2STON™ SPN Box

based on Turris Omnia

: Let's make the SPNBox-AP(a.k.a SPNBox-1000) !

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2IP R & D Center

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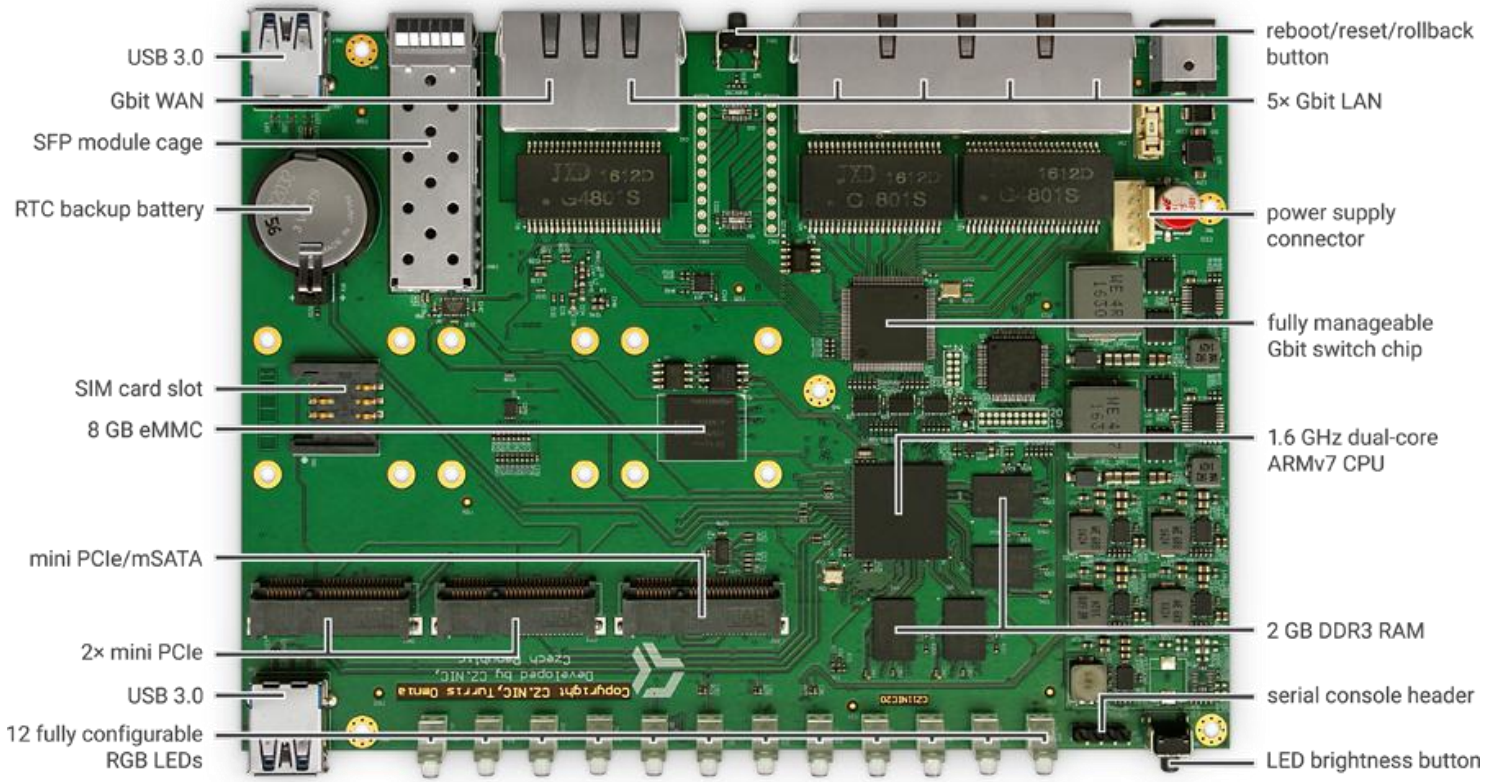
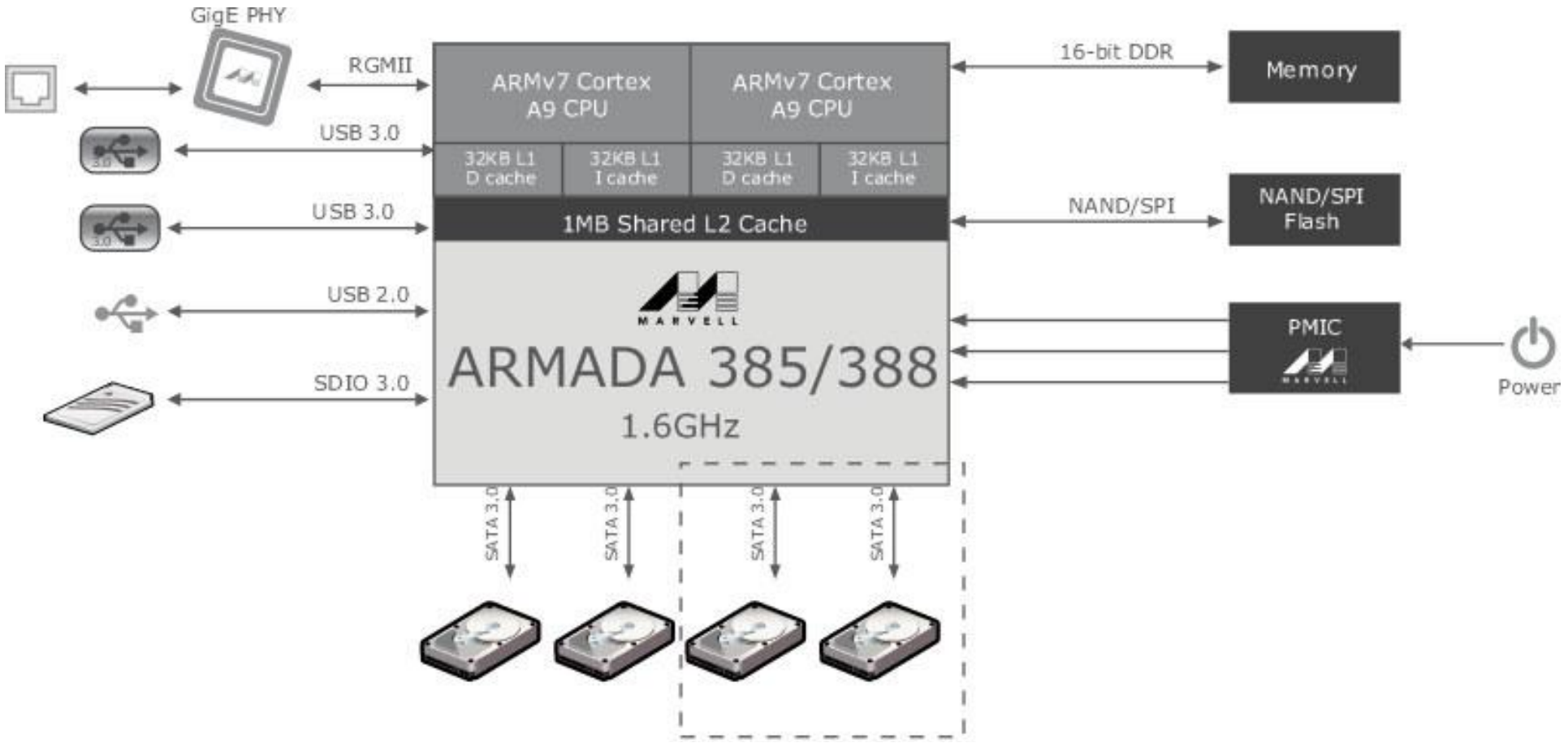
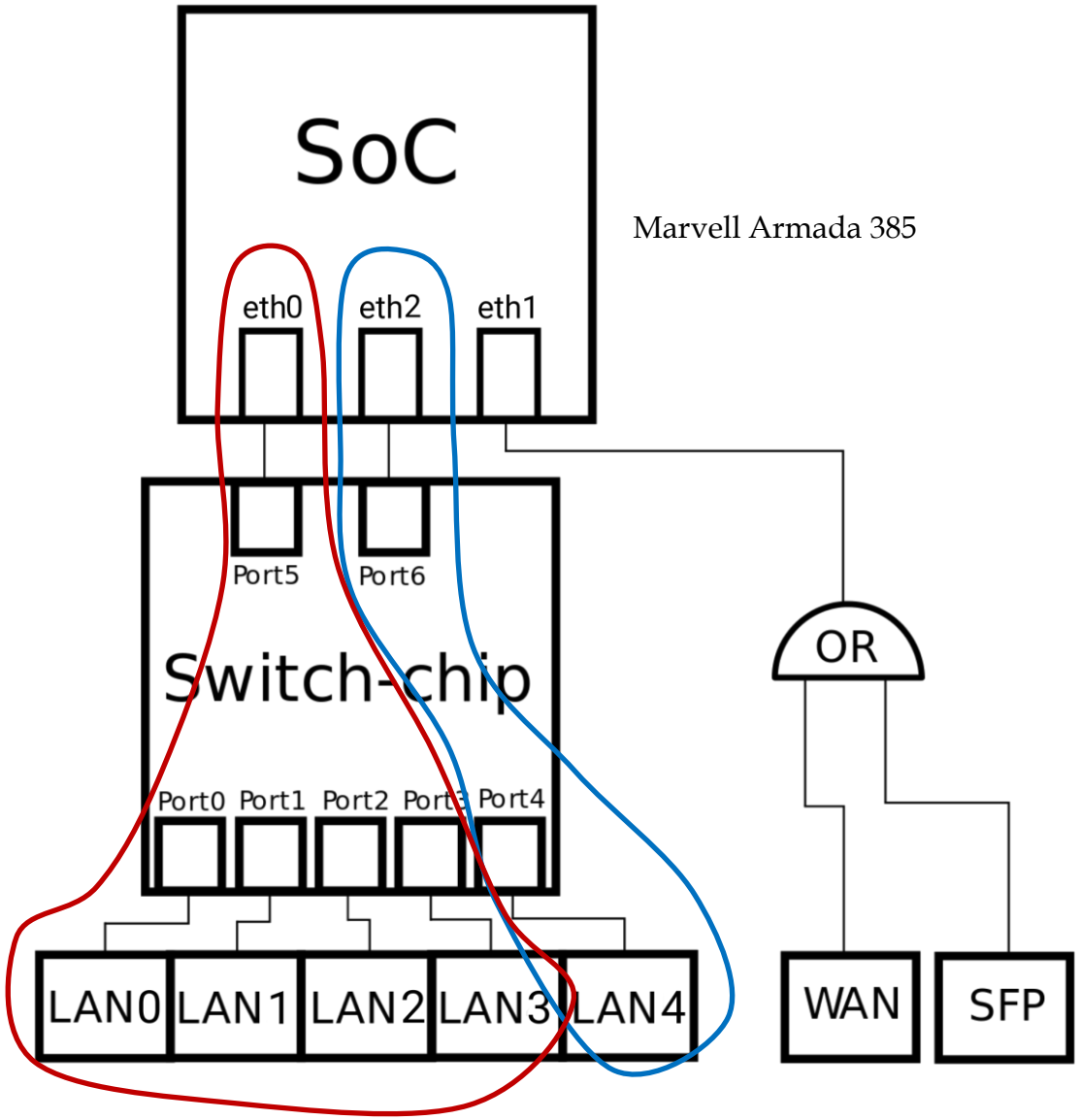
1. Turris Omnia(1) – Target Board



1. Turris Omnia(2) – ARMADA 385 SoC



1. Turris Omnia(3) – Switching Chip



1. Turris Omnia(4) – 3 miniPCIe

- mSATA
- 802.11ac Wi-Fi
- 802.11b/g/n Wi-Fi
- LTE

1. Turris Omnia(5) – Specification(1)

Hardware Specification	
CPU	Marvell Armada 385, dual-core 1.6 GHz
Memory	1 GB DDR3
Storage	8 GB eMMC
Antenna Type	2×2 MIMO Omni-directional high-gain dipole (2.4 GHz) 3×3 MIMO Omni-directional high-gain dipole (5 GHz)
Antenna Gain	3× 2.4 GHz 3.5 dBi, 5 GHz 4.6 dBi
LAN Port	5× 10/100/1000 Mbps (RJ-45)
WAN Port	1× 10/100/1000 Mbps (RJ-45) + SFP up to 2.5 Gb
External Ports	2× USB 3.0 (5 V, 1.5 A power output)
Internal Interfaces	1× UART (4 pins header) 1× miniPCIe/mSATA 1× miniPCIe (without USB and SIM Lock) 1× miniPCIe (with USB and SIM Lock) 1× JTAG 20 pin (CPU) 1× Programming connector 10 pin (MCU) 1× 5 pin Power connector (3V, 5V, 12V) for SATA drives 2× 10 pin GPIO connector (GPIO, SPI, I2C, UART)
Button and Switch	Reset, LED intensity
Appearance	
Size (Width x Depth x Height)	190 × 135 × 40 mm (without antena)
Weight	1180 g (no Wi-Fi 1130 g)
Power Supply	
AC Input	100–240 V / 1.0 A
Power Frequency	50/60 Hz, Single Phase
DC Output	12 V / 3.33 A
Power Consumption	5–40 W max (depends on connected peripheries)

Wireless Specification	
Standard (IEEE 802.11a/b/g/n/ac)	IEEE 802.11a/b/g/n/ac Simultaneous dual band Wi Fi (2 Wi Fi interfaces installed) Compex WLE200N2: 2.4 GHz, 300 Mbps Compex WLE900VX: 5 GHz, 1.3 Gbps or 2.4 GHz, 450 Mbps
Transmitting Power	23 dBm max.
Secured Transmission	64/128 bit WEP, WPA/WPA2, WPA-PSK/WPA2-PSK
Standard (IEEE 802.11b/g/n)	IEEE 802.11b/g/n 2.4 GHz: 300 Mbps
Transmitting Power	16 dBm max.
Secured Transmission	WEP, WPA, WPA2
HW Extensibility	NAS box with SATA connectivity, TV tuners via USB, security cameras, printers, LTE modem (miniPCIe or USB), USB soundcards, smart sensors via GPIO pins...
Network	
Internet Connection	By default: Dynamic IP, Static IP, PPPoE; other by Linux packages
Port Forwarding	Setup via web UI or via SSH
Maximum Port Forwarding Rules	Unlimited*
Maximum UPnP Rules	Unlimited*
Port Triggering	
Maximum Port Triggering Rules	Unlimited*
Minimum Port Triggering Timeouts	Unlimited*
DMZ	Yes
Network Standards	IPv4, IPv6 (DHCPv6 client, server and RA) by default, OSPF, BGP, NAT64 and DN64 by packages
DHCP	Server/client mode, client list, MAC address reservation
Maximum DHCP Reservations	Unlimited
LAN/WLAN IGMP Snooping	

1. Turris Omnia(5) – Specification(2)

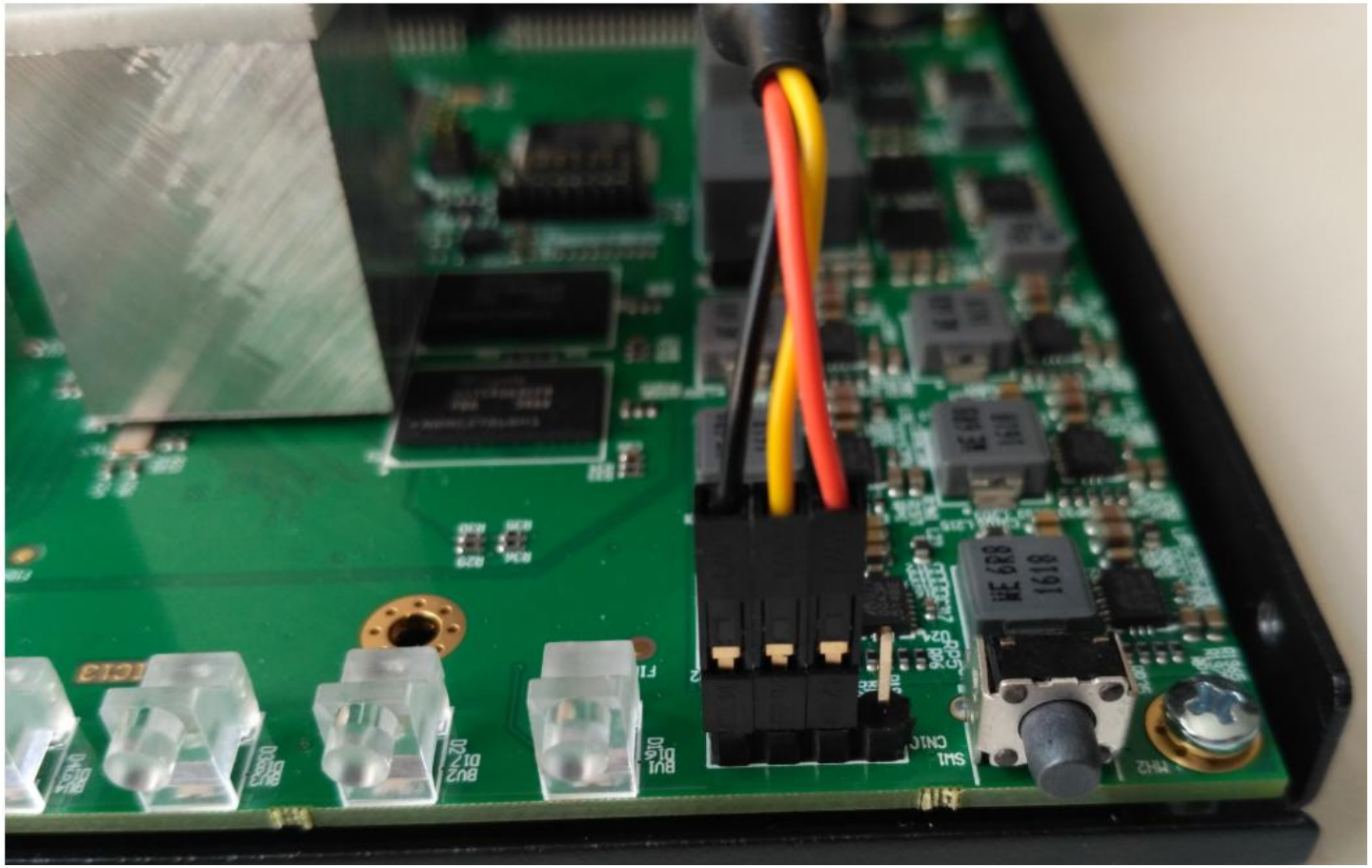
Policy Route, Static Route, Network Address Translation (NAT), PPPoE Relay	
Maximum IPv4 Static Rroutes	Unlimited*
Maximum IPv6 Static Routes	Unlimited*
Diagnosis Tools	Any Linux package
Management	
Operating System	Turris OS, open source, based on OpenWrt, endless SW extensibility by Linux packages
Free OS Upgrade	Frequent automatic security and feature updates
Remote Access	VPN, SSH
Operation Modes	Wireless Router, Wireless AP, Wireless Client
Wake on LAN (WOL)	Yes
Maximum Connected Devices	Unlimited*
Notification	Email, push notifications in mobile aplication in plan
SSH	Yes
SNMP	By third party packages
Configuration, Backup & Restore	Yes, simple Foris UI, advanced LuCI or SSH, UART serial bus accesible, easy reflash from USB drive
User Account Management	Yes
Printer Server	2× USB 3.0 ports, possible extension by USB hub
Parental Control	
Customized Internet Schedule, DNS-based Web-filter with Built-in Database, Customized Allow/Block List	Setup by single/multiple devices
Maximum Devices	Unlimited*
Maximum Blocked URLs	Unlimited*
Maximum Allowed URLs	Unlimited*
Traffic Control	
Internet Ban, Device Speed & Priority	Yes
Application Layer (L7) Quality of Service (QoS)	
Maximum Device Rules	Unlimited*
Maximum Application Rules per Device	Unlimited*
Traffic Monitor for Graphical Live /History Statistics	Yes, in Majordomo package for now, in advanced parental control in 2017
Security	
Wi-Fi Encryption	WEP, WPA/WPA2-Personal, WPA/WPA2-Enterprise
Wi-Fi MAC Address Filter	Yes
Firewall/SPI Firewall	Yes, with unlimited settings*
DoS Protection	Yes, by optional central-maintained, shared firewall
Special Security Features	Honeypots and minipots that are getting informations about attacker and share them with other Turris routers.
Mobile App	In development
File Service	
File System	EXT2/3/4, Btrfs, FAT, NTFS, HFS+, exFAT (depending on installed packages)
Access Support	Web browser, SSH, mobile app (in development)
Protocol Support	SMB, AFP, DLNA, FTP/FTPS, WebDAV
Apple Time Machine	User installable by package
Shared Folder Privileges	Manageable by Linux permissions

1. Turris Omnia(6) – Serial Console

- https://doc.turris.cz/doc/en/troubleshooting/serial_link

black (GND), yellow (RX), orange (TX)

```
screen /dev/ttyUSB0 115200
```



1. Turris Omnia(7) – ps

Foris UI가 제거된 모습

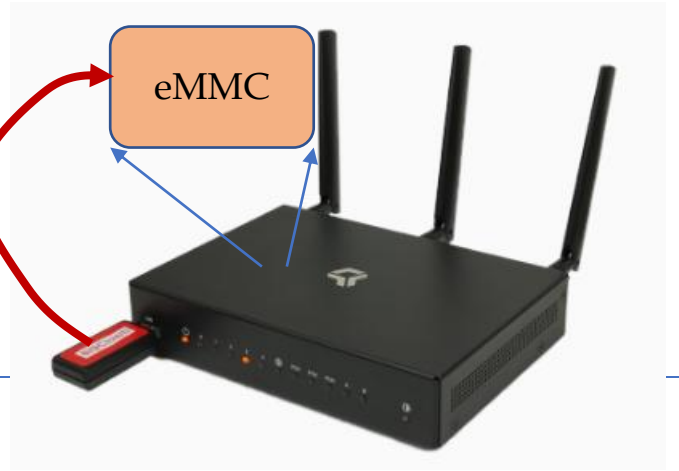
```
 1239 root         0 SW<  [kafsd]
 1244 root         0 SW<  [cifsiod]
 1259 root         0 SW<  [rpciod]
 1265 root         0 SW<  [nfsiod]
 1380 root         0 SW<  [cryptodev_queue]
 1400 root         0 SW<  [cfg80211]
 1405 root         0 SW<  [ath10k_wq]
 1406 root         0 SW<  [ath10k_aux_wq]
 1762 root      1280 S    /sbin/rpcd
 1795 root      1564 S    /usr/sbin/haveged -w 1024 -d 32 -i 32 -v 1
 1845 root      4780 S    {sfpswitch.py} /usr/bin/python /usr/sbin/sfpswitch.py --nodaemon
 1870 root      1552 S    /sbin/netifd
 2008 root      1128 S    /usr/sbin/odhcpd
 2049 nobody     792 S    /usr/sbin/atd -f
 2087 root      2792 S    /usr/sbin/sshd -f /var/etc/ssh/sshd_config
 2094 root      8208 S    /usr/sbin/syslog-ng -F
 2353 root      2080 S    /usr/sbin/hostapd -P /var/run/wifi-phy1.pid -B /var/run/hostapd-phy1.conf
 2377 root      4976 S    /usr/sbin/lighttpd -D -f /etc/lighttpd/lighttpd.conf
 2383 root       936 S    /sbin/mountd -f
 2408 root       764 S    /usr/sbin/cron -n
 2421 root      1756 S    /usr/sbin/smartd -q never
 2662 root      2080 S    /usr/sbin/hostapd -P /var/run/wifi-phy0.pid -B /var/run/hostapd-phy0.conf
 2681 root      1108 S    udhcpc -p /var/run/udhcpc-eth1.pid -s /lib/netifd/dhcp.script -f -t 0 -i eth1
 2710 root         0 SW<  [wg-crypt-spn0]
 2715 root       852 S    odhcp6c -s /lib/netifd/dhcpv6.script -P0 -U -t120 eth1
 2799 nobody    1168 S    /usr/sbin/dnsmasq -C /var/etc/dnsmasq.conf -k -x /var/run/dnsmasq/dnsmasq.pid
 2867 root     34620 S    /usr/bin/kresd -c /tmp/kresd.config -f 1 /tmp/kresd -a 0.0.0.0 53 -a :: 53
 3041 root      1108 S<   /sbin/ntpd -n -N -S /usr/sbin/ntpd-hotplug -p 217.31.202.100 -p 195.113.144.20
 3566 root      2812 S    sshd: root@pts/0
 3594 root      1120 S    -ash
 8809 root         0 SW   [kworker/0:0]
11466 root      2812 S    sshd: root@pts/1
11671 root      1112 S    -ash
14672 root         0 SW<  [kworker/u5:1]
14777 root         0 SW   [kworker/u4:0]
17371 root         0 SW   [kworker/0:2]
18242 root       716 S    nethist
18669 root         0 SW   [kworker/u4:1]
19099 root      1112 R    ps
```

2. How to flash firmware image(1)

- https://doc.turris.cz/doc/en/howto/omnia_factory_reset
  - 이 site 내용 참조

- http://api.turris.cz/openwrt-repo/omnia/medkit/
  - omnia-medkit-201811301131.tar.gz (or latest 파일을 download 받음)
  - **이 파일을 USB stick(/ 파티션)에 복사(압축을 풀지 않고, 그대로 복사)한 후, 장비 전면의 USB slot에 삽입**
  - 참고: 이 파일을 풀면, usr/lib/python3.6/site-packages/foris 아래에 foris webUI(python code)가 있을 것임.

- 장비 후면의 reset button을 누른 상태에서 아래 LED(4번)가 켜지면 떼면 됨. 이후 Serial console을 통해 flashing 진행 상태 확인하면 됨.
  - 1 LED: Standard (re)boot
  - 2 LEDs: Rollback to latest snapshot
  - 3 LEDs: Rollback to factory reset
  - **4 LEDs: Re-flash router from flash drive**
  - 5 LEDs or more: Boot to rescue shell

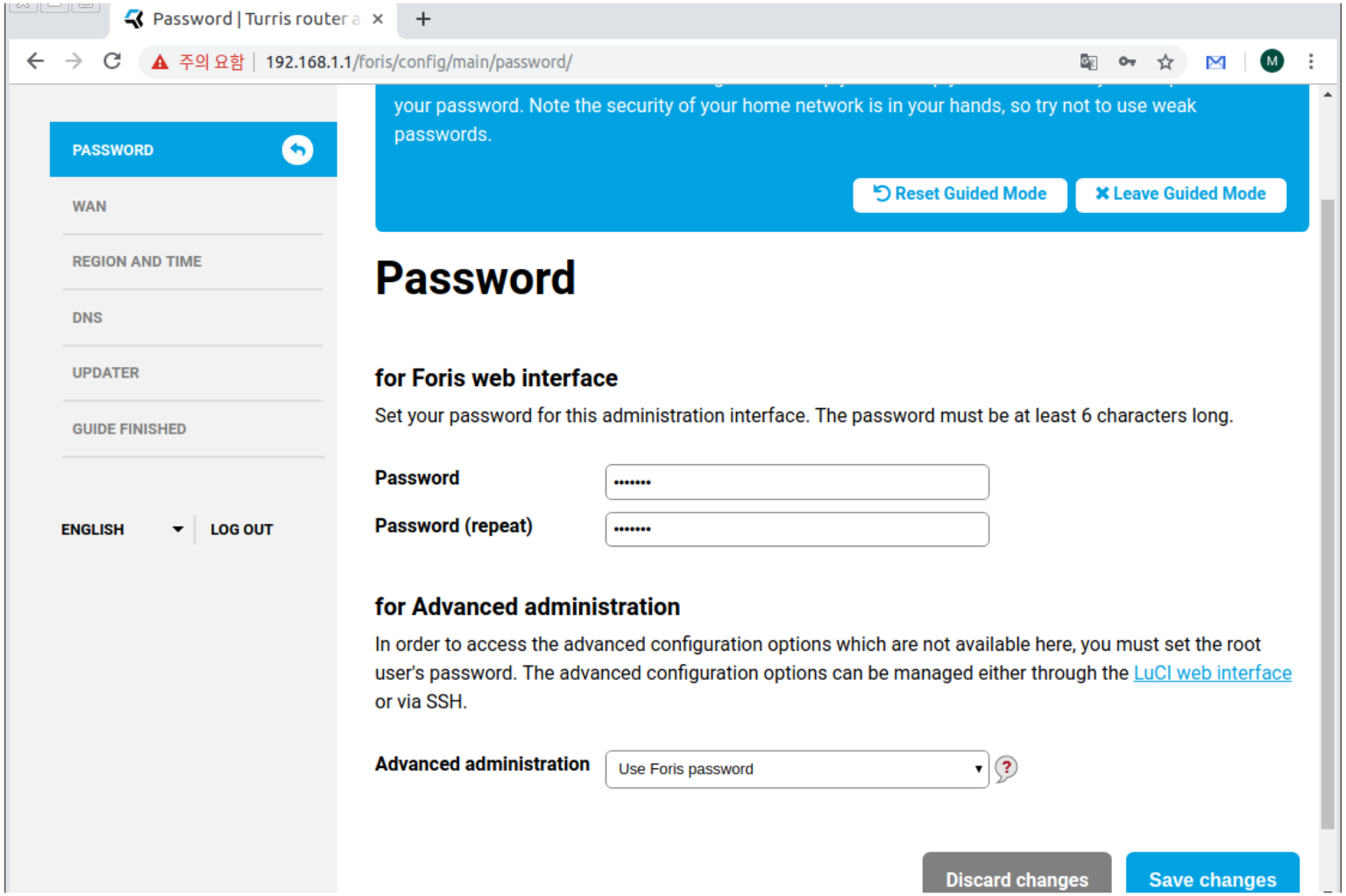


2. How to flash firmware image(2)

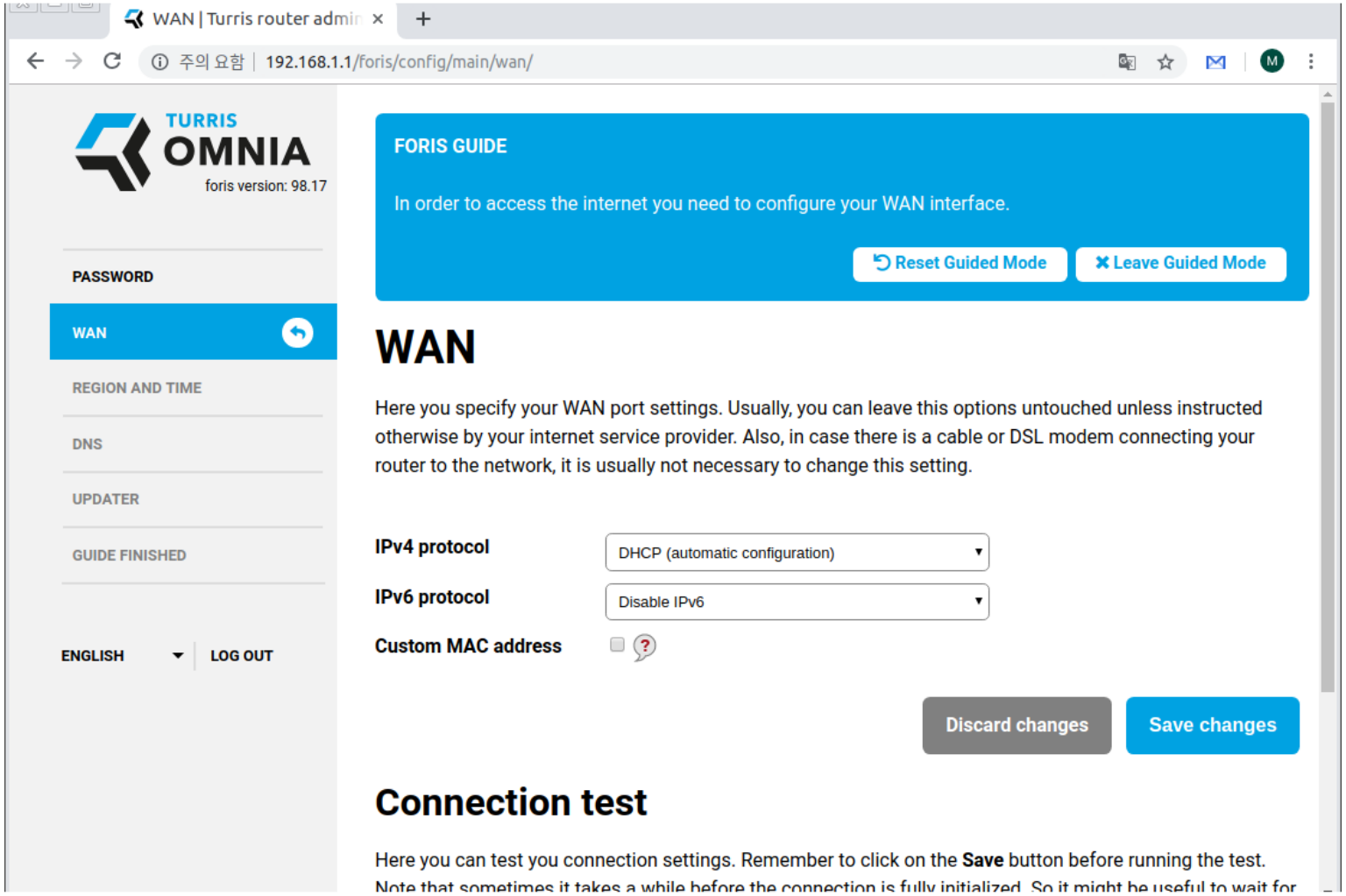
- 1) USB memory stick 준비
  - <Ubuntu 16.04>
  - $ sudo umount /dev/sdc1
    - ✓ */dev/sdc1은 자신의 환경에 맞는 값을 입력해 주면 됨.*
  - $ sudo fdisk /dev/sdc
  - $ sudo mkfs.ext4 /dev/sdc1
  - $ sudo cp ./omnia-medkit-latest.tar.gz /media/chyi/michael
    - ✓ / 파티션에 medkit 파일을 복사해 주면 됨.
    - ✓ **주의: omnia-medkit-latest.tar.gz 파일은 build_spnbox.sh을 통해 새로 생성한 것을 사용해야 함.**
- 2) Serial Console 연결 [꼭 필요한 사항은 아님]
- 3) USB stick을 Turris Omnia 전면 USB slot에 삽입
- 4) 장비 후면의 reset 버튼을 누른 상태에서 LED4가 켜지면 뗌.
  - 전원 cable을 연결한 상태에서 진행해도 됨.
- 5) Serial console을 통해 flashing(to EMMC)이 진행되는 것을 확인. 설치가 완료되면 system 자동 reboot 됨.

3. Turris WebUI(Foris) Wizard 설정(1)

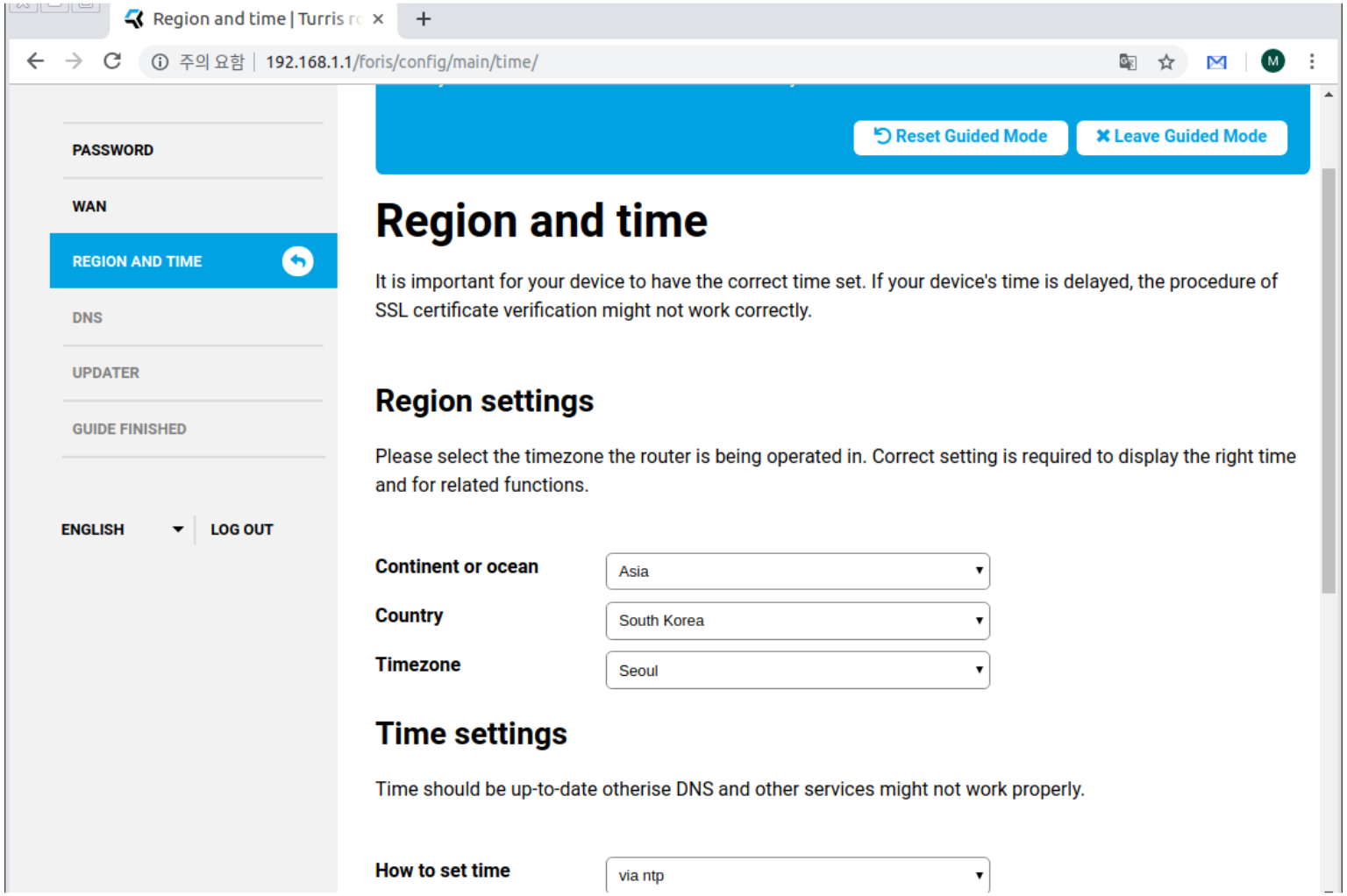
Firmware 설치 후, 192.168.1.1로 접속



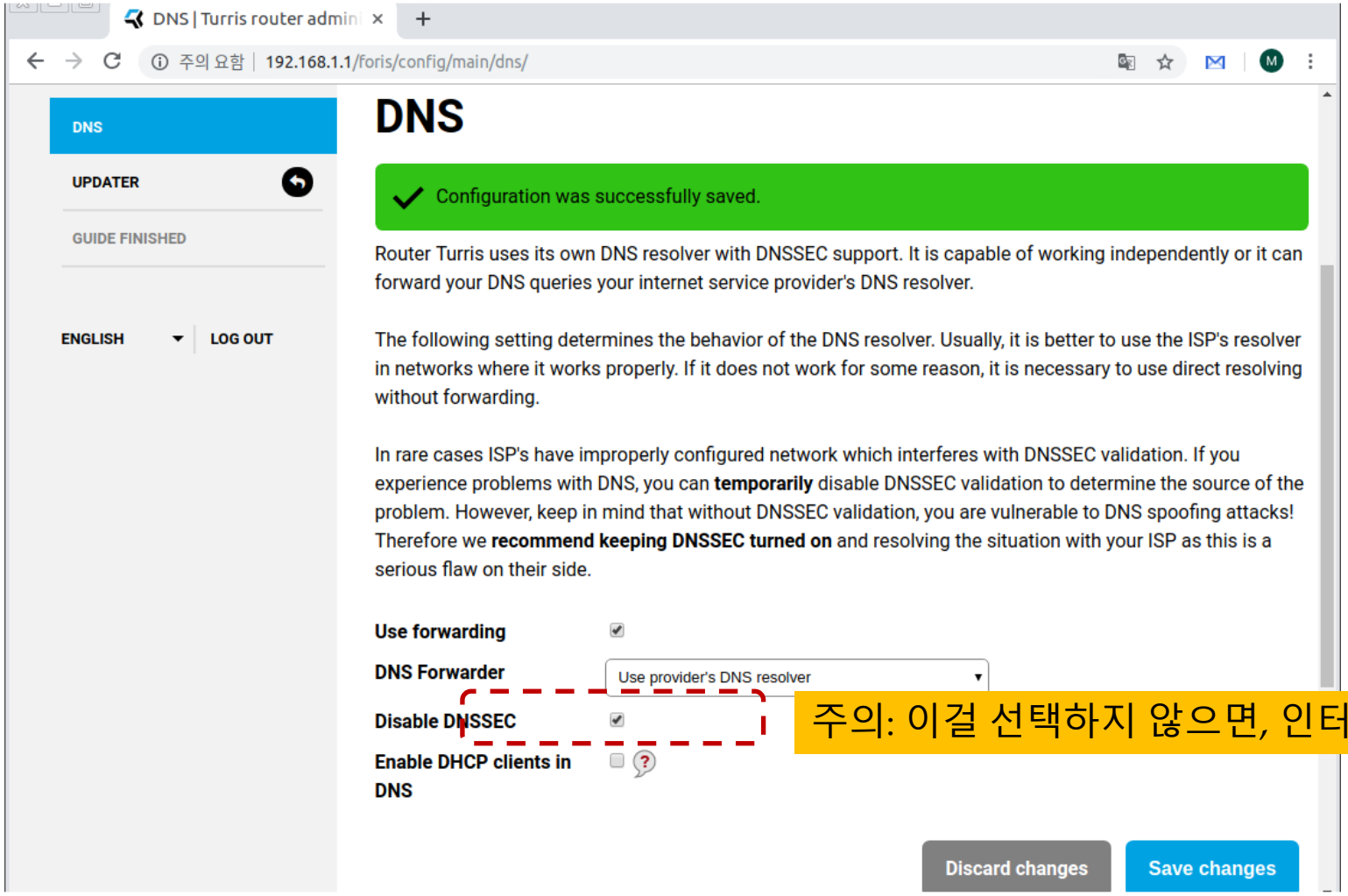
3. Turris WebUI(Foris) Wizard 설정(2)



3. Turris WebUI(Foris) Wizard 설정(3)

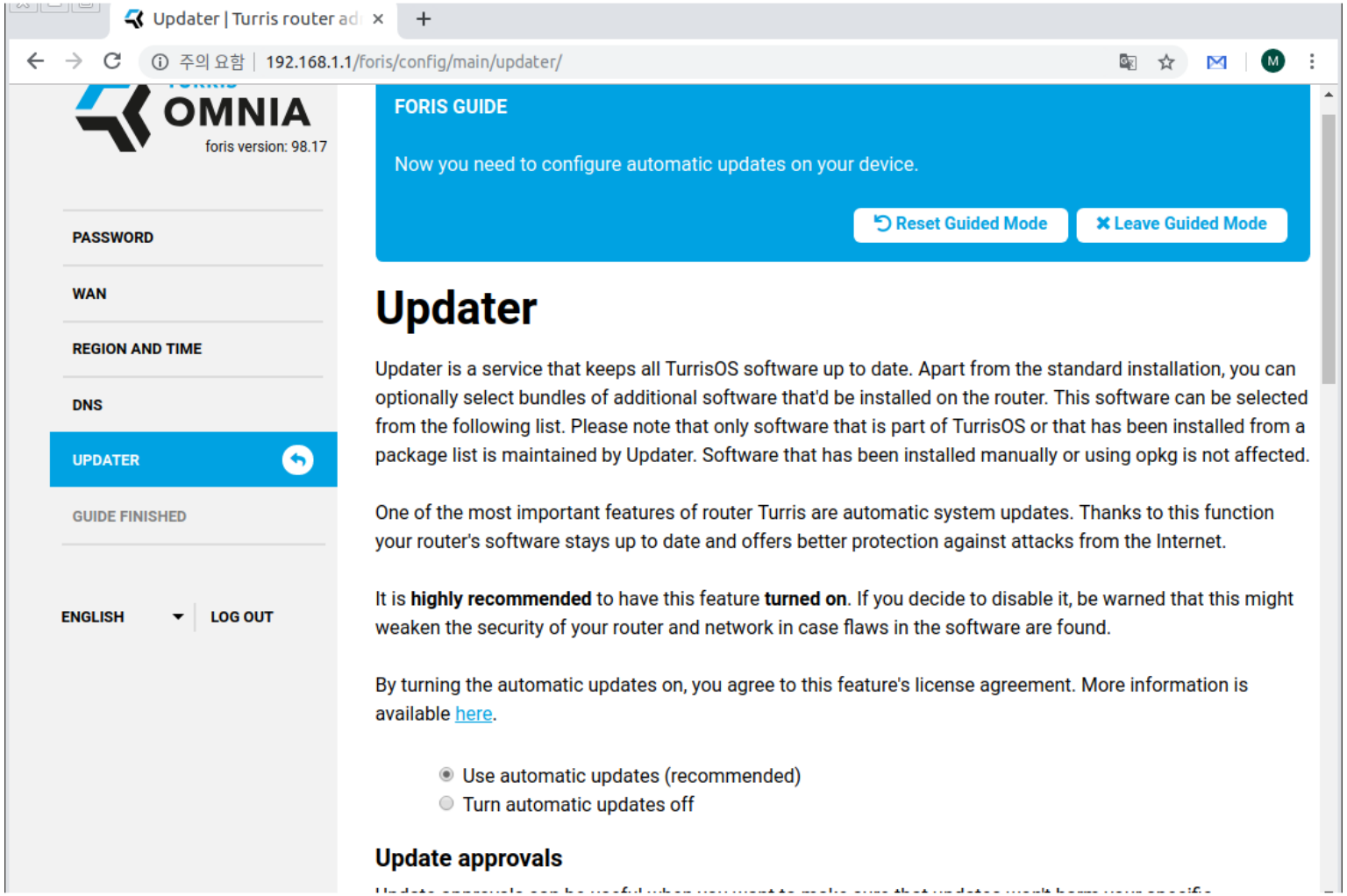


3. Turris WebUI(Foris) Wizard 설정(4)

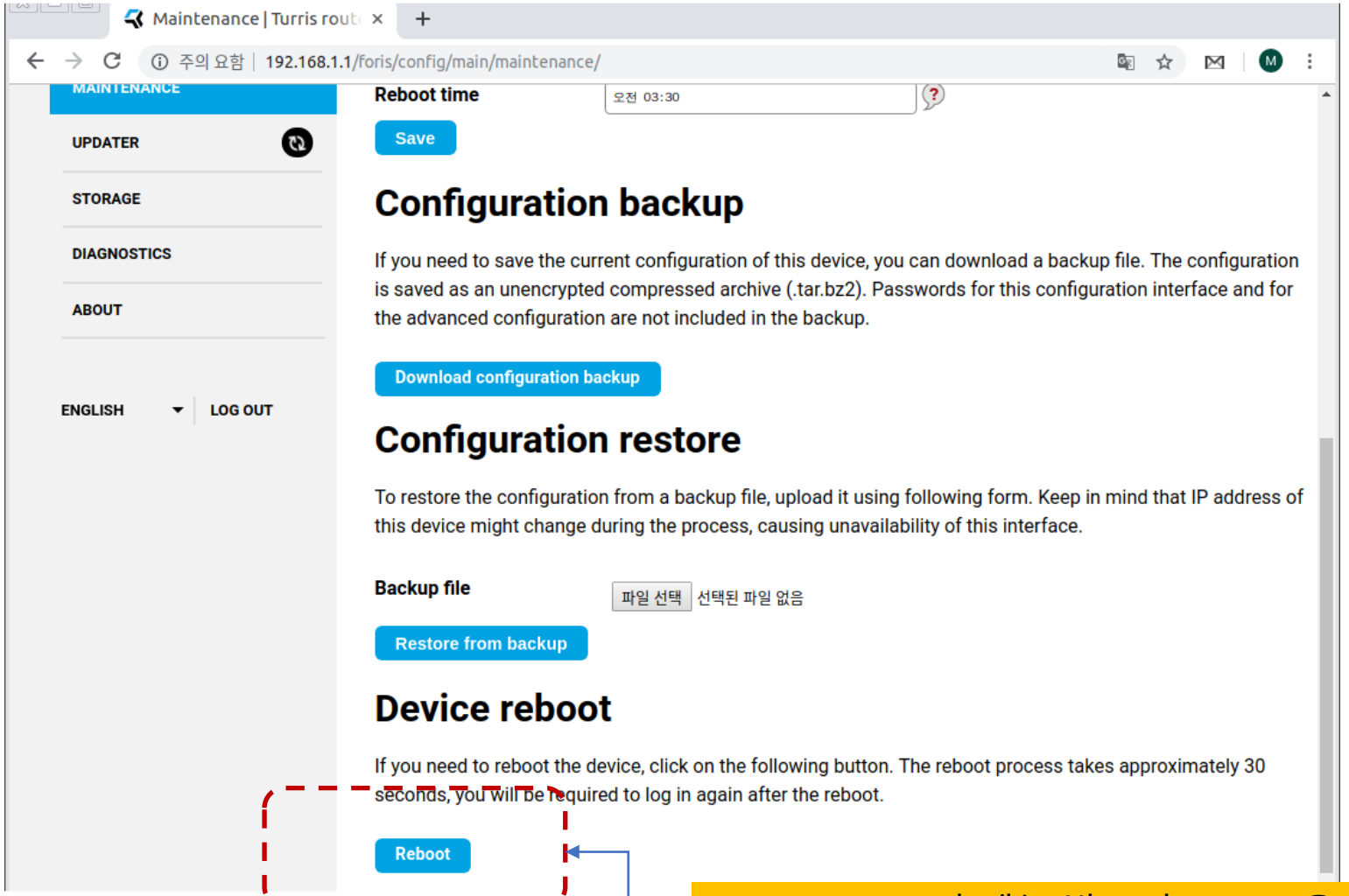


주의: 이걸 선택하지 않으면, 인터넷 연결이 안될 수 있음.

3. Turris WebUI(Foris) Wizard 설정(5)

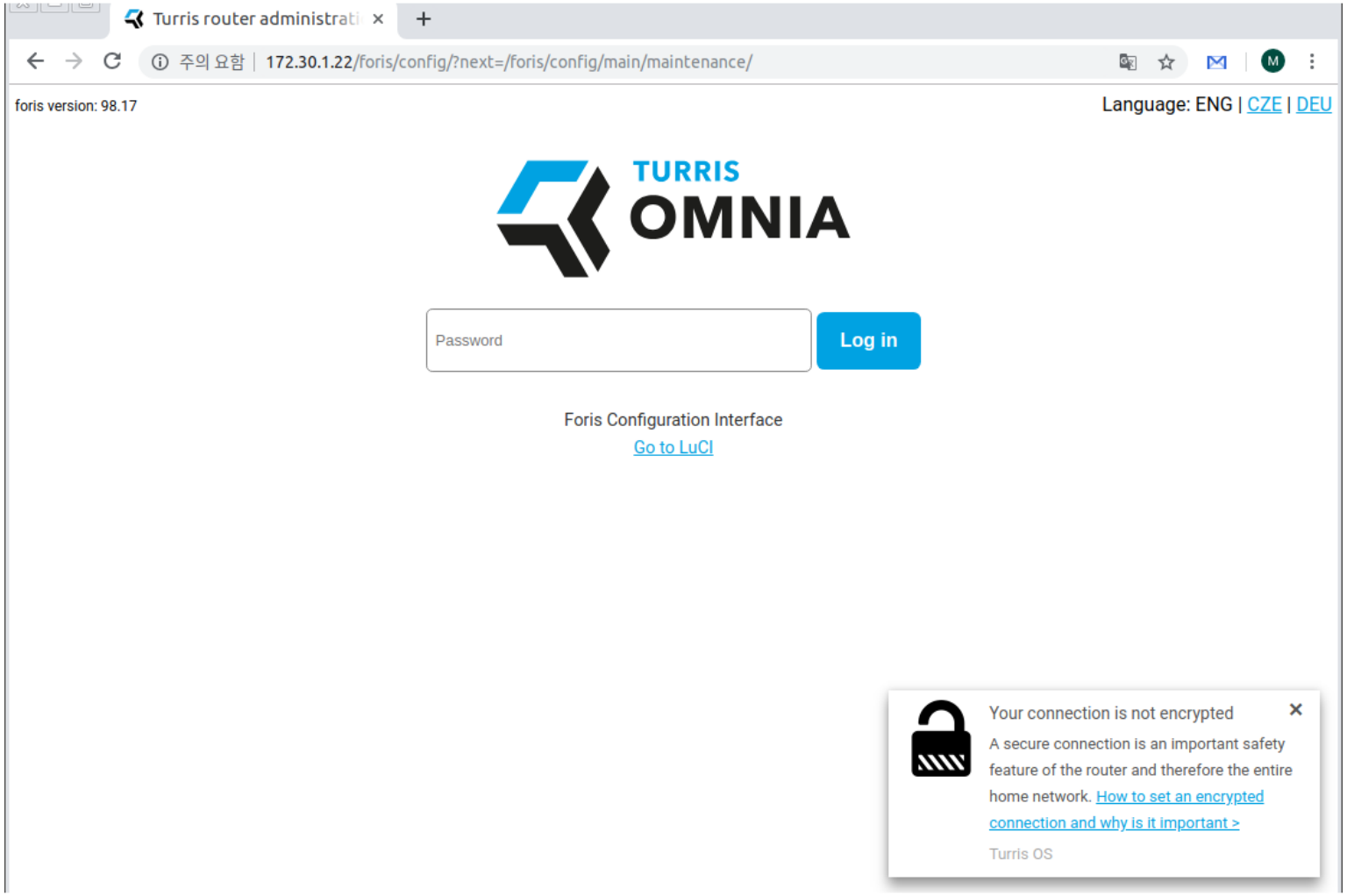


3. Turris WebUI(Foris) Wizard 설정(6)



Wizard setup 후에는 반드시 Reboot을 해주어야 한다.

3. Turris WebUI(Foris) Wizard 설정(7)



4. SPNBox(1) – Build and Install SPNBox S/W

```
========================================
 ** 2STON SPNBox/Cloud Image Generator **
========================================

Would you like to:
                1. generate an image for ARM64 ESPRESSObin board
                2. generate an image for ARM64 GrapeBoard
                3. generate an image for ARM64 MACCHIATObin board
                4. generate an image for ARM64 Raspberry Pi 3 B+ board
                5. generate an image for X86_64 C1037 board(10 ports)
                6. generate an image for X86_64 J1900 board(4 ports)
                7. generate an image for X86_64 D525 board(6 ports)
                8. generate an image for X86_64 XD1518 board(8 ports)
                9. generate an image for X86_64 H310 board(KIPI2 Box)
               10. generate an image for X86_64 Fitlet2 board(NextCloud)
               11. generate an image for SPN OS(based on VyOS)
               12. generate an image for Amazon Web Service EC2
               13. generate an image for Amazon Web Service NAT instance
               14. generate an image for ARM32 BPI-R2 board(Access Point)
               15. generate an image for ARM32 Turris Omnia board(Access Point)
               16. generate an image for MIPS32 GL.iNet AR750S board(Access Point)
               17. generate an image for MIPS32 GL.iNet USB150 board(Access Point)
               18. generate an image for ARM32 GL.iNet B1300 board(Access Point)
               19. generate an image for MIPS32 GL.iNet AR150 board(Access Point)
               20. generate an image for MIPS32 GL.iNet X750 board(Access Point/LTE)
               21. generate an image for MIPS32 GL.iNet MiFi board(Access Point/LTE)
               22. login to AWS EC2
               i. Information
               q. Quit this program
Please select one of the above (1-22 or i or q): 15
```

<Ubuntu 16.04 Desktop>

omnia-medkit-latest.tar.gz 파일 설치 시, /root/workspace 아래에 자동으로 spnbox_install.tar.gz이 복사되게 됨.

수동 설치

```
root@turris:~/workspace/spnbox_install# ./Install.sh

*******************************************************************************
*                              2IP 2STON SPNBox 1.00                          *
*                        (C)opyright 2018, All rights reserved.                *
*******************************************************************************


Installing 2ston spnbox package for Turris_Omnia ...
OK, done.
>>> Do you want to restart the system now?(y/n)y
root@turris:~/workspace/spnbox_install# Connection to 172.30.1.49 closed by remote host.
Connection to 172.30.1.49 closed.
```

SPNBox-AP(Target Board)

4. SPNBox(2) – SPN Tunnel 설정 예(1)

```
chyi@jupiter:~/2IP/spn/Turris/turris-os$ ssh root@172.30.1.49
root@172.30.1.49's password:


BusyBox v1.29.3 () built-in shell (ash)

  _______  _    _  _____   _____   _____   _____
 |__   __|| |  | ||  __ \ |  __ \ |_   _| / ____|
    | |   | |  | || |__) || |__) |  | |  | (___
    | |   | |  | ||  _  / |  _  /   | |   \___ \
    | |   | |__| || | \ \ | | \ \  _| |_  ____) |
    |_|    \____/ |_|  \_\|_|  \_\|_____||_____/



Build On Dec 18 2018 11:25:38
turris> en
turris# configure  terminal
turris(config)# show running-config
#Writed on Tue Dec 18 14:30:36 2018
ip address spn0 10.1.1.99 255.255.255.0
ip route 172.31.0.0 255.255.0.0 10.1.1.99
spn link-up
spn listenport 59760
spn peer gXlNPhrIpbOSr4rMD9tF614mVFvF/GqyONJo4kmNB3I= allowed-ips 172.31.0.0/16,10.1.1.0/24 endpoint 1
3.125.60.224:59760 persistent-keepalive 25
!
turris(config)#
```

주의 !

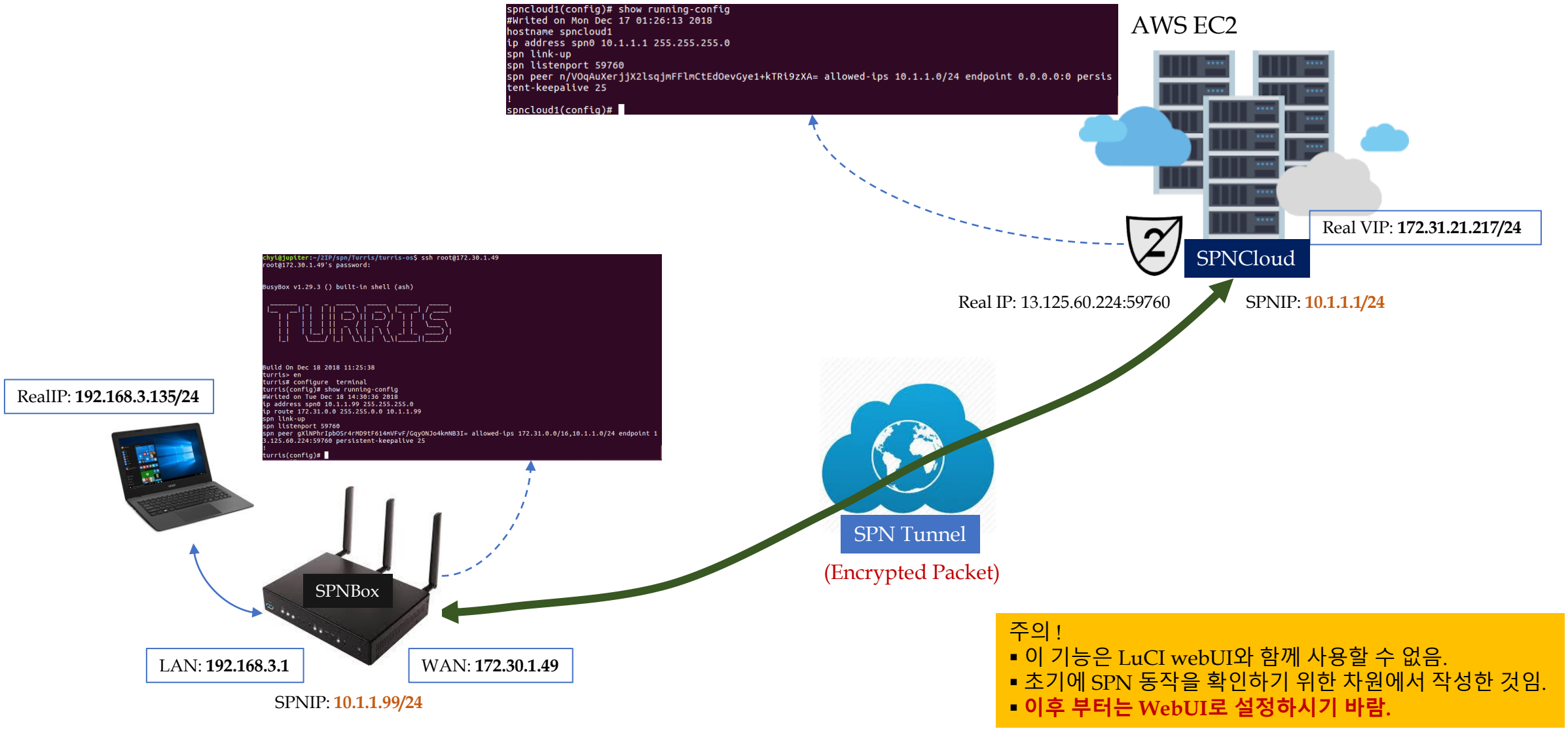
- 이 기능은 LuCI webUI와 함께 사용할 수 없음.
- 초기에 SPN 동작을 확인하기 위한 차원에서 작성한 것임.
- **이후 부터는 WebUI로 설정하시기 바람.**

```
turris(config)# show spn
interface: spn0
  public key: YHcfMMMzZjfOM7RlQyhG+T/wgtSkUXEUJJ+4khqSM3o=
  private key: (hidden)
  listening port: 59760

peer: gXlNPhrIpbOSr4rMD9tF614mVFvF/GqyONJo4kmNB3I=
  endpoint: 13.125.60.224:59760
  allowed ips: 172.31.0.0/16, 10.1.1.0/24
  latest handshake: 1 minute, 25 seconds ago
  transfer: 228.48 KiB received, 230.25 KiB sent
  persistent keepalive: every 25 seconds

interface: spn1
turris(config)#
```

4. SPNBox(2) – SPN Tunnel 설정 예(2)



주의 !
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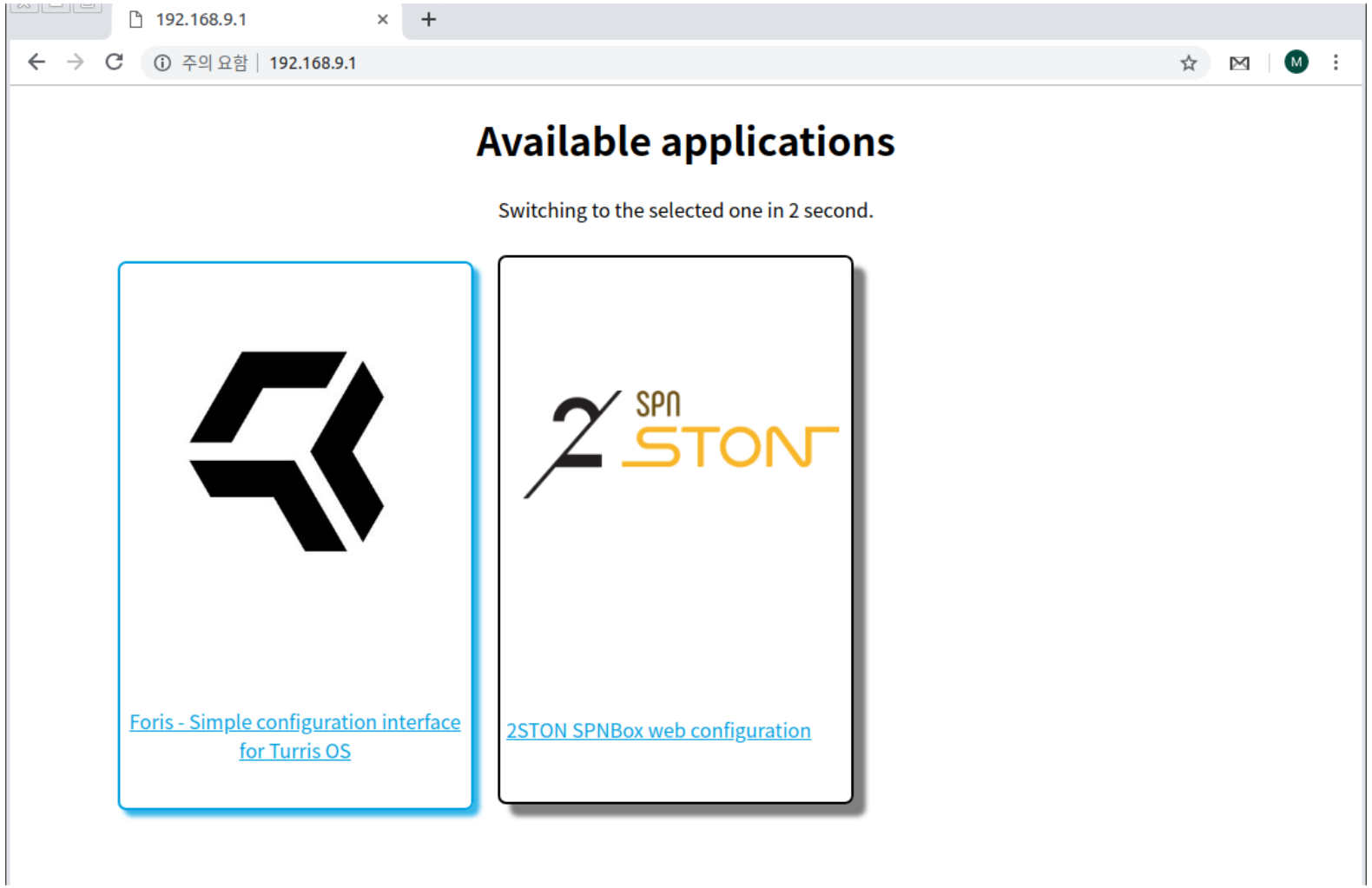
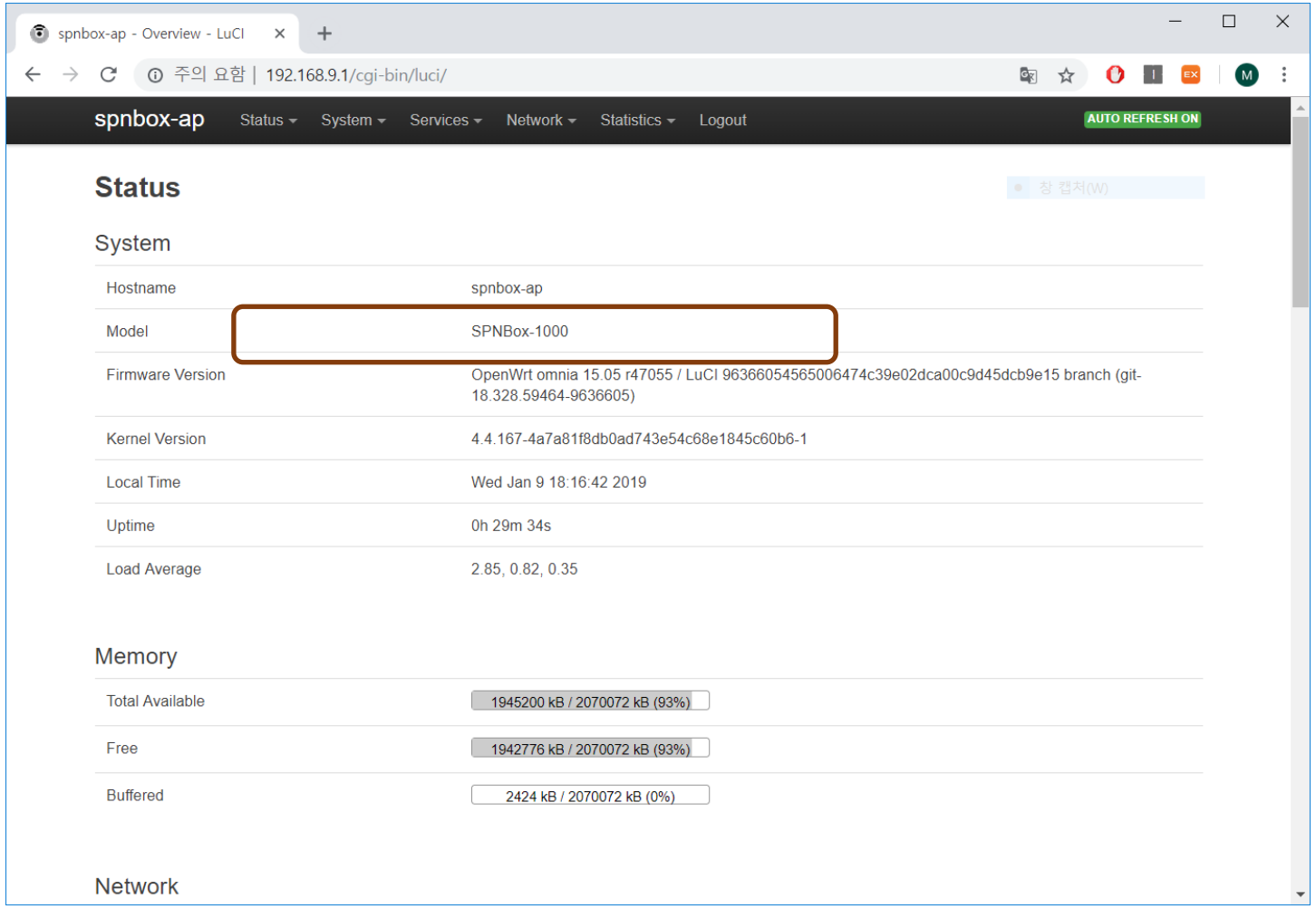
- **이후 부터는 WebUI로 설정하시기 바람.**

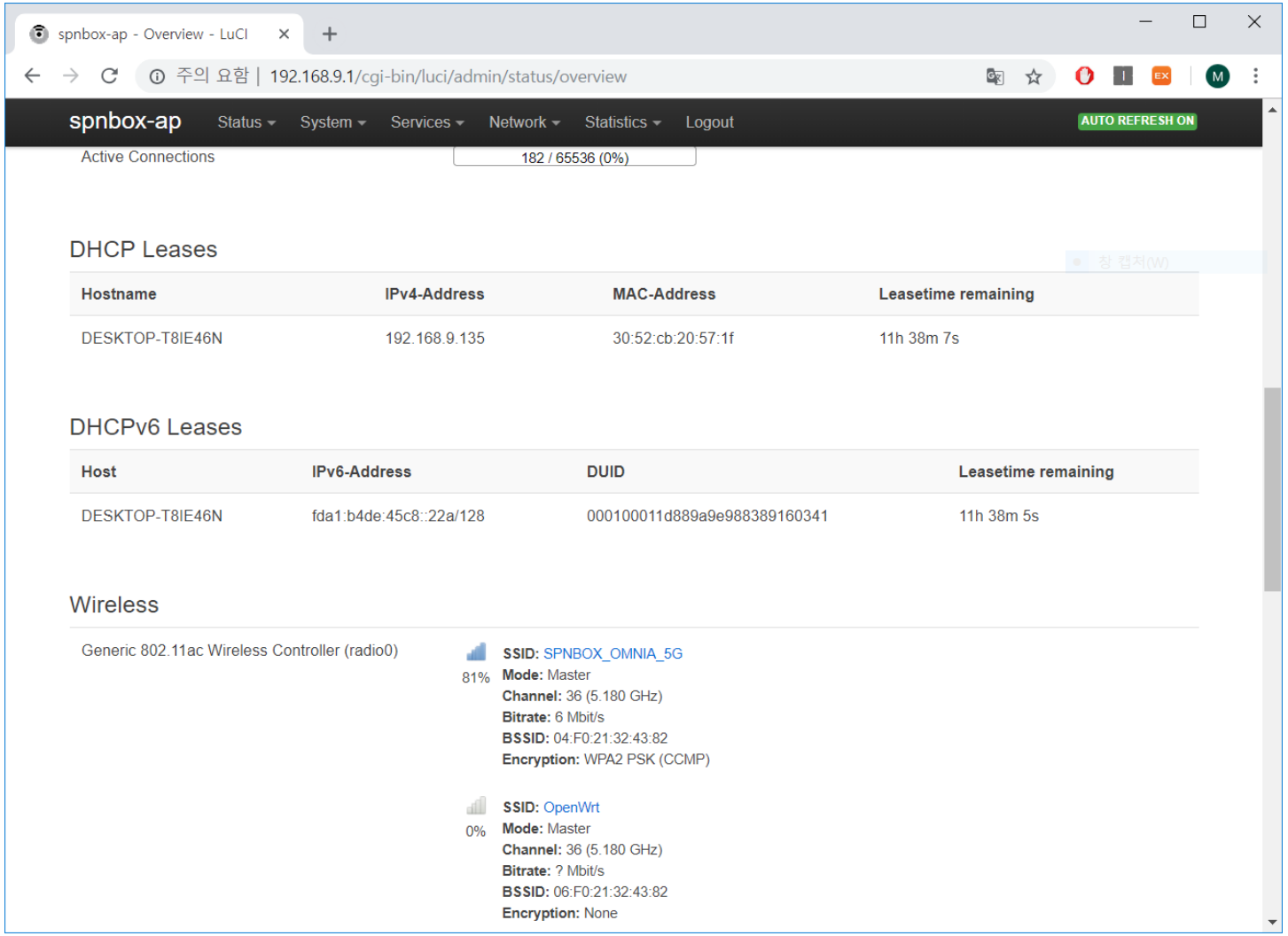
5. LuCI WebUI(1) – Login



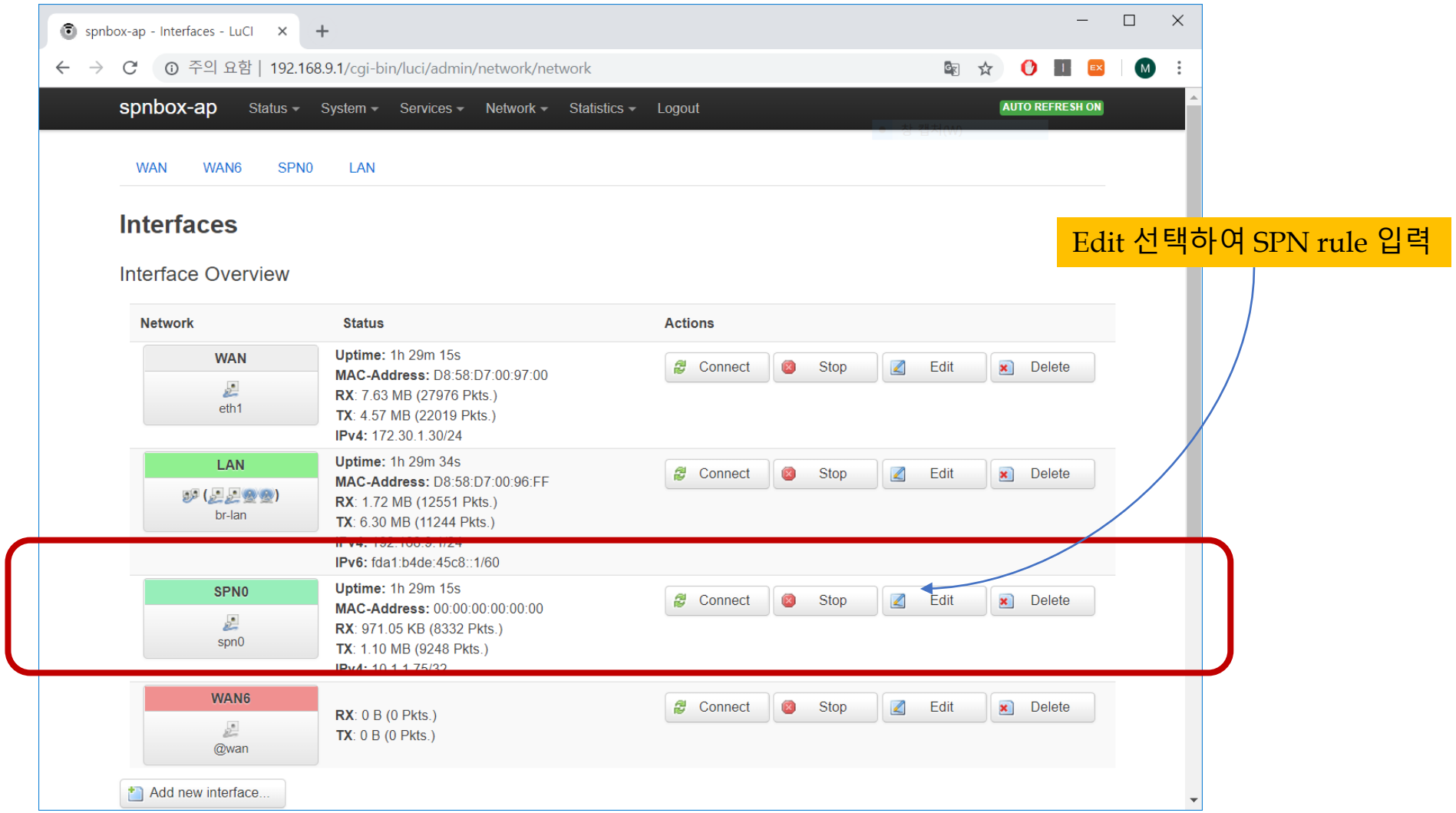
5. LuCI WebUI(2) – Status Page(1)



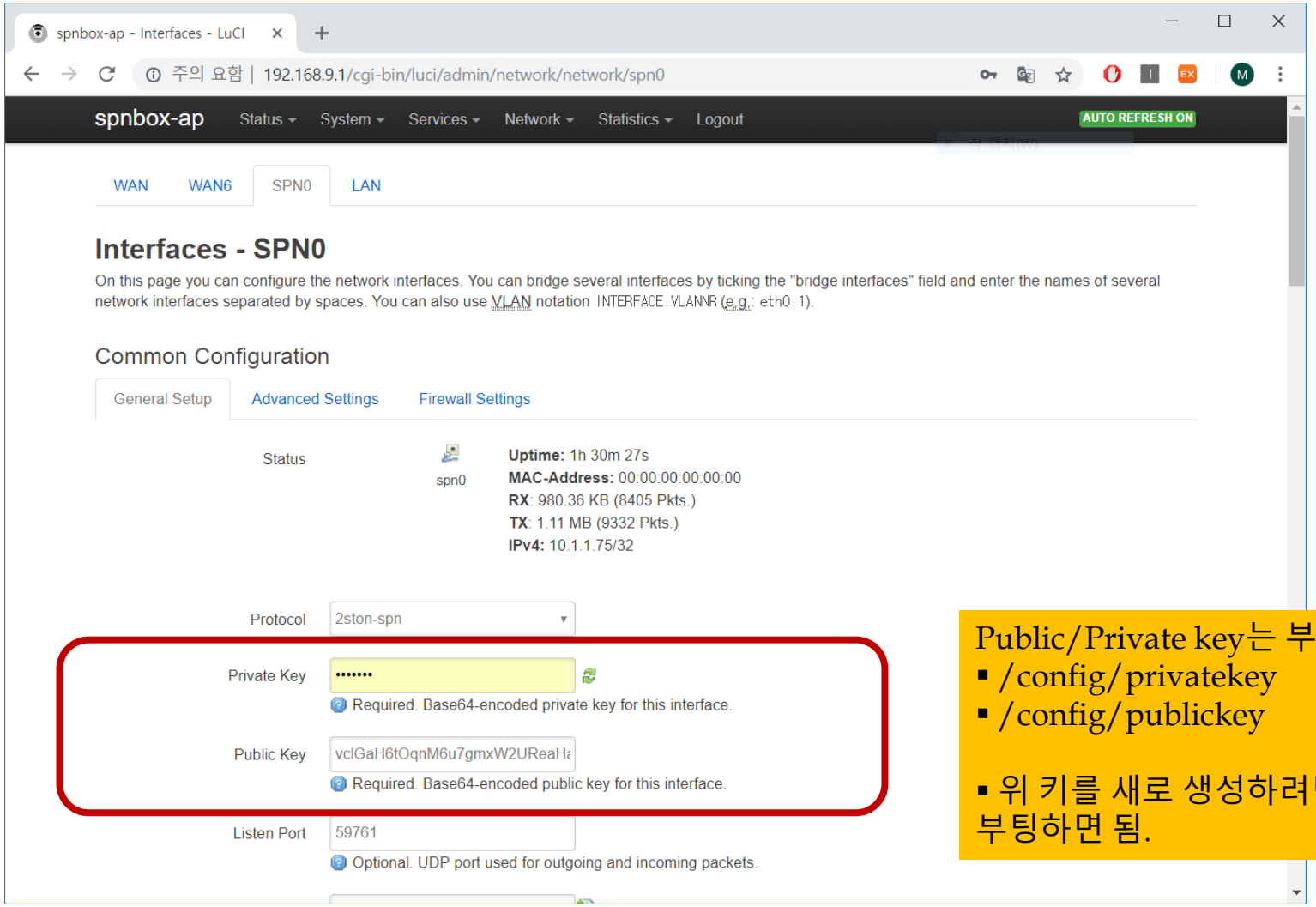
5. LuCI WebUI(2) – Status Page(2)



5. LuCI WebUI(3) – SPN Interface Up/Down



5. LuCI WebUI(4) – SPN Local 설정

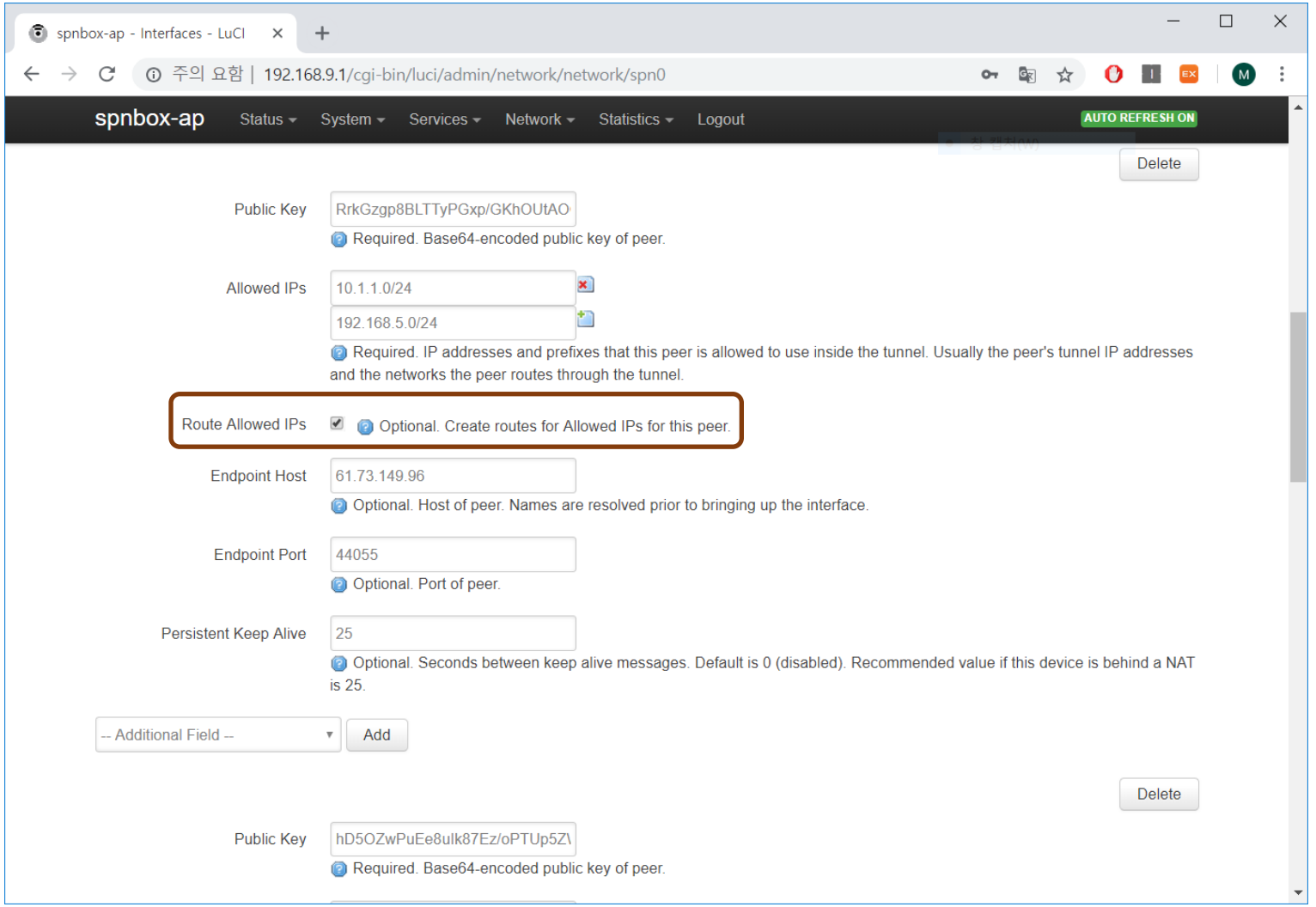


Public/Private key는 부팅하면서 자동 생성됨.

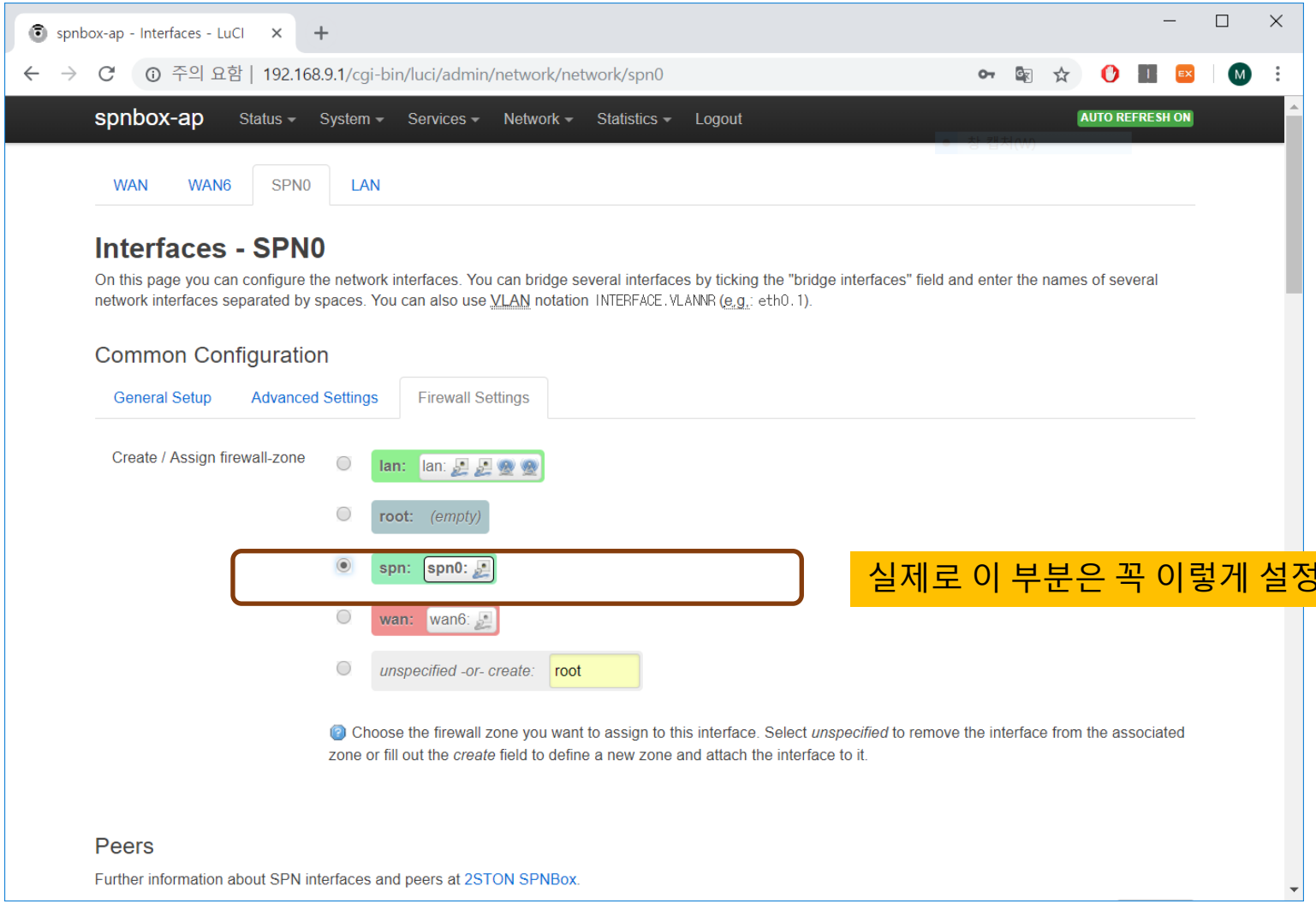
- /config/privatekey
- /config/publickey

- 위 키를 새로 생성하려면 위 두개의 파일을 제거하고 부팅하면 됨.

5. LuCI WebUI(5) – Peer 추가하기

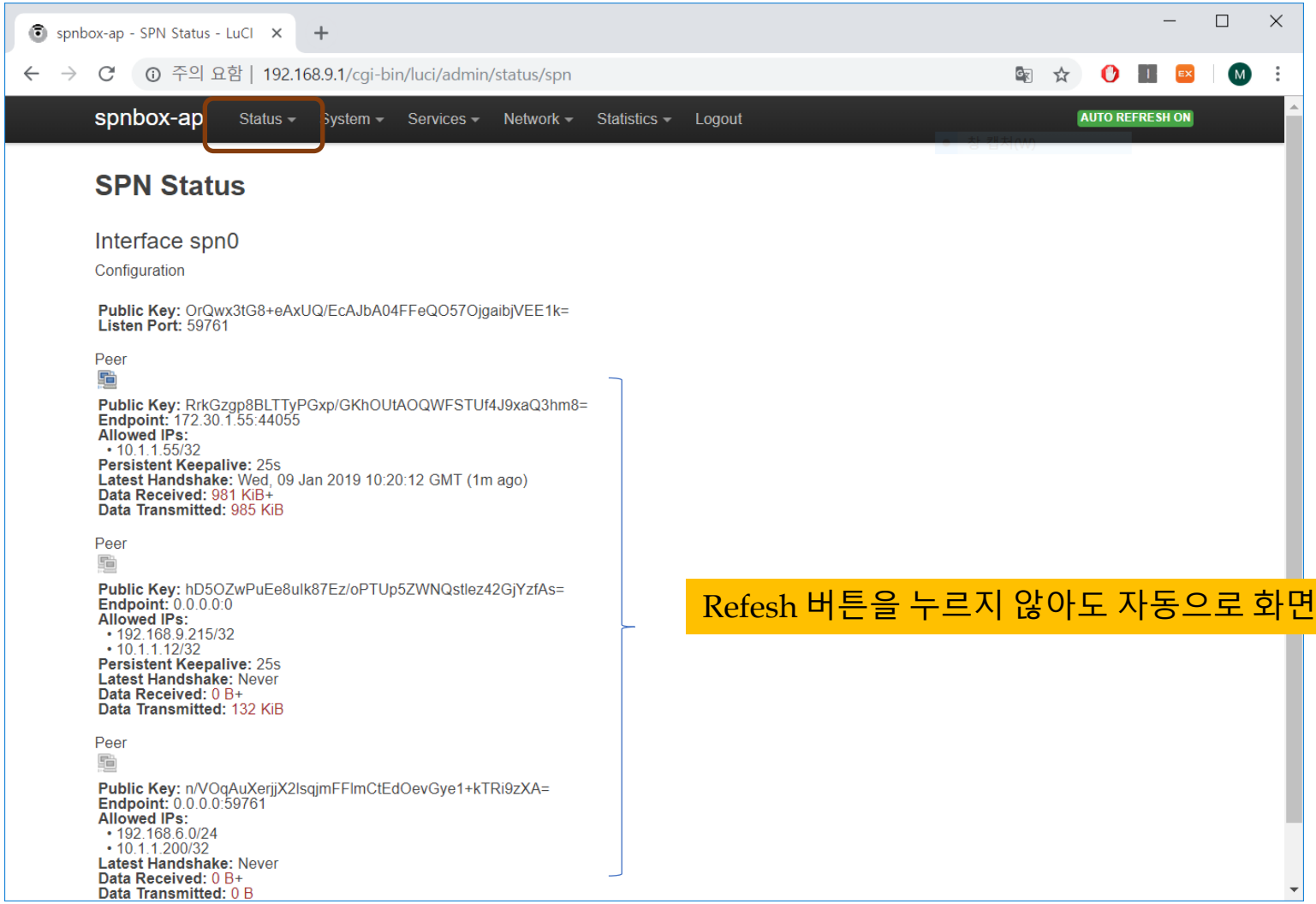


5. LuCI WebUI(6) – Firewall Zone 설정하기



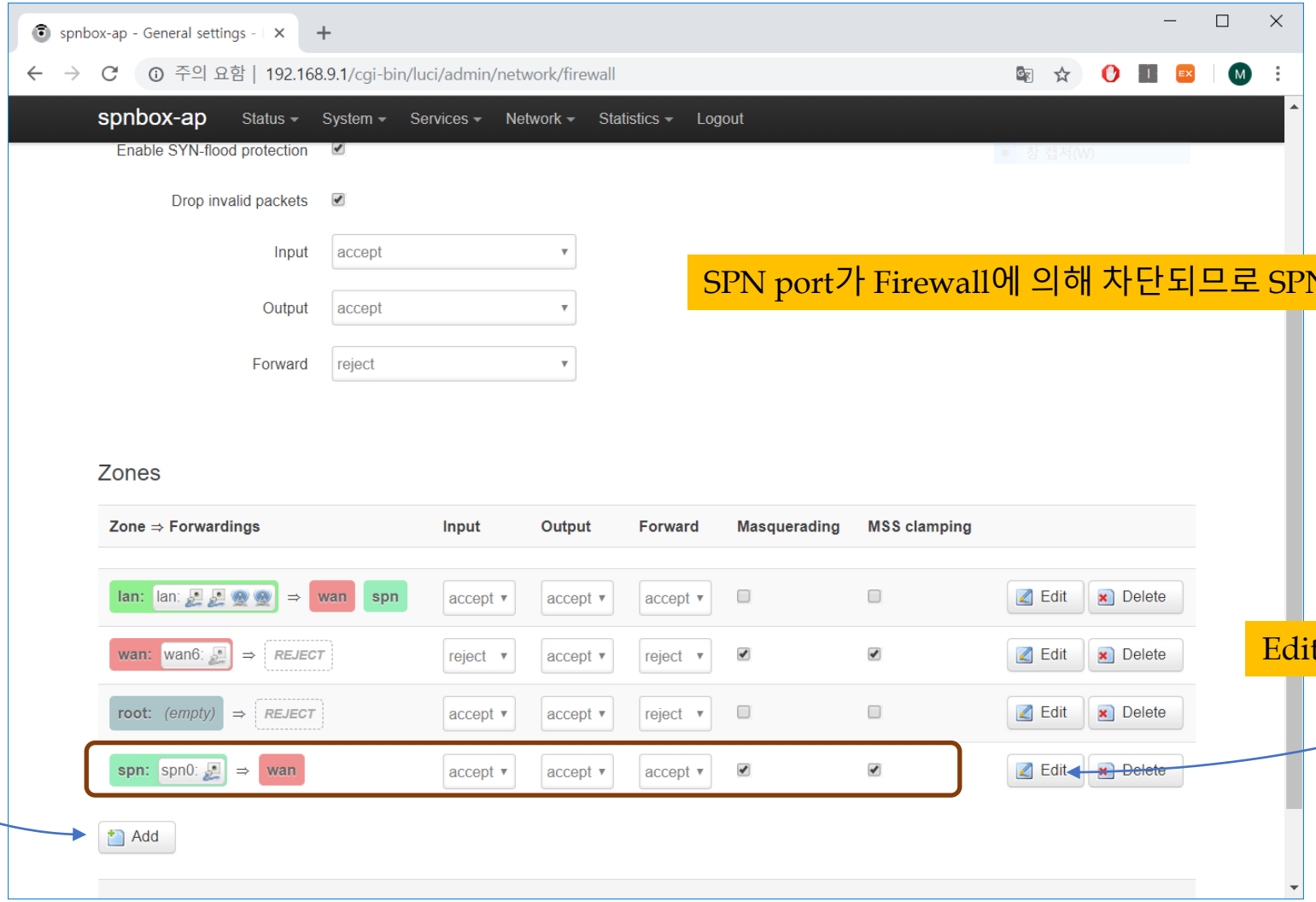
실제로 이 부분은 꼭 이렇게 설정해야 하는 것은 아님.

5. LuCI WebUI(7) – SPN 연결 상태 보기



Refesh 버튼을 누르지 않아도 자동으로 화면 내용이 갱신됨.

5. LuCI WebUI(8) – Firewall SPN Zone 추가(1)

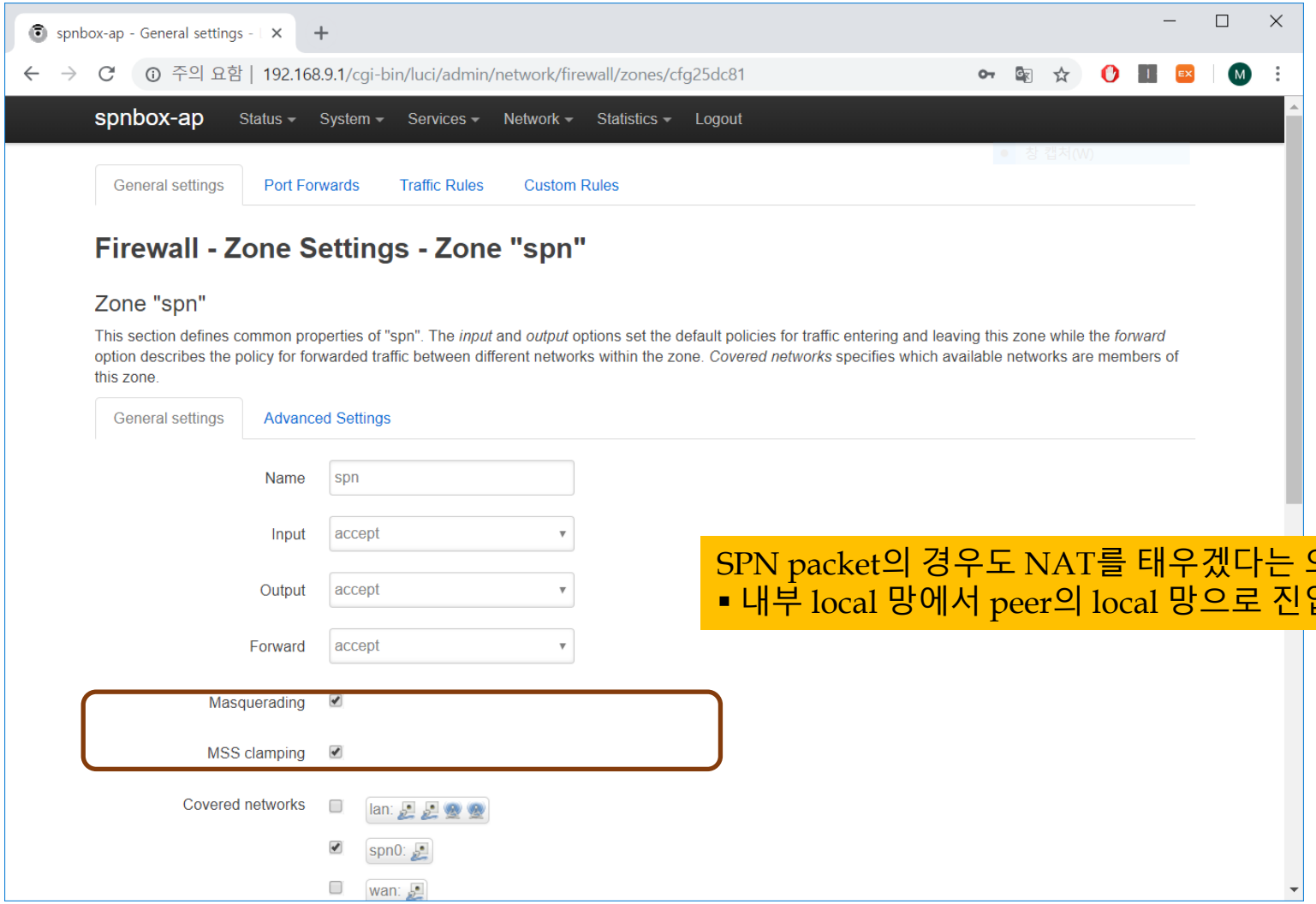


SPN port가 Firewall에 의해 차단되므로 SPN port를 허용해 주어야 함.

spn zone 신규 추가

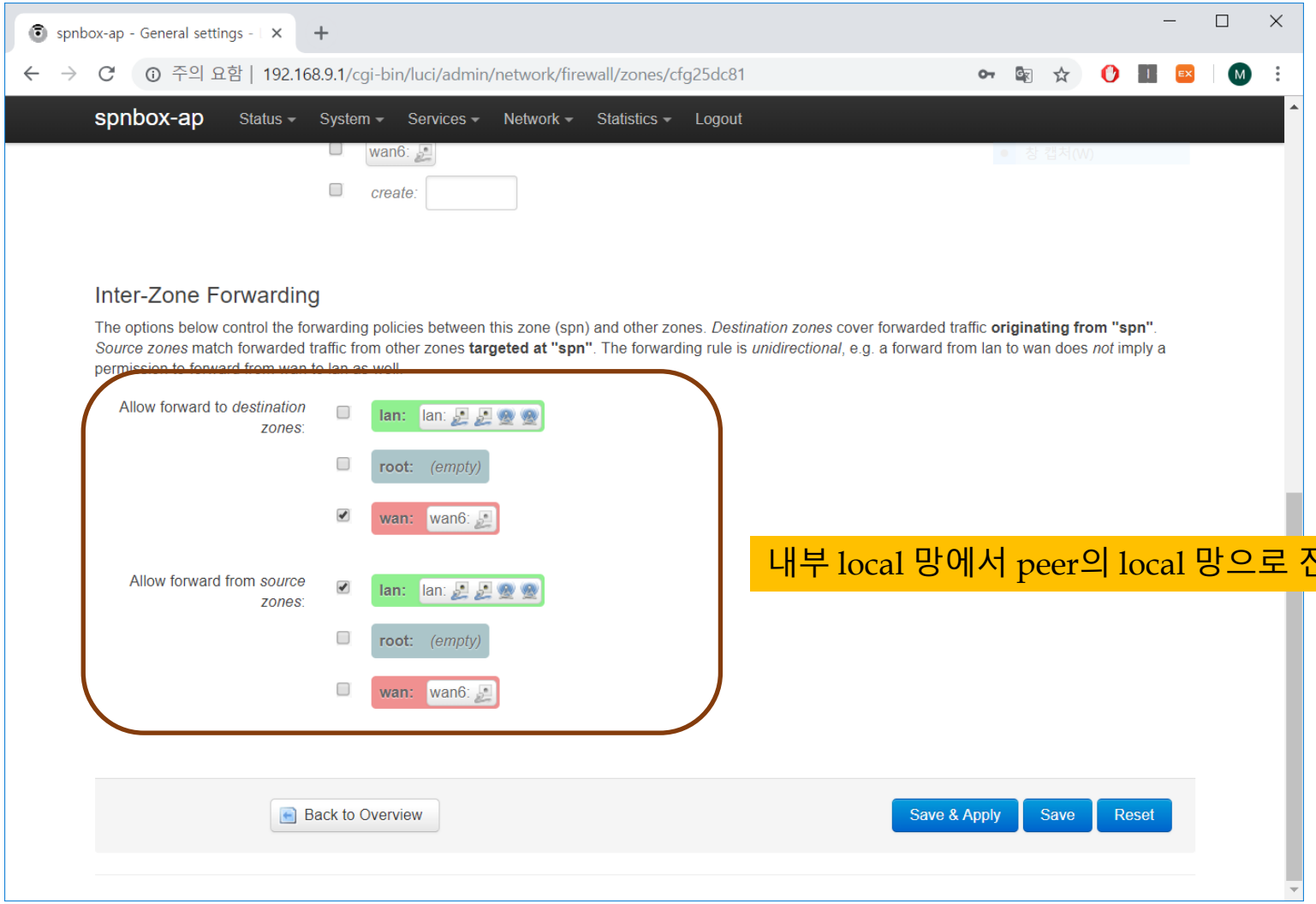
Edit 버튼 선택하여 상세 설정

5. LuCI WebUI(8) – Firewall SPN Zone 추가(2)



SPN packet의 경우도 NAT를 태우겠다는 의미임.
▪ 내부 local 망에서 peer의 local 망으로 진입시 반드시 필요함.

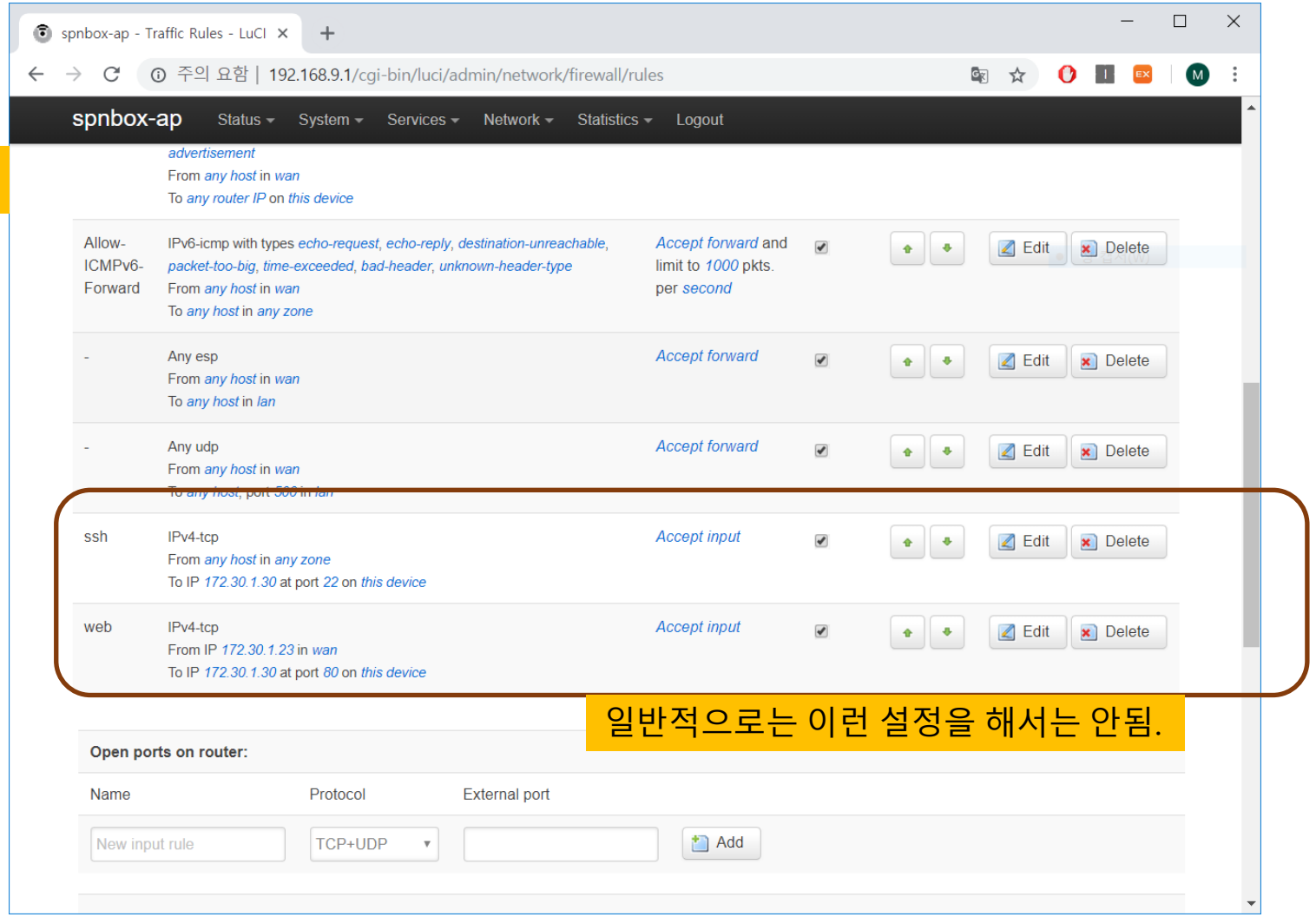
5. LuCI WebUI(8) – Firewall SPN Zone 추가(3)



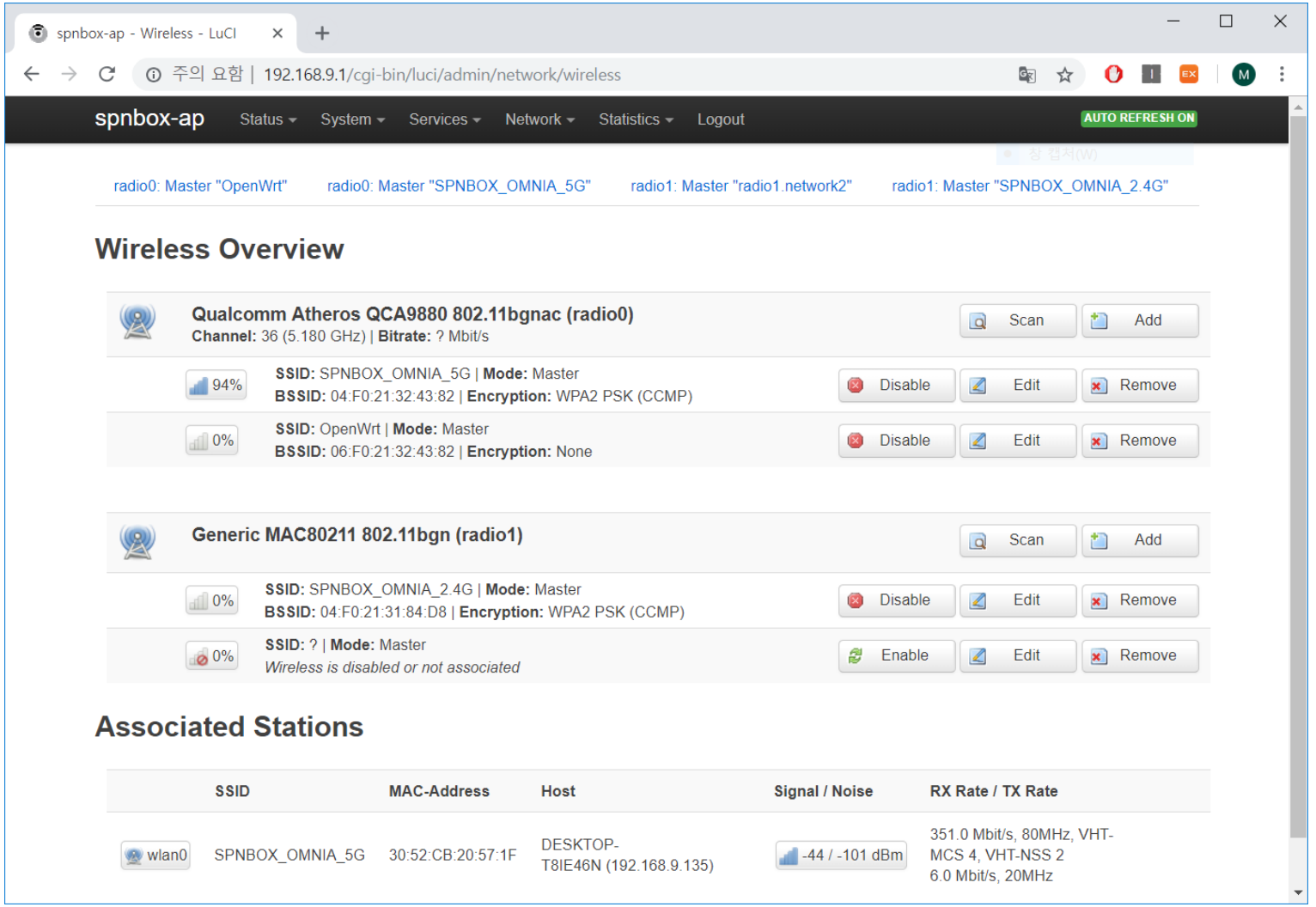
내부 local 망에서 peer의 local 망으로 진입시 반드시 필요함.

5. LuCI WebUI(9) – 외부망에서 SPNBox 접근 허용 예

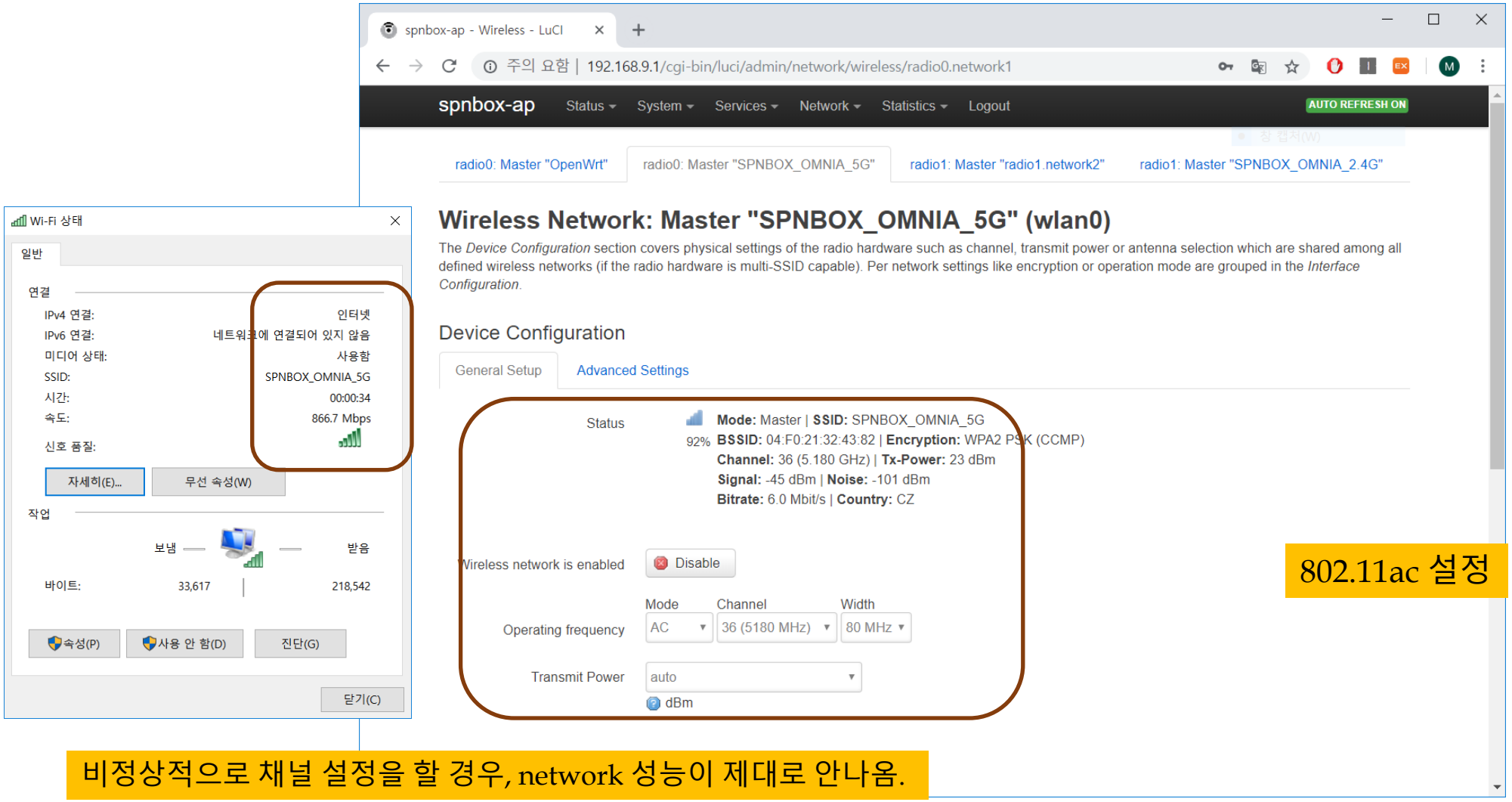
Firewall - Traffic Rules



5. LuCI WebUI(10) – Wireless 설정(1)



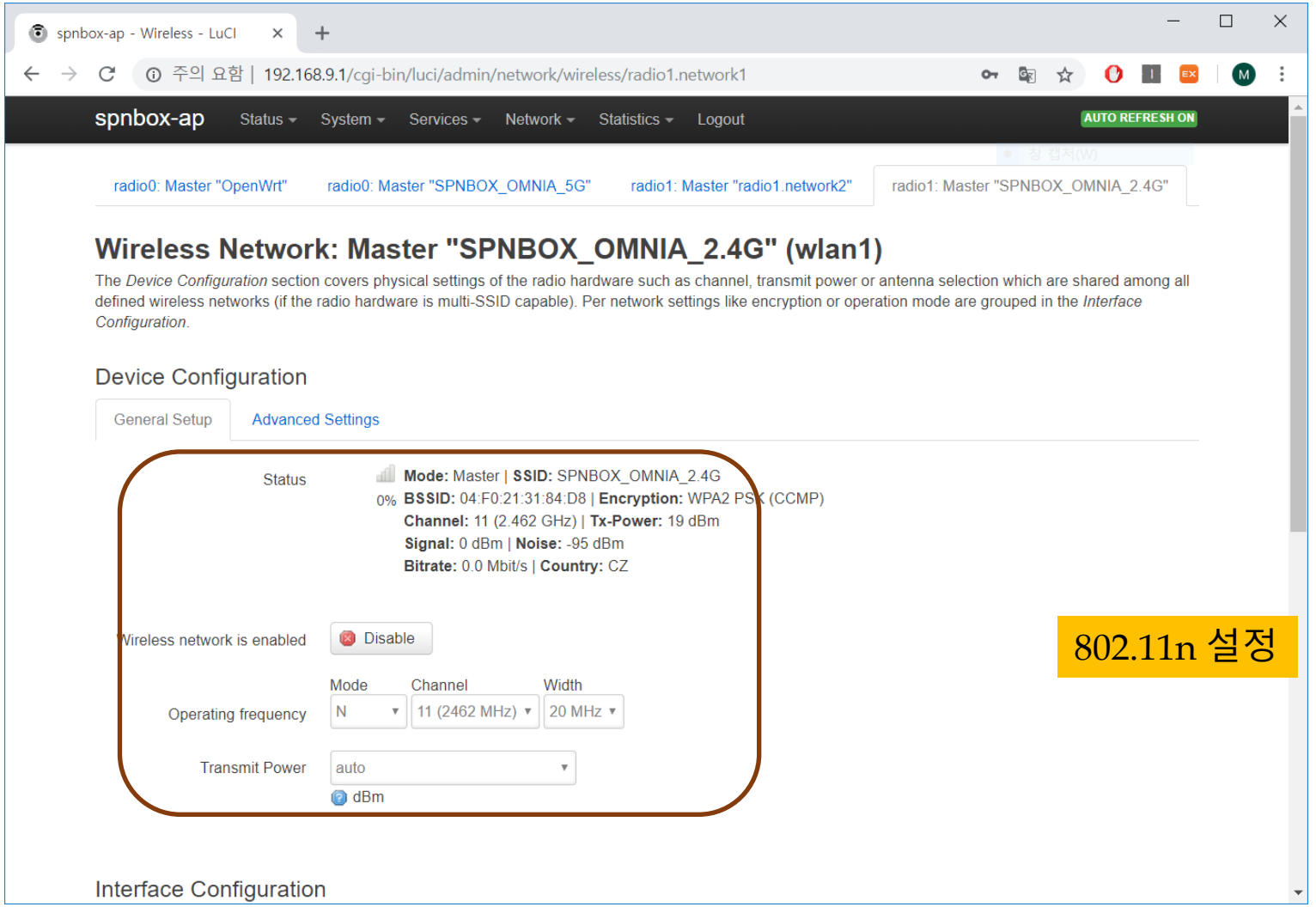
5. LuCI WebUI(10) – Wireless 설정(2)



802.11ac 설정

비정상적으로 채널 설정을 할 경우, network 성능이 제대로 안나옴.

5. LuCI WebUI(10) – Wireless 설정(3)

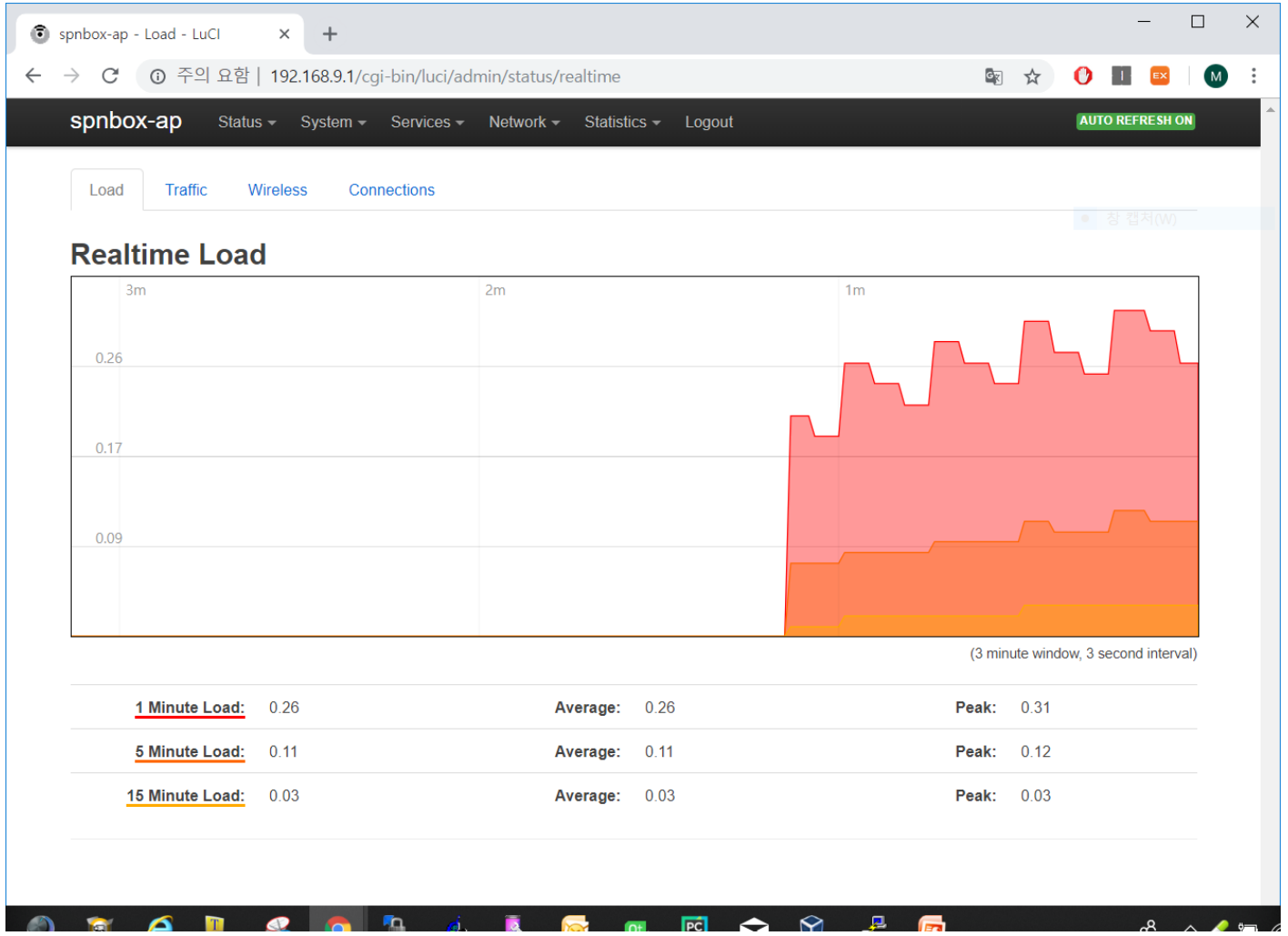


5. LuCI WebUI(10) – Wireless 설정(4)

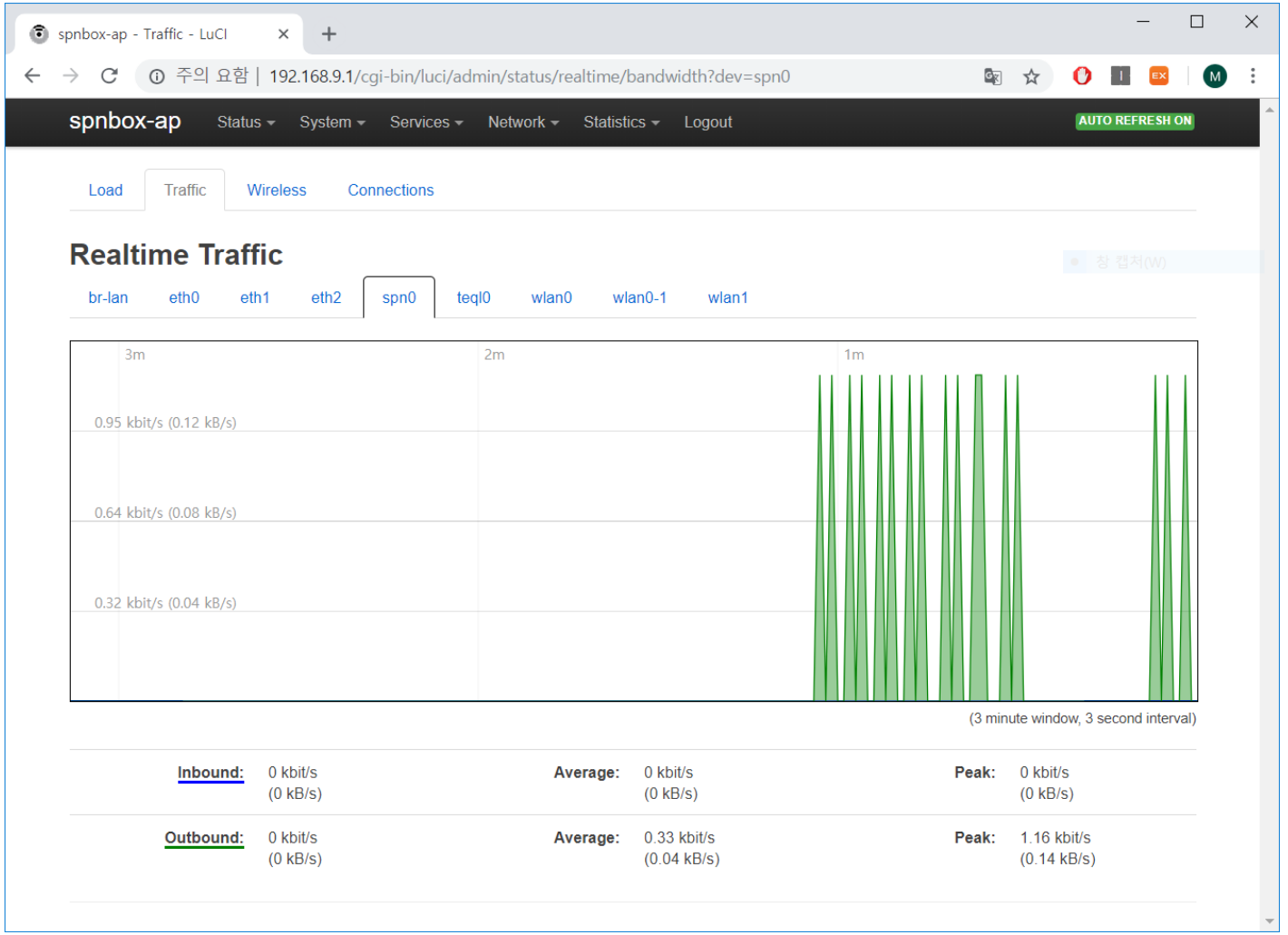
기능	상세 정보
1. 지원 모드	Access Point, Client, Ad-Hoc 802.11s(mesh), WDS(AP or Client)
2. AP Security	WPA-PSK, WPA2-PSK, WPA-PSK/WPA2-PSK Mixed mode, WPA-EAP, WPA2-EAP
3. Cipher	Force CCMP(AES), Force TKIP, Force TKIP and CCMP(AES)
4. Fast Roaming	802.11r Fast Transition
5. 802.11w Management Frame Protection	지원(실제 data가 아니라 wifi 연결을 위한 frame이 암호화 되는 기능)
6. MAC Filter	Supported

(*) 너무 많아서 일일이 화면 capture를 할 수는 없으나, 고사양 wireless LAN에서 언급하는 거의 대부분의 기능을 제공함.

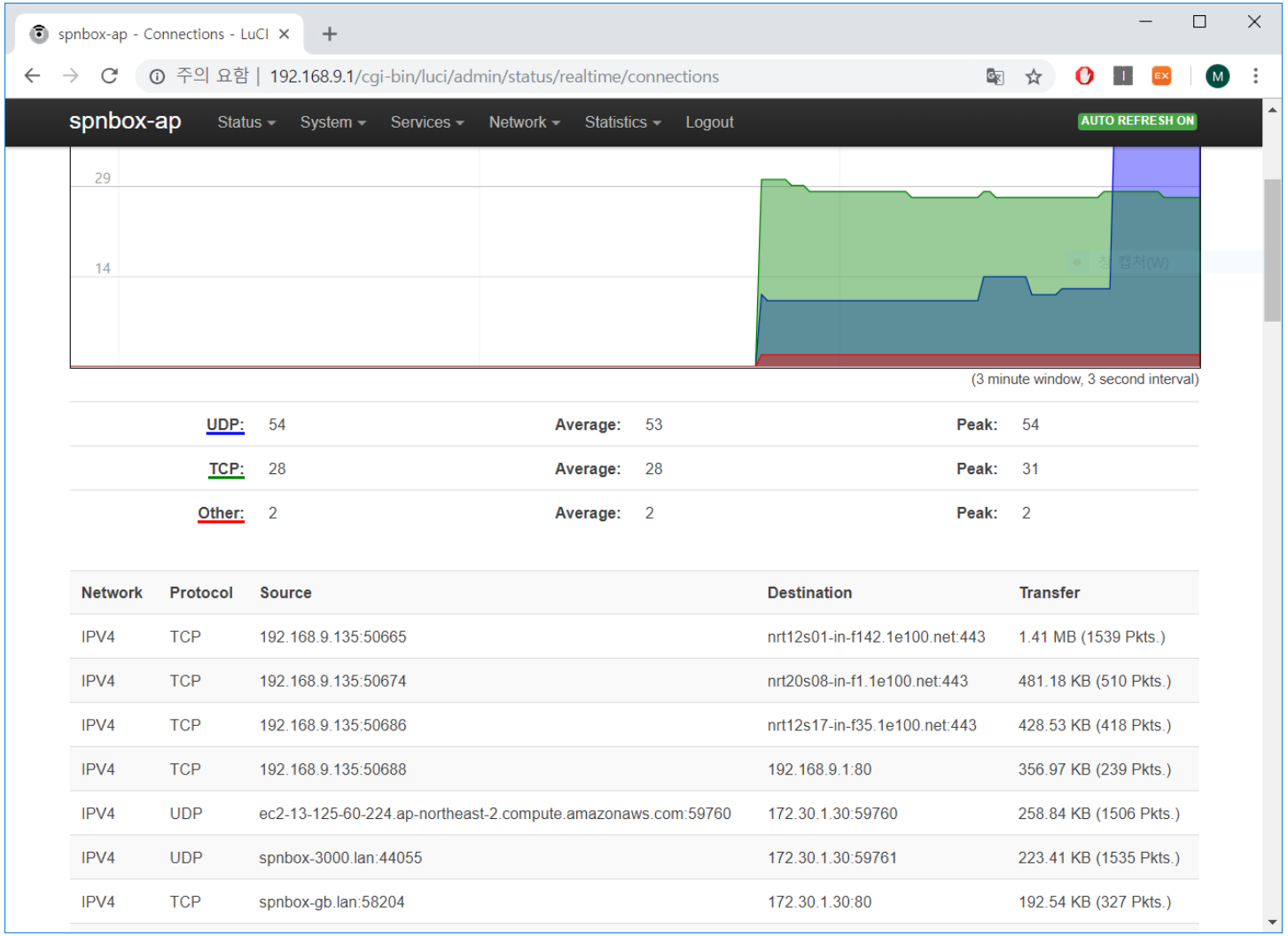
5. LuCI WebUI(11) – RealTime Graph(1)



5. LuCI WebUI(11) – RealTime Graph(2)



5. LuCI WebUI(11) – 세션 정보 확인



6. Foris WebUI 분석(1) – Foris 화면 진입 차단하기

- **<foris & luci UI 화면이 구동되는 순서>**

/etc/lighttpd/lighttpd.conf (=> lighttpd의 configuration file)

➔

include "/etc/lighttpd/conf.d/*.conf"

➔

/etc/lighttpd/conf.d/turis-root.conf

➔

/usr/share/turris-webapps/turris-root-cgi

➔

여기서 foris와 luci 화면으로 분기하는군 ... 아래와 같이 00_foris.conf 파일을 삭제하면, 자동으로 foris 화면으로 넘어가는 것을 막을 수 있다.

```
root@turris:/usr/share/turris-webapps# ls -la
drwxr-xr-x    1 root     root           130 Dec 27 15:00 .
drwxr-xr-x    1 root     root           398 Dec 26 11:02 ..
-rw-r--r--    1 root     root           144 Dec 18 21:02 00_foris.conf.ORIG   ← 00_foris.conf 파일을 제거하자.
-rw-r--r--    1 root     root            84 Nov 30 19:32 05_luci.conf
-rwxr-xr-x    1 root     root          3730 Dec 27 14:51 turris-root-cgi
-rwxr-xr-x    1 root     root          3730 Dec 27 14:51 turris-root-cgi.ORIG
```

6. Foris WebUI 분석(2) – Foris daemon 중지하기

<foris daemon 제거하기>

✓ /etc/rc.d/ 아래의 아래 link를 제거(삭제)

✓ foris-controller, foris-ws(web socket) daemon의 구동을 막을 수 있음.

- lrwxrwxrwx 1 root root 18 Dec 26 11:02 K1foris-ws -> ../init.d/foris-ws
- lrwxrwxrwx 1 root root 18 Dec 26 11:48 S69foris-ws -> ../init.d/foris-ws
- lrwxrwxrwx 1 root root 26 Dec 26 11:49 S70foris-controller -> ../init.d/foris-controller

7. SPNBox-AP 2IP WebUI(1)

2IP WebUI
(PHP engine)
(Coyote)

Controller
(Racoon)

User Input(CLI)

inet socket(UDP)
or
domain socket

Only SPN Rules

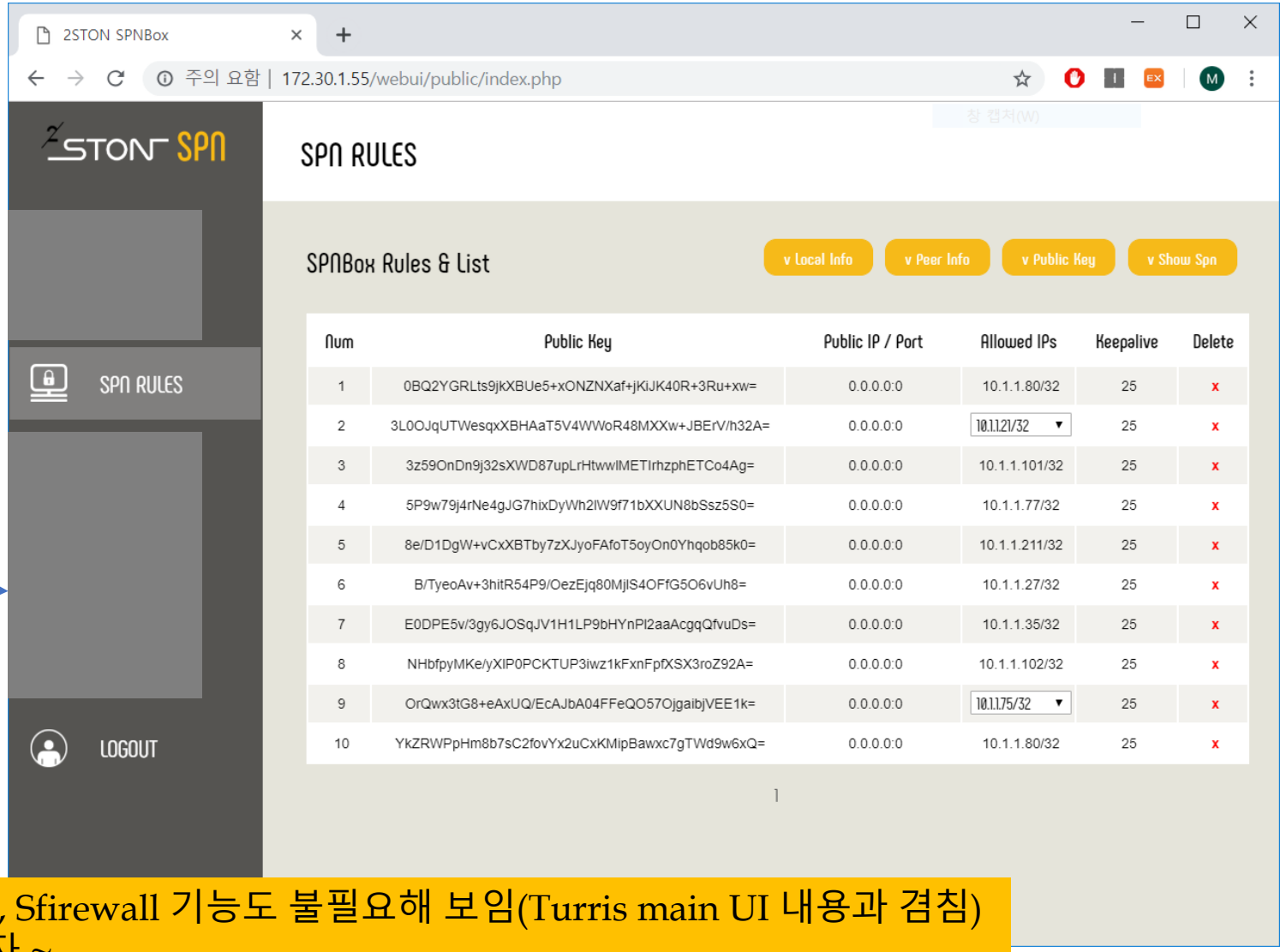
vtysh

/sbin/vtysh

위 동물 그림은 크게 신경쓰지 마시길^^

7. SPNBox-AP 2IP WebUI(2)

Turris main UI

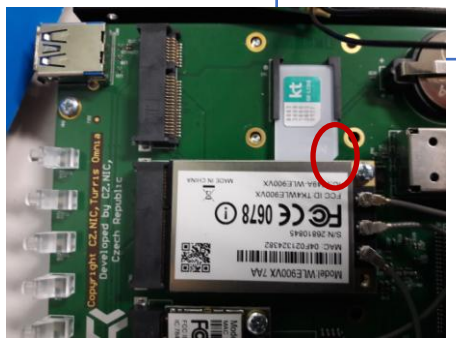


(*) 사실상, Sfirewall 기능도 불필요해 보임(Turris main UI 내용과 겸침)

- 빼자 ~

8. LTE Module 연결(1) – Quectel EC25-E LTE Module

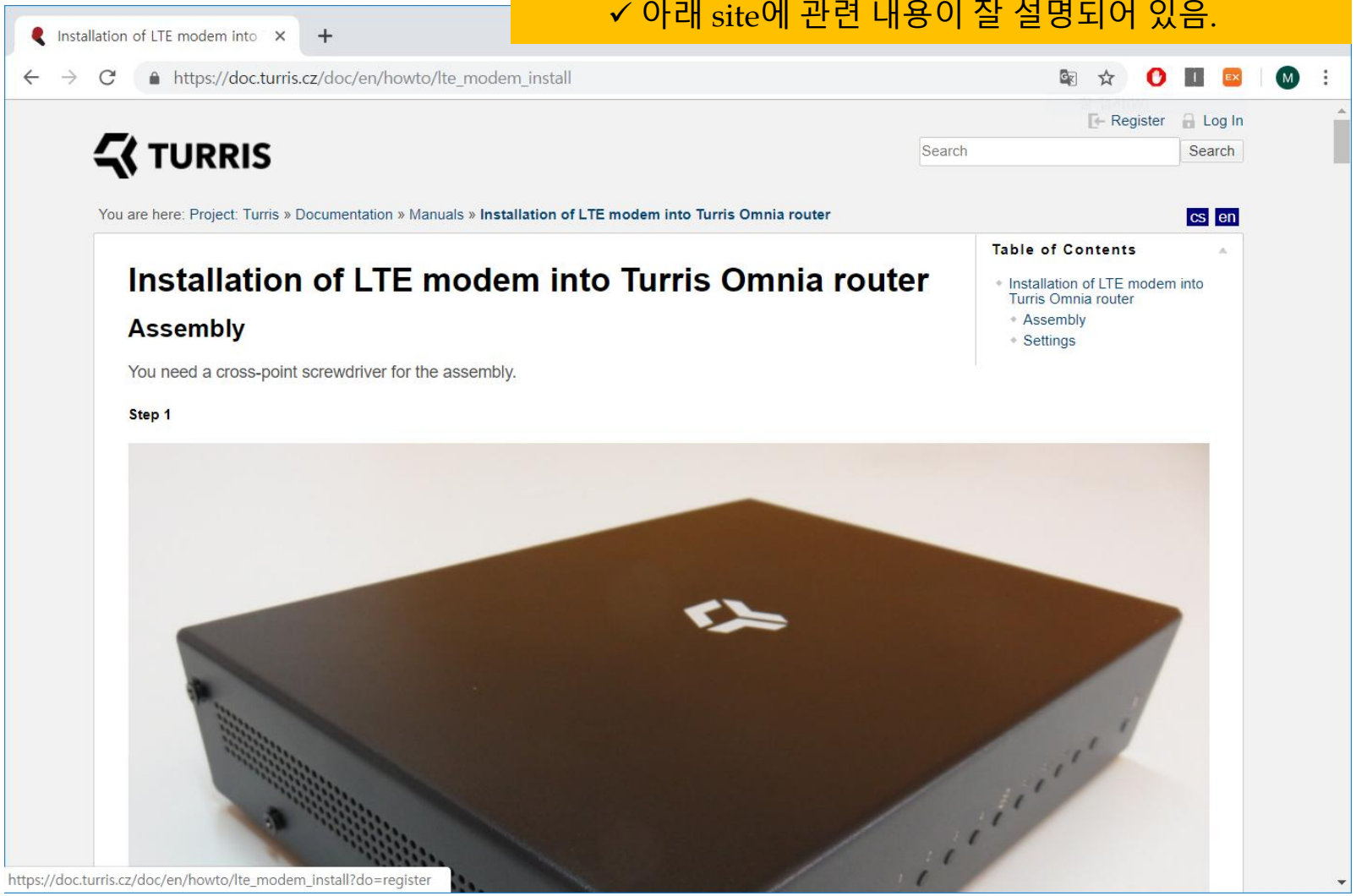
요 아래에 USIM이 꽂혀 있음.
✓/ 모서리 깍인 부분이 아래로 위치함.



[주의 사항]
LTE 모뎀을 붙일 때에는 USIM을 꽂은 상태에서 반드시 장비를 2~3번 정도 재 부팅해 주어야 한다 => USIM 문제

8. LTE Module 연결(2) – 참고 Site(1)

https://doc.turris.cz/doc/en/howto/lte_modem_install
✓ 아래 site에 관련 내용이 잘 설명되어 있음.



8. LTE Module 연결(3) – 참고 Site(2)

Step 2

Now we should be redirected to the settings page. You can see that the protocol is set to `UMTS/GPRS/EV-DO`.

Put `/dev/ttyUSB2` into the `Modem device` field.

> If `/dev/ttyUSB2` is not in the menu it could mean that it is necessary to install the **kmod-usb-serial-qualcomm** package.
>
> If you have automatic updates allowed on your router make sure that you have the `netutils` userlist enabled. You can do it in the foris web interface (LuCI password was set there). Just click on the `UPDATER` tab and enable the `Extensions of network protocols` option. Don't forget to store the settings using `Save Changes` button. The package will be automatically installed a bit later.
>
> If you don't have automatic updates allowed you need to install the package manually.

Choose `UMTS/GPRS` for the `Service Type`.

> Don't be confused by the name of the option. The card could use LTE network even though the LTE option is not mentioned. To see which network is currently used by your card you could connect to your router using SSH and insert a command:
>
> `uqmi -d /dev/cdc-wdm0 –get-signal-info`

Then set the `APN` field. Your provider should instruct you what to put there (usually it is something like “internet”).

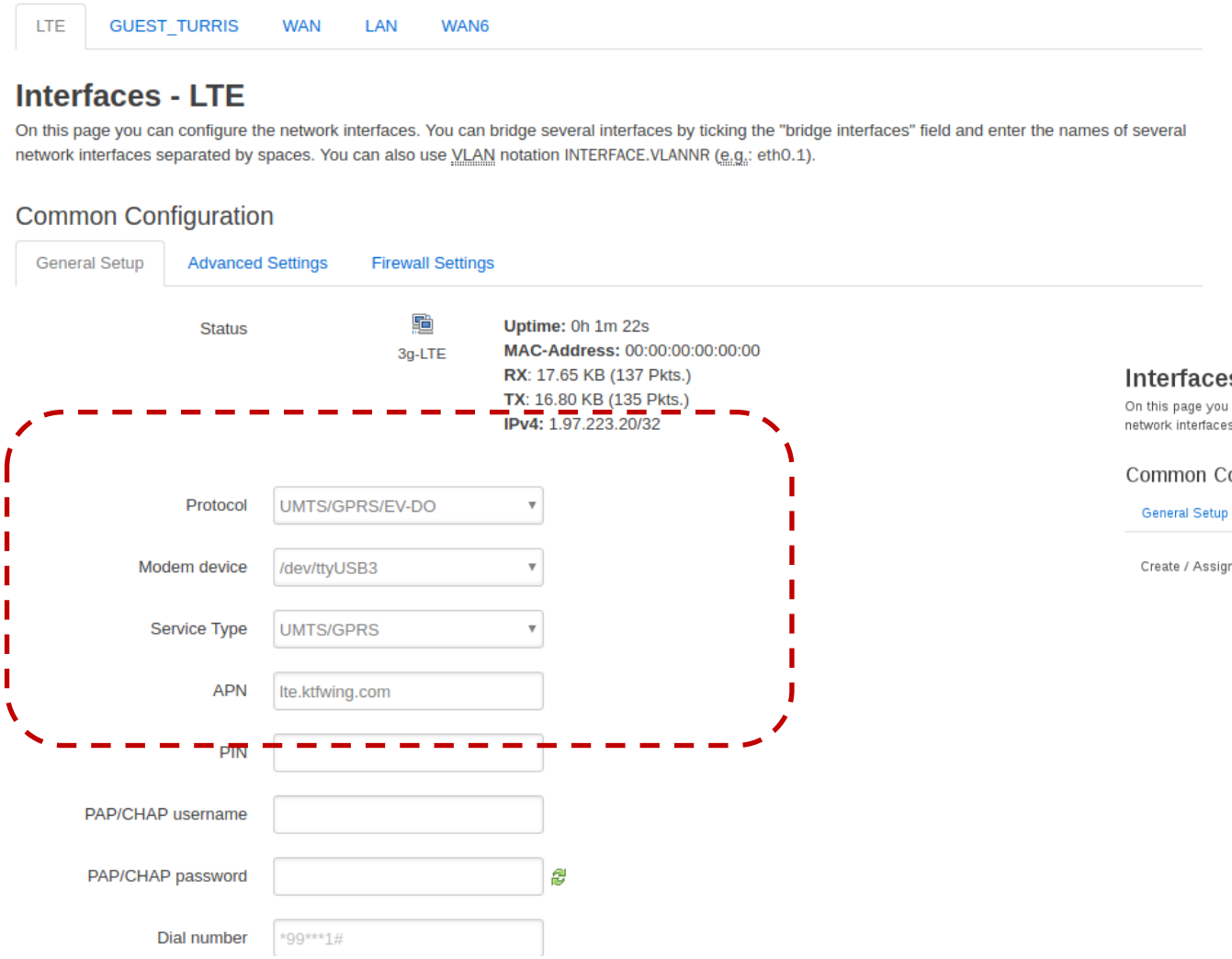
Lastly set the `PIN` for your SIM card. If you don't have it set for your card just leave the field empty.

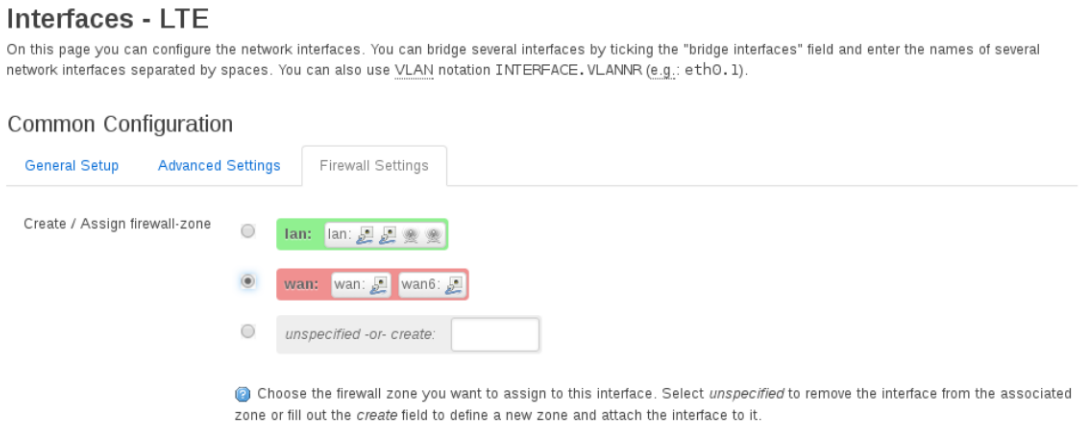
> Make sure that you insert the correct pin code. Usually the pin code is blocked after 3 failed attempts and it is necessary to unblock it afterwards.

LTE modue이 정상 동작하려면 Linux와 USB interface가 정상적으로 올라와 져야 한다.

```
root@SPNBox-1000:~# opkg install kmod-usb-serial-qualcomm
Package kmod-usb-serial-qualcomm (4.4.169+2-1-7bc33afbb1b35f5830b2b1b42c9cd8a0-2) installed in root is up
 to date.
root@SPNBox-1000:~#
root@SPNBox-1000:~#
root@SPNBox-1000:~# ls -l /dev/ttyUSB*
crw-r--r--    1 root     root      188,   0 Mar 22 13:04 /dev/ttyUSB0
crw-r--r--    1 root     root      188,   1 Mar 22 13:04 /dev/ttyUSB1
crw-r--r--    1 root     root      188,   2 Mar 22 13:04 /dev/ttyUSB2
crw-r--r--    1 root     root      188,   3 Mar 22 13:04 /dev/ttyUSB3
```

8. LTE Module 연결(4) – LuCI 설정





8. LTE Module 연결(5) – ps & netstat -nr

```
2761 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2764 root     21124 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2766 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2767 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2768 root     20952 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2775 root     20952 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2778 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2782 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2786 root     20900 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2787 root     21028 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2793 root     21004 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
2794 root     21108 S    {foris-controlle} /usr/bin/python3.6 /usr/bin/foris-controller -b openwrt -C
3784 root      2812 R    sshd: root@pts/0
3810 root      1112 S    -ash
5831 root         0 SW   [kworker/0:1]
5924 root         0 SW   [kworker/u4:0]
5925 root         0 SW<  [kworker/u5:0]
5994 root         0 SW   [kworker/u4:3]
6066 root      1272 S    /bin/sh /etc/rc.common /etc/init.d/kresd reload
6067 root      1108 S    sleep 60
6111 root      1552 S    /sbin/netifd
6400 root      2080 S    /usr/sbin/hostapd -P /var/run/wifi-phy1.pid -B /var/run/hostapd-phy1.conf
6470 root         0 SW   [kworker/1:0]
6486 root      2084 S    /usr/sbin/hostapd -P /var/run/wifi-phy0.pid -B /var/run/hostapd-phy0.conf
6570 root      1108 S    udhcpc -p /var/run/udhcpc-eth1.pid -s /lib/netifd/dhcp.script -f -t 0 -i eth1
6683 nobody    1168 S    /usr/sbin/dnsmasq -C /var/etc/dnsmasq.conf -k -x /var/run/dnsmasq/dnsmasq.pid
6744 root      1272 S    /bin/sh /etc/rc.common /etc/init.d/kresd reload
6745 root      1108 S    sleep 60
7173 root       984 S    /usr/sbin/pppd nodetach ipparam LTE ifname 3g-LTE +ipv6 set AUTOIPV6=1 nodefa
7196 root      1152 S    /bin/sh /sbin/hotplug-call iface
7214 root       852 S    odhcp6c -s /lib/netifd/dhcpv6.script -P0 -t120 3g-LTE
7375 root      1272 S    /bin/sh /etc/rc.common /etc/init.d/kresd reload
7376 root      1108 S    sleep 60
7382 root     31776 S    /usr/bin/kresd -c /tmp/kresd.config -f 1 /tmp/kresd -a 0.0.0.0 53 -a :: 53
7406 root      1152 S    /bin/sh /sbin/hotplug-call iface
7407 root      1156 S    /bin/sh /usr/bin/foris-notify-wrapper -n -m networks -a network_change {"netw
7409 root      5536 R    {foris-notify} /usr/bin/python3.6 /usr/bin/foris-notify -n -m networks -a net
7410 root      1112 R    ps
root@SPNBox-1000:~#
```

붙었다 ☺

```
root@SPNBox-1000:~# netstat -nr
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         10.64.64.64     0.0.0.0         UG        0 0          0 3g-LTE
10.1.1.0        0.0.0.0         255.255.255.0   U         0 0          0 spn0
10.64.64.64     0.0.0.0         255.255.255.255 UH        0 0          0 3g-LTE
10.111.222.0    0.0.0.0         255.255.255.0   U         0 0          0 br-guest_turris
172.30.1.0      0.0.0.0         255.255.255.0   U         0 0          0 eth1
172.30.1.254    0.0.0.0         255.255.255.255 UH        0 0          0 eth1
192.168.1.0     0.0.0.0         255.255.255.0   U         0 0          0 br-lan
```

Thank You

We Secure the Internet of Things with 2STON™