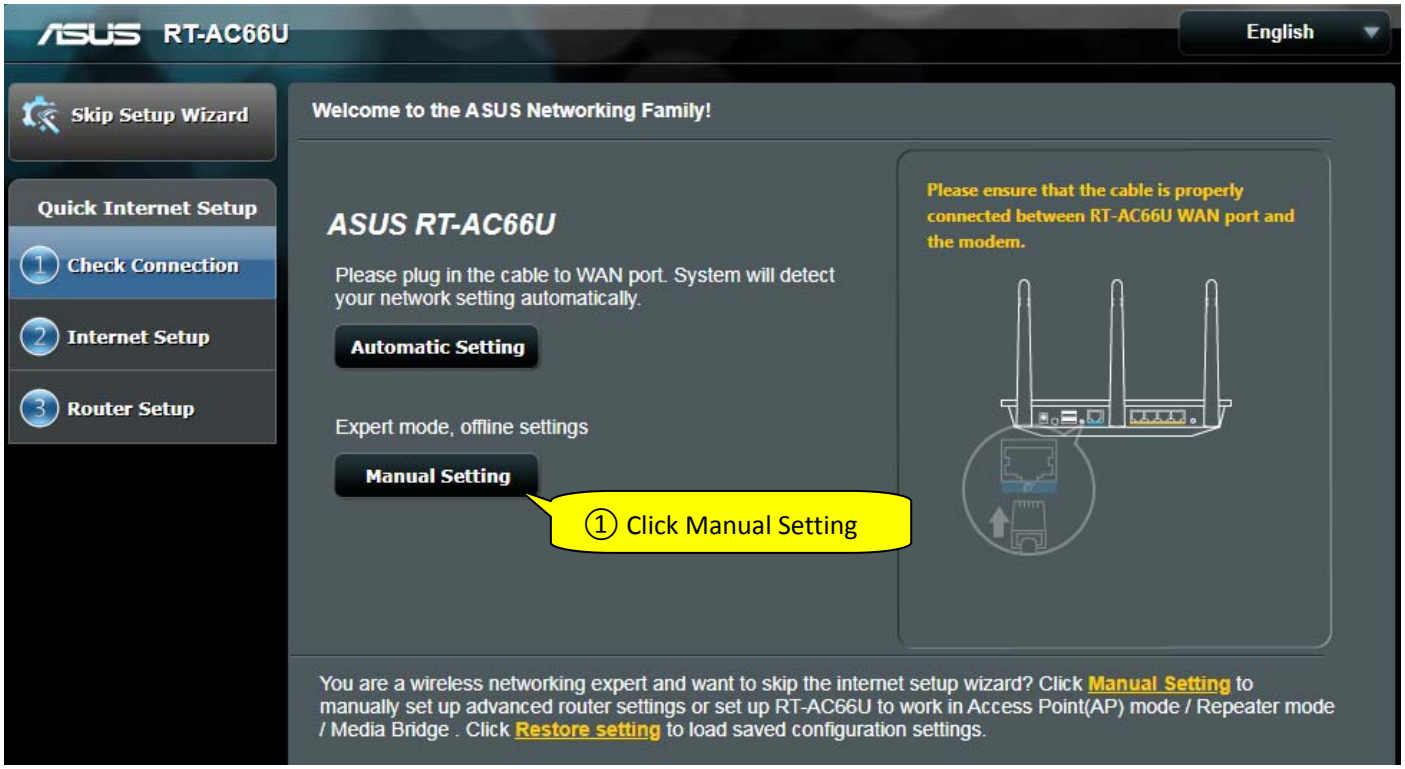
PART 1: Quick setup

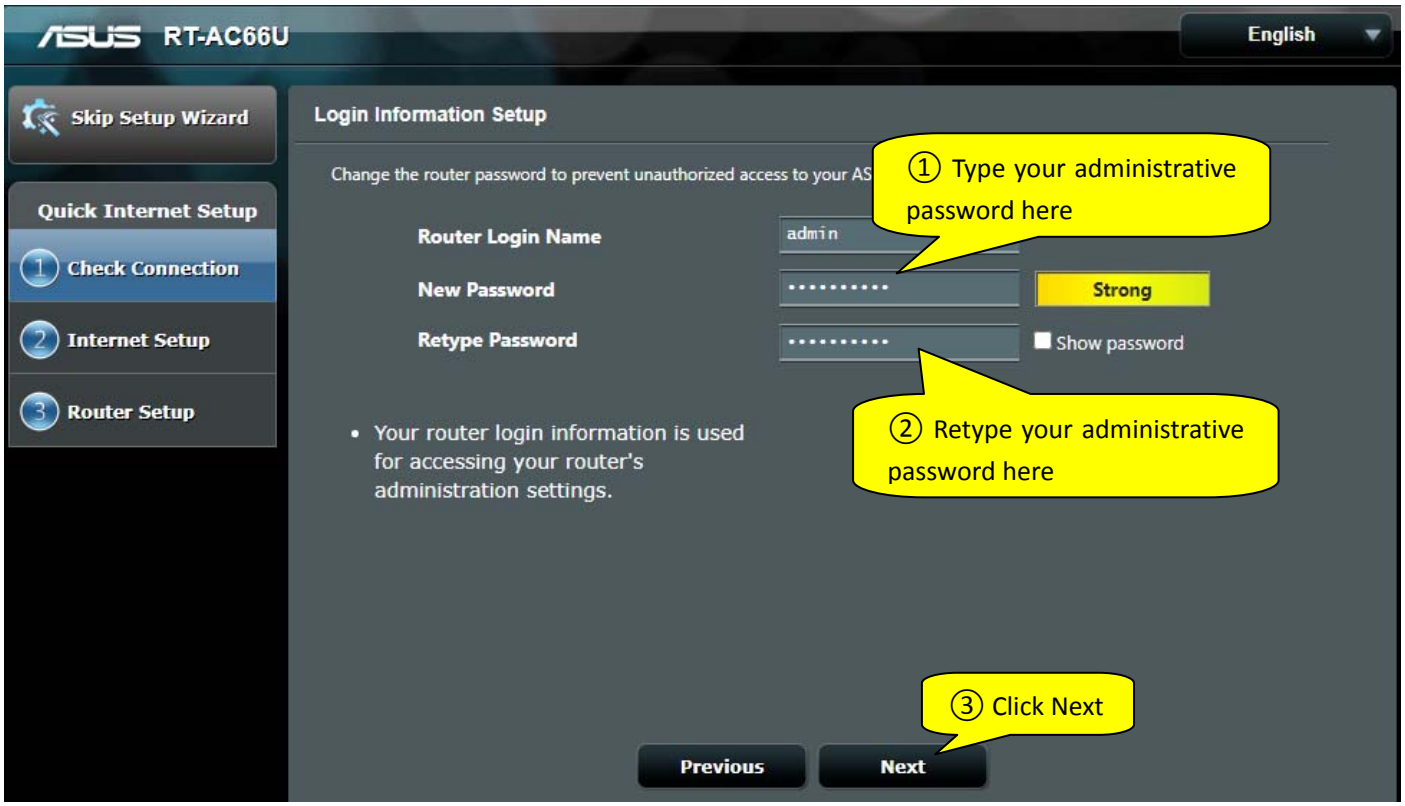
1.1 Connect to RT-AC66U

Plug one end of the network cable into the RJ45 outlet on the wall and the other end into the WAN port of the router.
Plug one end of the power adapter in to the DC-IN port of the router and the other end into the power outlet on the wall.
Press the power button and wait until Wi-Fi LEDs on.
Search Wi-Fi SSID for the name ASUS or ASUS_5G at your laptop computer.
Connect to ASUS or ASUS_5G which is password-free.
Type "http://192.168.50.1/" at your web browser to access the initial web configuration interface.

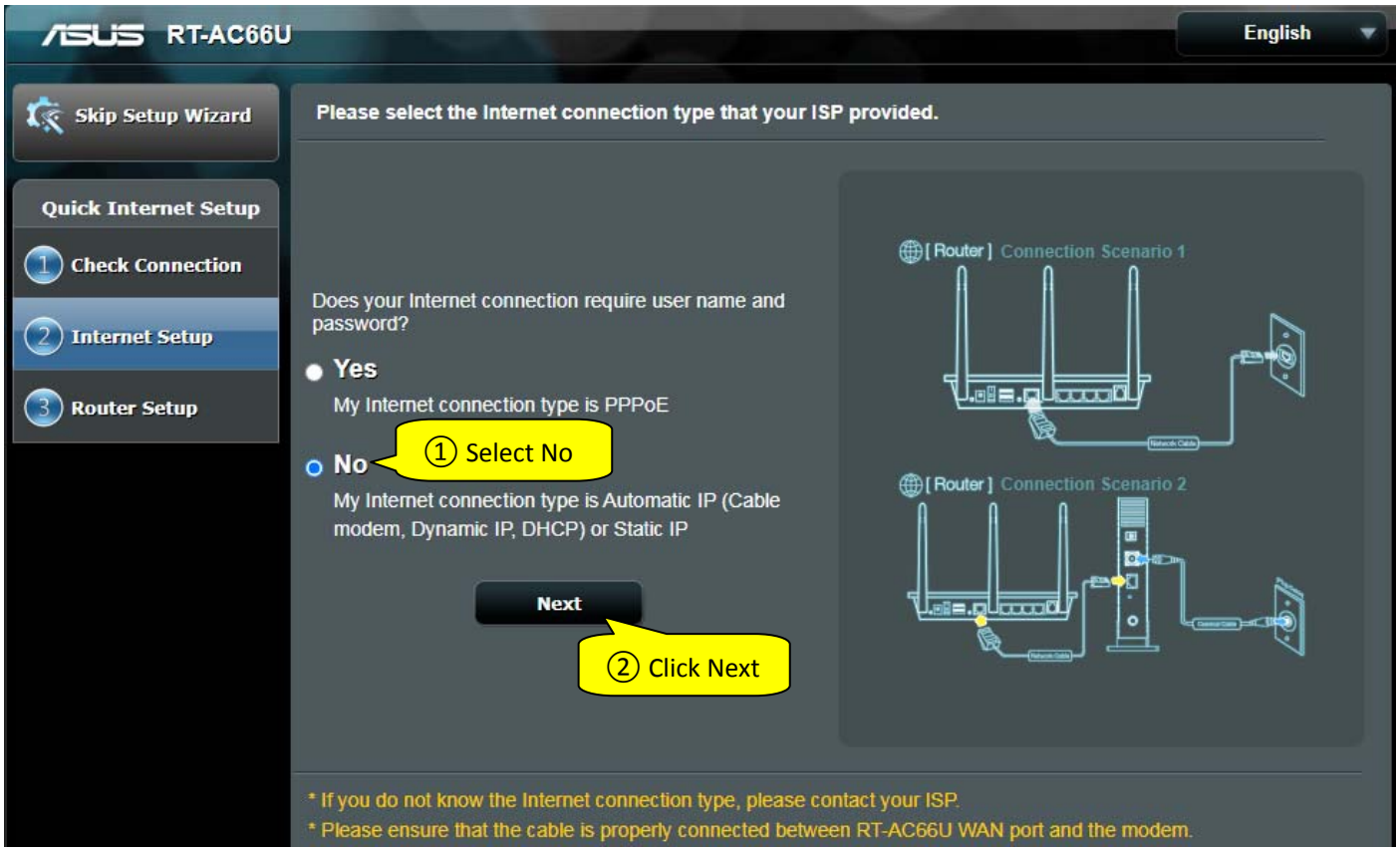
1.2 Change the language to English

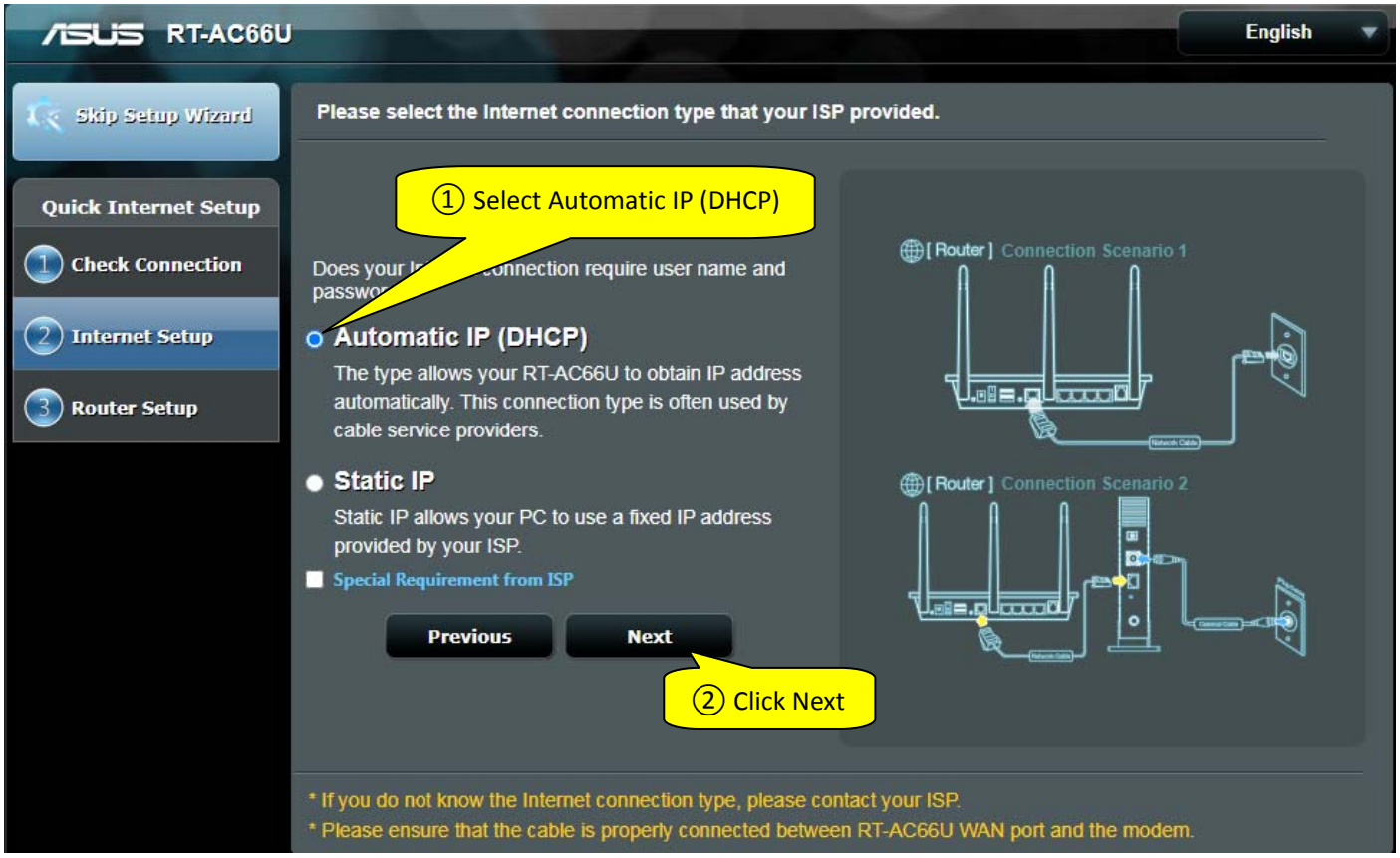
1.3 Complete Quick Internet Setup Wizard

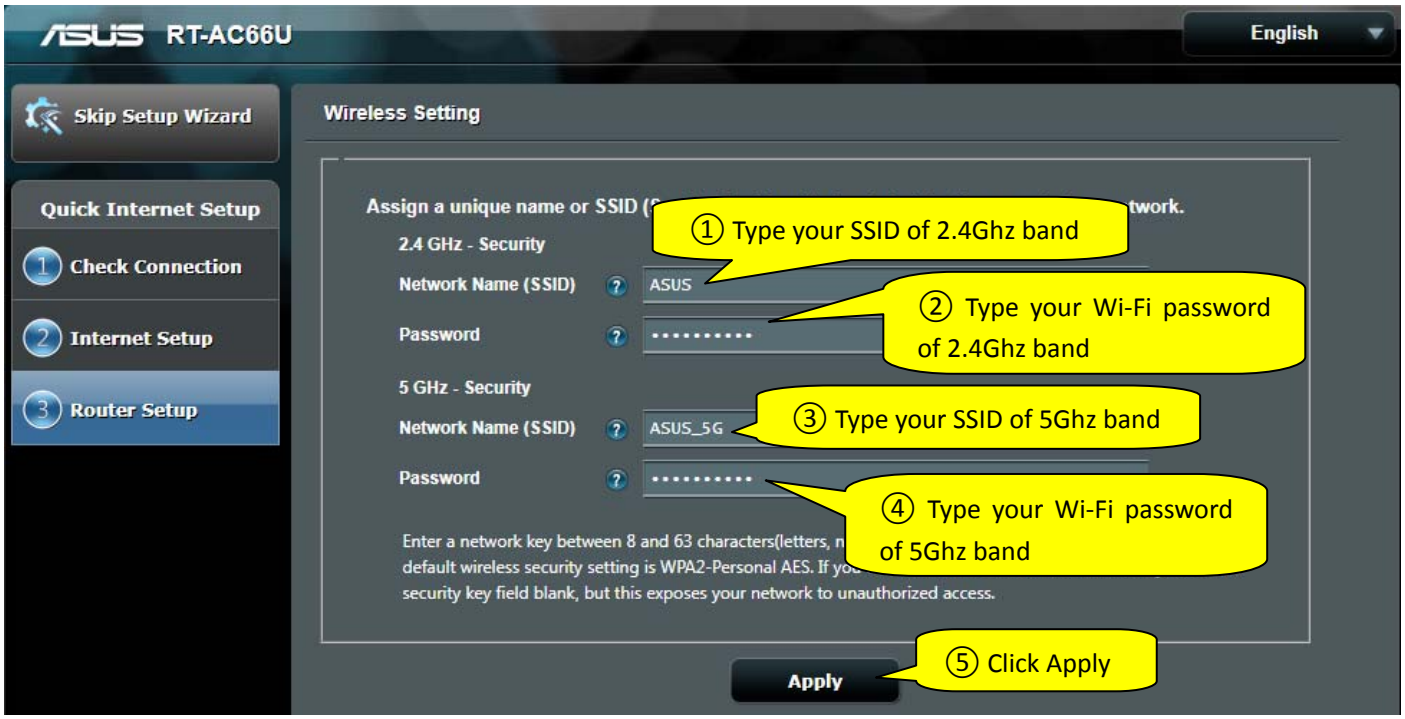

RT-AC66U
English
Skip Setup Wizard
Welcome to the ASUS Networking Family!
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
ASUS RT-AC66U
Please plug in the cable to WAN port. System will detect your network setting automatically.
Automatic Setting
Expert mode, offline settings
Manual Setting
① Click Manual Setting
Please ensure that the cable is properly connected between RT-AC66U WAN port and the modem.
You are a wireless networking expert and want to skip the internet setup wizard? Click Manual Setting to manually set up advanced router settings or set up RT-AC66U to work in Access Point(AP) mode / Repeater mode / Media Bridge . Click Restore setting to load saved configuration settings.

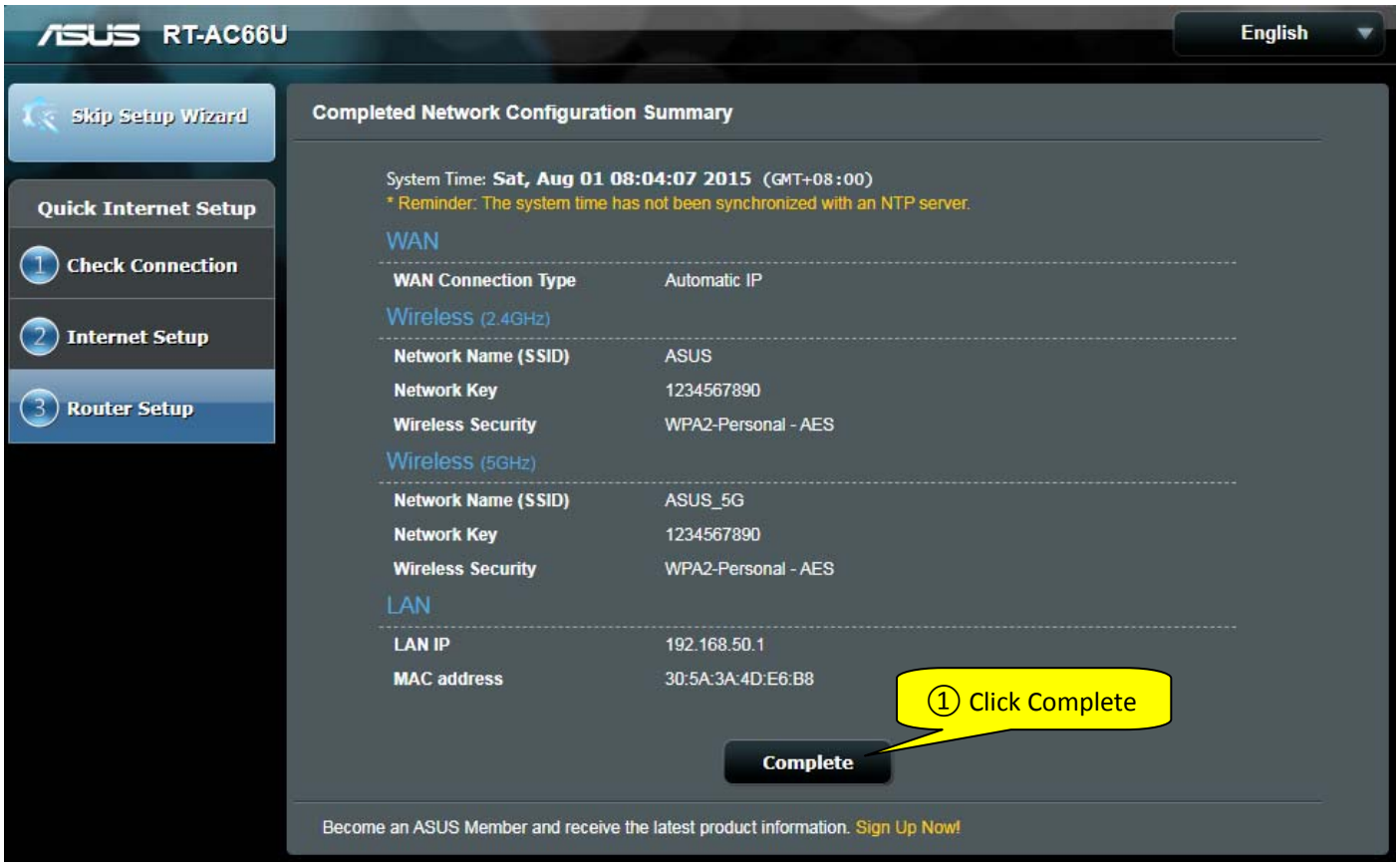

RT-AC66U
English
Skip Setup Wizard
Login Information Setup
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
Change the router password to prevent unauthorized access to your AS
① Type your administrative password here
Router Login Name
admin
New Password
Strong
Retype Password
Show password
② Retype your administrative password here
• Your router login information is used for accessing your router's administration settings.
③ Click Next
Previous
Next


RT-AC66U
English
Skip Setup Wizard
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
① Keep the default selection, i.e. Wireless router mode
different requirements. Please select the mode that
Wireless router mode (Default)
Repeater mode
Access Point(AP) mode
Media Bridge
In wireless router/ IP sharing mode, RT-AC66U connects to the Internet via PPPoE, DHCP, PPTP, L2TP, or Static IP and shares the wireless network to LAN clients or devices. In this mode, NAT, firewall, and DHCP server are enabled by default. UPnP and Dynamic DNS are supported for SOHO and home users. Select this mode if you are a first-time user or you are not currently using any wired/wireless routers.
② Click Next
Previous
Next

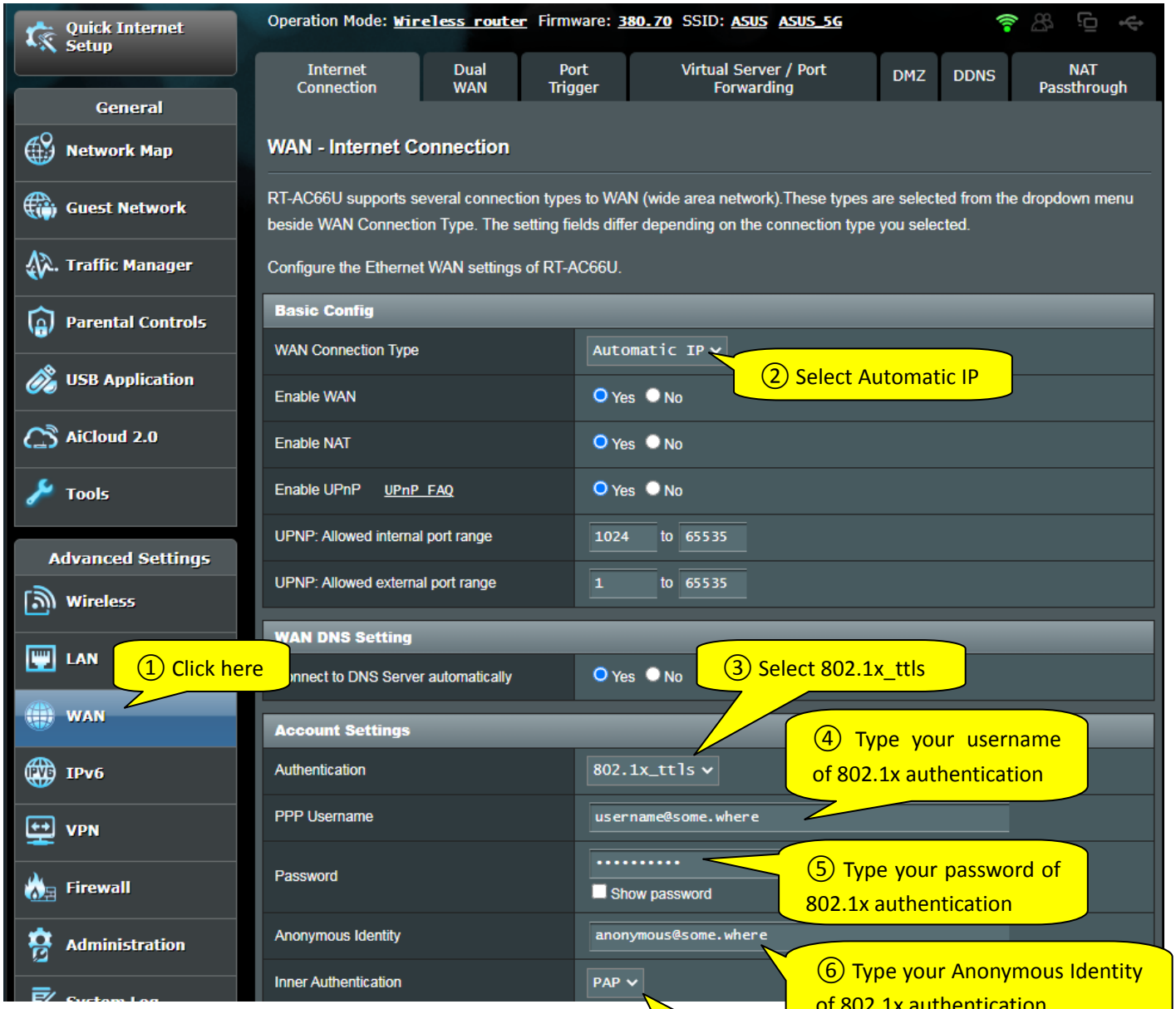

RT-AC66U
English
Skip Setup Wizard
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
Please select the Internet connection type that your ISP provided.
Does your Internet connection require user name and password?
Yes
My Internet connection type is PPPoE
No
My Internet connection type is Automatic IP (Cable modem, Dynamic IP, DHCP) or Static IP
① Select No
Next
② Click Next
[Router] Connection Scenario 1
[Router] Connection Scenario 2
* If you do not know the Internet connection type, please contact your ISP.
* Please ensure that the cable is properly connected between RT-AC66U WAN port and the modem.


RT-AC66U
English
Skip Setup Wizard
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
Please select the Internet connection type that your ISP provided.
① Select Automatic IP (DHCP)
Automatic IP (DHCP)
The type allows your RT-AC66U to obtain IP address automatically. This connection type is often used by cable service providers.
Static IP
Static IP allows your PC to use a fixed IP address provided by your ISP.
Special Requirement from ISP
Previous
Next
② Click Next
[Router] Connection Scenario 1
[Router] Connection Scenario 2
* If you do not know the Internet connection type, please contact your ISP.
* Please ensure that the cable is properly connected between RT-AC66U WAN port and the modem.


RT-AC66U
English
Skip Setup Wizard
Quick Internet Setup
1 Check Connection
2 Internet Setup
3 Router Setup
Wireless Setting
2.4 GHz - Security
Network Name (SSID)
ASUS
① Type your SSID of 2.4Ghz band
Password
② Type your Wi-Fi password of 2.4Ghz band
5 GHz - Security
Network Name (SSID)
ASUS_5G
③ Type your SSID of 5Ghz band
Password
④ Type your Wi-Fi password of 5Ghz band
Apply
⑤ Click Apply



1.4 setup EAP_TTLS/PAP which is the new 802.1x authentication methods added in this modified firmware



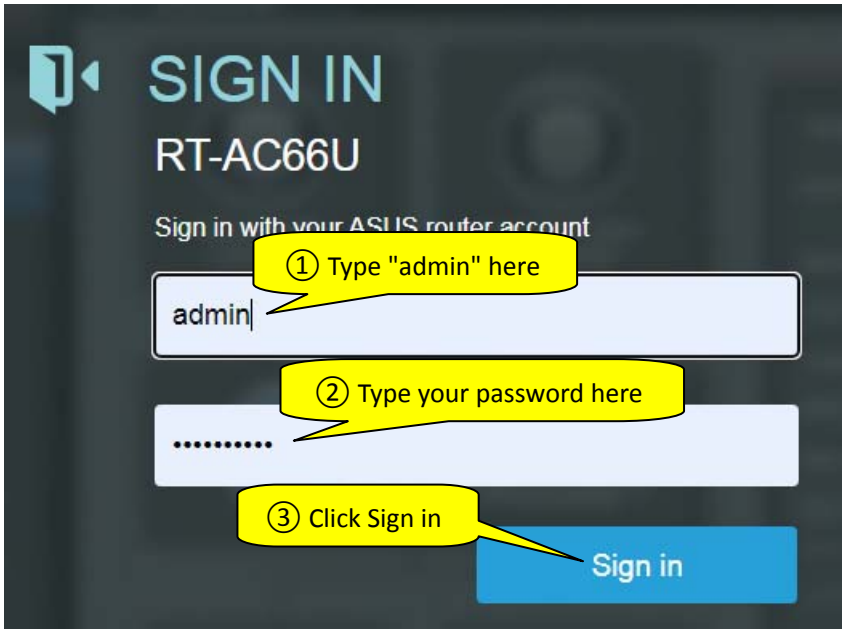
Don't forget to click 'APPLY' button to save your change.

That's all. Now you can check if you can visit Internet at the wireless device connected to this router.

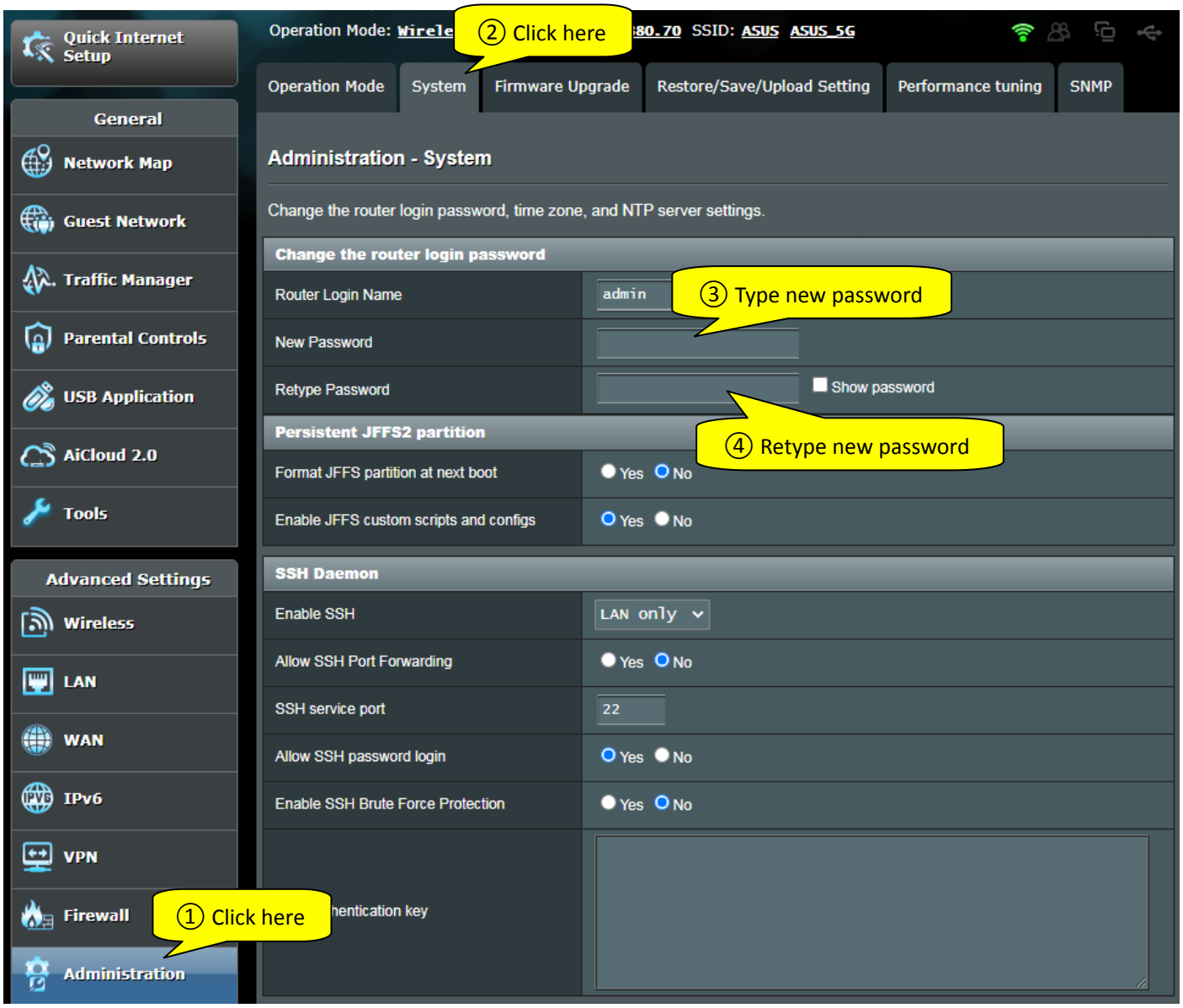
PART 2: Further configuration

2.1 Login to the web management interface of RT-AC66U

Connect your laptop computer to the router via Wi-Fi
Type "http://192.168.50.1/" at your web browser



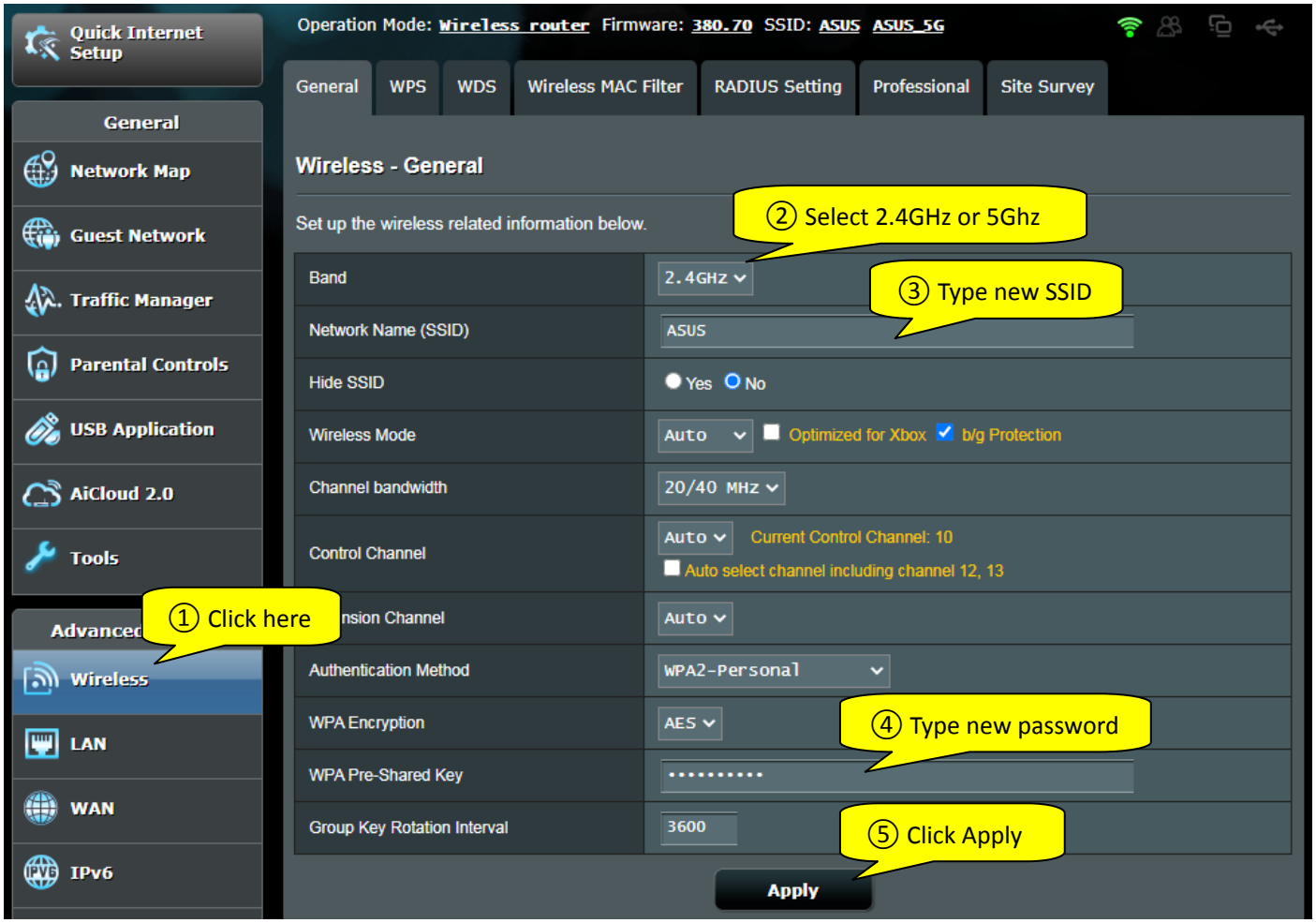
2.2 Modify the administrative password of RT-AC66U



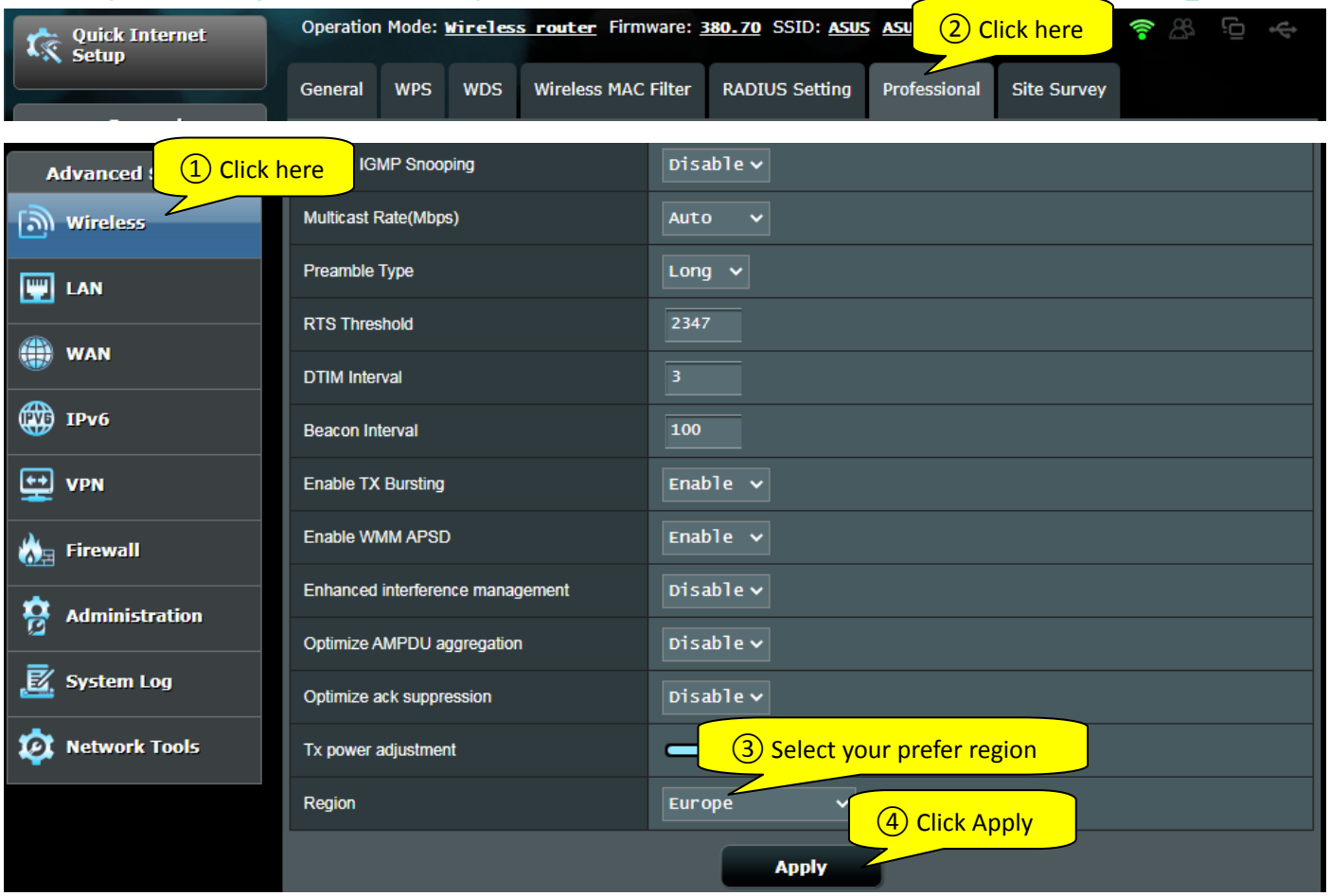
Don't forget to click 'APPLY' button to save your change.

2.3 Modify the Wi-Fi SSID or the Wi-Fi password of RT-AC66U

RT-AC66U has two Wi-Fi band, 2.4Ghz and 5Ghz. Each band has independent SSID and password. You should modify them separately.

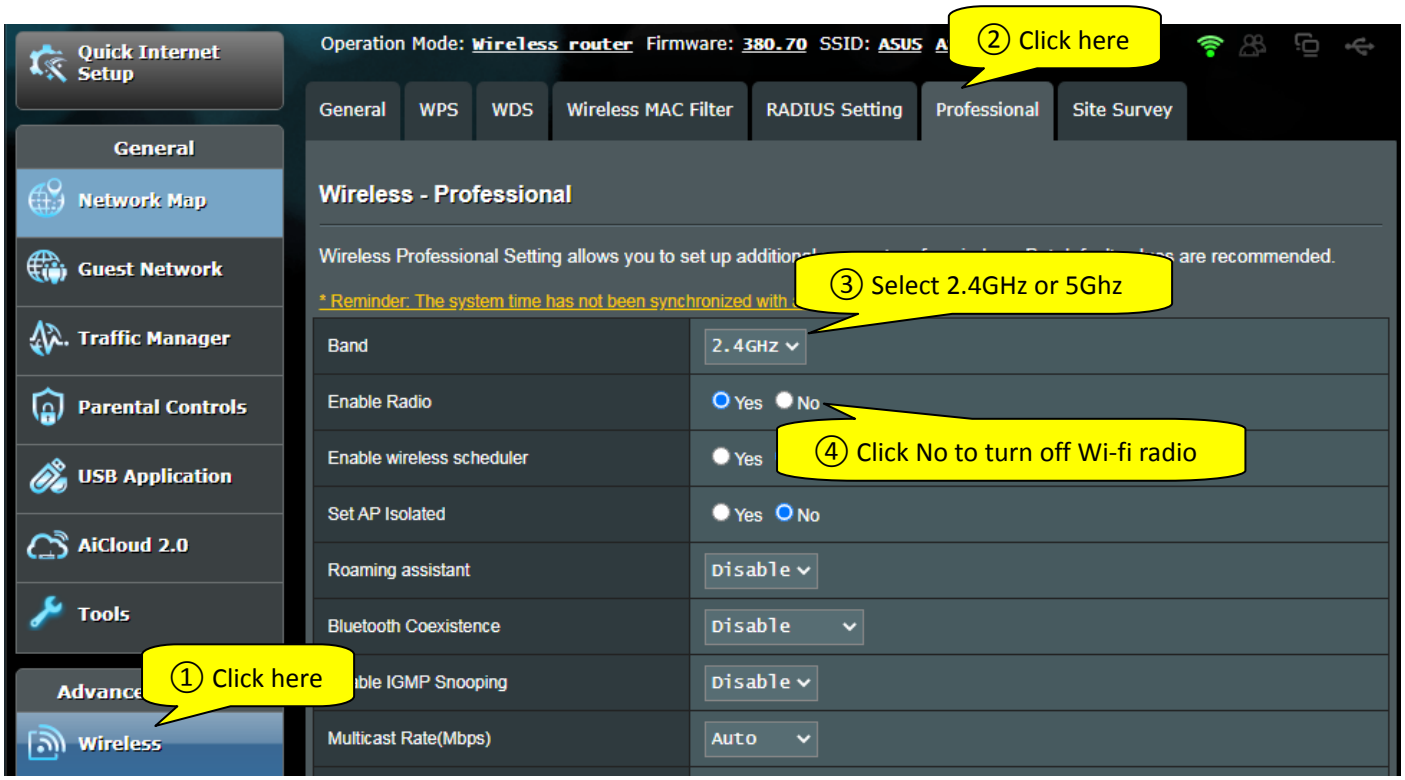


2.4 Modify the Wi-Fi region of RT-AC66U If you wireless device can't find SSID of 5GHz Wi-Fi band, e.g. ASUS_5G



If your wireless device can't connect to the 5Ghz band, e.g. ASUS_5G, one possible reason is your wireless device's Wi-Fi 5GHz channels are locked in certain region. Try to change the Wi-Fi region on the router side. Due to the regulation, only some selected channels are permitted in a given region. So try it one by one to test if the select region works for all your wireless devices . Please read the following link for more details. https://en.wikipedia.org/wiki/List_of_WLAN_channels

2.5 Turn Wi-Fi radio off



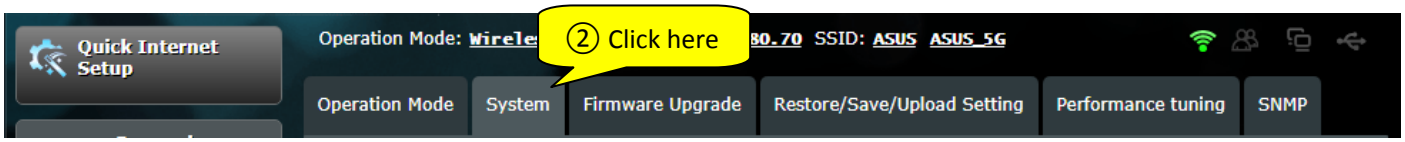
Don't forget to click 'APPLY' button to save your change.

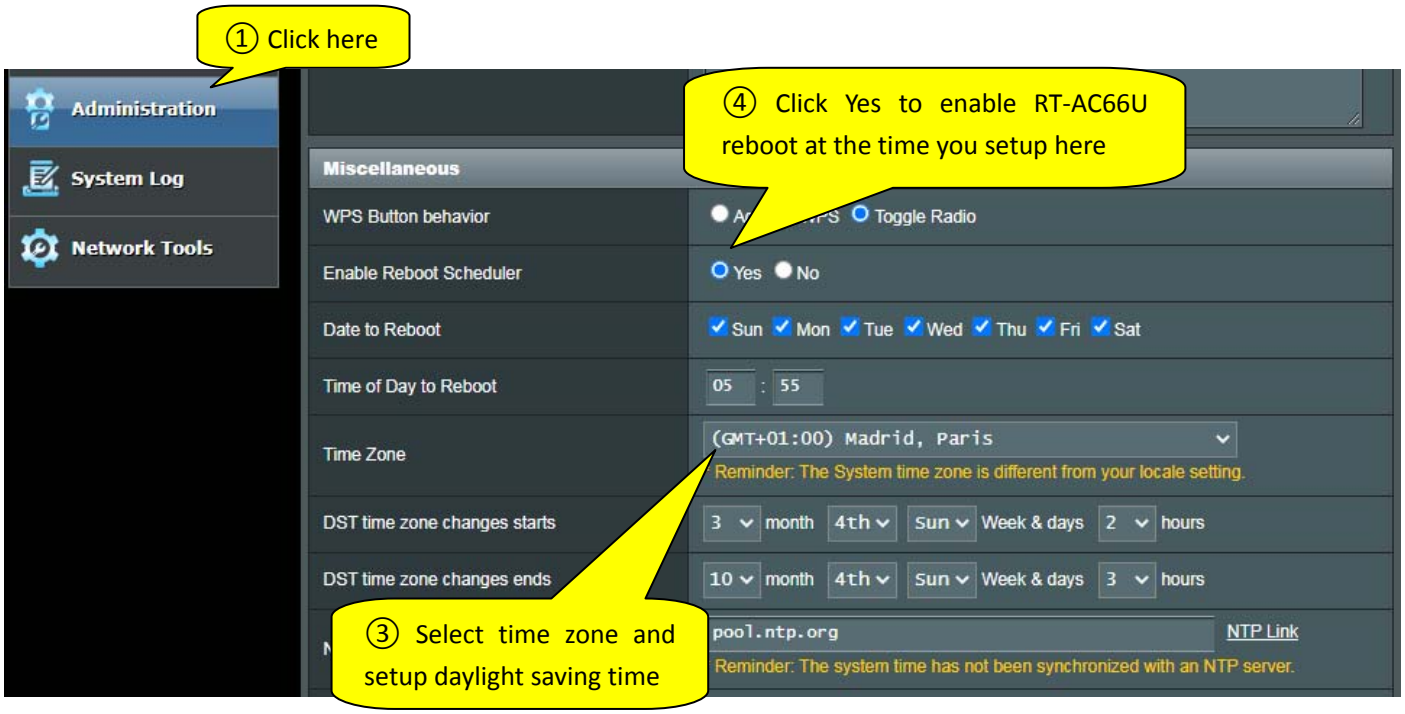
For example, if all your wireless devices support the 5GHz band, you can turn the legacy 2.4GHz band off.

You will notice the Wi-Fi icon should be changed from  to  .

2.6 set the time zone and set a reboot scheduler

You should set the correct time zone according to your region.
Also a daily reboot scheduler will help RT-AC66U run healthily.



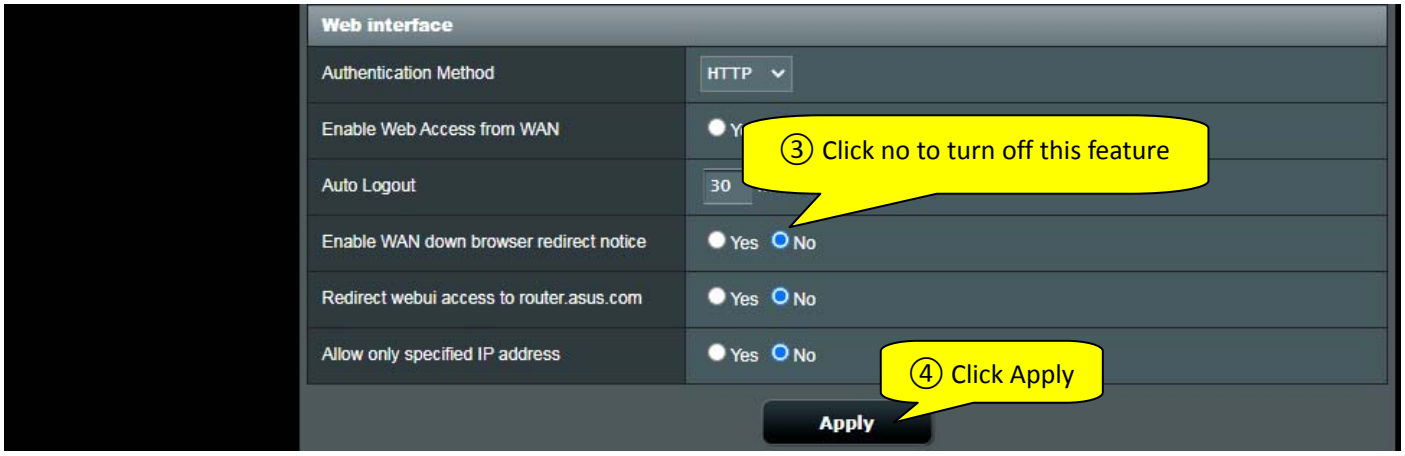


Don't forget to click 'APPLY' button to save your change.

2.7 Fix a weird DNS problem

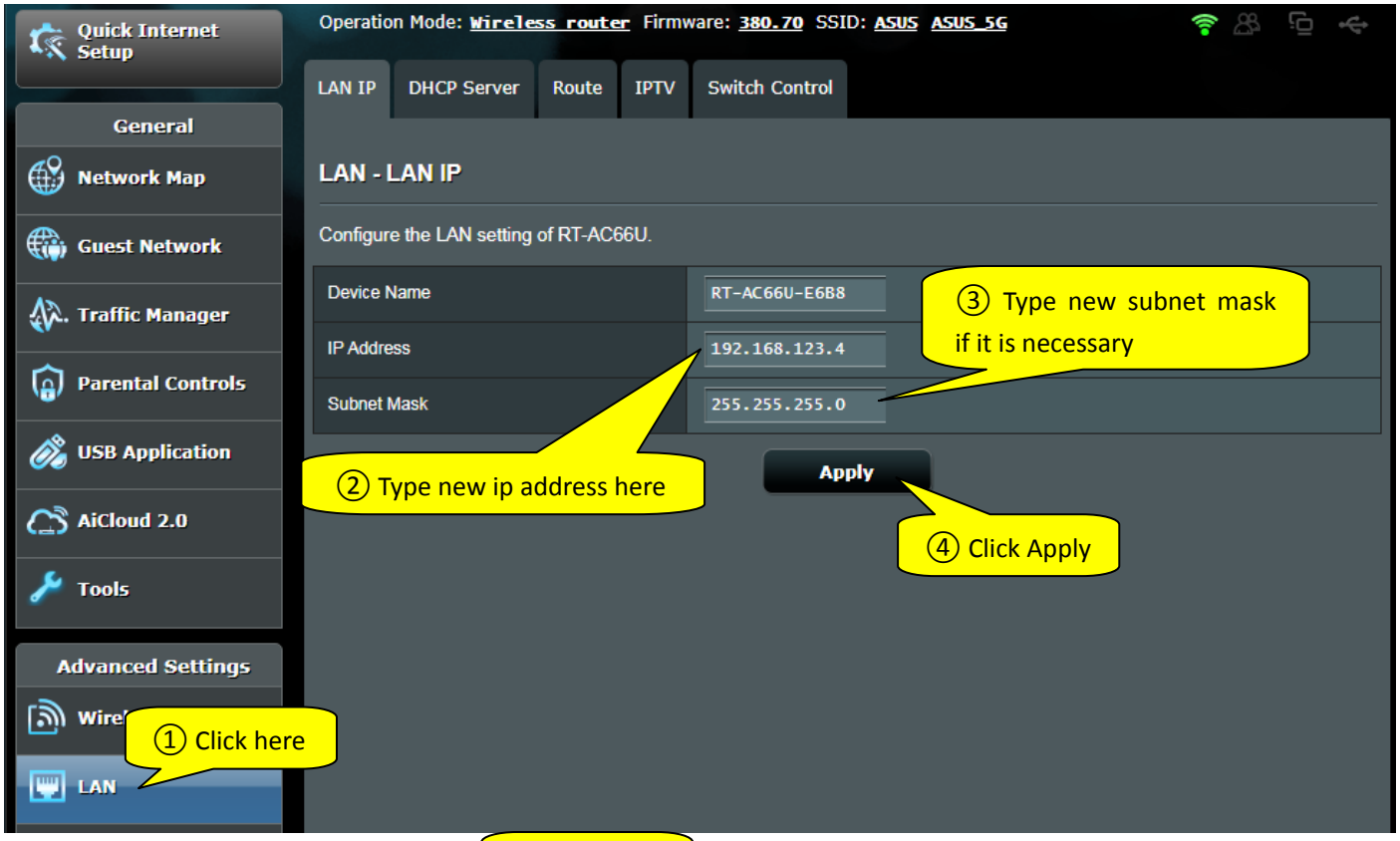
Here is a weird DNS problem that any DNS domain will resolved to 10.0.0.1 if WAN has gone down. You can fix this problem by turning off the feature "Enable WAN down browser redirect notice".

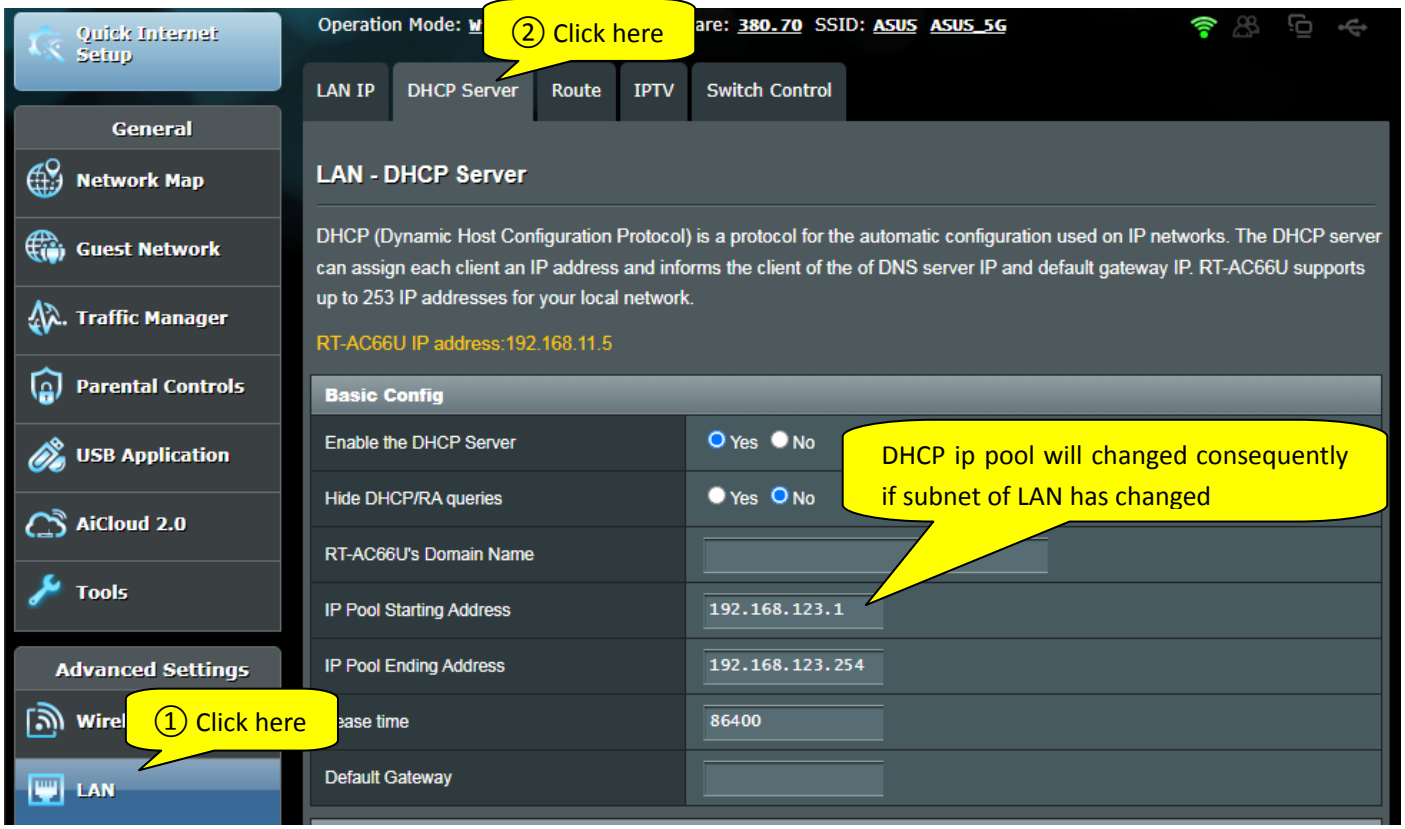
① Please click "Administration" at left menu column and ② then click "System" at the top tabs.



2.8 Change the ip address of RT-AC66U

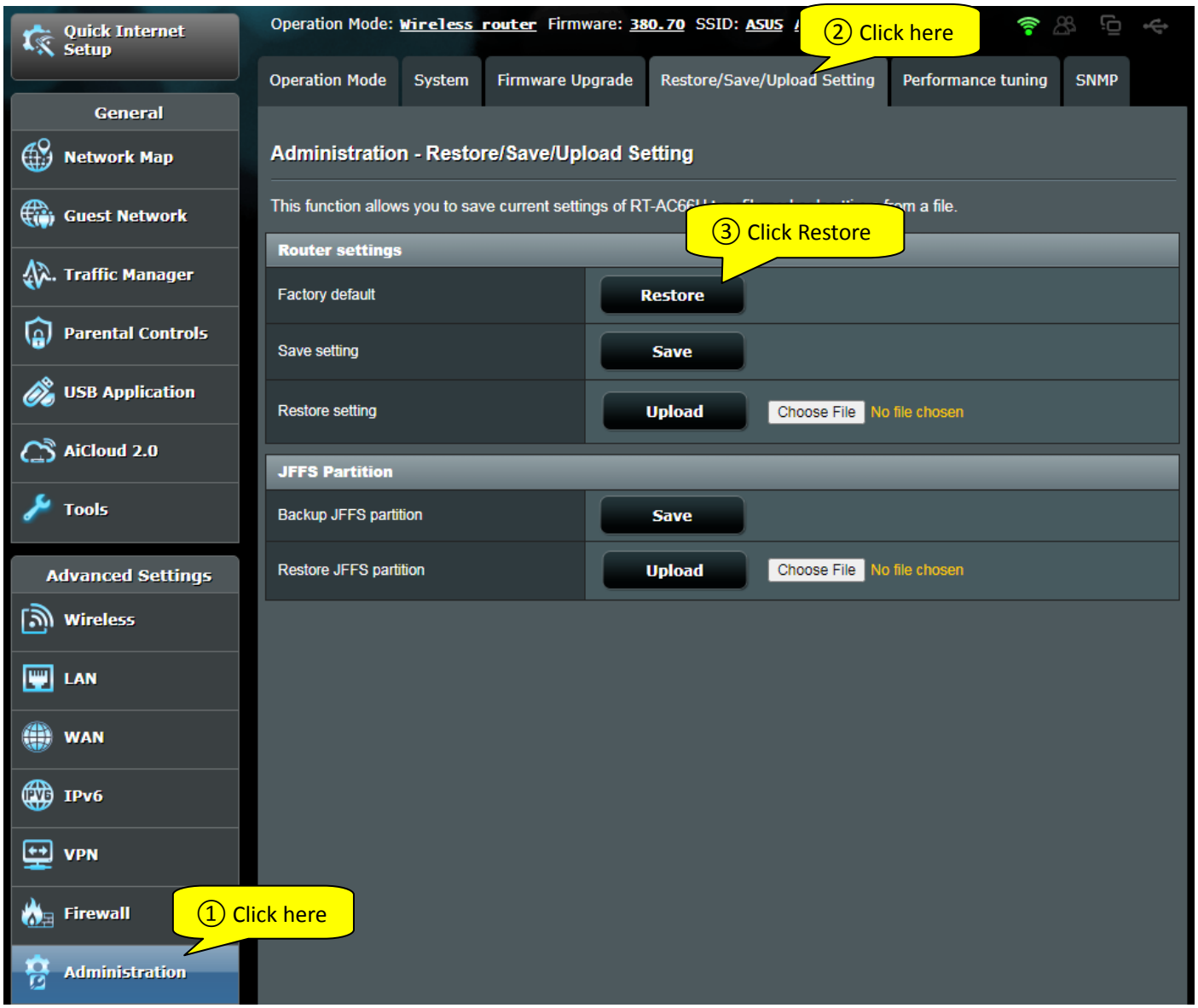
The default ip address of LAN is 192.168.50.1 and its subnet mask is 255.255.255.0. If you change the ip address of LAN and the subnet mask of LAN, it will modify the scope of DHCP ip pool automatically.





Please remember the new ip address of LAN. You will return the web management interface using this new ip address.

2.9 restore all the setting of RT-AC66U to the factory default



2.10 revert the firmware back to the official release version 380.70 of ASUSWRT-MERLIN

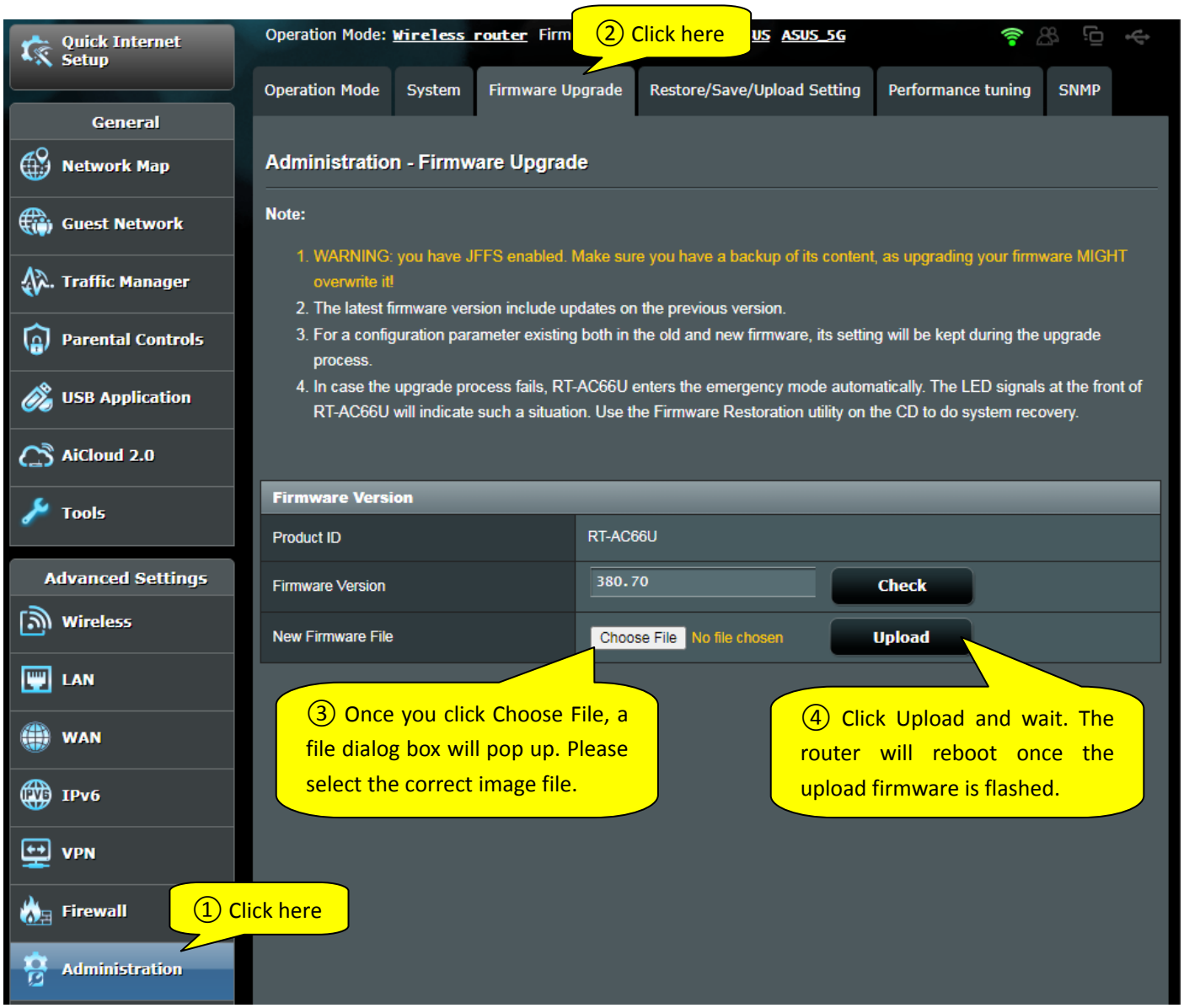
At first you should download the firmware image following the instruction provided by ASUSWRT-MERLIN.
The official ASUSWRT-MERLIN website is here. https://www.asuswrt-merlin.net/
You can download a zip file named RT-AC66U_380.70_0.zip when you click the link below
https://sourceforge.net/projects/asuswrt-merlin/files/RT-AC66U/Release/RT-AC66U_380.70_0.zip/download
The official release image file is RT-AC66U_380.70_0.trx which can be extracted from the zip file RT-AC66U_380.70_0.zip.
Now you could upload the file RT-AC66U_380.70_0.trx to RT-AC66U to overwrite the current firmware .

I have upload both the official release image and the modified image to GitHub. You can download them directly following the links below.
the official release image: https://github.com/ypyd/asuswrt-merlin-ypyd/raw/main/RT-AC66U_380.70_0.trx
the modified image: https://github.com/ypyd/asuswrt-merlin-ypyd/raw/main/RT-AC66U_380.70_0_ttls.trx

Here are the md5 checksums of these two files.
70f3fdf4fa2dd464c0b999fb62c525c4 RT-AC66U_380.70_0.trx
4a469f15f424c4c089195a27abca44c0 RT-AC66U_380.70_0_ttls.trx

Furthermore if you have a old RT-AC66U, either flashed with Asus stock firmware or Asuswrt-Merlin firmware, you can use

the same web interface to upgrade the legacy firmware to the new modified firmware to enjoy the new EAP_TTLS/PAP feature.



If you have a old RT-AC66U which has be flashed with third-party firmware, such as Fresh Tomato WRT or DD-WRT, you can use the rescue mode method to flash the new firmware. Read the following link for the details.
https://www.asus.com/support/FAQ/1000814/

You can download the utility, ASUS Firmware Restoration (version 2.1.0.3), following the link below and selecting "Windows 7 b4 bits".
https://www.asus.com/us/Networking-IoT-Servers/WiFi-Routers/ASUS-WiFi-Routers/RTAC66U/HelpDesk_Download/

2.11 Factory Reset vs. Hard Factory Reset

If you forget the administrative password or the ip address of LAN, or if RT-AC66U doesn't boot correctly, you can perform a Factory Reset / Hard Factory Reset to take the router back to factory default.

Method Factory Reset:
Step 1: Press the POWER button. Wait 1-2 minutes until Wi-Fi LEDs turn on constantly. Now the router boots normally.
Step 2: Use a toothpick to press and hold the RESET button for 3 seconds until your power LED light starts to blink. Now

you can release the RESET button.
Step 3: The router will reboot and clear all the settings. Wait 1-2 minutes until the router boots normally. You will see Wi-Fi LEDs turn on constantly. Now your laptop can connect to the router via Wi-Fi SSID ASUS or ASUS_5G without password. Type "https://192.168.50.1/" in your browser, you can setup the router again from the very beginning.

If it is still fail to connect to the router, try the next method.
Method Hard Factory Reset:
Step 1: Turn off the router
Step 2: Press and hold the WPS button, then Press the POWER button to turn on the router.
Step 3: Don't release the WPS button for 5 to 10 seconds. During this period The router will erase NVRAM partition. If you see the power LED light is flashing, you can release the WPS button.
Step 4: Now the power light stops flashing and the router will automatically reboot. Wait for 2 minutes you can connect to the router again for the initial setup.

Here are the links for more details.
[Wireless Router] How to reset the router to factory default setting?
https://www.asus.com/support/FAQ/1000925/
[Wireless Router] ASUS router Hard Factory Reset - Method 1
https://www.asus.com/support/FAQ/1039077

2.12 Further references

RT-AC66U is a powerful router with lots of functions, such as network printer sharing, port forwarding, firewall, etc. Here I give you some import links for help.

The official home page of RT-AC66U.
https://www.asus.com/us/Networking-IoT-Servers/WiFi-Routers/ASUS-WiFi-Routers/RTAC66U/

The download page of the official manuals
https://www.asus.com/us/Networking-IoT-Servers/WiFi-Routers/ASUS-WiFi-Routers/RTAC66U/HelpDesk_Manual/

The official home page of Asuswrt-Merlin which is an open-source custom firmware written for Asus routers with lots of enhanced features.
https://www.asuswrt-merlin.net/

The official Wiki/documentation for Asuswrt- Merlin
https://github.com/RMerl/asuswrt-merlin.ng/wiki

I created a patch to modify the codes of Asuswrt- Merlin firmware in version 380.70 for RT-AC66U. The patch, the document and firmware images were uploaded to GitHub. Here is the link.
https://github.com/ypyd/asuswrt-merlin-ypyd

Read the link below to understand what is 802.1X and how does it work?
https://www.securew2.com/solutions/802-1x

Wpa_supplicant, which is used in Asus-Merlin, is an open-source implement of 802.1x supplicant. If you want to know how to turn on the requisite authentication methods in compiling the codes, please read the link below.
https://w1.fi/wpa_supplicant/

PART 3: How to build the firmware image from the modified source codes

3.1 Prepare a host to build the firmware image

The operating system I used to build the firmware image is Ubuntu 20.04 LTS. You can install the OS either on a real PC or on a virtual machine. The easiest way to set up a virtual machine for building the firmware is by using Canonical's Multipass which can runs on Linux, MacOS and Windows,. Read the link below for the installation.
https://github.com/RMerl/asuswrt-merlin.ng/wiki/Setting-up-Build-VM-under-Multipass
https://multipass.run/docs/how-to-guides

Here are the commands to create a VM instance and enter the shell of the VM instance.

```
multipass launch --name merlin --cpus 2 --disk 32G --mem 2G 20.04
multipass shell merlin
```

3.2 Install the required packages

Next you should install the necessary packages required while building the firmware image.

```
sudo dpkg --add-architecture i386
sudo apt update
sudo apt upgrade
sudo apt-get install libtool-bin cmake libproxy-dev uuid-dev liblzo2-dev autoconf automake bash bison \
bzip2 diffutils file flex m4 g++ gawk groff-base libncurses-dev libtool libslang2 make patch perl pkg-config shtool \
subversion tar texinfo zlib1g zlib1g-dev git-core gettext libexpat1-dev libssl-dev cvs gperf unzip \
python libxml-parser-perl gcc-multilib gconf-editor libxml2-dev g++-multilib gitk libncurses5 mtd-utils \
libncurses5-dev libvorbis-dev git autopoint autogen sed build-essential intltool libelf1:i386 libglib2.0-dev \
xutils-dev lib32z1-dev lib32stdc++6 xsltproc gtk-doc-tools
sudo apt-get install lib32z1-dev lib32stdc++6
```

3.3 Download the source code of Asuswrt-Merlin

```
cd ~
git clone -c advice.detachedHead=false --branch 380.70 --depth=1 --single-branch https://github.com/RMerl/asuswrt-merlin
```

3.4 Prepare the build enviroment

```
sudo ln -s ~/asuswrt-merlin/tools/brcm /opt/brcm
sudo ln -s ~/asuswrt-merlin/release/src-rt-6.x.4708/toolchains/hndtools-arm-linux-2.6.36-uclibc-4.5.3 /opt/brcm-arm
```

```
export PATH=$PATH:/opt/brcm/hndtools-mipsel-linux/bin:/opt/brcm/hndtools-mipsel-uclibc/bin:/opt/brcm-arm/bin
```

```
sudo mkdir -p /media/ASUSWRT/
sudo ln -s ~/asuswrt-merlin /media/ASUSWRT/asuswrt-merlin
```

3.5 fix the codes to avoid some problems which will occur during the building process on Ubuntu 20.04.4 LTS

```
cp /usr/include/proxy.h ~/asuswrt-merlin/release/src/router/neon/
```

```
cd ~/asuswrt-merlin/release/src/router/libdaemon
aclocal
```

```
cd ~/asuswrt-merlin/release/src/router/libxml2
sed -i s/AM_C_PROTOTYPES/#AM_C_PROTOTYPES/g ~/asuswrt-merlin/release/src/router/libxml2/configure.in
aclocal
```

```
cd ~/asuswrt-merlin/release/src/router/libvorbis
aclocal
```

```
cd ~/asuswrt-merlin/release/src/router/libogg
aclocal
automake
```

```
cd ~/asuswrt-merlin/release/src/router/wget
aclocal
automake
```

```
cd ~/asuswrt-merlin/release/src/router/tor
aclocal
automake
```

```
sed -i '/#include <sys\/stat.h>/a#include <sys\/sysmacros.h>'
~/asuswrt-merlin/release/src-rt/linux/linux-2.6/scripts/squashfs/mksquashfs.c
```

3.6 apply the patch to support EAP_TTLS/PAP in the legacy asuswrt-merlin

I have made a patch to modify the source codes in order to support the EAP_TTLS/PAP method. Five files will be modified.

```
cd ~/asuswrt-merlin
curl -sLf https://github.com/ypyd/asuswrt-merlin-ypyd/raw/main/rt-ac66u_380.70_ttls.patch | patch -p0
```

3.7 build the image

```
cd ~/asuswrt-merlin/release/src-rt-6.x
make clean
make rt-ac66u
```

3.8 all-in-one script

I have integrated the above steps into an all-in-one script. You can run the following command directly after Ubuntu is installed

```
sh <(curl -sLf https://github.com/ypyd/asuswrt-merlin-ypyd/raw/main/rt-ac66u_380.70_ttls_build_image.sh)
```

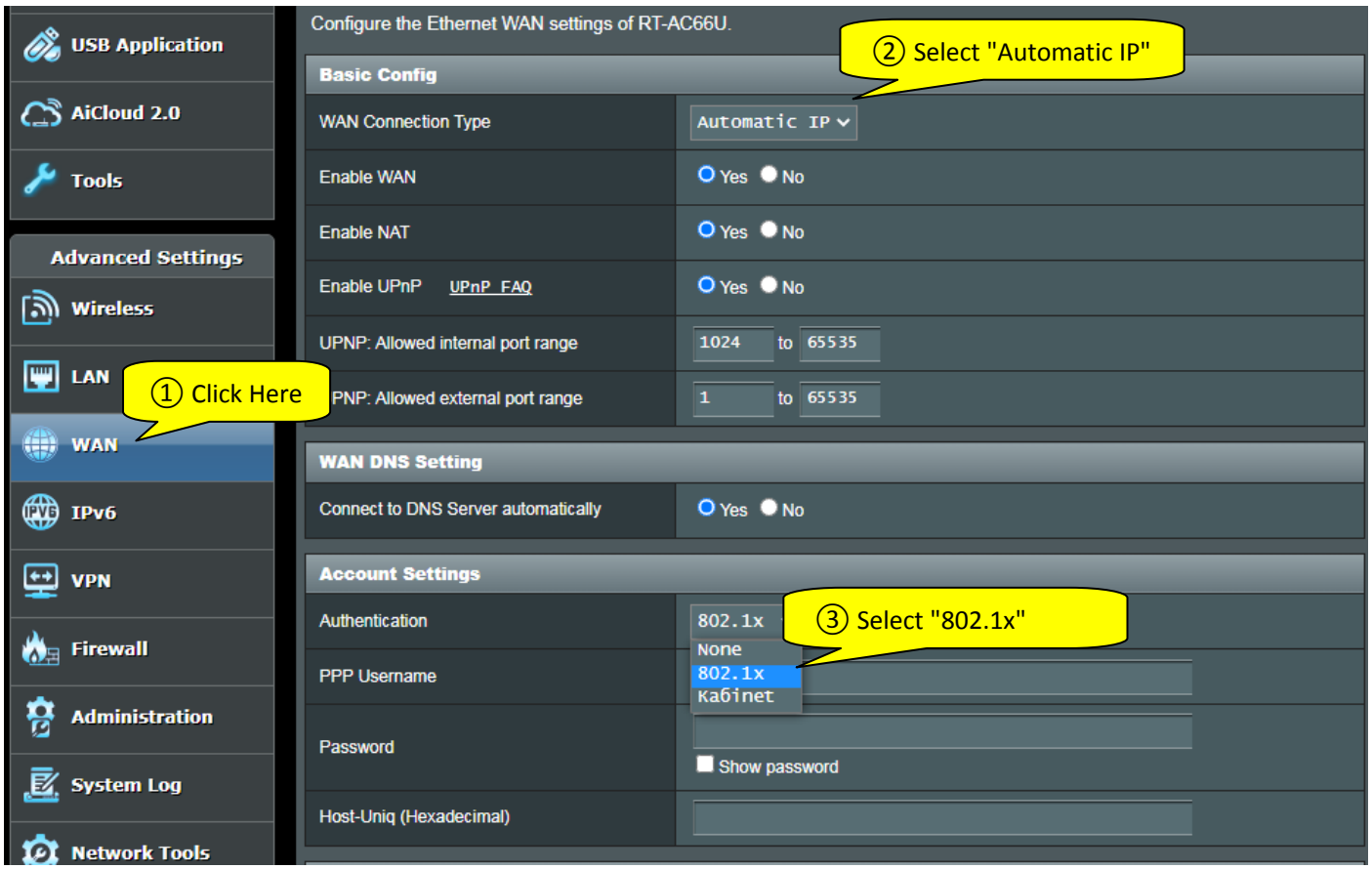
3.9 Further readings

https://github.com/RMerl/asuswrt-merlin.ng/wiki/OBSOLETE-Compile-Firmware-from-source-using-Ubuntu

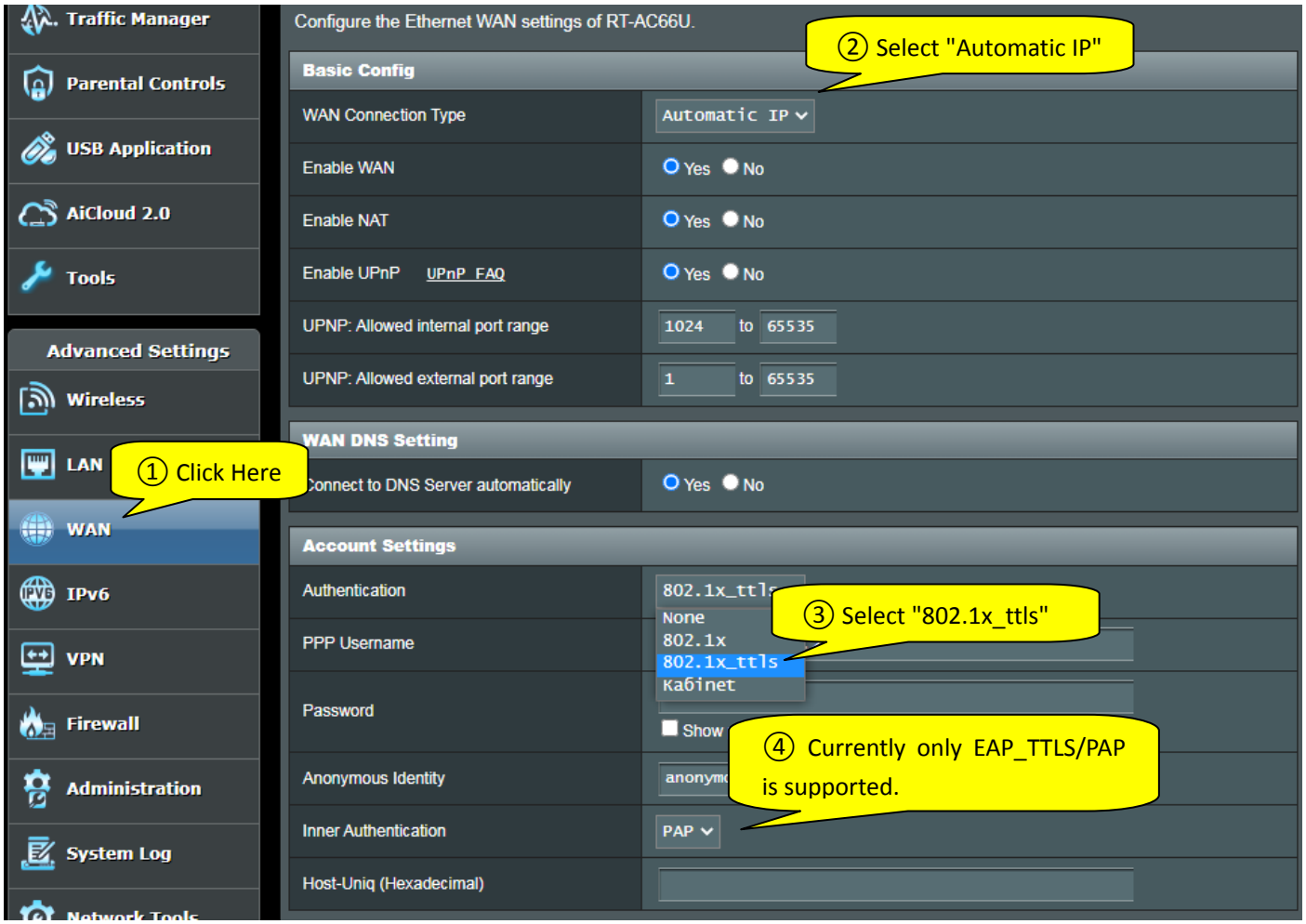
PART 4: How to modify the source codes of asuswrt-merlin to support EAP-TTLS/PAP

4.1 What have been changed in the firmware

The last version of the legacy Asuswrt-Merlin which supports the ASUS RT-AC66U is 380.70. The developers have moved the codes to asuswrt-merlin.ng which never supports ASUS RT-AC66U again. The version 380.70 supports EAP-MD5 as the only method of IEEE 802.1x authentication. We can find the setting interface at the web management of RT-AC66U. It looks like this.



Fortunately the WPA implement in the version 380.70, i.e. /usr/sbin/wpa_supplicant, supports EAP-TTLS/PAP which is a popular IEEE 802.1x authentication method used by eduroam in many universities. We can modify some files of asuswrt-merlin to add the support of EAP-TTLS/PAP. The modified setting interface looks like this.



We can read the following link to understand the different IEEE 802.1x authentication methods.
https://support.brother.com/g/s/id/htmldoc/mfc/cv_mfc4335dw/use/html/GUID-671FA87D-2269-46C5-9C98-BECAA50C7C5E_289.html

4.2 the modification of the web interface

The web page we saw in the above picture was rendered by /usr/sbin/httpd with the template file Advanced_WAN_Content.asp.

Firstly we should modify the source file ./release/src/router/www/Advanced_WAN_Content.asp
- to add the option "8021x-ttls" under entry "Authentication",
- to add two new entries, i.e. "Anonymous Identity" and "Inner Authentication",
- to show these two new entries if we select "8021x-ttls" and hide them otherwise,
- to show the stored value of "Anonymous Identity" while the web page is rendering with option "8021x-ttls".

Asuswrt-merlin supports multiple languages. The strings of different languages are stored in dict files. Next we should modify the source file ./release/src/router/www/EN.dict
- to add some new strings as we will saw them in the web page .

When we move mouse point over the lable "Anonymous Identity" or "Inner Authentication" and click the left button of the mouse, a hint window will pop up. We should modify the source file ./release/src/router/www/help_content.js to register these two new hints.

4.3 understanding the mechanism of web interaction

Step 1: Once we filled the entries of the web page "Advanced_WAN_Content.asp" and click the button "Apply", the browser will encode all the data of these entries and post to the httpd server of RT-AC66U.

Step 2: Once the httpd program of RT-AC66U, i.e. /usr/sbin/httpd, receives this post information, it will decode it. Based on the decoded information, httpd will render the template file ./release/src/router/www/start_apply.htm and send this rendering result back to the browser.

Step 3: Now we will see the browser showing "Applying Settings ...". Once the browser read all the bounced back rendering result of start_apply.htm, It will post new data to httpd server based on the received data.

Step 4: Again httpd received this new post information and decode it. Again based on the decoded information, httpd will determine which template file will be rendered and send the result back to the browser. As we will see on the browser, httpd renders Advanced_WAN_Content.asp again with the filled information we typed before.

After these four steps, the information we typed or selected on the web interface takes into effect.

OK. Let's take look at step two and read the source file ./release/src/router/www/start_apply.htm. We find update_variables() and notify_services() will be called while httpd is rendering start_apply.htm.

Once httpd calls update_variables(), it will compare the entry values of html forms with the values of the persistent variables stored in NVRAM. if the values of the same variable name are not the same, update_variables() will update the new value into NVRAM. In brief, update_variables() save what we filled on the web interface into the storage of RT-AC66U.

These persistent variables are declared in the file ./release/src/router/shared/defaults.c. We should add two new variables, i.e. "wan_8021x_anonymous" and "wan_8021x_innerauth", in this source file.

4.4 the modification of the background works

Similar to update_variables(), notify_services() will execute /sbin/rc to take the new configuration of WAN into effect. We should modify the source file ./release/src/router/rc/auth.c to add support of EAP_TTLS/PAP.

That's all. Please read those modified source files for details. Now we can build the new image from the modified codes and test the new image once it is upload and is flashed into RT-AC66U.

All the modifications are based on the codes of version 380.70 and the modified firmware works well in the test of RT-AC66U only.