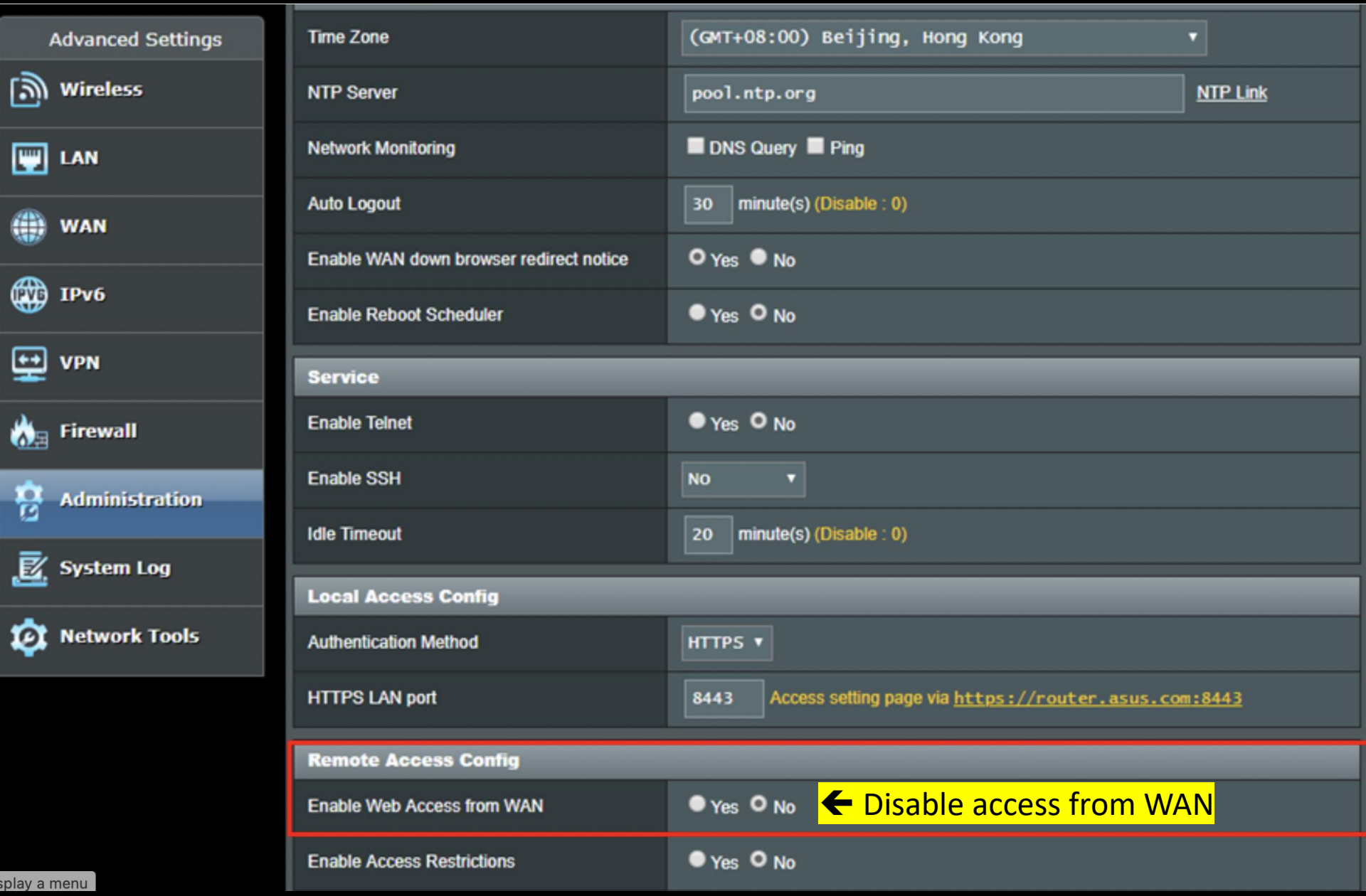
Where Security Gets Complicated



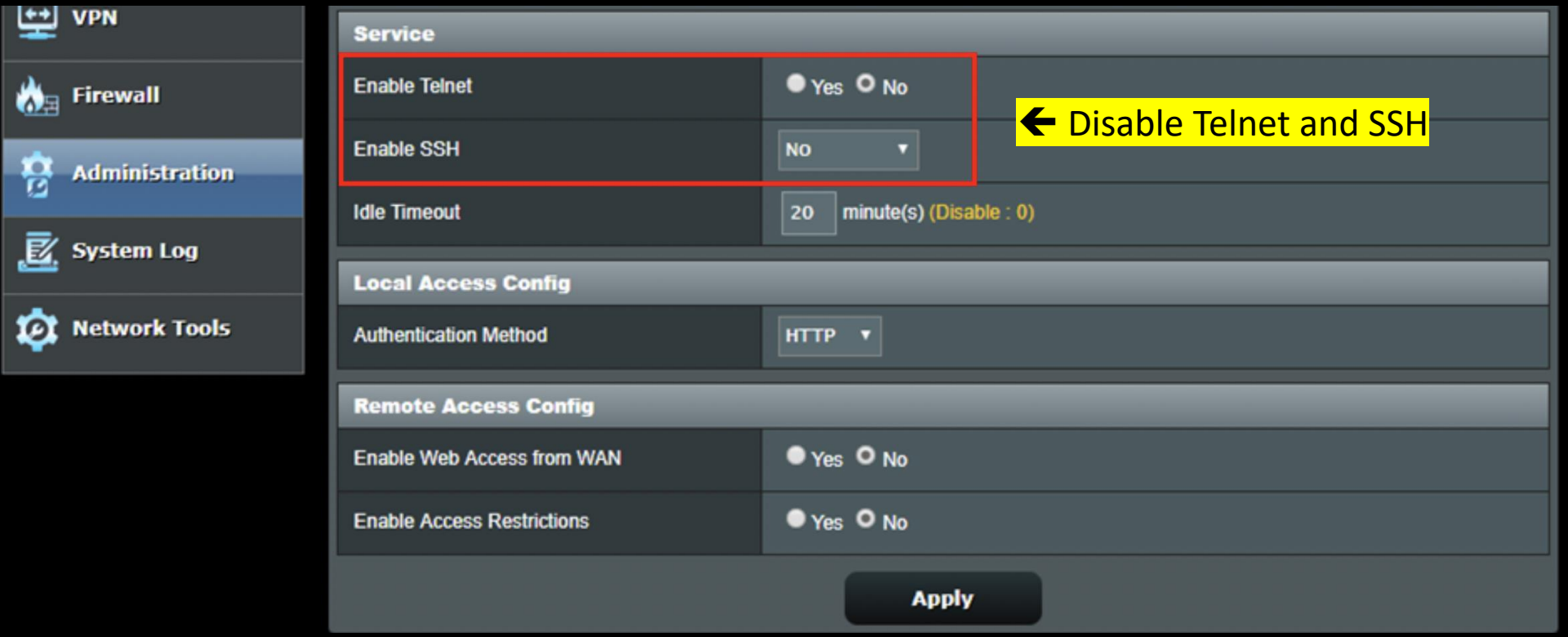
For ASUS RT-AX86U router

Recommendations from ASUS

Where Security Gets Complicated (cont.)



Where Security Gets Complicated (cont.)



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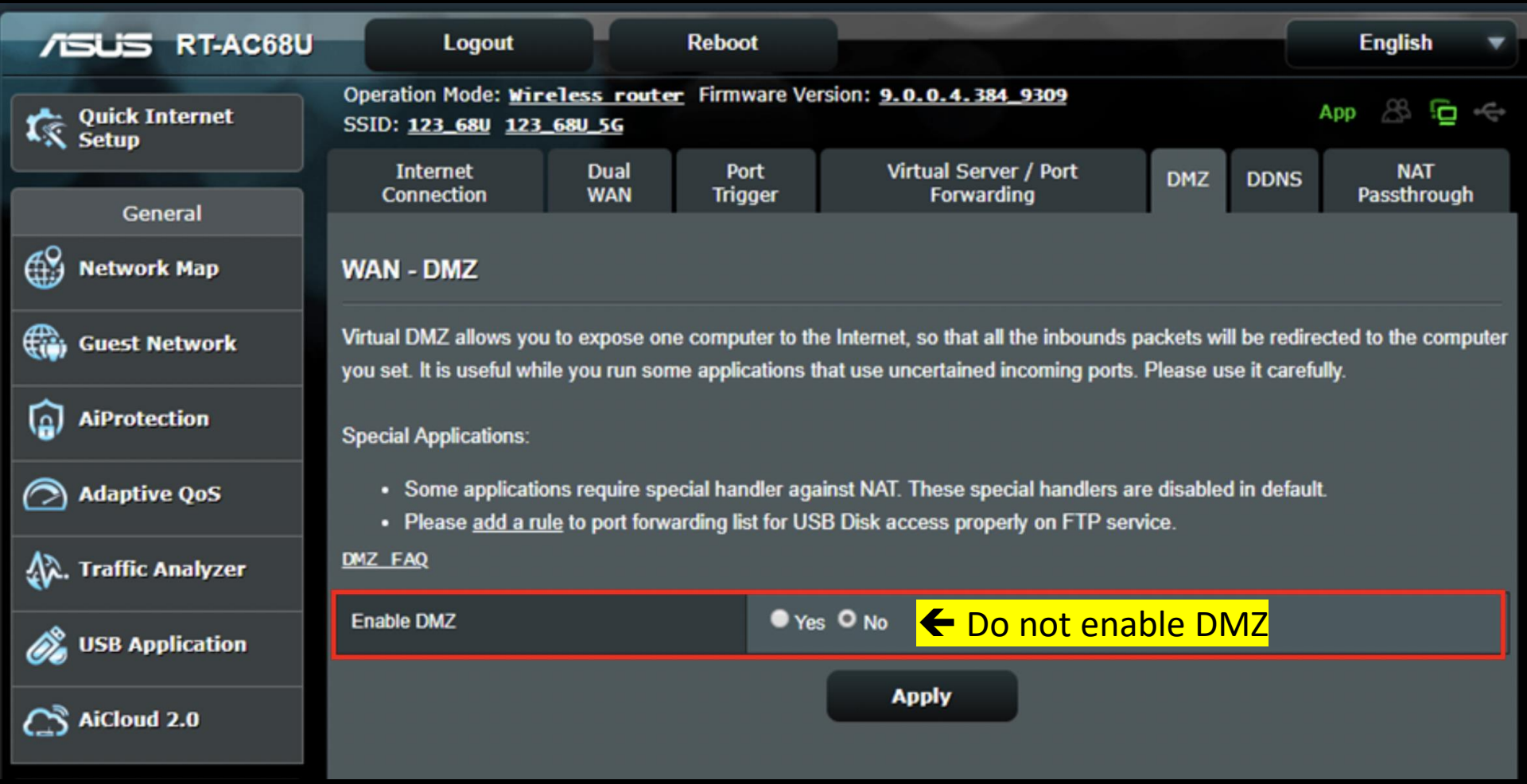

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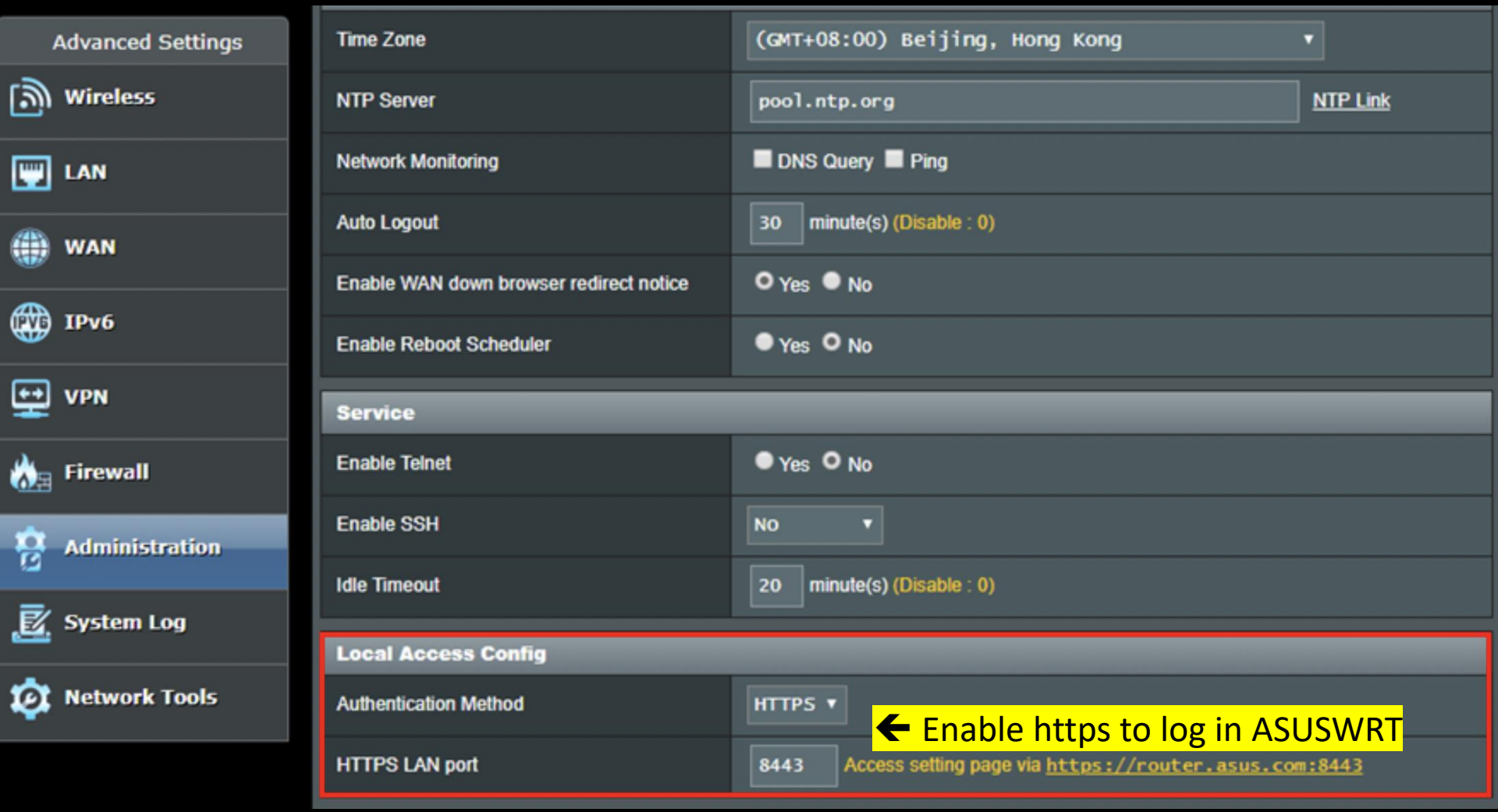
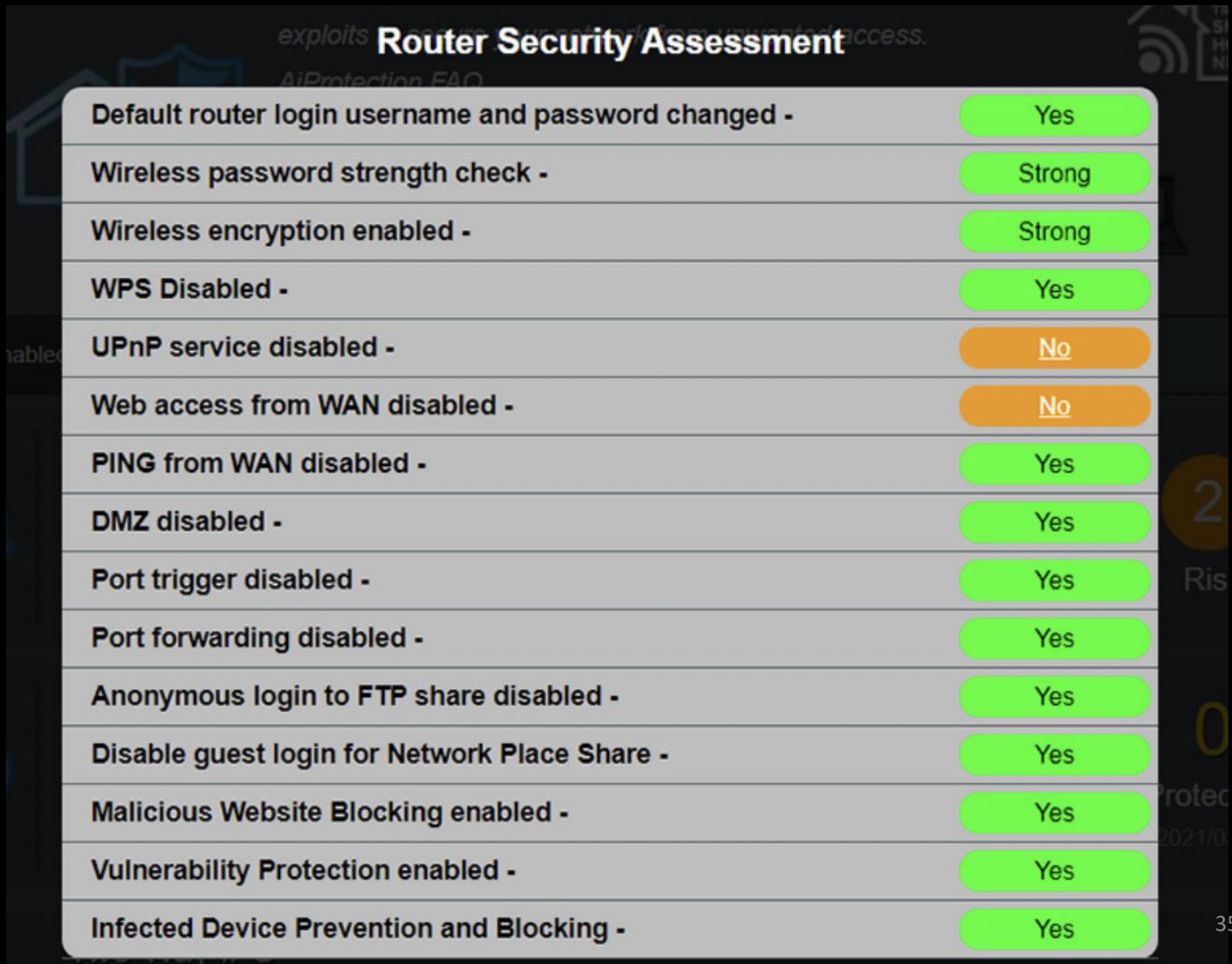


ASUS RT-AX86U—Admin Portal



Thanks for Listening!