MikroTik RouterOS Training

Базовый курс для настройки оборудования MikroTik
I-часть

Цель Курса

- Получить необходимые знания и практические навыки ПО MikroTik RouterOS по маршрутизации для небольших и средних локальных сетей.
- После окончания курса Вы сможете планировать, развертывать и обслуживать сети на MikroTik RouterOS

MikroTik's History

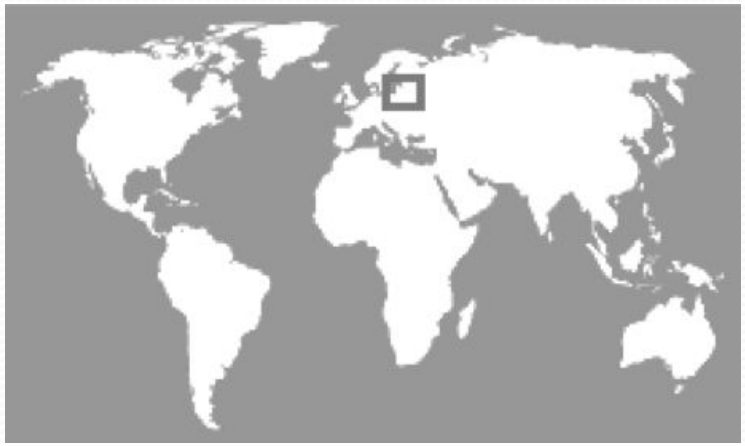
- 1995: Established
- 1997: RouterOS software for x86 (PC)
- 2002: RouterBOARD is born (Hardware solutions)
- 2006: First MUM (MikroTik User Meeting)
- 05.2009: First WiFi-radiolink Moldtelecom

About MikroTik

- Router software and hardware manufacturer
- Products used by ISPs, companies and individuals
- Make Internet technologies faster, powerful and affordable to wider range of users

Where is MikroTik?

- www.mikrotik.com
- www.routerboard.com
- Riga, Latvia, Northern Europe, EU

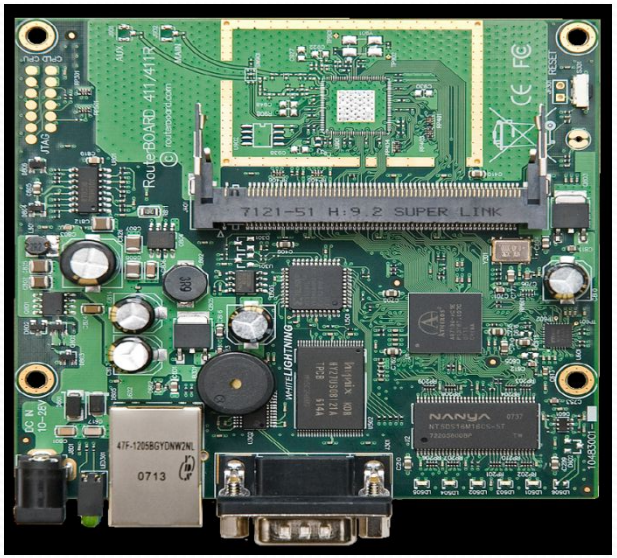


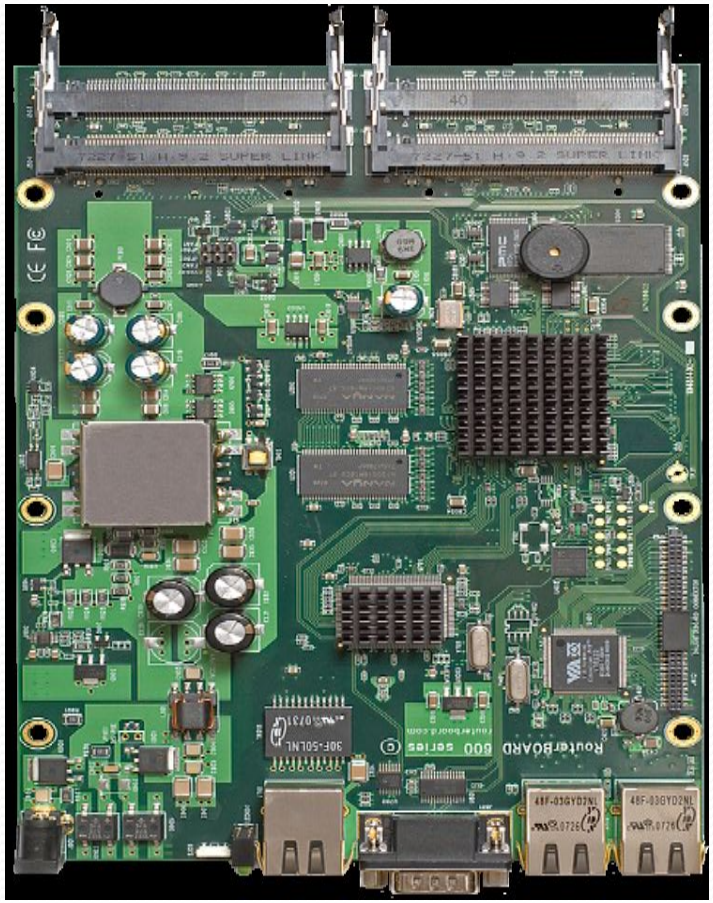
What is RouterOS ?

- RouterOS is an operating system that will make your device:
- a dedicated router
- a bandwidth shaper
- a (transparent) packet filter
- any 802.11 a, b/g/n wireless device
- The operating system of RouterBOARD
- Can be also installed on a PC

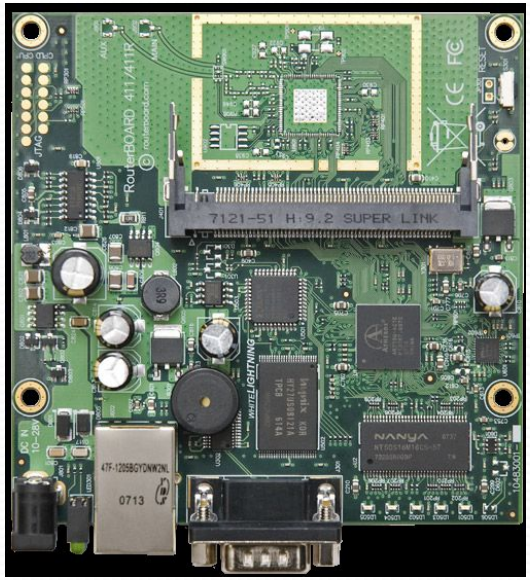
What is RouterBOARD ?

- Hardware created by MikroTik
- Range from small home routers to carrierclass access concentrators



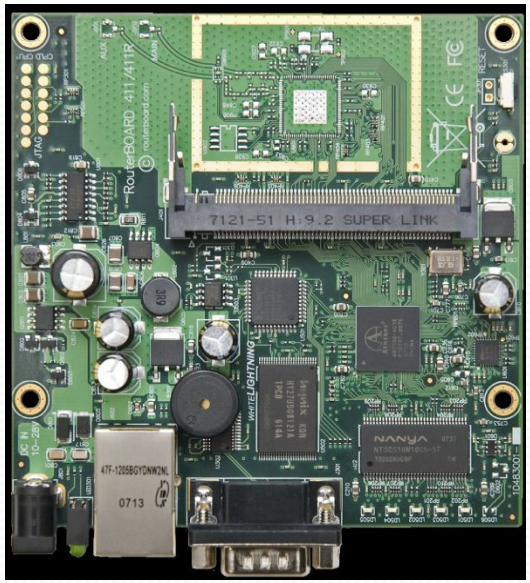


RouterBOARD 411a



CPU	Atheros AR7130 300MHz network processor
Memory	32MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	64MB onboard NAND memory chip
Ethernet	One 10/100 Mbit/s Fast Ethernet port with Auto-MDI/X
miniPCI	One MiniPCI Type IIIA/IIIB slot
Extras	Reset switch, Beeper
Serial port	One DB9 RS232C asynchronous serial port
LEDs	Power, NAND activity, 5 user LEDs
Power options	Power over Ethernet: 10..28V DC
Dimensions	10.5 cm x 10.5 cm (4.13 in x 4.13 in) Weight: 82 g
Power consumption	~3W without extension cards, maximum – 12 W
Operating System	MikroTik RouterOS v3, Level3 license

RouterBOARD 411AH



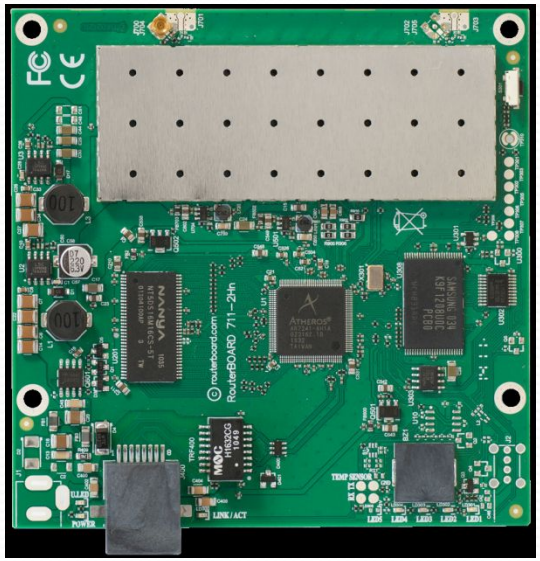
CPU	Atheros AR7161 680MHz network processor
Memory	64MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	64MB onboard NAND memory chip
Ethernet	One 10/100 Mbit/s Fast Ethernet port with Auto-MDI/X
miniPCI	One MiniPCI Type IIIA/IIIB slot
Extras	Reset switch, Beeper
Serial port	One DB9 RS232C asynchronous serial port
LEDs	Power, NAND activity, 5 user LEDs
Power options	Power over Ethernet: 10..28V DC
Dimensions	10.5 cm x 10.5 cm (4.13 in x 4.13 in) Weight: 82 g
Power consumption	~3W without extension cards, maximum – 12 W
Operating System	MikroTik RouterOS v3, Level4 license

RouterBOARD R52n-M

Dual band IEEE 802.11a/b/g/n standard

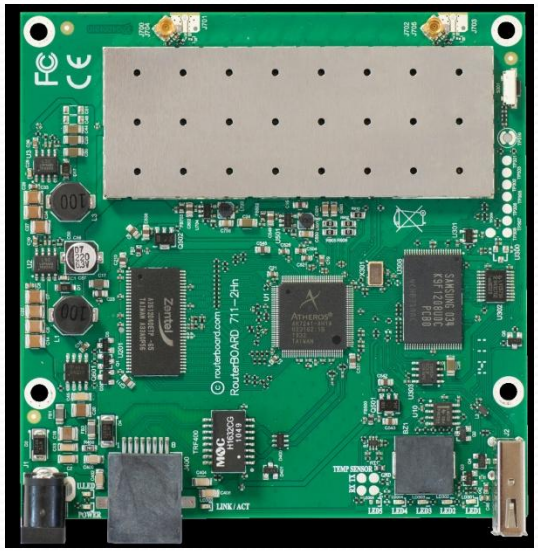
- Output Power of up to 23 dBm
- Support for up to 2x2 MIMO with spatial multiplexing
- Four times the throughput of 802.11a/g
- Atheros AR9220, chipset
- High Performance (up to 300Mbps physical data rates and 200Mbps of actual user throughput) with Low Power Consumption
- Two MMCX antenna connectors
- Modulations: OFDM: BPSK, QPSK, 16 QAM, 64QAM DSSS: DBPSK, DQPSK, CCK
- Operating temperatures: -50ºC to 60ºC
- Power consumption MAX 1.95W
- ESD protection +/- 12kV

RouterBOARD 711-2Hn



CPU	Atheros AR7241 400MHz network processor
Memory	32MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	128MB onboard NAND memory chip
Ethernet	One 10/100 Mbit/s Fast Ethernet port with Auto-MDI/X
miniPCI	none
Wireless	Built in 2GHz AR9280 802.11b/g/n card, 1x1 MIMO, 1x MMCX
Extras	Reset switch, Beeper
Serial port	none
LEDs	Power, NAND activity, 5 user LEDs
Power options	PoE: 10..28V DC (except power over datalines). No power jack
Dimensions	10.5 cm x 10.5 cm (4.13 in x 4.13 in) Weight: 67g
Power consumption	Up to 4.5W at 18V full load (0.245A)
Operating System	MikroTik RouterOS v4, Level3 license

RouterBOARD 711-2HnD

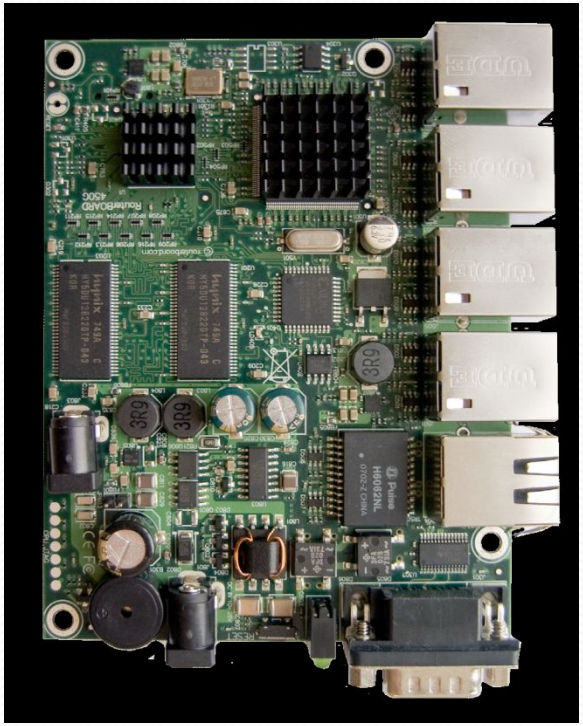


CPU	Atheros AR7241 400MHz network processor
Memory	64MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	64MB onboard NAND memory chip
Ethernet	One 10/100 Mbit/s Fast Ethernet port with Auto-MDI/X
Wireless	Built in 2GHz AR9283 802.11b/g/n card, 2x2 MIMO, 2x MMCX
Extras	Reset switch, Beeper
Serial port	none
LEDs	Power, NAND activity, 5 user LEDs
Power options	PoE: 8-30V DC on Ether1 (Non 802.3af).
Dimensions	10.5 cm x 10.5 cm (4.13 in x 4.13 in) Weight: 67g
Power consumption	Up to 4.5W at 18V full load (0.245A)
Operating System	MikroTik RouterOS v4, Level4 license

RouterBOARD RB751U-2HnD

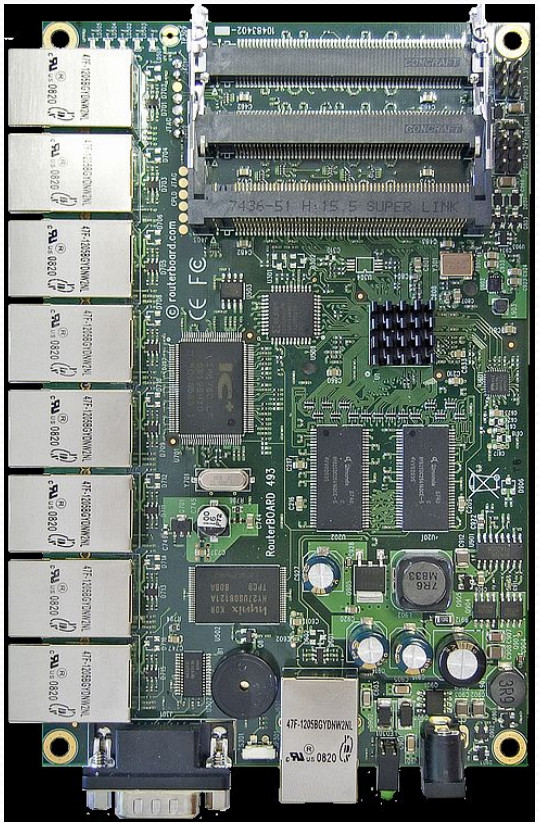
Features RB751U-2HnD (USB, 2GHz, 802.11n, dual chain)
CPU Atheros AR7241 400MHz CPU
Memory 32MB DDR SDRAM onboard memory
Data storage 64MB onboard NAND storage chip
Ethernet Five independent 10/100 Ethernet ports
LEDs Power, NAND activity, 5 Ethernet LEDs, wireless activity LED
Power options PoE: 8-30V DC on Ether1 (Non 802.3af). Jack: 8-30V DC
Dimensions 113x138x29mm. Weight without packaging and cables: 230g
Power consumption Up to 10W
Operating Temp -20C .. +50C
Operating System MikroTik RouterOS, Level4 license
Package contains RouterBOARD in a plastic case, power adapter

RouterBOARD 450G



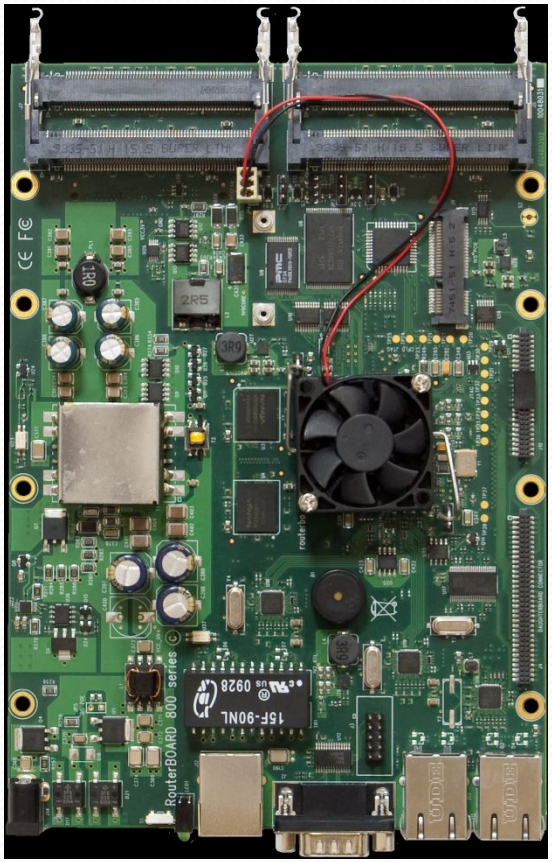
CPU	Atheros AR7161 680MHz network processor
Memory	256MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	512MB onboard NAND memory chip, microSD slot
Ethernet	Five 10/100/1000 Mbit/s Ethernet ports with Auto-MDI/X
Extras	Reset switch, Beeper
Serial port	One DB9 RS232C asynchronous serial port
LEDs	Power, NAND activity, 5 user LEDs
Power options	Power over Ethernet: 10..28V DC
Dimensions	9 cm x 11.5 cm, 105 grams
Operating System	MikroTik RouterOS v3, Level4 license

RouterBOARD 493AH



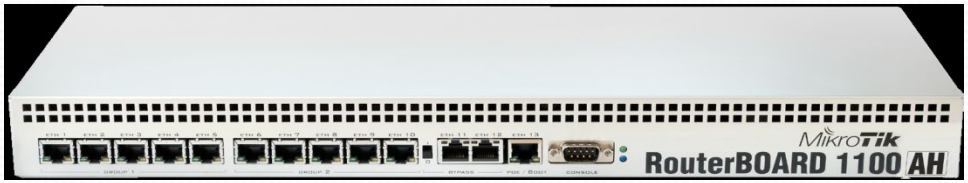
CPU	Atheros AR7161 680MHz
Memory	128MB DDR SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	64MB onboard NAND memory chip
Ethernet	Nine 10/100 Mbit/s Fast Ethernet ports with Auto-MDI/X
miniPCI	Three miniPCI slots
Extras	Reset switch, Beeper
Serial port	One DB9 RS232C asynchronous serial port
LEDs	Power, NAND activity, 5 user LEDs
Power options	Power over Ethernet: 10..28V DC (except power over datalines). Power jack: 10..28V DC
Dimensions	105mm x 160mm, 189 grams
Power consumption	~3W without extension cards, maximum – 16 W
Operating System	MikroTik RouterOS v3, Level5 license

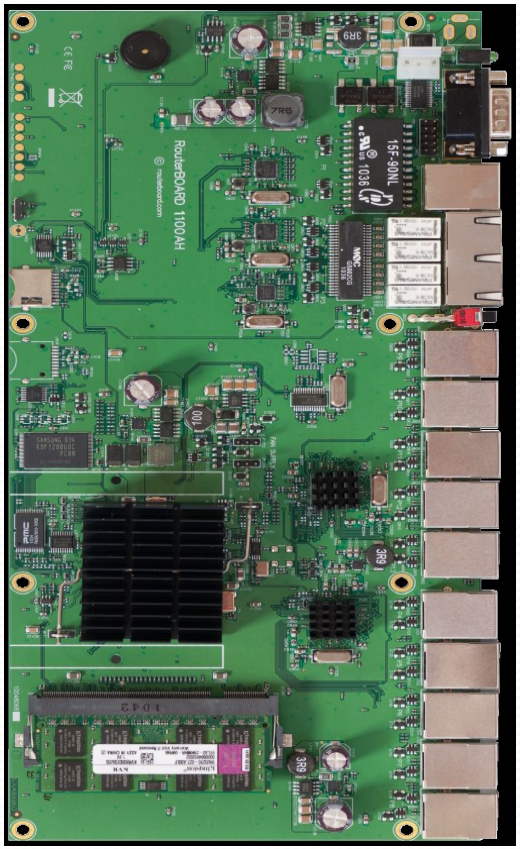
RouterBOARD 800



CPU	MPC8544 800MHz
Memory	256MB DDR2 SDRAM onboard memory
Boot loader	RouterBOOT
Data storage	NAND memory chip, CF slot on back
Ethernet Three	10/100/1000 Mbit/s Ethernet ports with Auto-MDI/X
miniPCI	4 x miniPCI, 1 x miniPCI-e
Extras	Reset switch, Beeper, 4x Fan headers (JP1,JP3 = 3.3V, JP2,JP4 = 5.5V)
Serial port	One DB9 RS232C asynchronous serial port, One serial port
LEDs	Power, 1x User LED
Power options	PoE: 36-56V DC (including power over datalines)
Power jack:	10-56V DC
Dimensions	14 cm x 20 cm (5.51 in x 7.87 in), 285 g
Operating System	MikroTik RouterOS v4, Level6 license

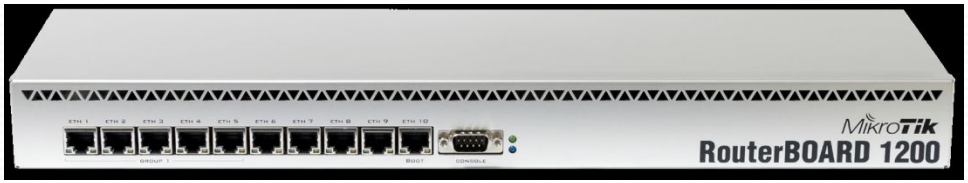
RouterBOARD 1100AH

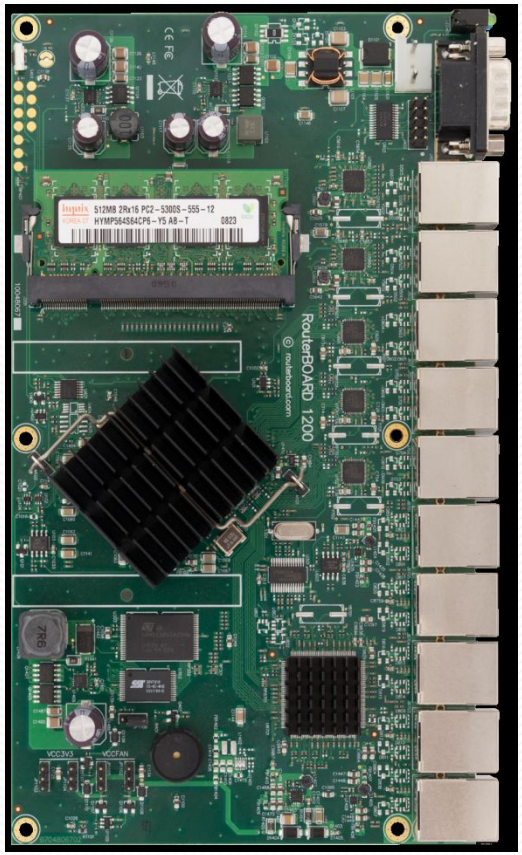




CPU	PowerPC 1066MHz network CPU
Memory	SODIMM DDR Slot, 2GB installed
Boot loader	RouterBOOT, 1Mbit Flash chip
Data storage	Onboard NAND memory chip, one microSD card slot
Ethernet	Thirteen 10/100/1000 Mbit/s Gigabit Ethernet with Auto-MDI/X
Ethernet	Includes switch to enable Ethernet bypass mode in two ports
miniPCI	none
Serial port	One DB9 RS232C asynchronous serial port
Extras	Reset switch, beeper, voltage and temperature sensors
Power options	(standard connector 110/220V), PoE (12-24V on port 13)
Fan	no fan, no fan headers
Dimensions	1U case: 44 x 176 x 442 mm, 1275g. Board only: 365g
Operating System	MikroTik RouterOS, Level 6 license

RouterBOARD 1200





CPU	PowerPC PPC460GT
Memory	SODIMM DDR Slot, 512MB RAM
Boot loader	RouterBOOT, 1Mbit Flash chip
Ethernet	Ten 10/100/1000 Mbit/s Gigabit Ethernet with Auto-MDI/X
miniPCI	none
Storage	64MB NAND
Serial port	One DB9 RS232C asynchronous serial port
Extras	Reset switch, Beeper
Power options	IEC C14 standard connector 110/220V
Fan	no cooling fan
Dimensions	1U case: 44 x 176 x 442 mm, 1200g. Board only: 365g
Operating System	MikroTik RouterOS, Level 6 license

RouterBOARD SXT

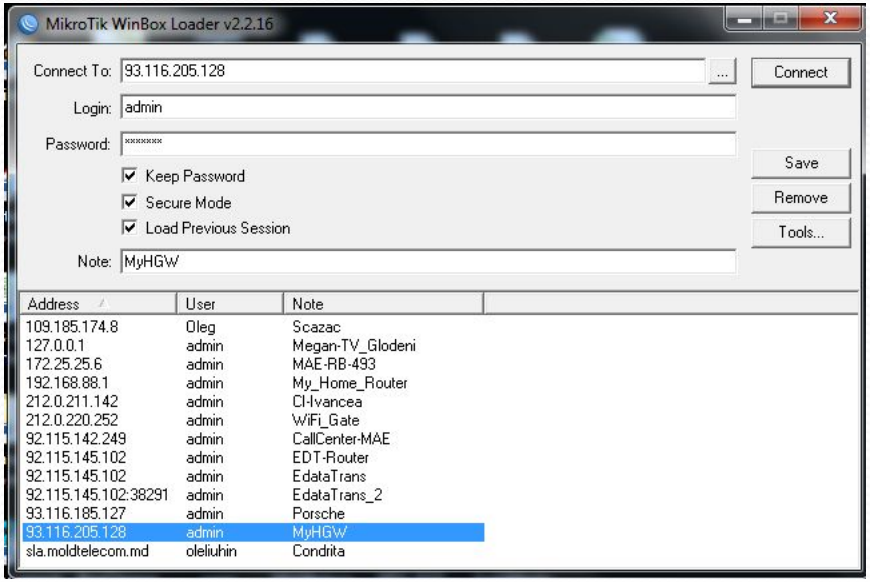
Features 5HnD (5Ghz, High power wireless, 802.11n, Dual-chain)
CPU Atheros AR7241 400MHz CPU
Memory 32MB DDR SDRAM onboard memory
Data storage 64MB onboard NAND storage chip
Ethernet One 10/100 ethernet port, L2MTU frame size up to 4076
Wireless cards Onboard dual chain 5GHz 802.11a/n Atheros AR9280 wireless module; 10kV ESD protection on each RF port
Extras Reset switch, beeper, USB 2.0 port, voltage and temperature monitors
LEDs Power LED, Ethernet LED, 5 wireless signal LED
Power options Power over Ethernet: 8-30V DC
Packaged with 24V DC 0.8A power adapter and passive PoE injector
Dimensions 140x140x56mm. Weight without packaging, adapters and cables: 265g
Power consumption Up to 7W
Operating Temperature -30C .. +80C
Operating System MikroTik RouterOS v5, Level3 license

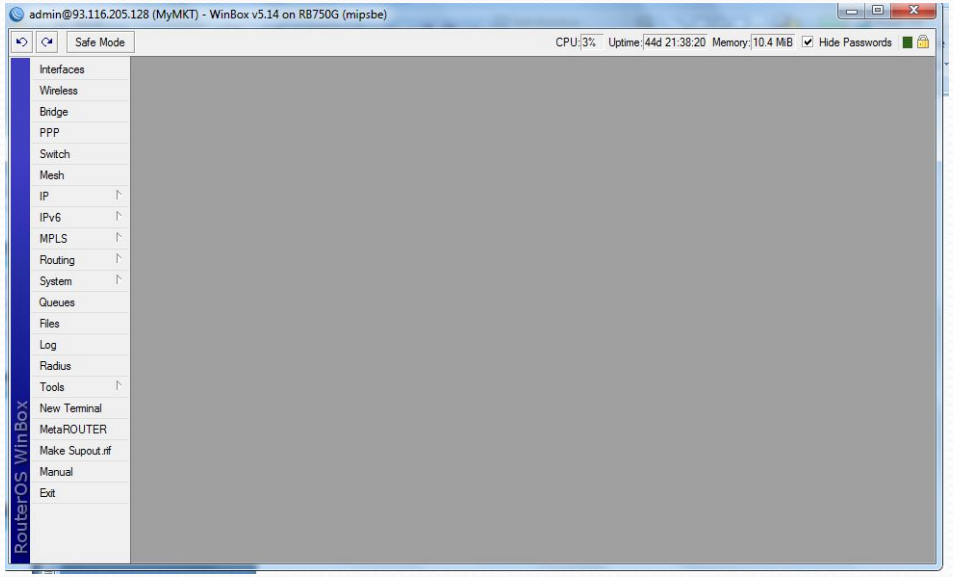
License Levels

Level number	0 (FREE)	1 (DEMO)	3 (WISP CPE)	4 (WISP)	5 (WISP)	6 (Controller)
EoIP tunnels	24h limit	1	unlimited	unlimited	unlimited	unlimited
OVPN tunnels	24h limit	1	200	200	unlimited	unlimited
VLAN interfaces	24h limit	1	unlimited	unlimited	unlimited	unlimited
Queues	24h limit	1	unlimited	unlimited	unlimited	unlimited
Wireless AP	24h limit	-	-	yes	yes	yes
Wireless Client and Bridge	24h limit	-	yes	yes	yes	yes
RIP, OSPF, BGP protocols	24h limit	-	yes(*)	yes	yes	yes
RADIUS client	24h limit	-	yes	yes	yes	yes
Web proxy	24h limit	-	yes	yes	yes	yes
User manager active sessions	24h limit	1	10	20	50	Unlimited
PPPoE tunnels	24h limit	1	200	200	500	unlimited
PPTP tunnels	24h limit	1	200	200	500	unlimited
L2TP tunnels	24h limit	1	200	200	500	unlimited
HotSpot active users	24h limit	1	1	200	500	unlimited

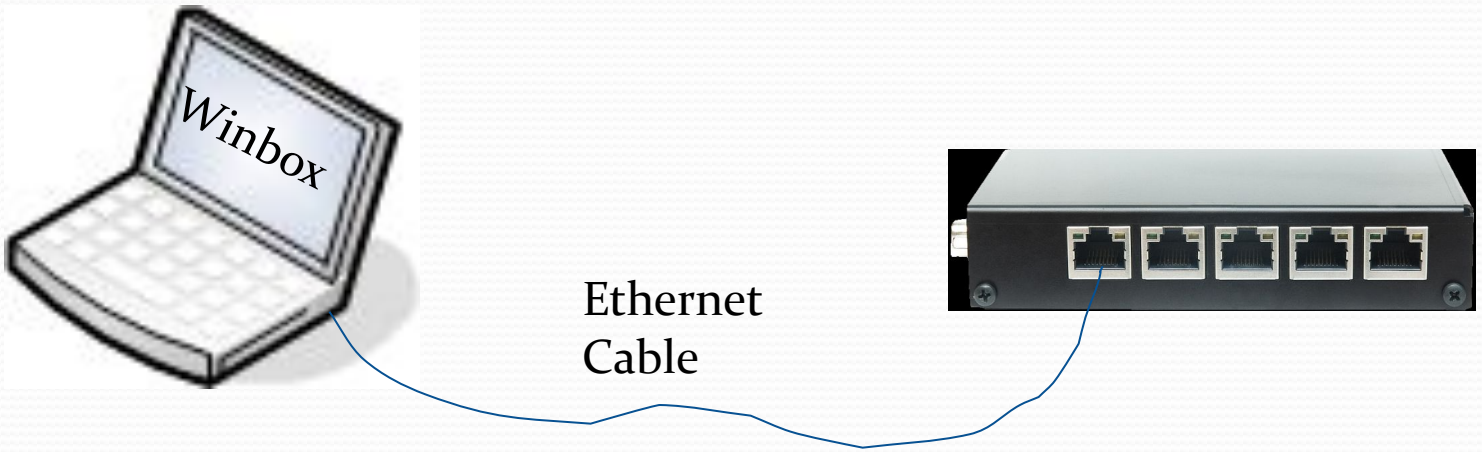
Winbox

- The application for configuring RouterOS
- It can be downloaded from http://www.mikrotik.com/download.html

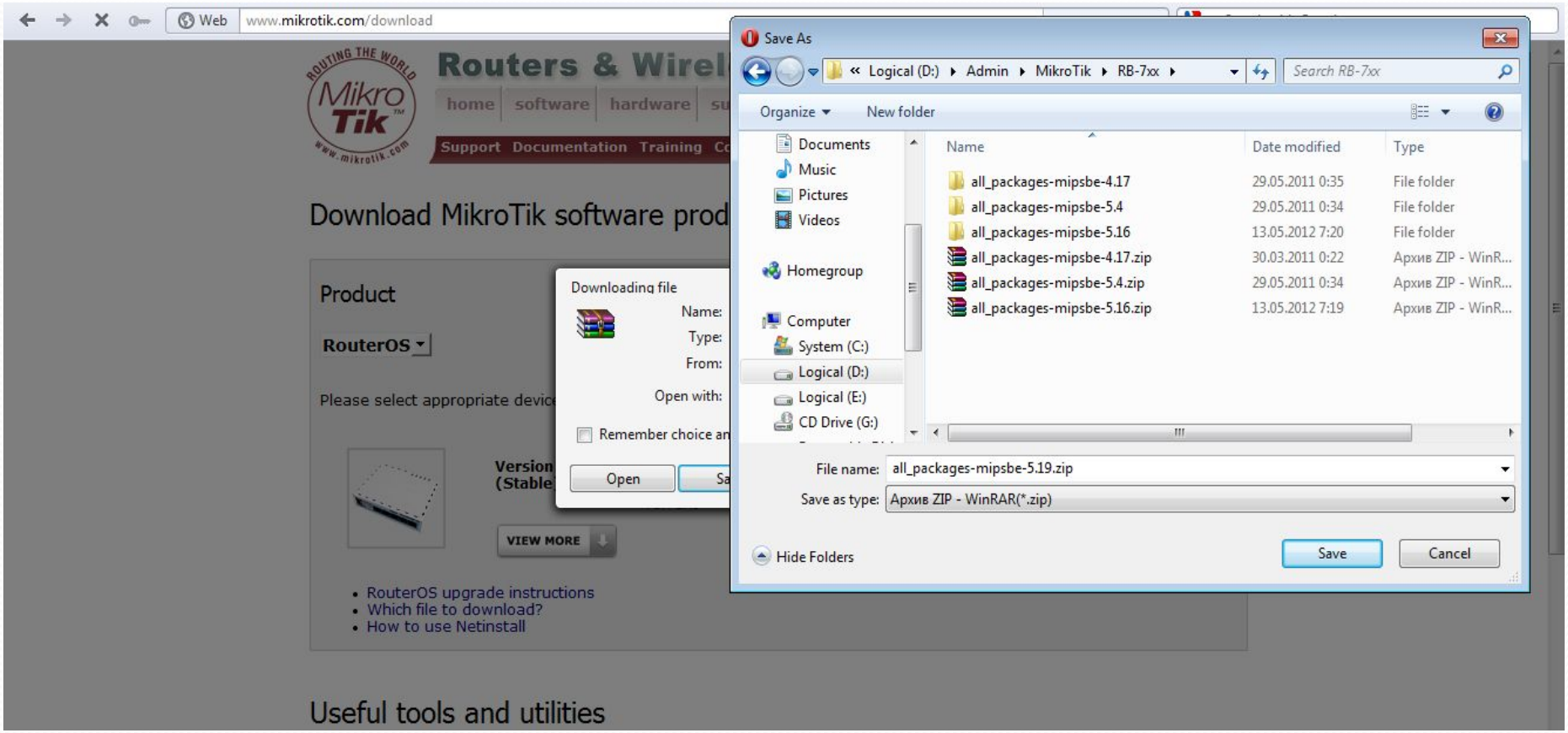




Connecting



Upgrade and Downgrade RouterOS

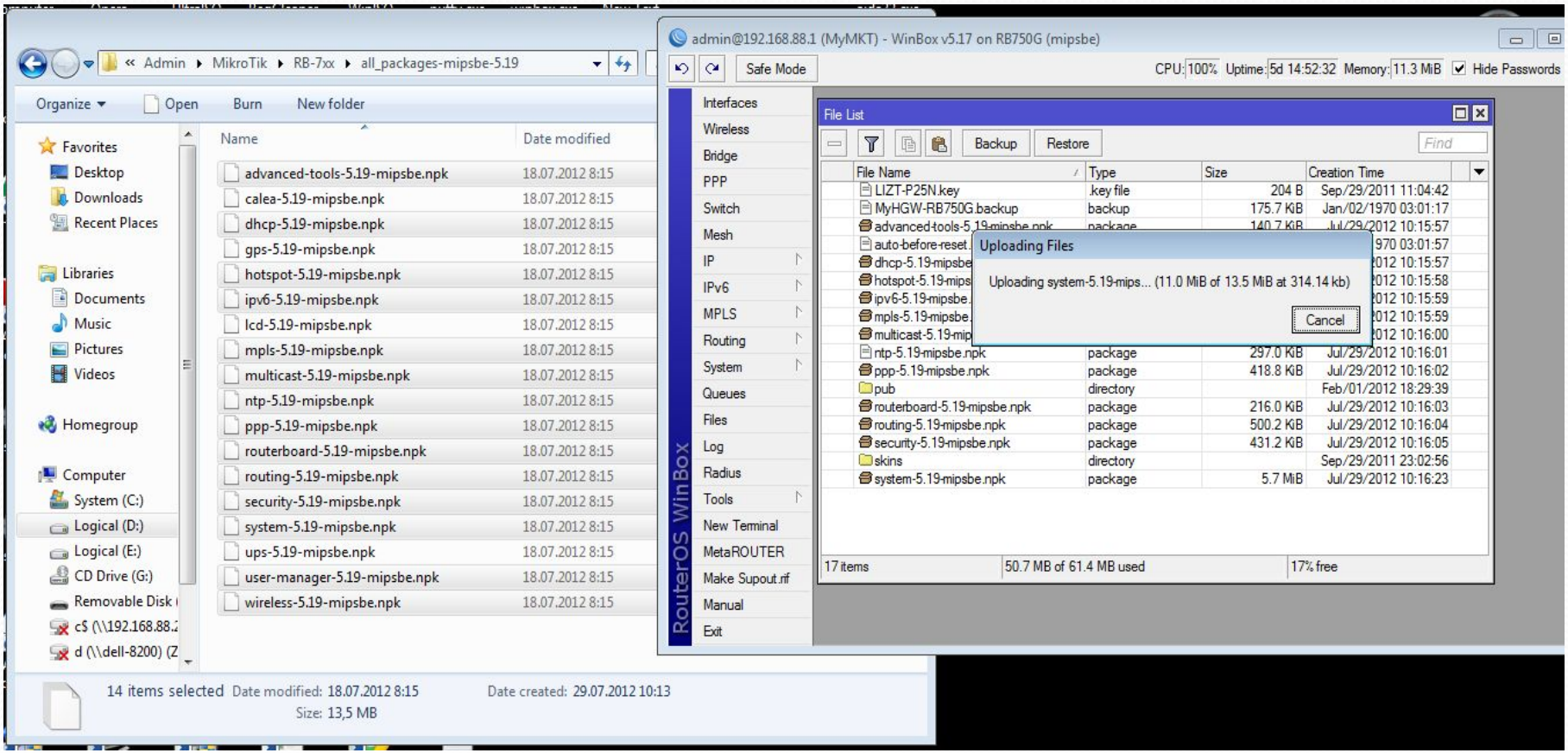


Downgrade RouterOS

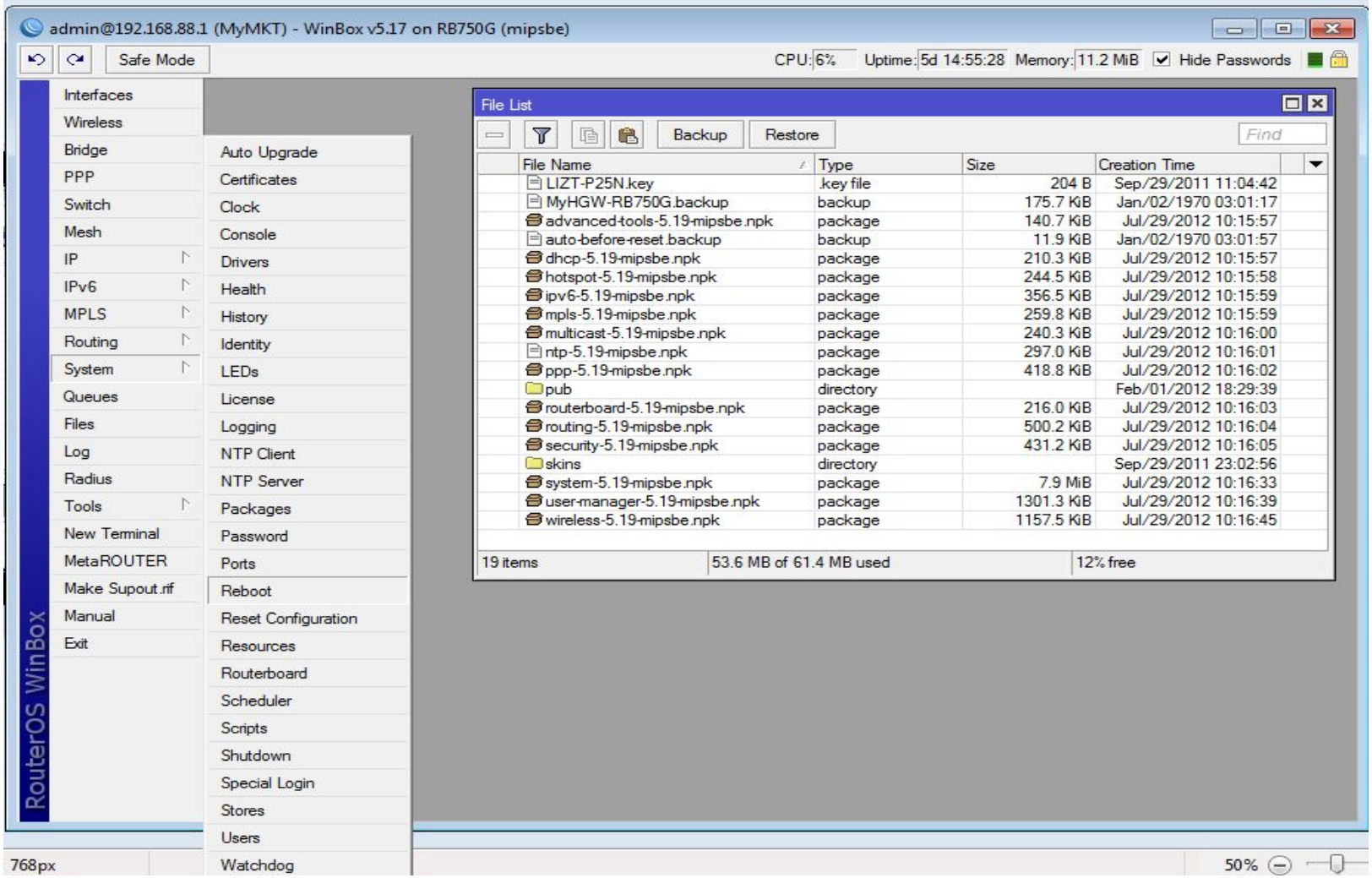
Package Information

Name	Functions
advanced-tools	Email client, ping, netwatch
dhcp	DHCP Server and Client
hotspot	HotSpot Gateway
ntp	NTP server
ppp	PPP, PPTP, L2TP, PPPoE
routerboard	RouterBOARD specific functions
routing	RIP, OSPF, BGP
security	Secure Winbox, SSH, IPSec
wireless	Wireless 802.11a/b/g
user-manager	User-Manager management system
ipv6	IPv6

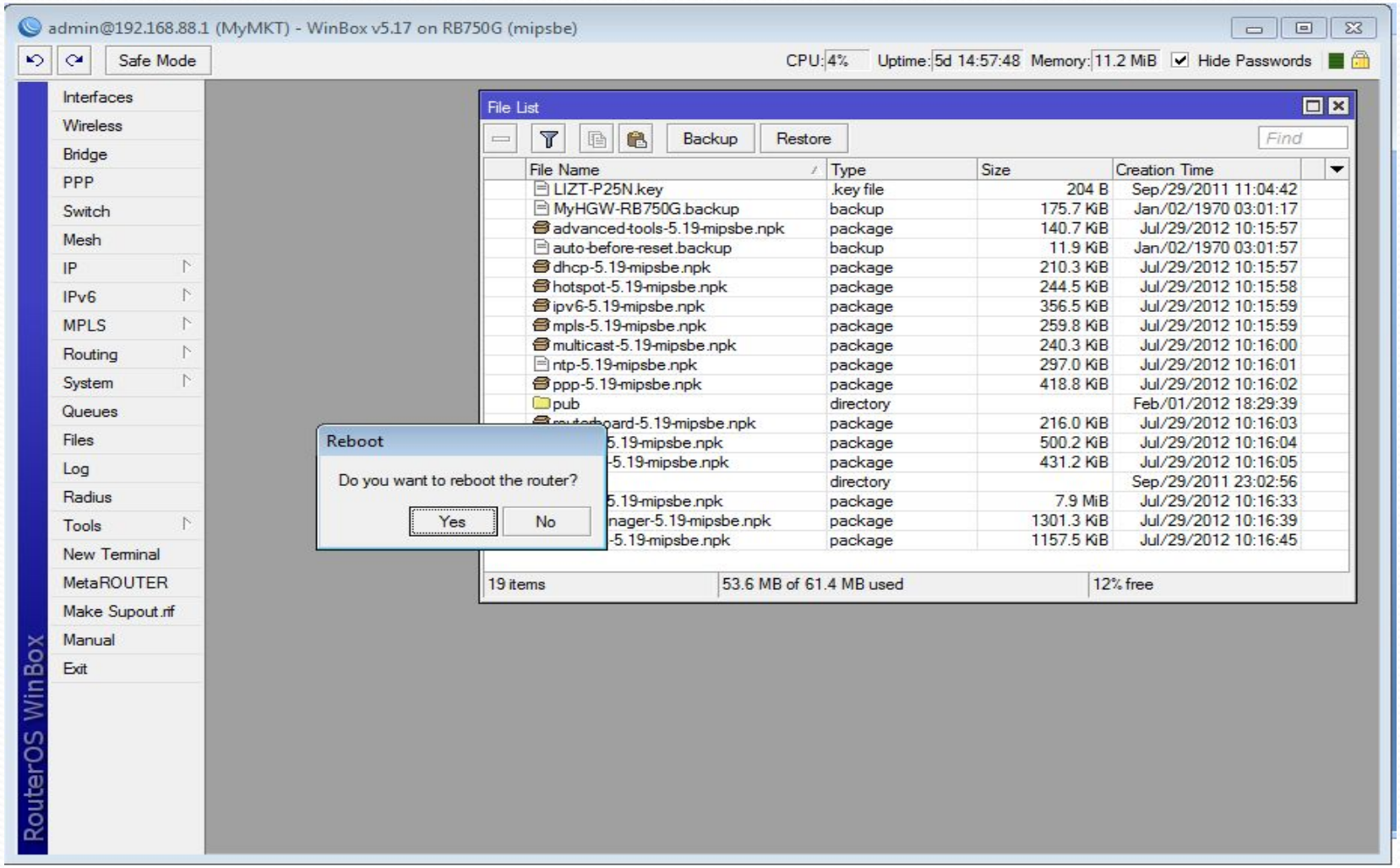
Upgrade RouterOS



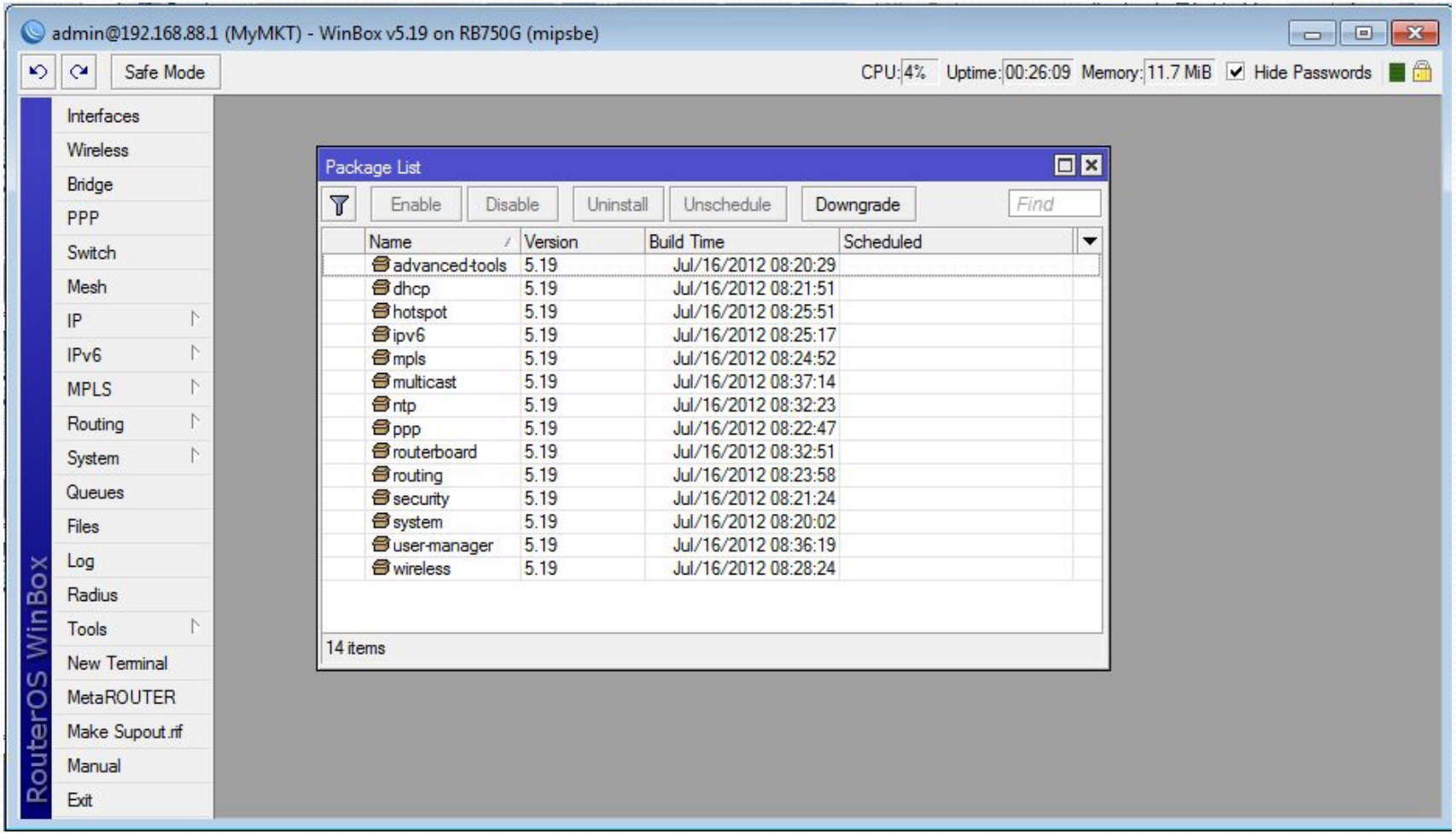
Upgrade RouterOS



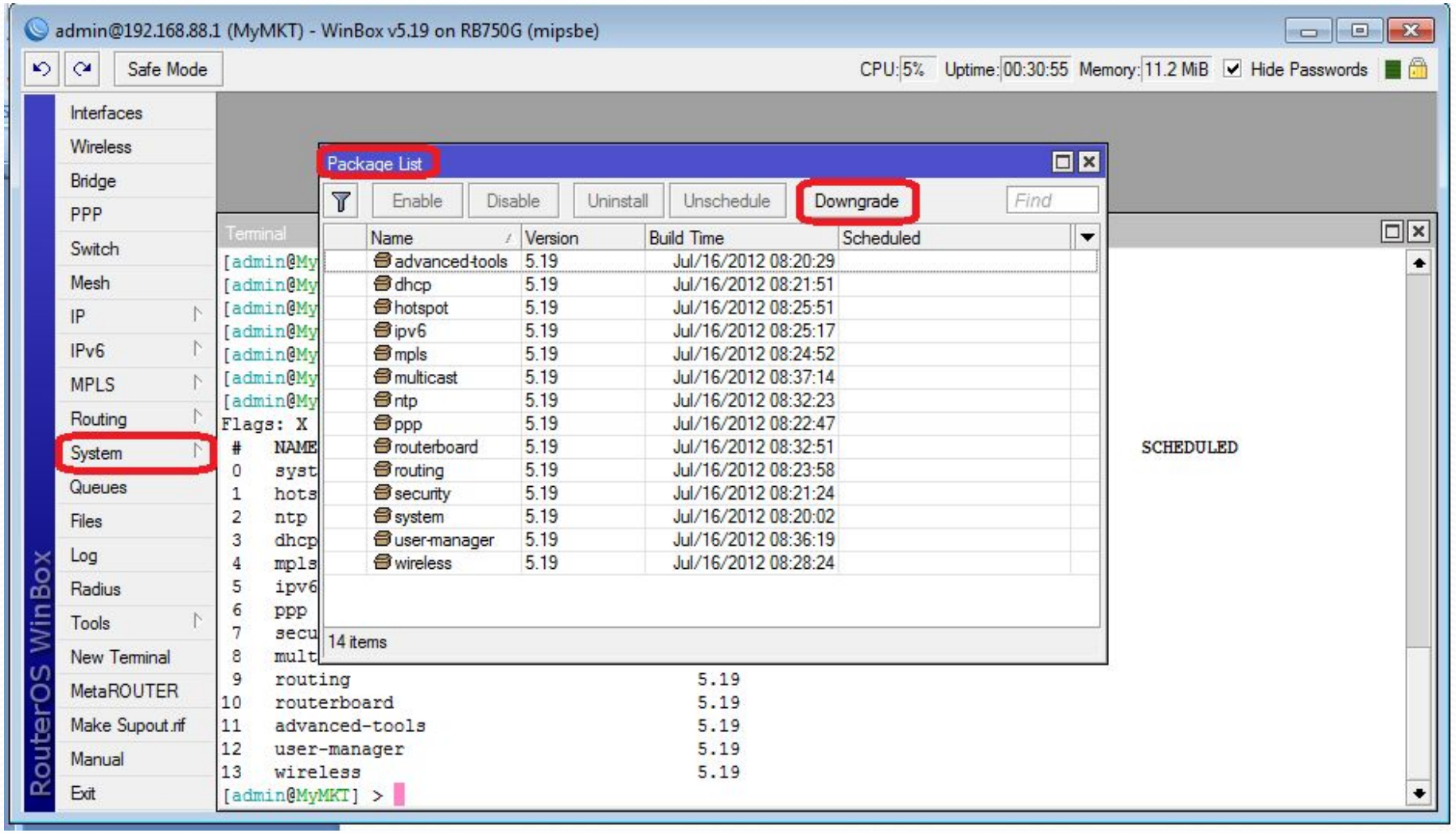
Upgrade RouterOS



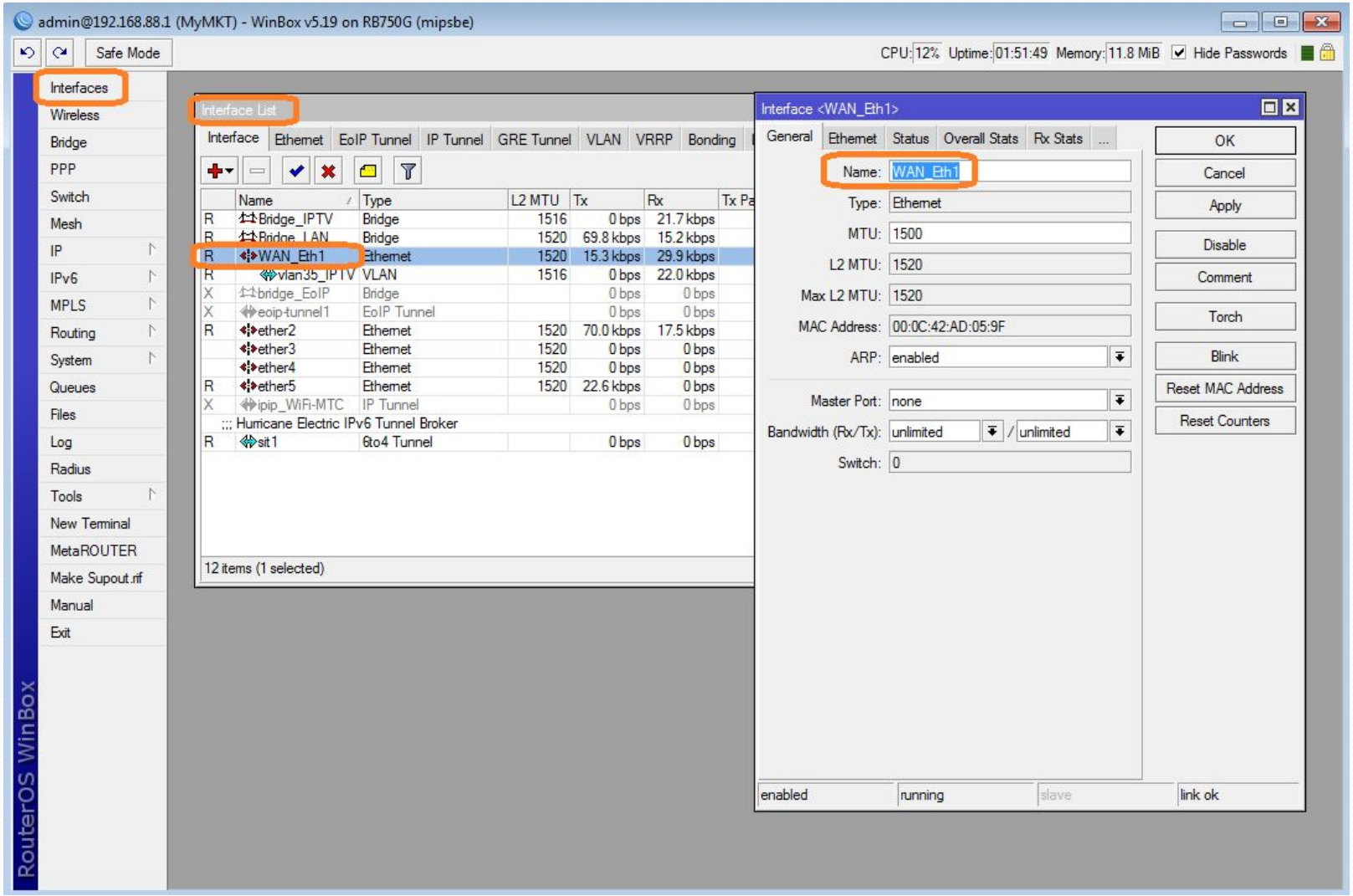
Upgrade RouterOS



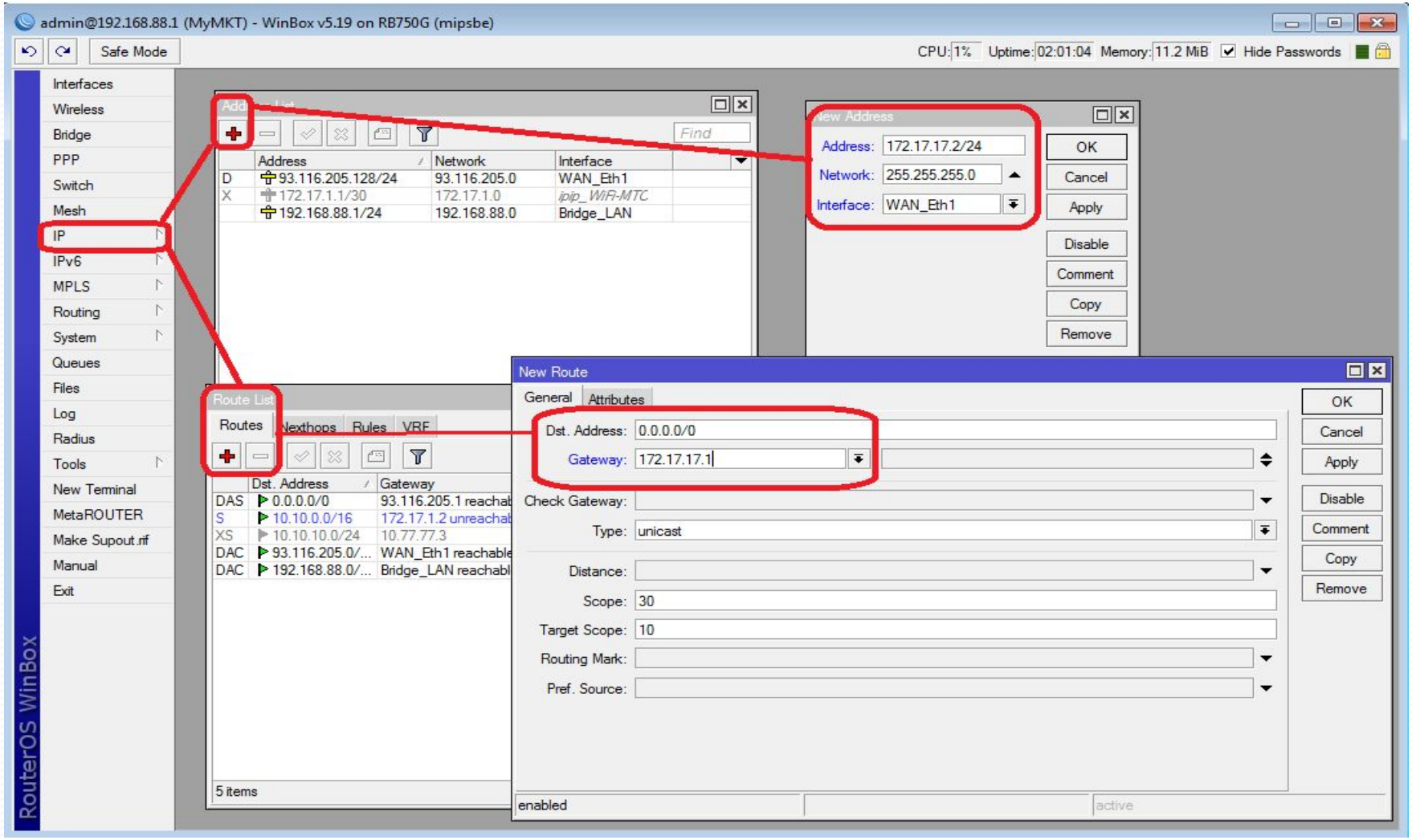
Downgrade RouterOS



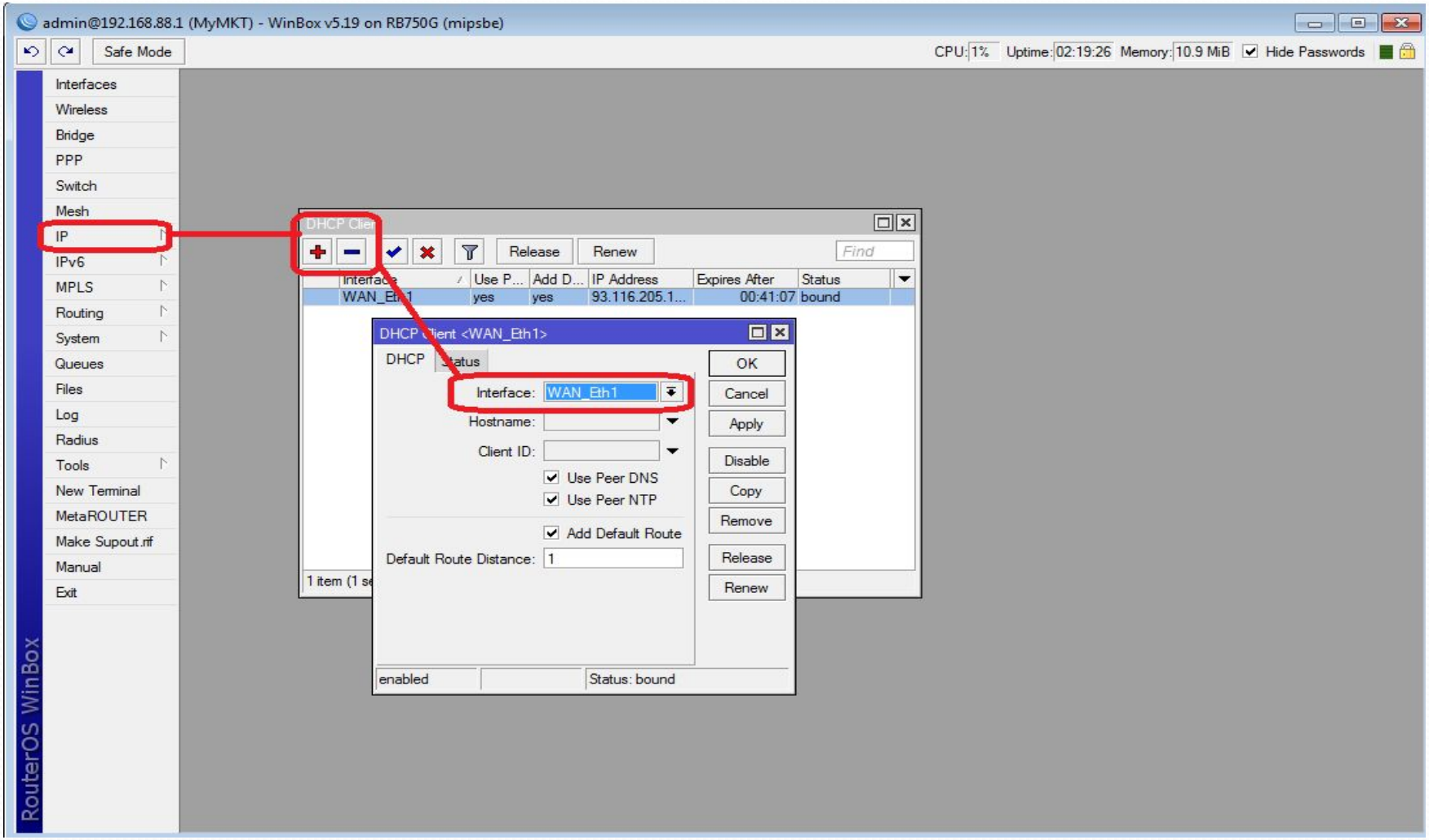
Interface WAN



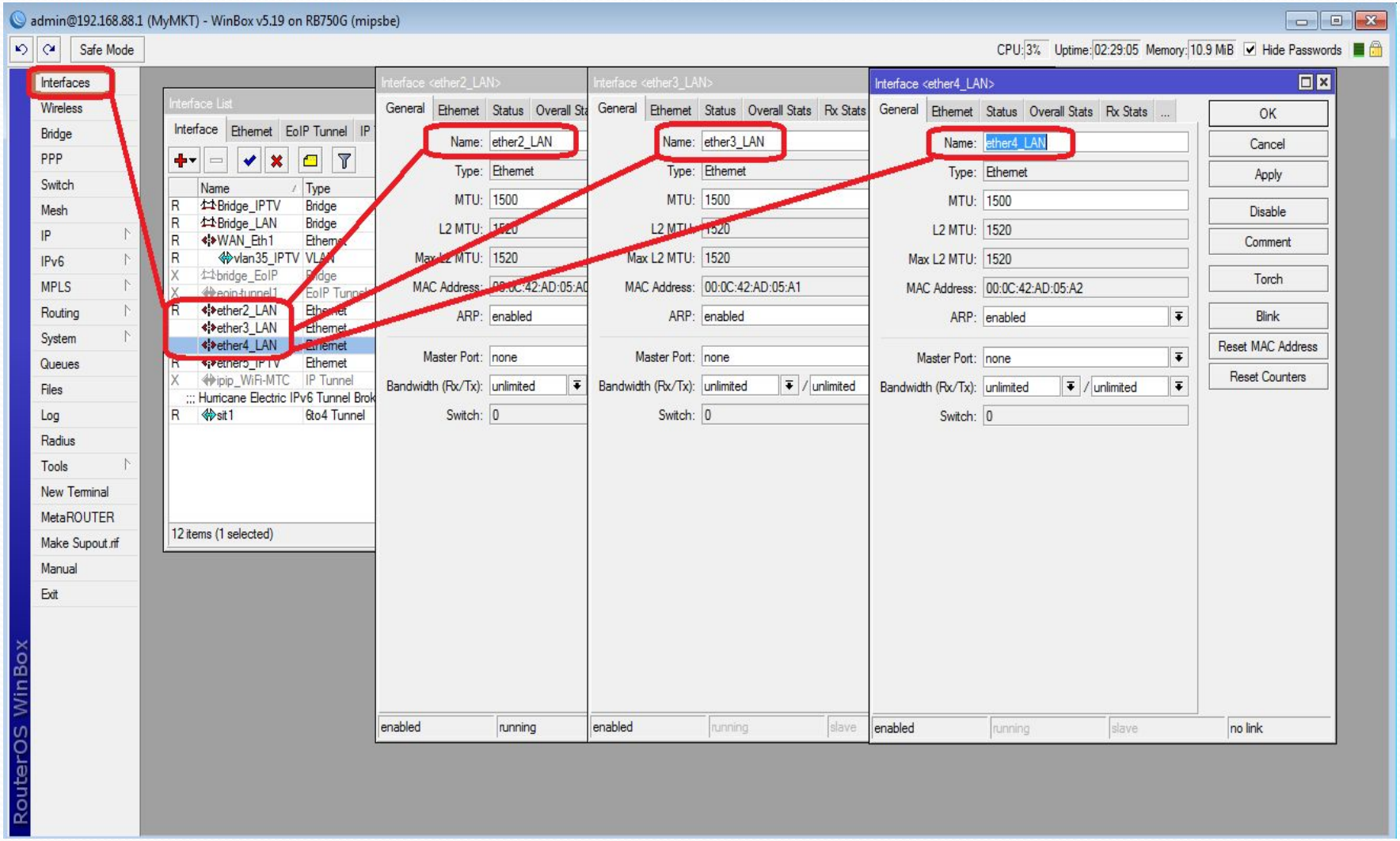
Set static Ip address on WAN interface



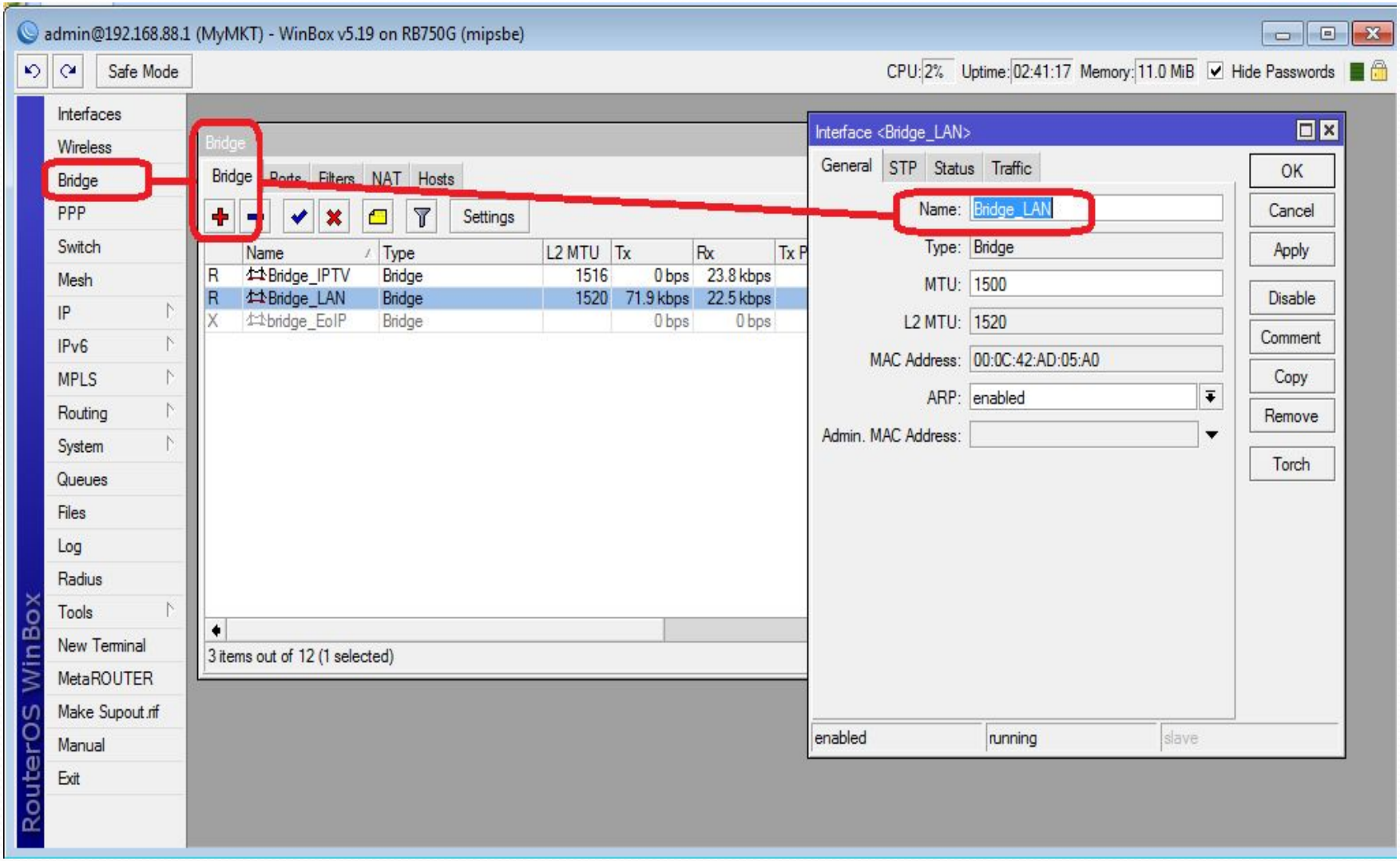
Set dynamic Ip address on WAN interface



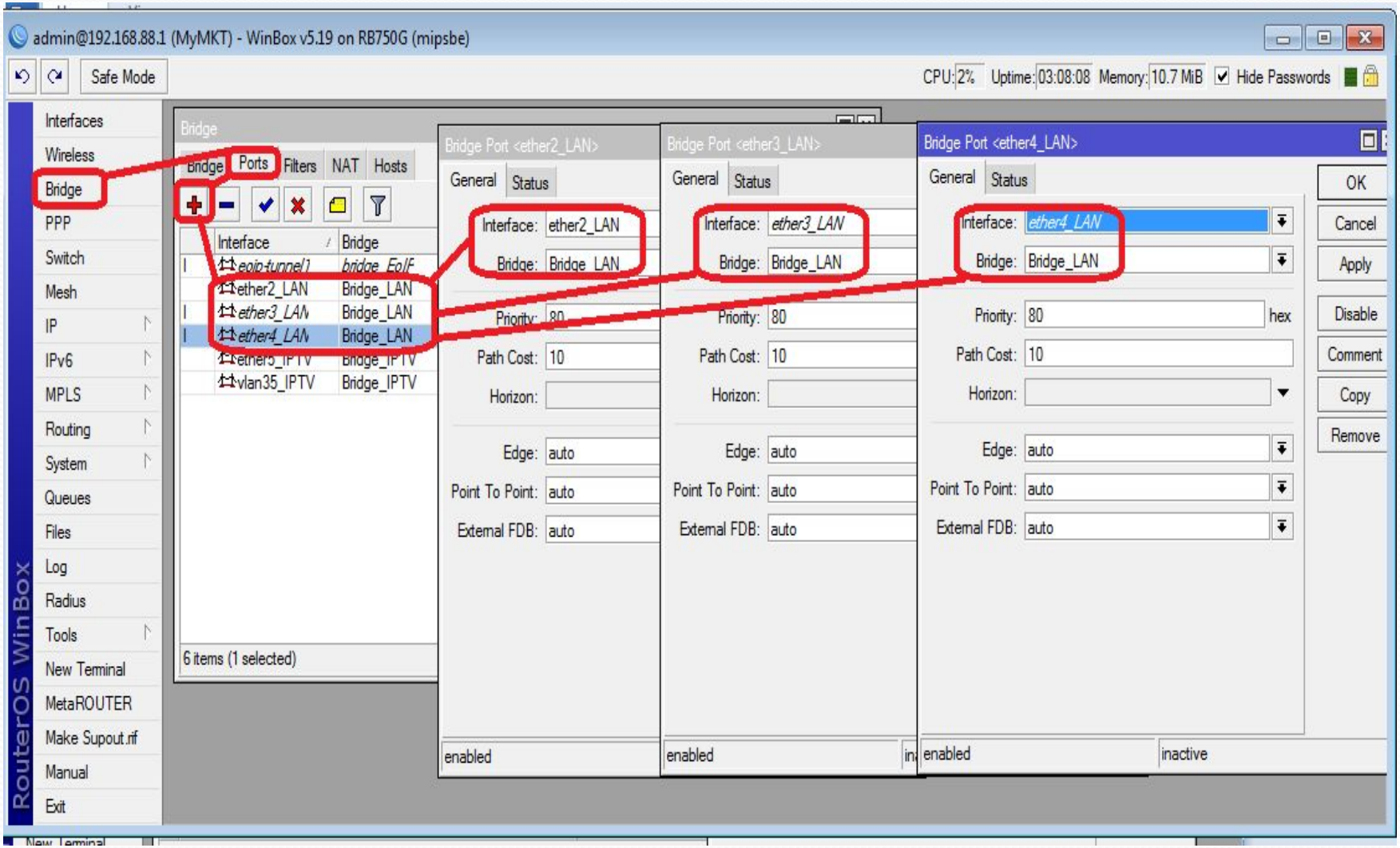
Set LAN interfaces



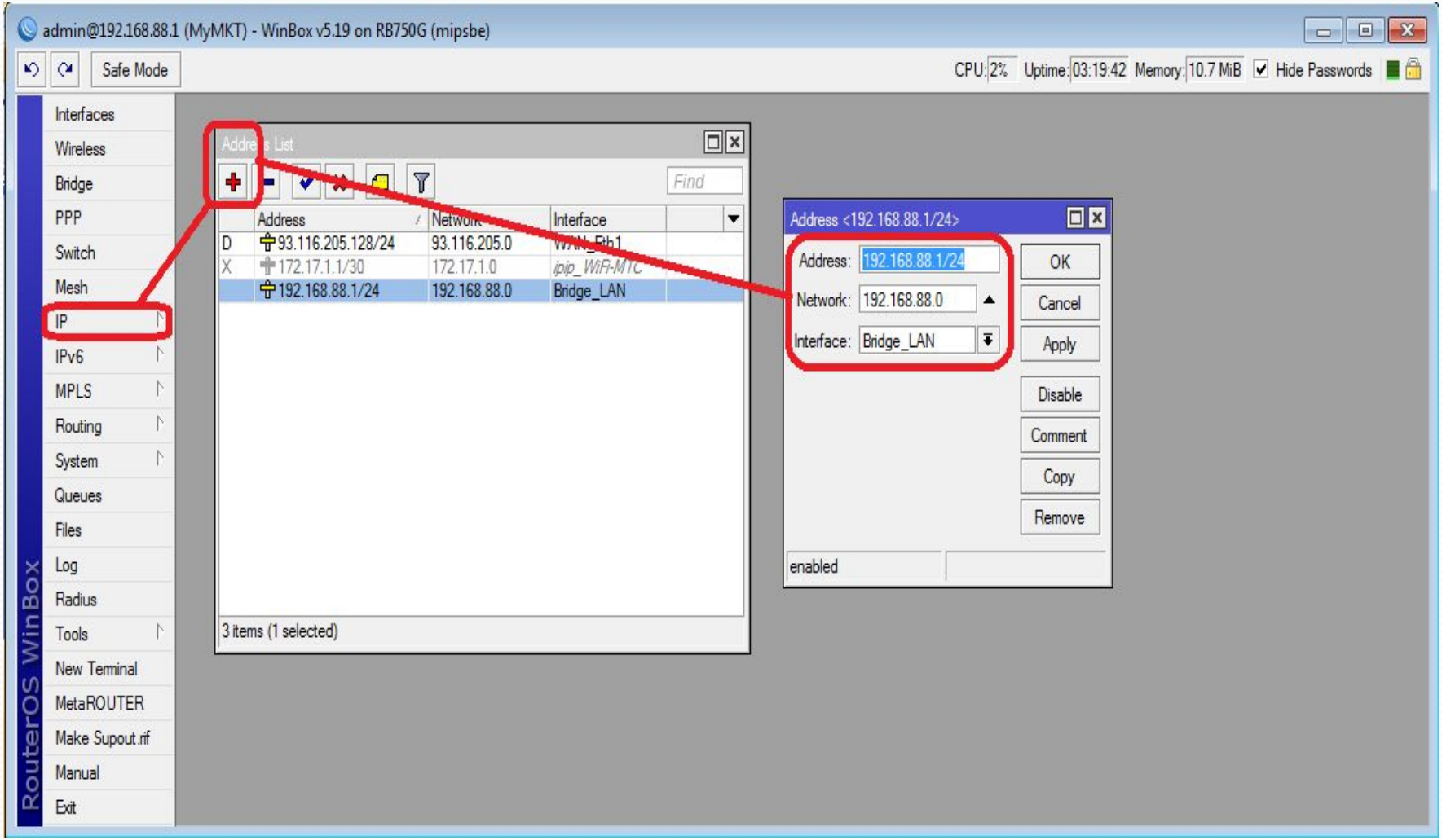
Create Bridge-LAN interface



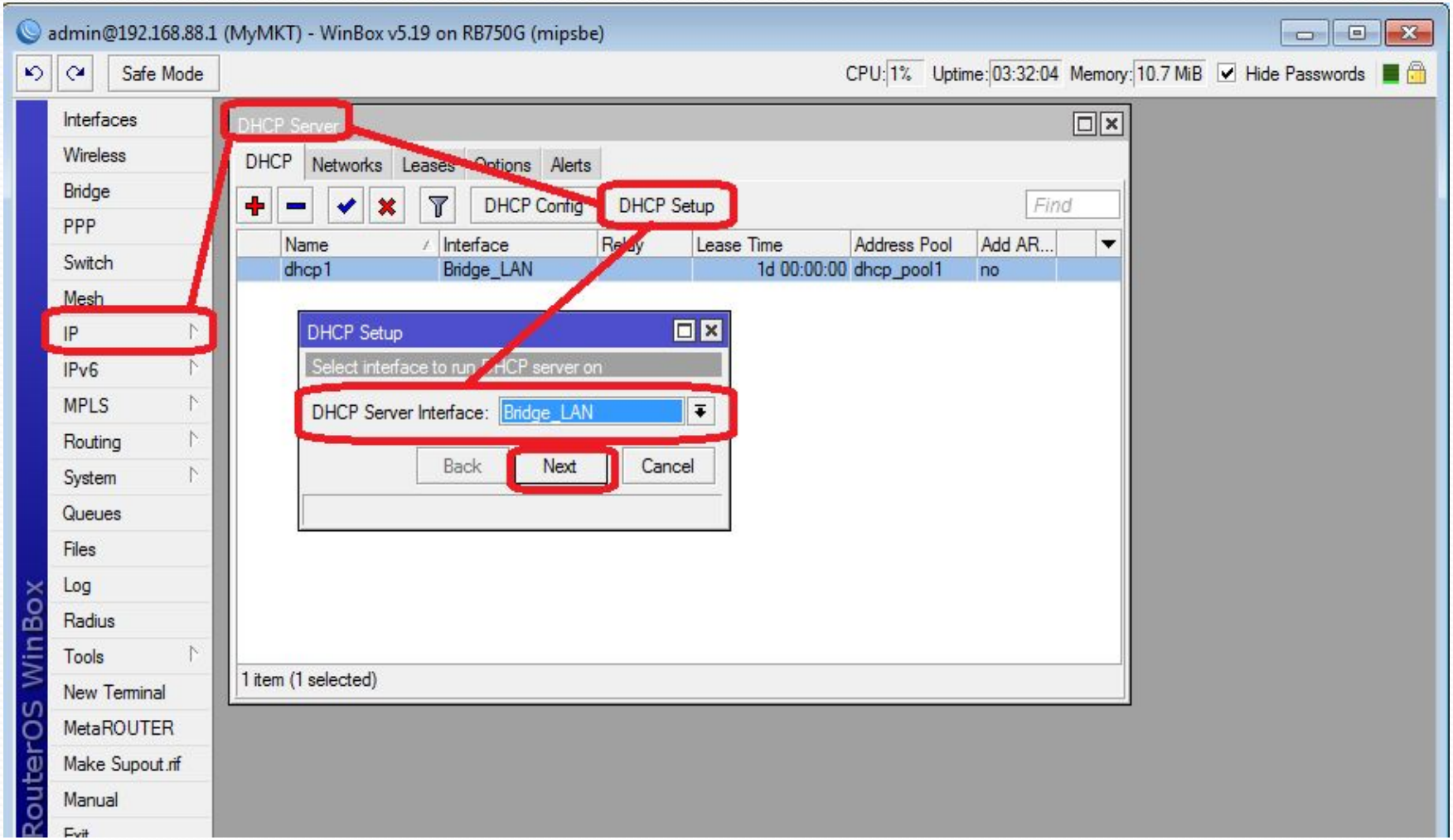
Add ether-LAN to Bridge-LAN interface



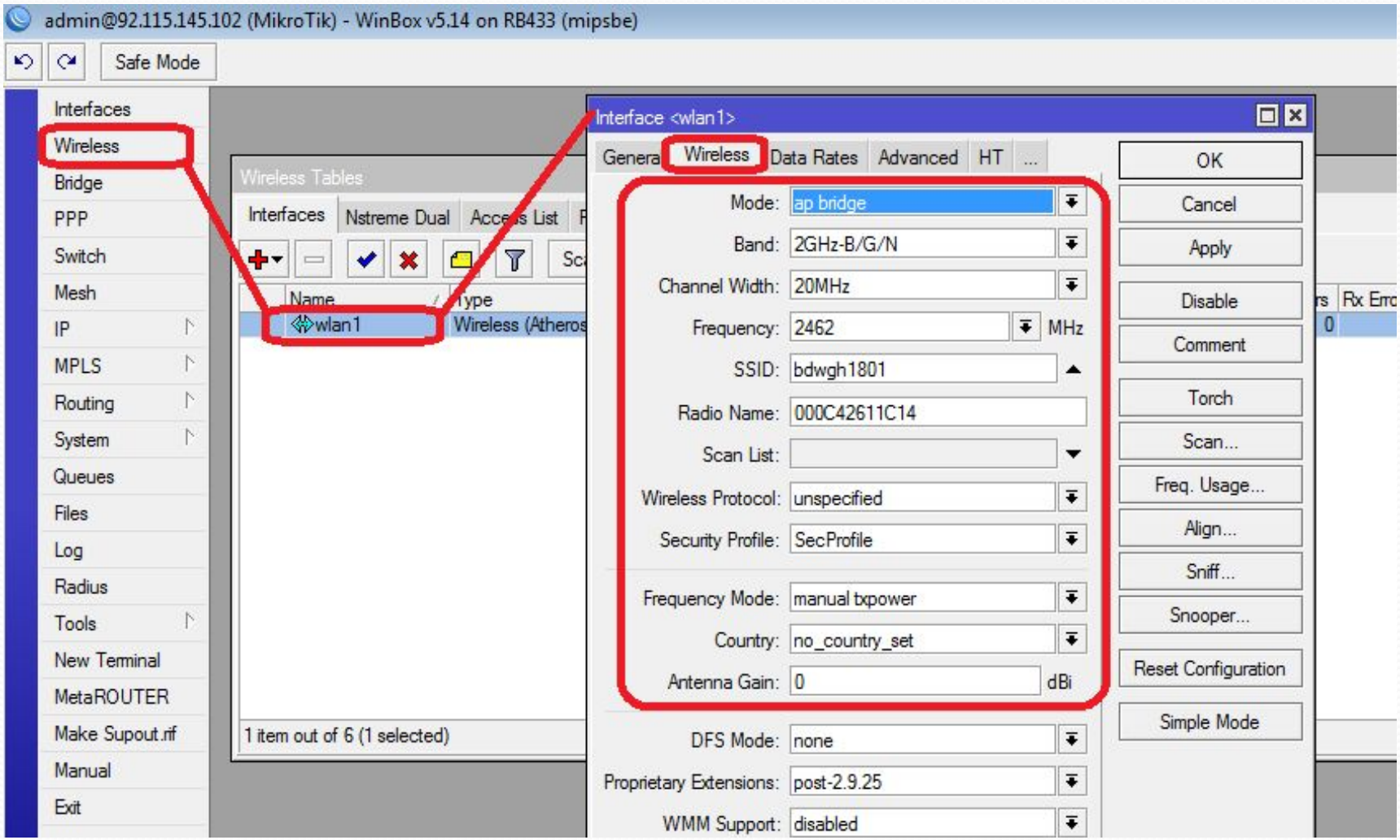
Set static Ip address on Bridge-LAN interface



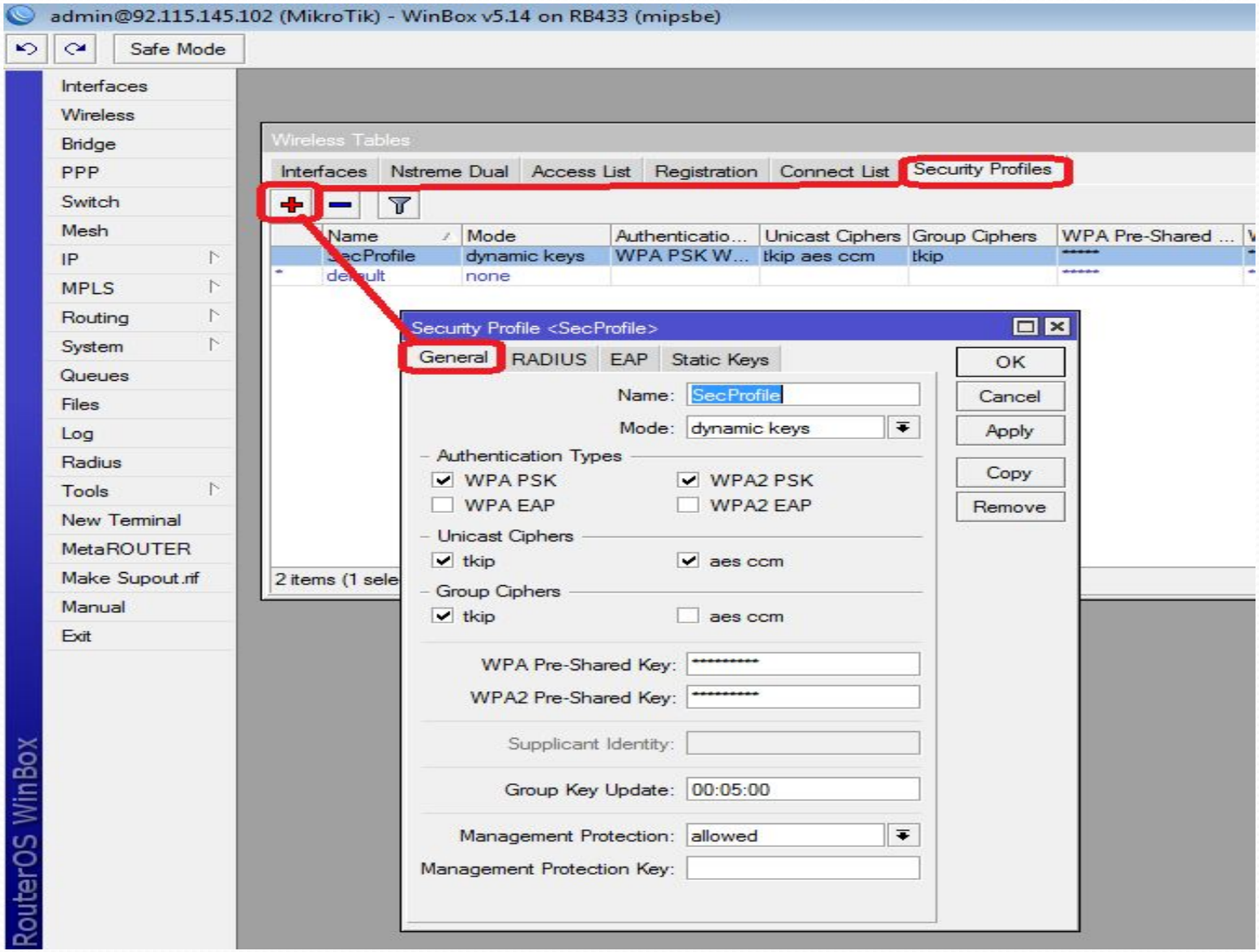
Set DHCP-Server on Bridge-LAN interface



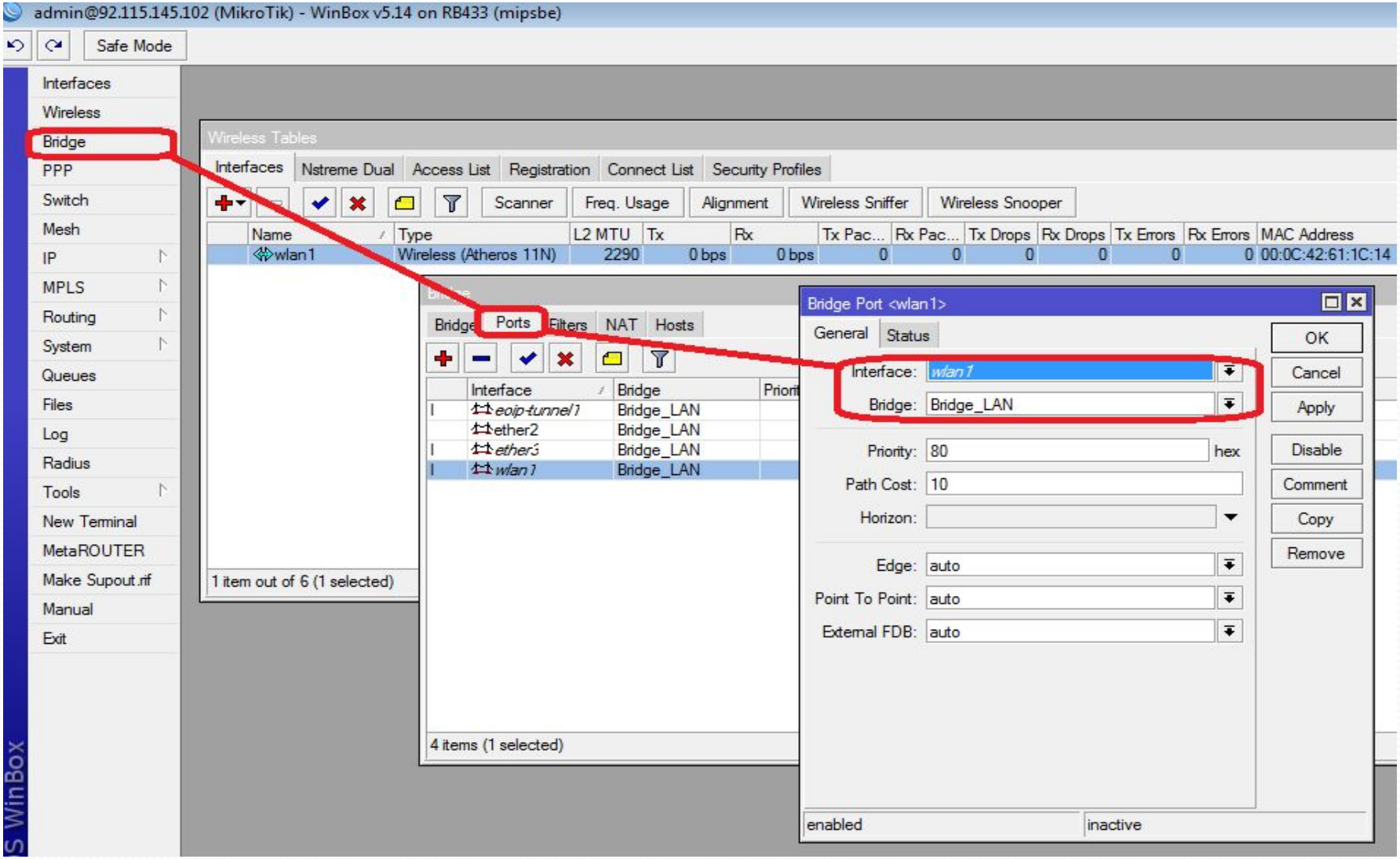
Set wireless interface



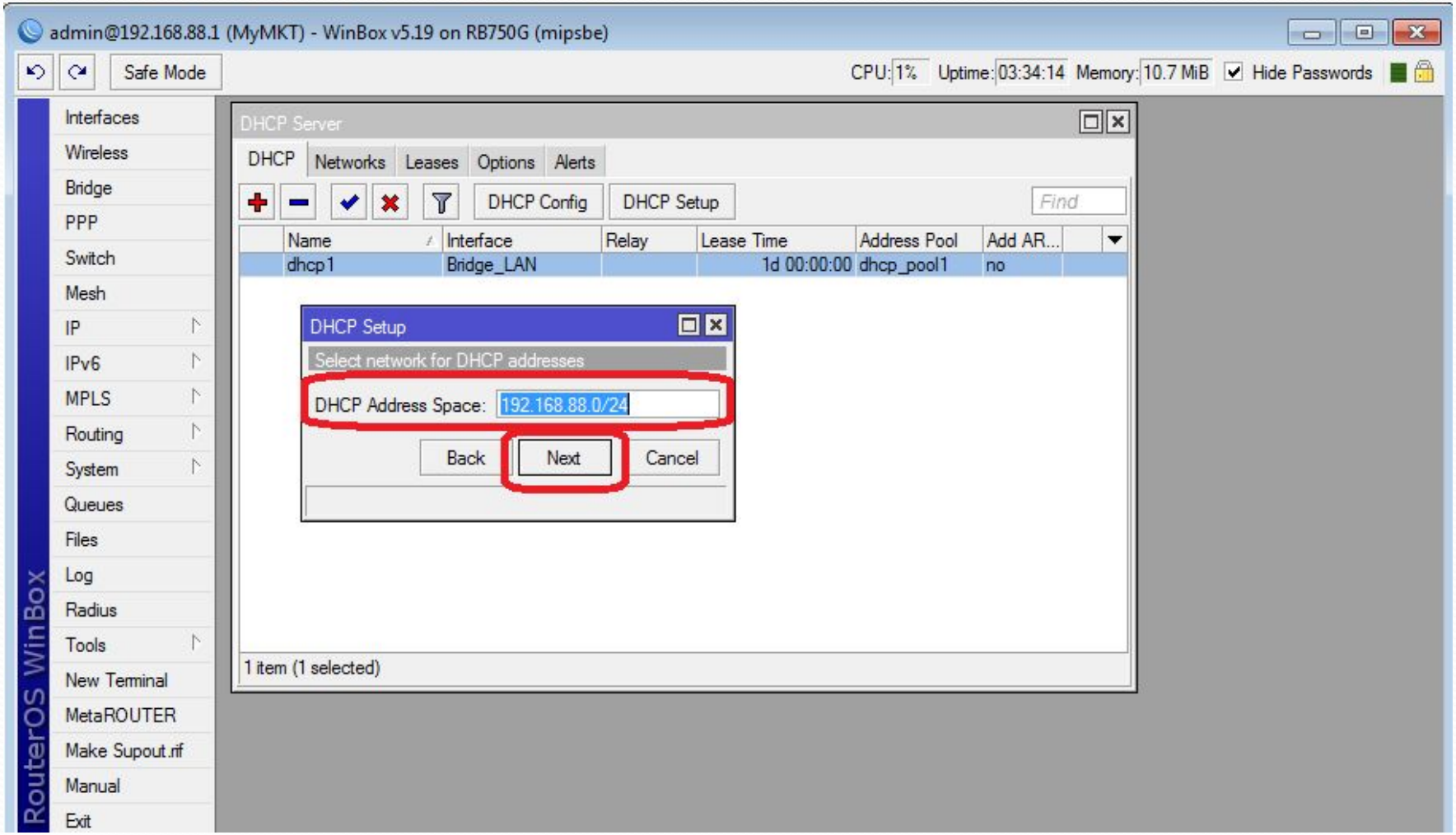
Set wireless interface



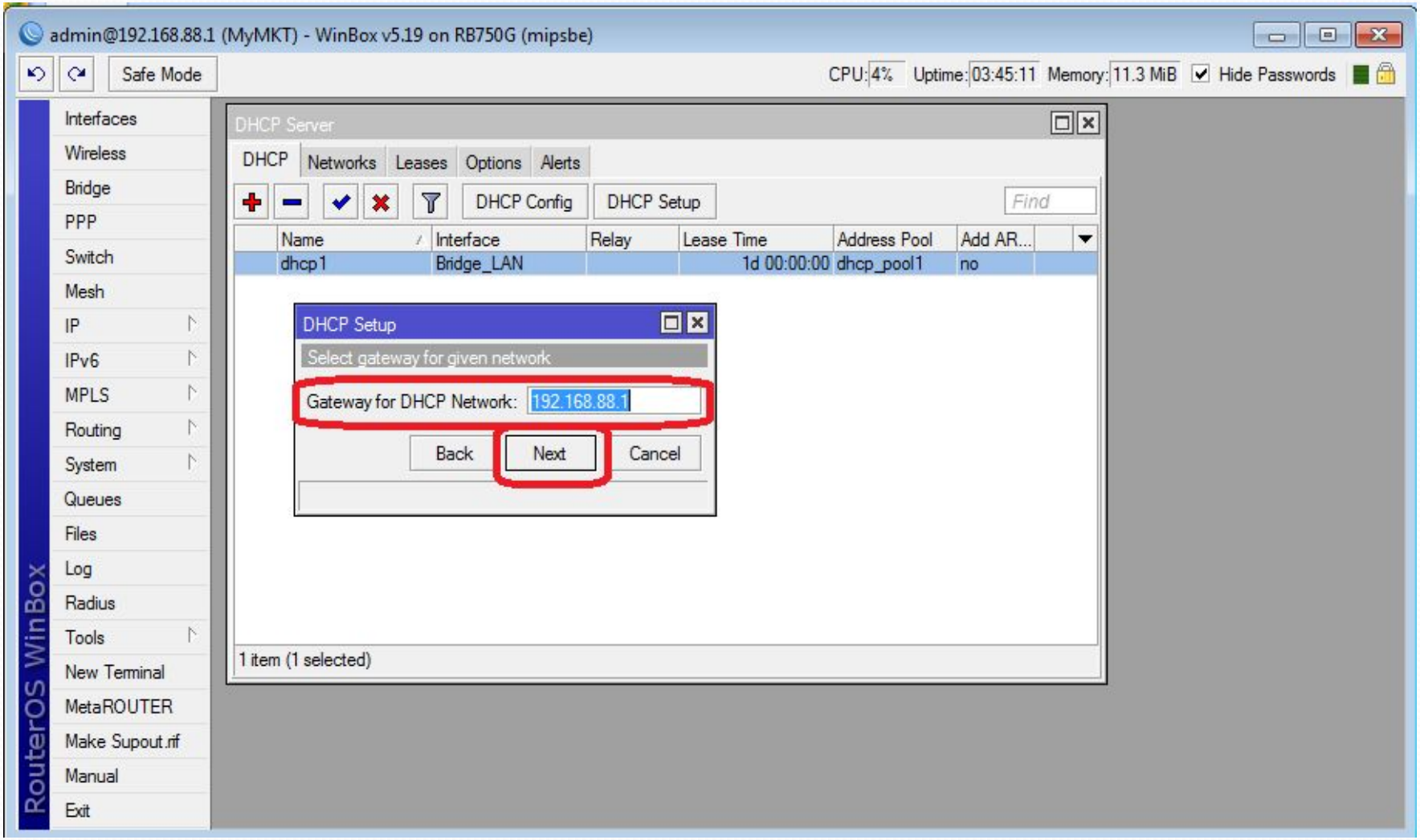
Add wireless interface to Bridge-LAN



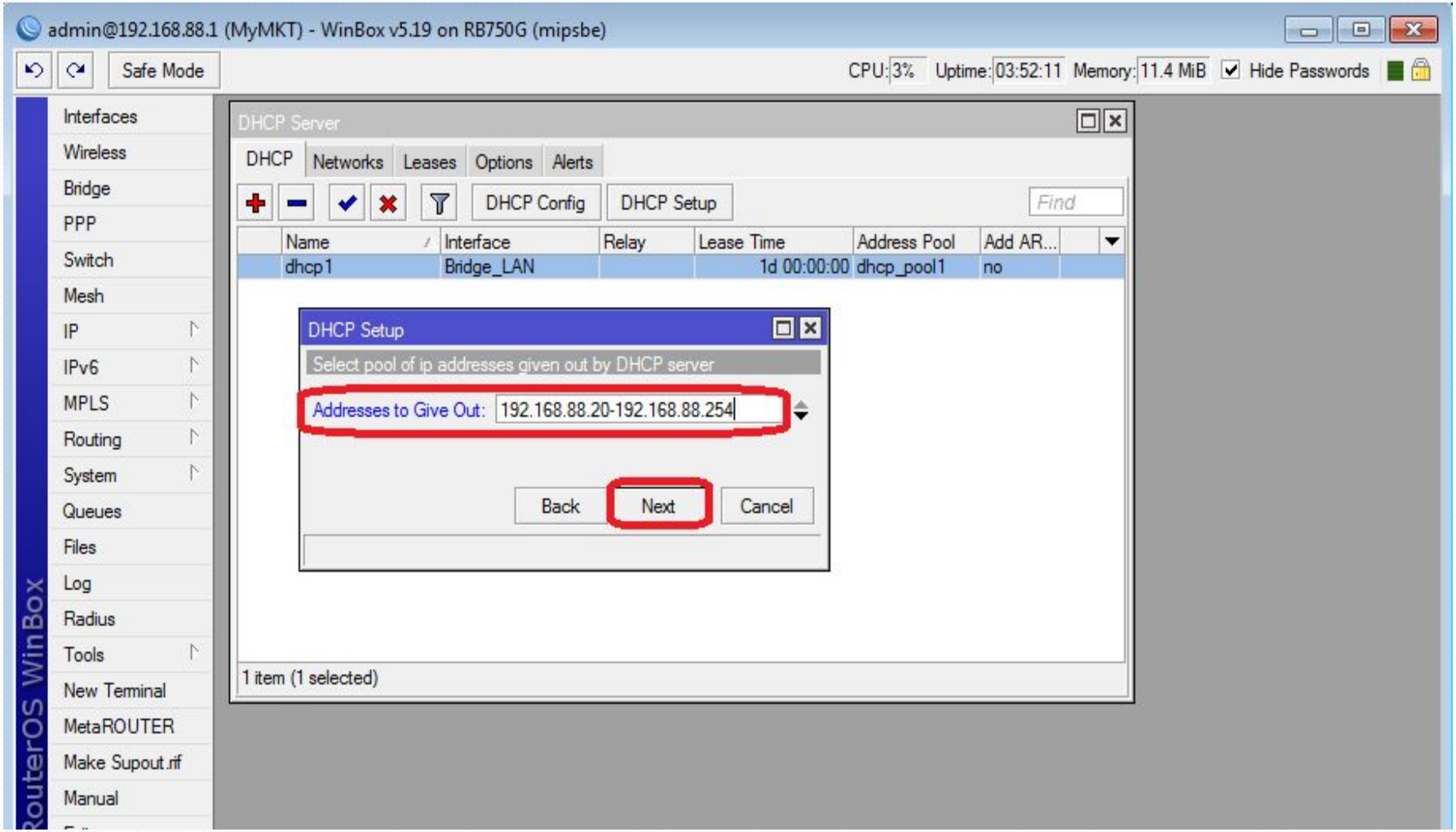
Set for DHCP-Server address space



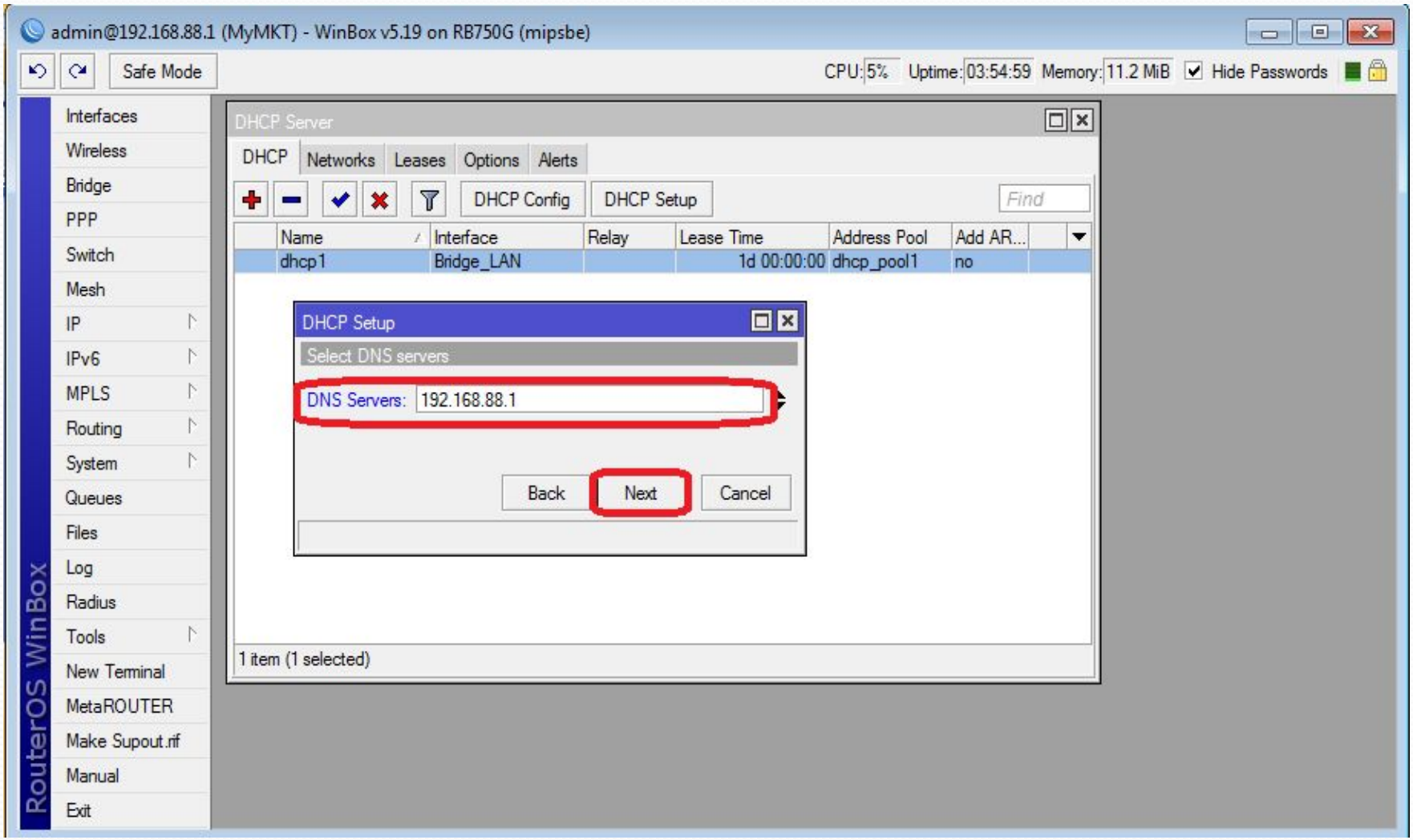
Set for DHCP network default gateway



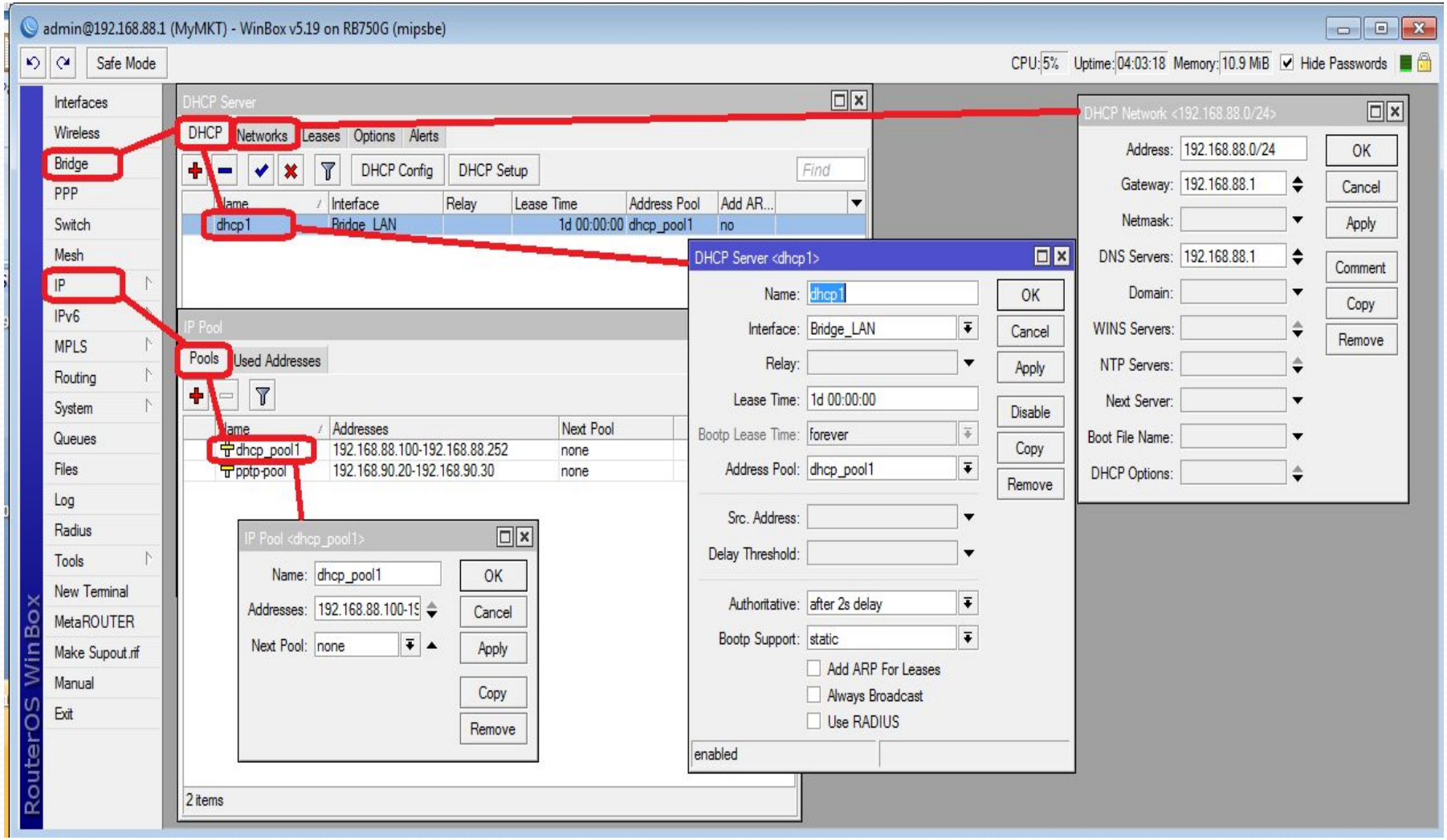
Set for DHCP network IP addresses range



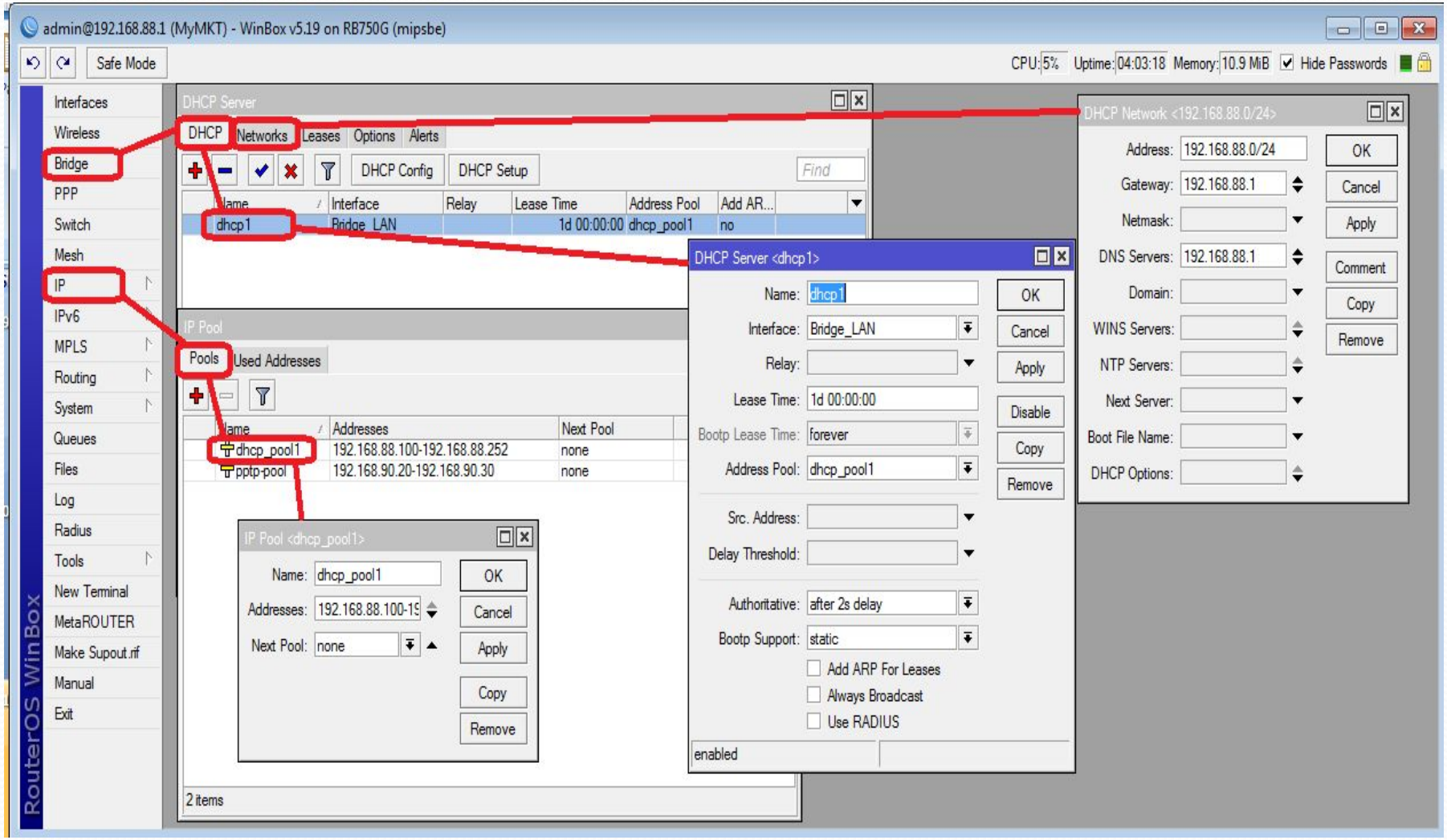
Set for DHCP network DNS servers



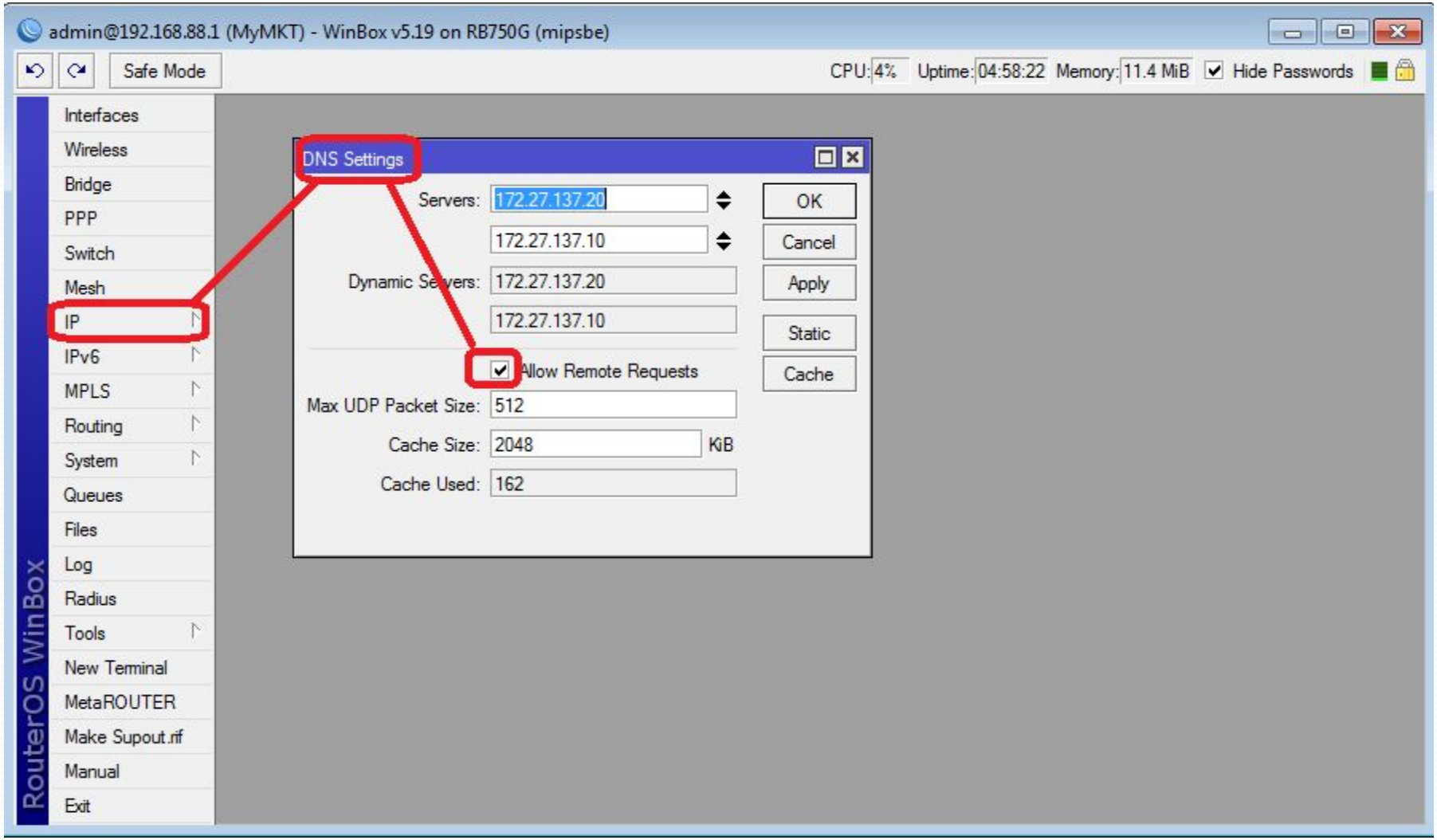
Verification of settings for DHCP-server



Verification of settings for DHCP-server



Setup for cache DNS-server



NAT Network address translation

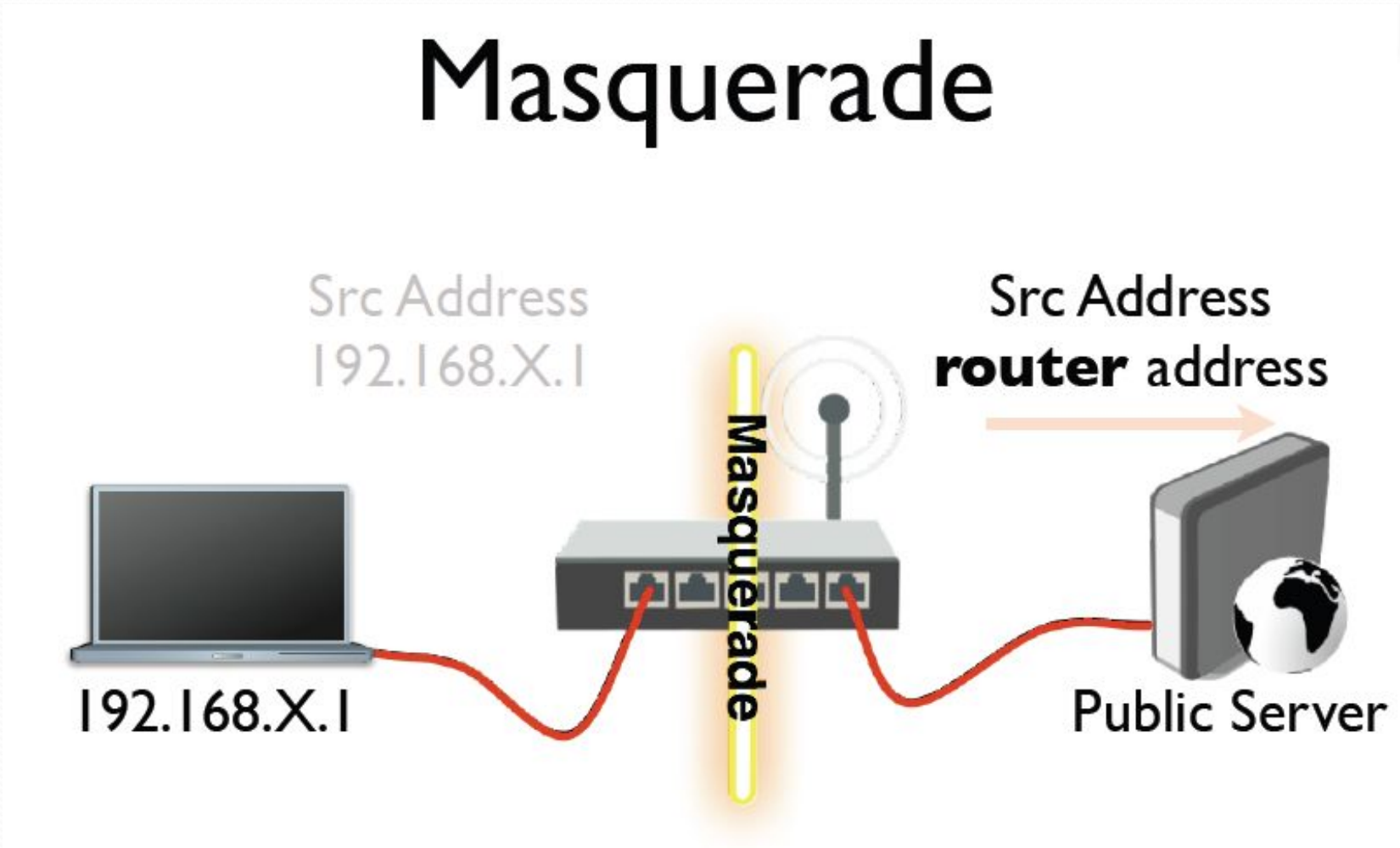
- Router is able to change **Source** or **Destination** address of packets flowing trough it
- This process is called **src-nat** or **dst-nat**

NAT Network address translation

SRC-NAT

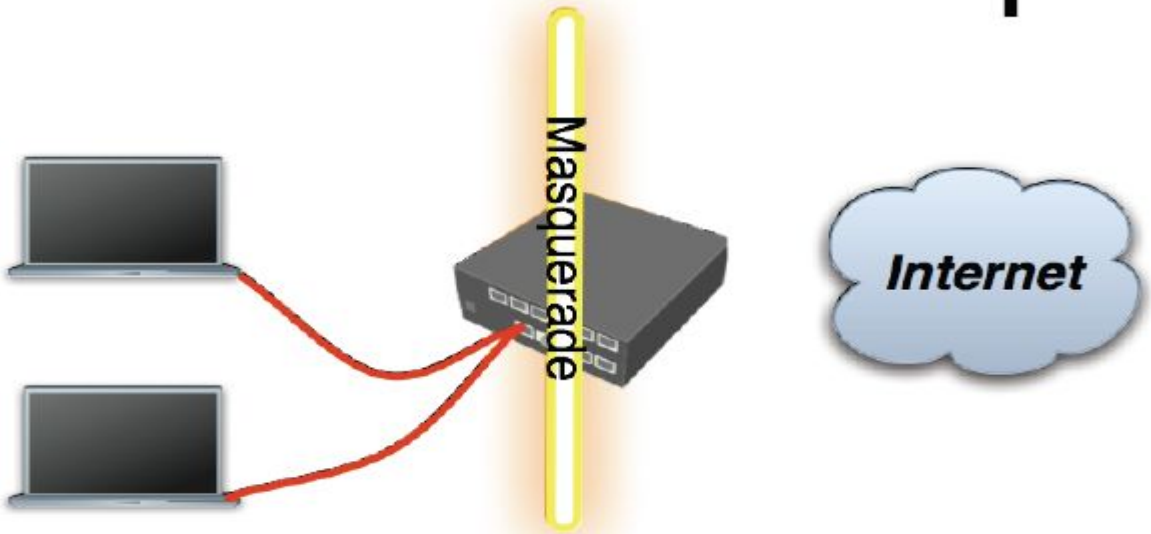
- SRC-NAT changes packet's source address
- You can use it to connect private network to the Internet through public IP address
- **Masquerade** is one type of SRC-NAT

NAT Network address translation



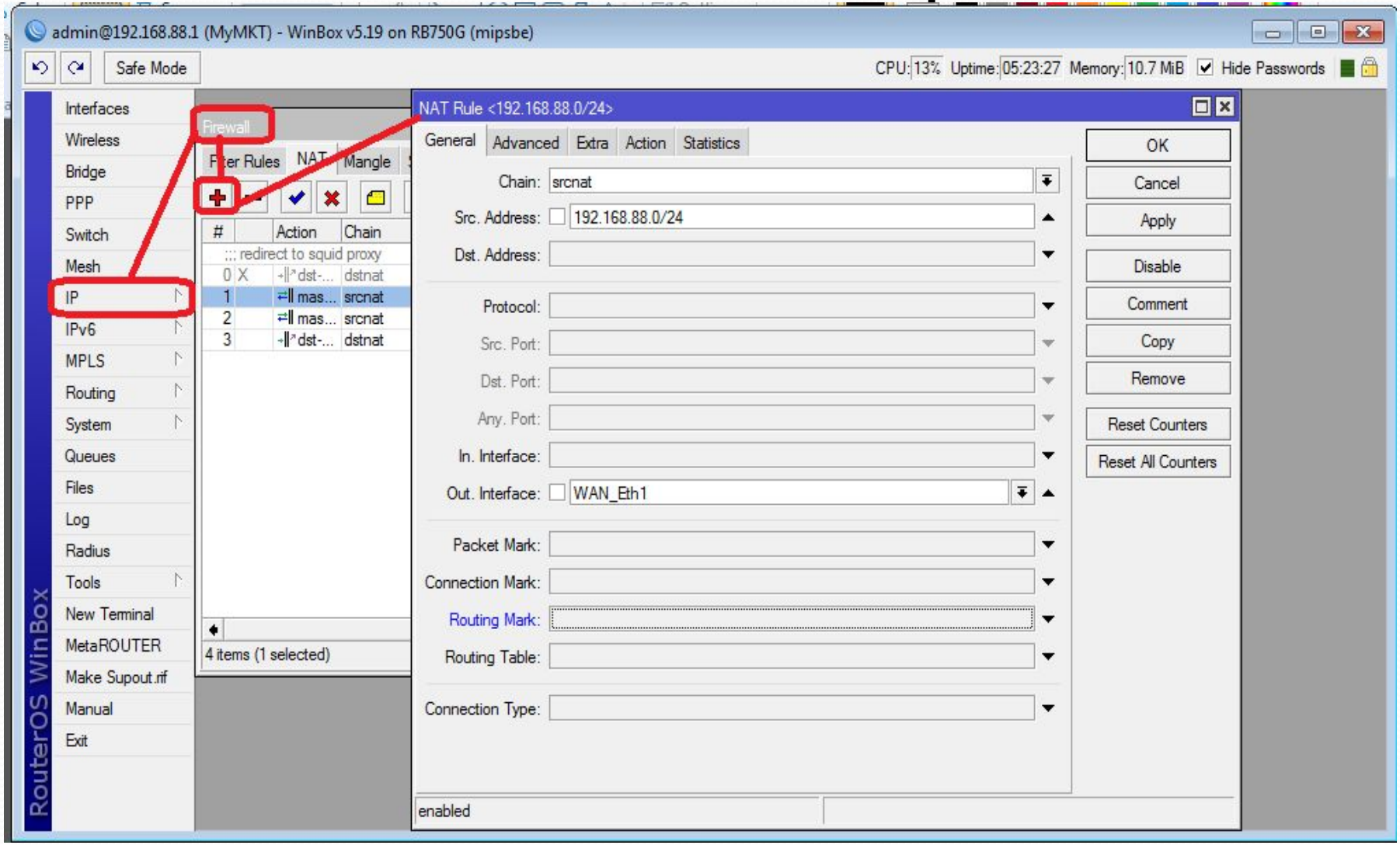
NAT Network address translation

Private and Public space

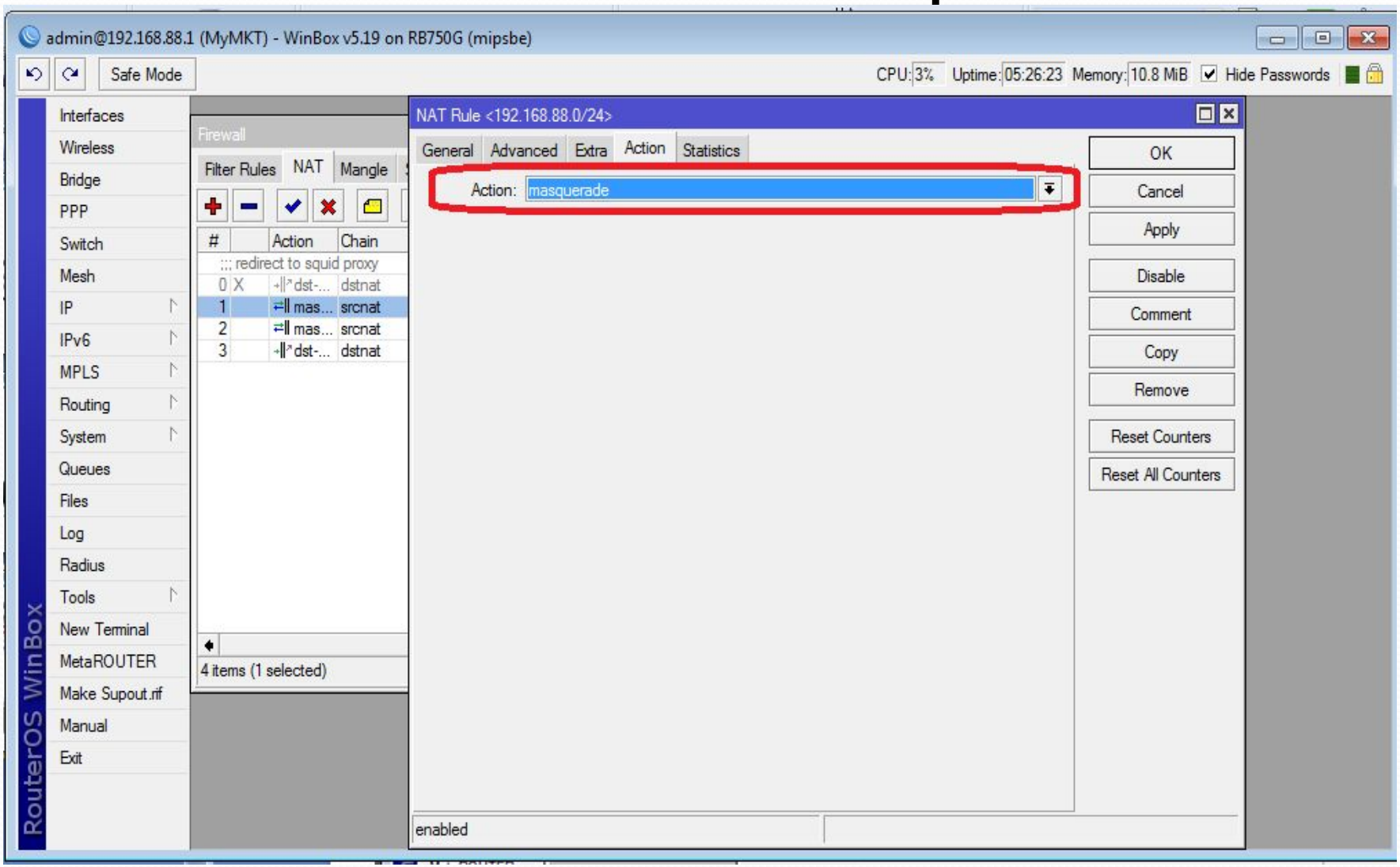


- **Masquerade** is used for Public network access, where private addresses are present
- Private networks include 10.0.0.0-10.255.255.255, 172.16.0.0-172.31.255.255, 192.168.0.0-192.168.255.255

SRC-NAT over Masquerade



SRC-NAT over Masquerade

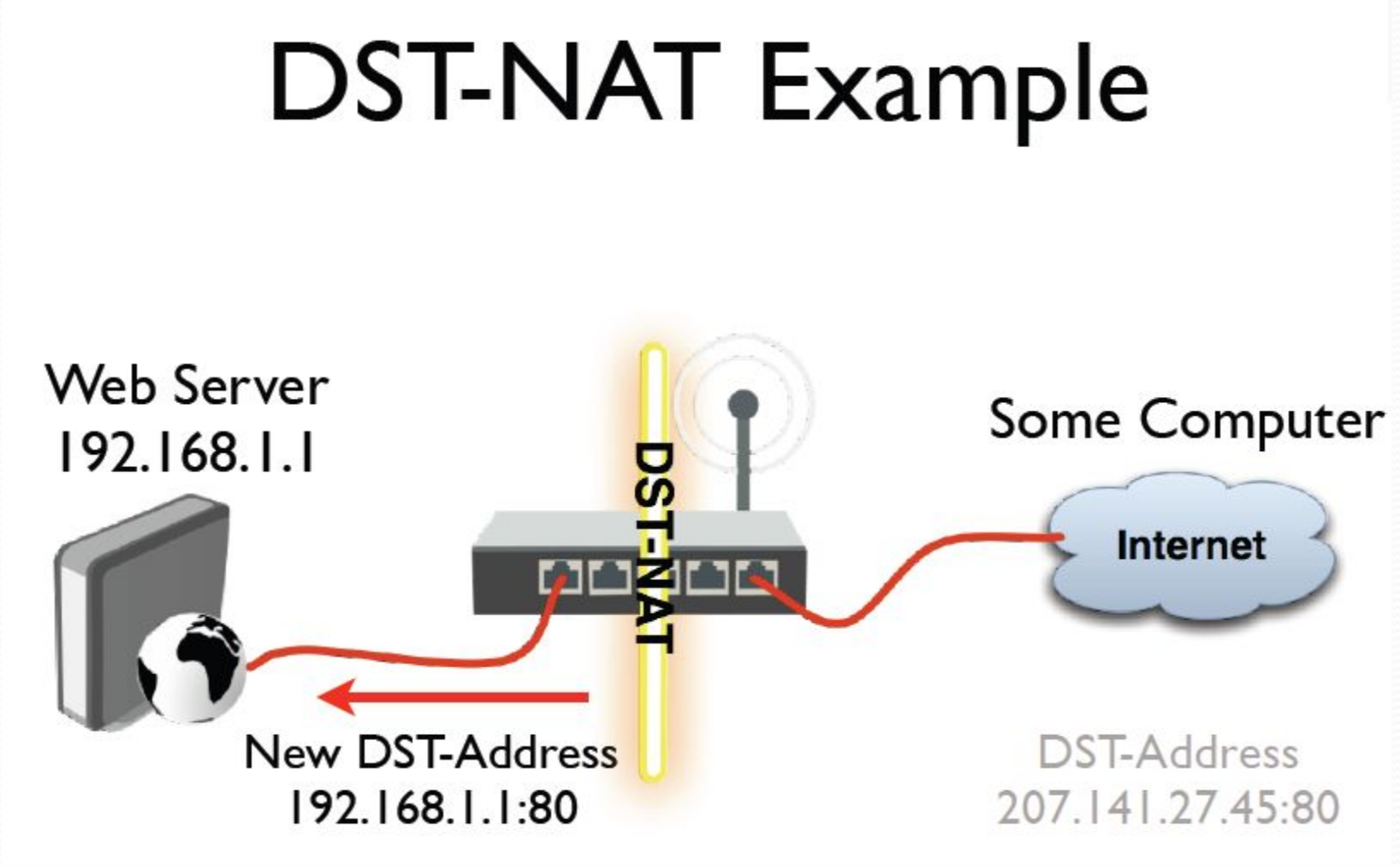


NAT Network address translation

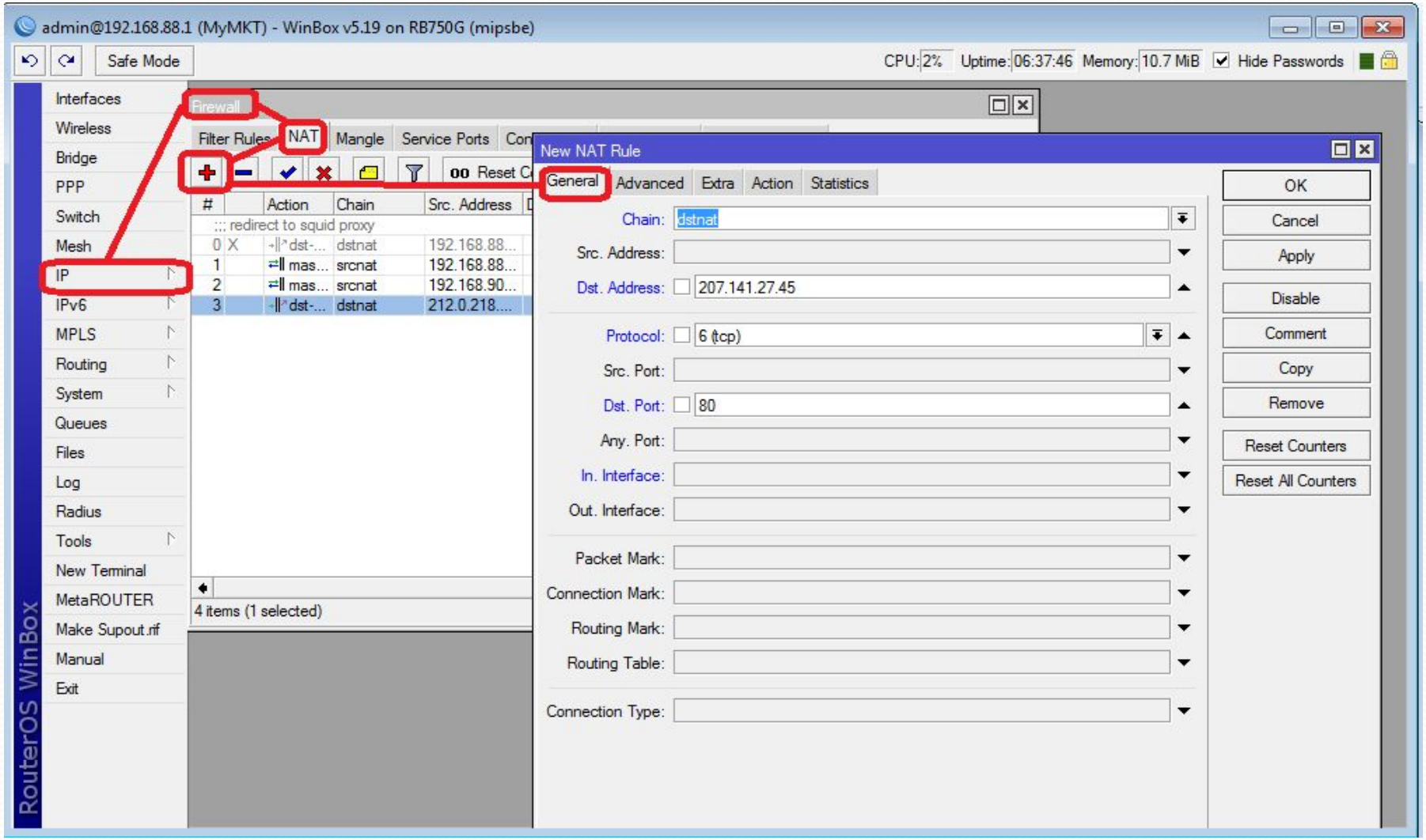
DST-NAT

- DST-NAT changes packet's destination address and port
- It can be used to direct internet users to a server in your private network

NAT Network address translation



DST-NAT for clients services



DST-NAT for clients services

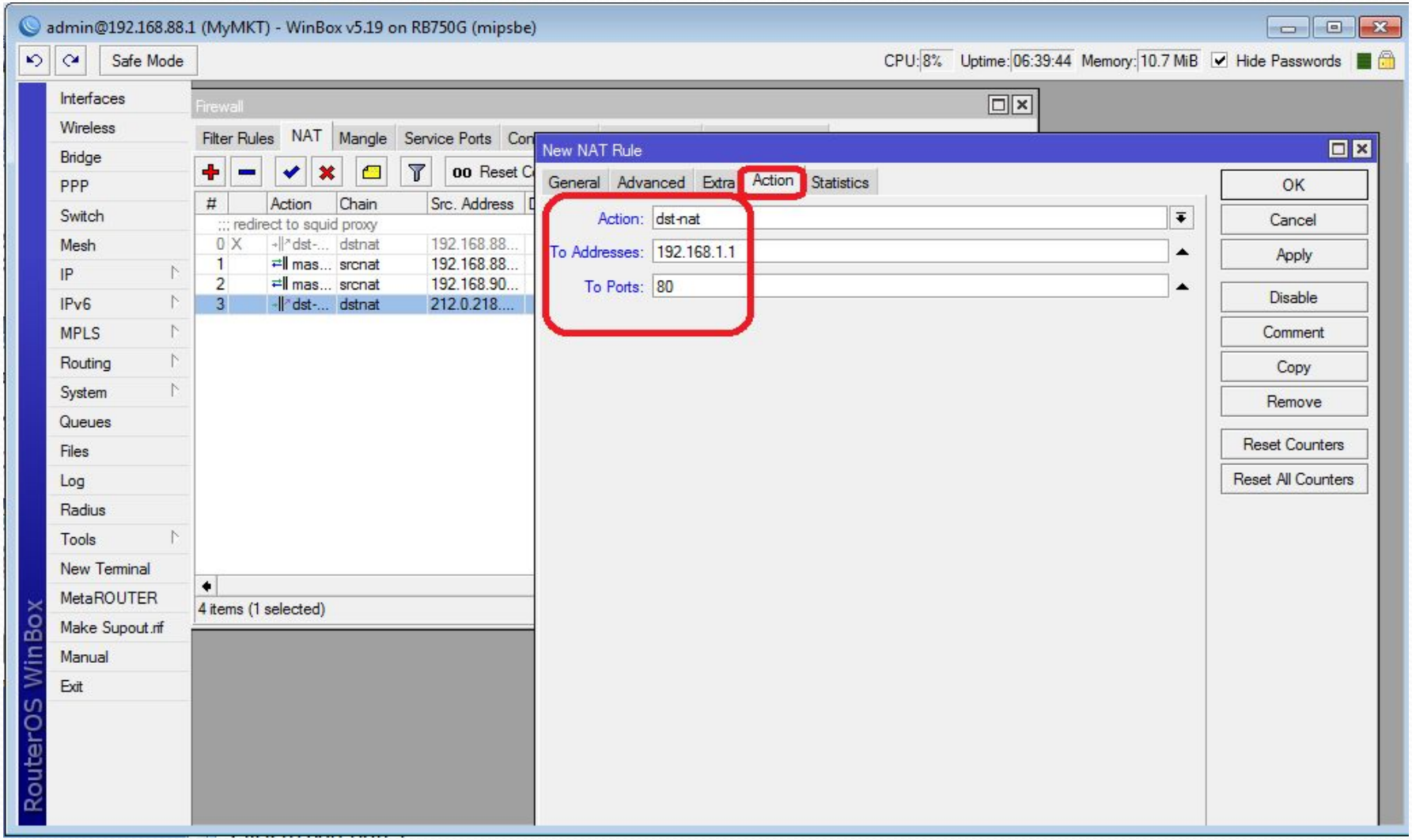
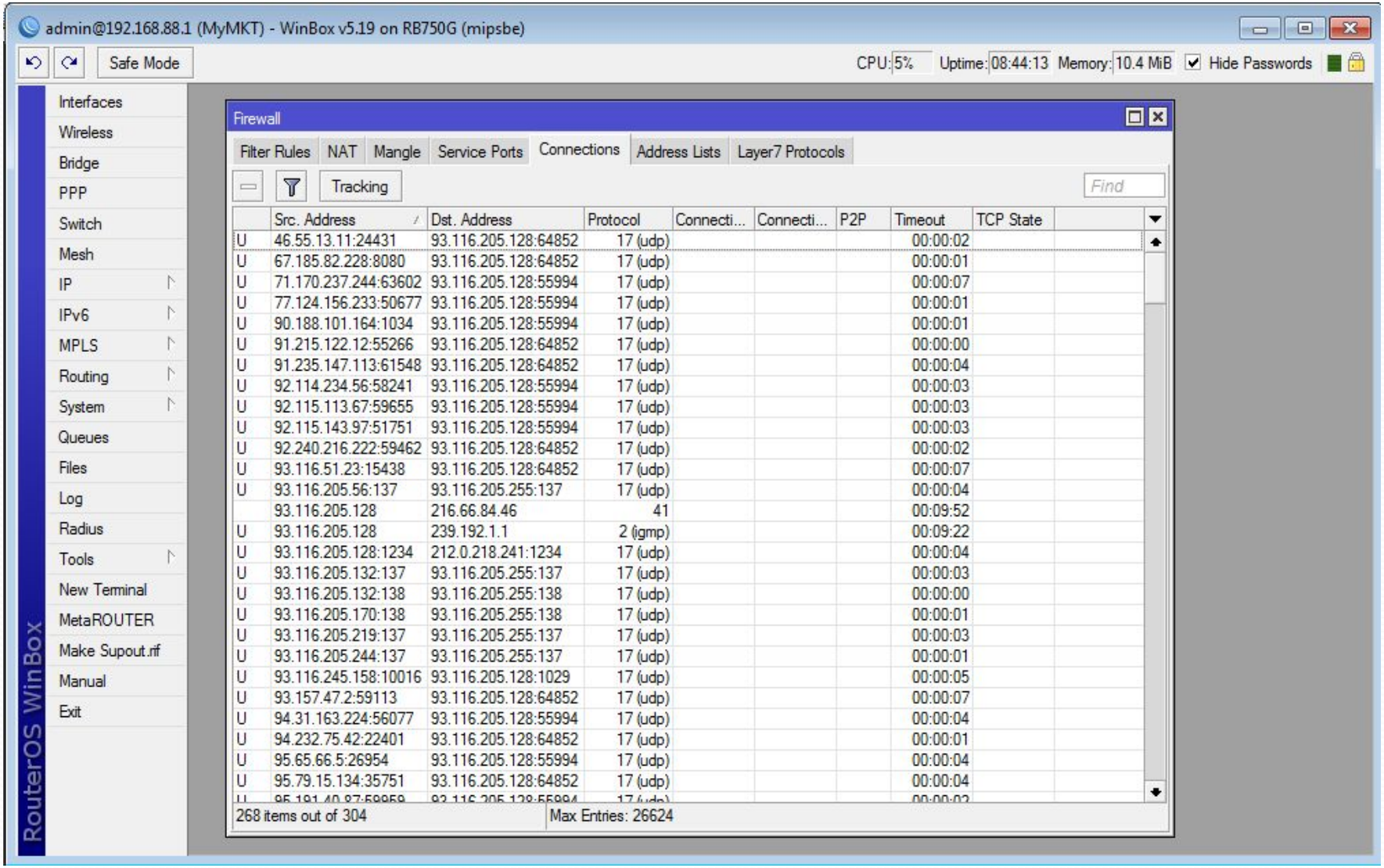


Table of NAT connections



Firewall

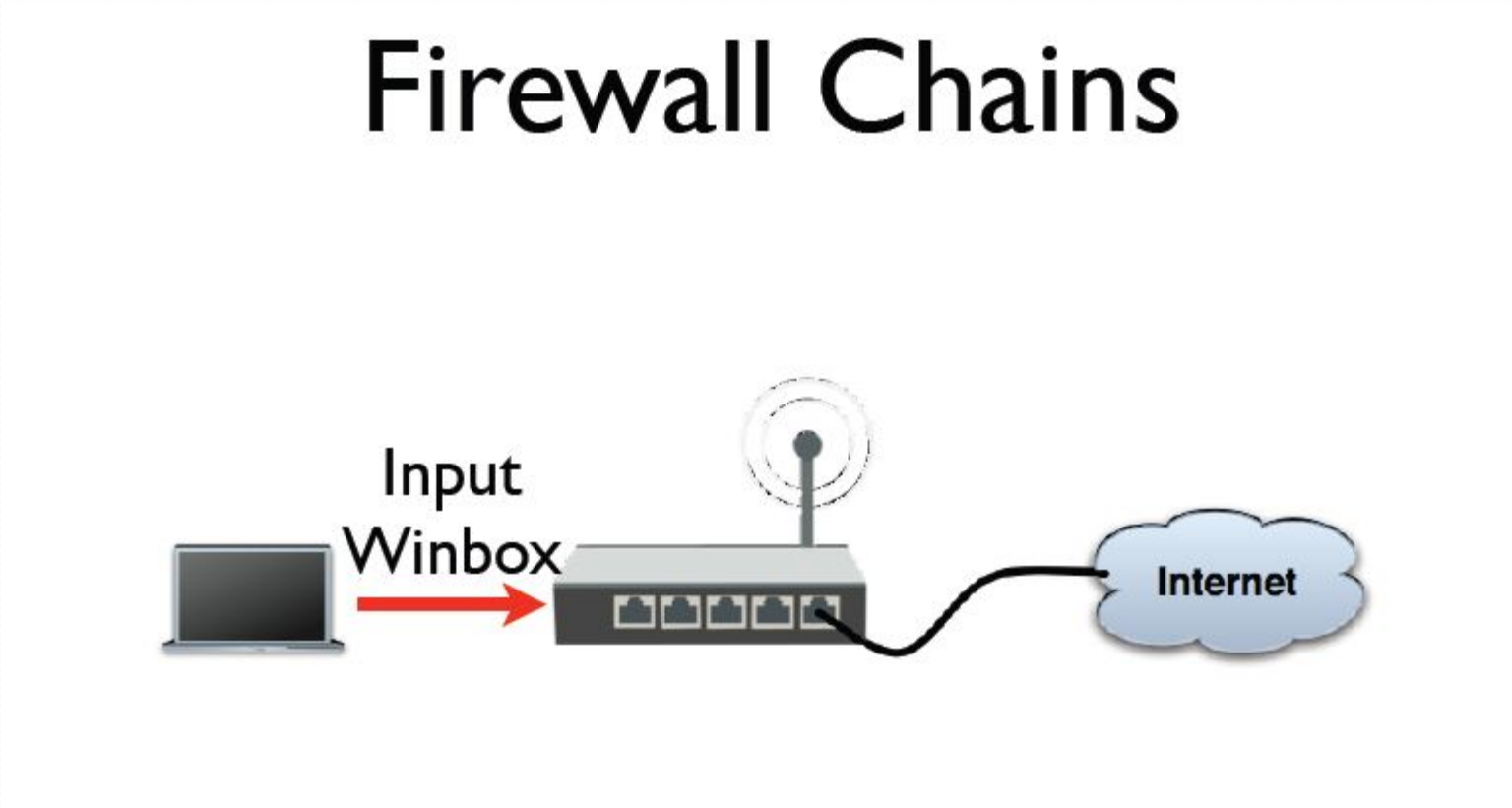
- Protects your router and clients from unauthorized access
- This can be done by creating rules in Firewall Filter and NAT facilities

Firewall rules

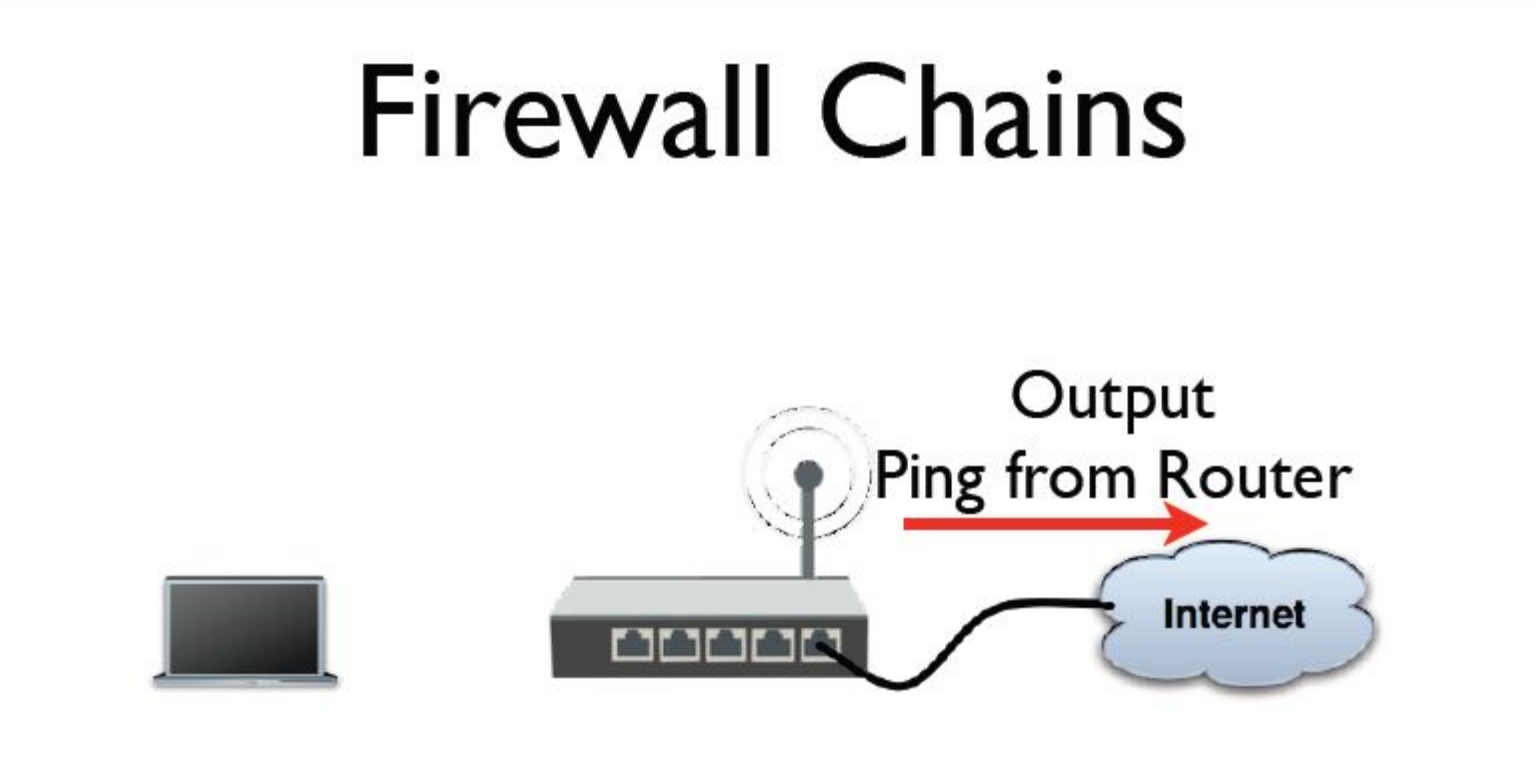
Filter Chains

- Rules can be placed in three default chains
  - input (**to** router)
  - output (**from** router)
  - forward (**trough** the router)

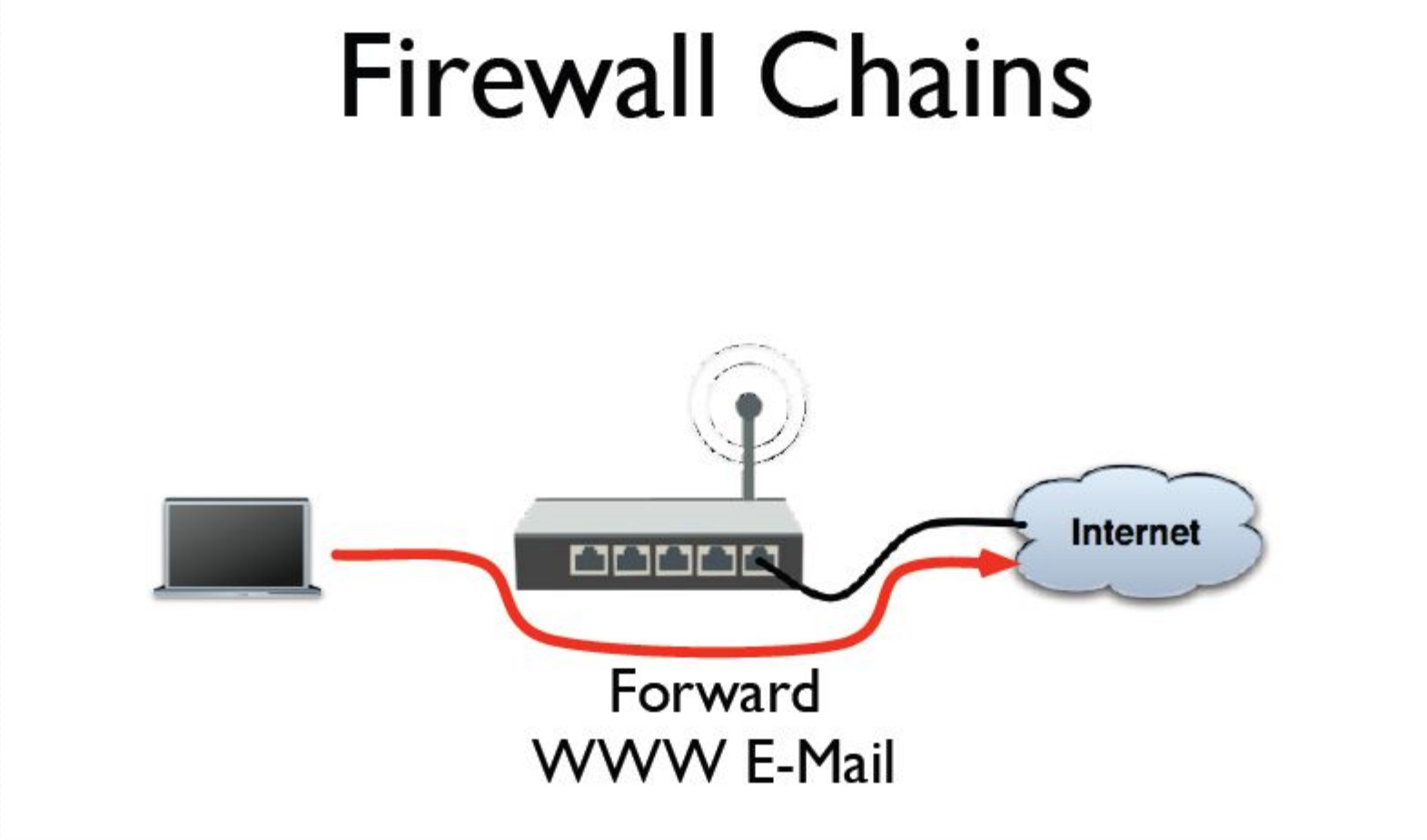
Firewall rules



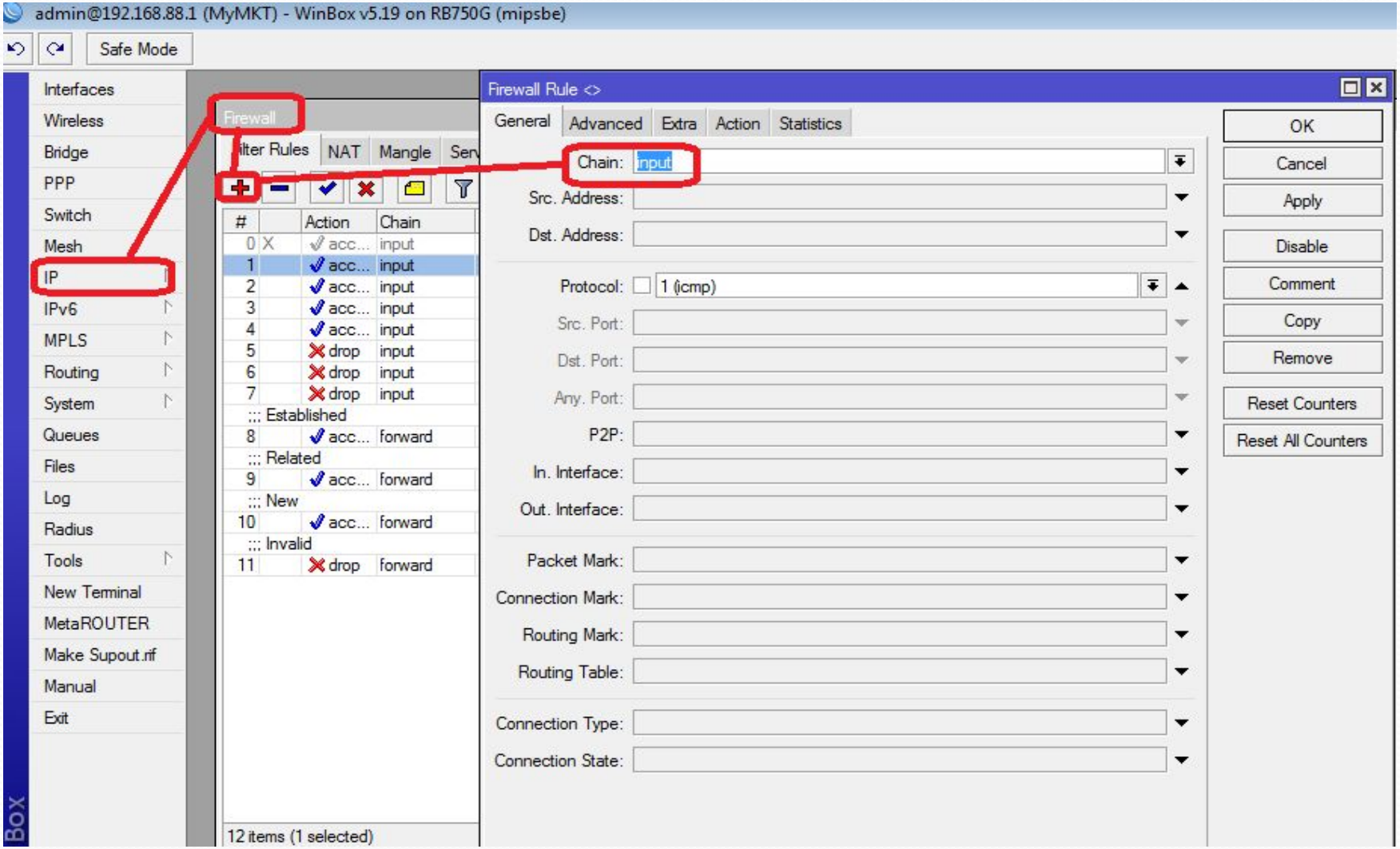
Firewall rules



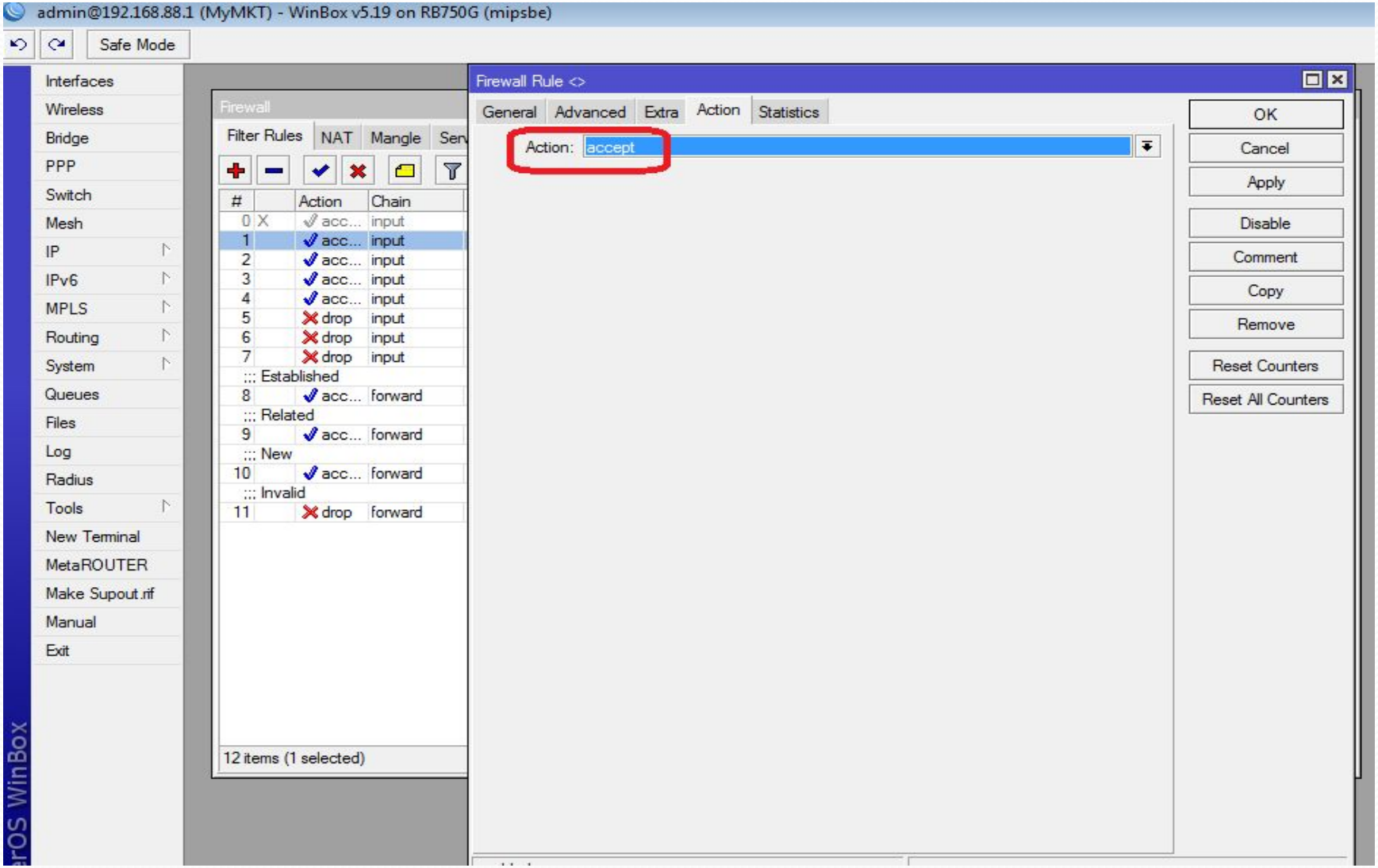
Firewall rules



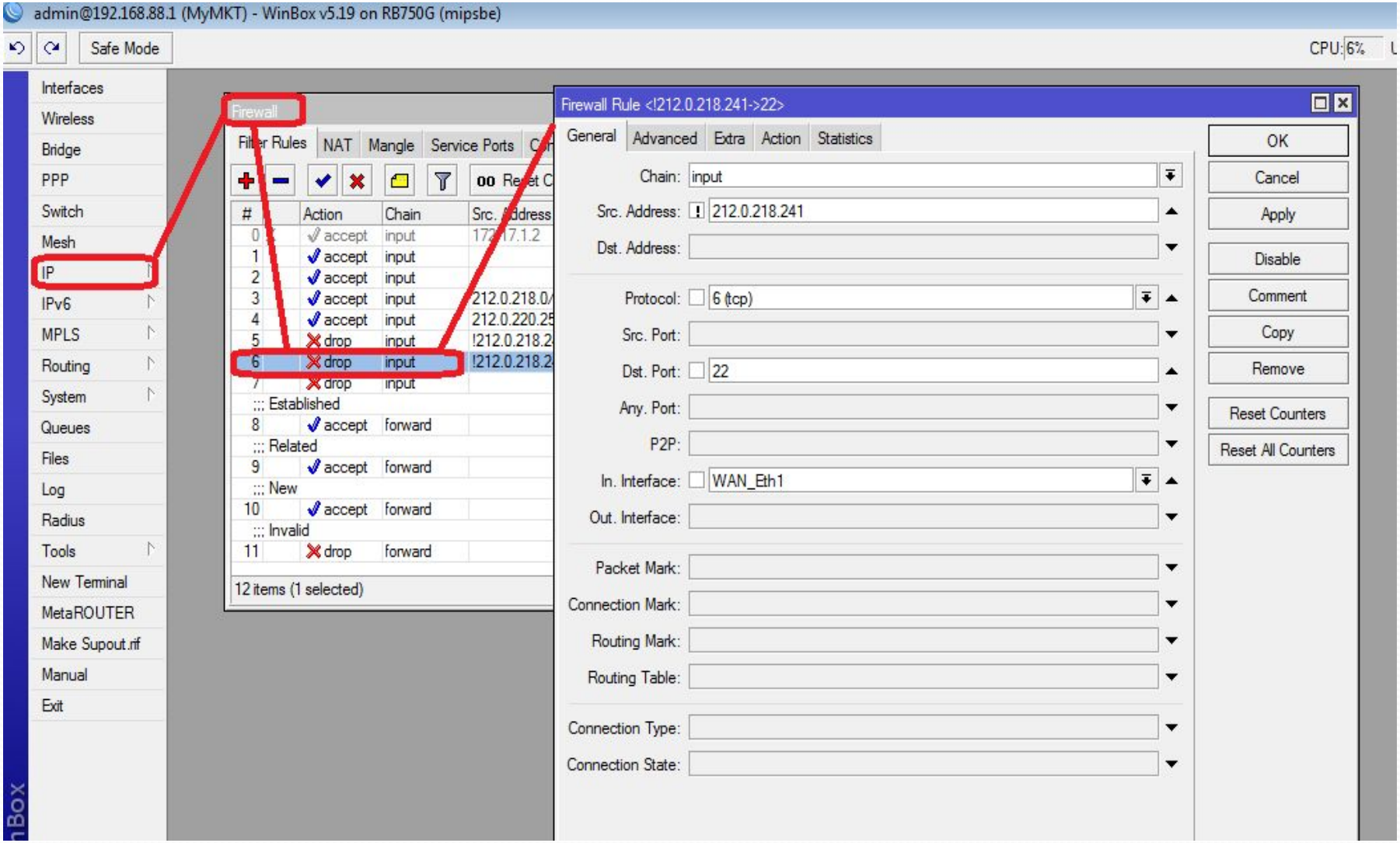
Firewall. Input chain



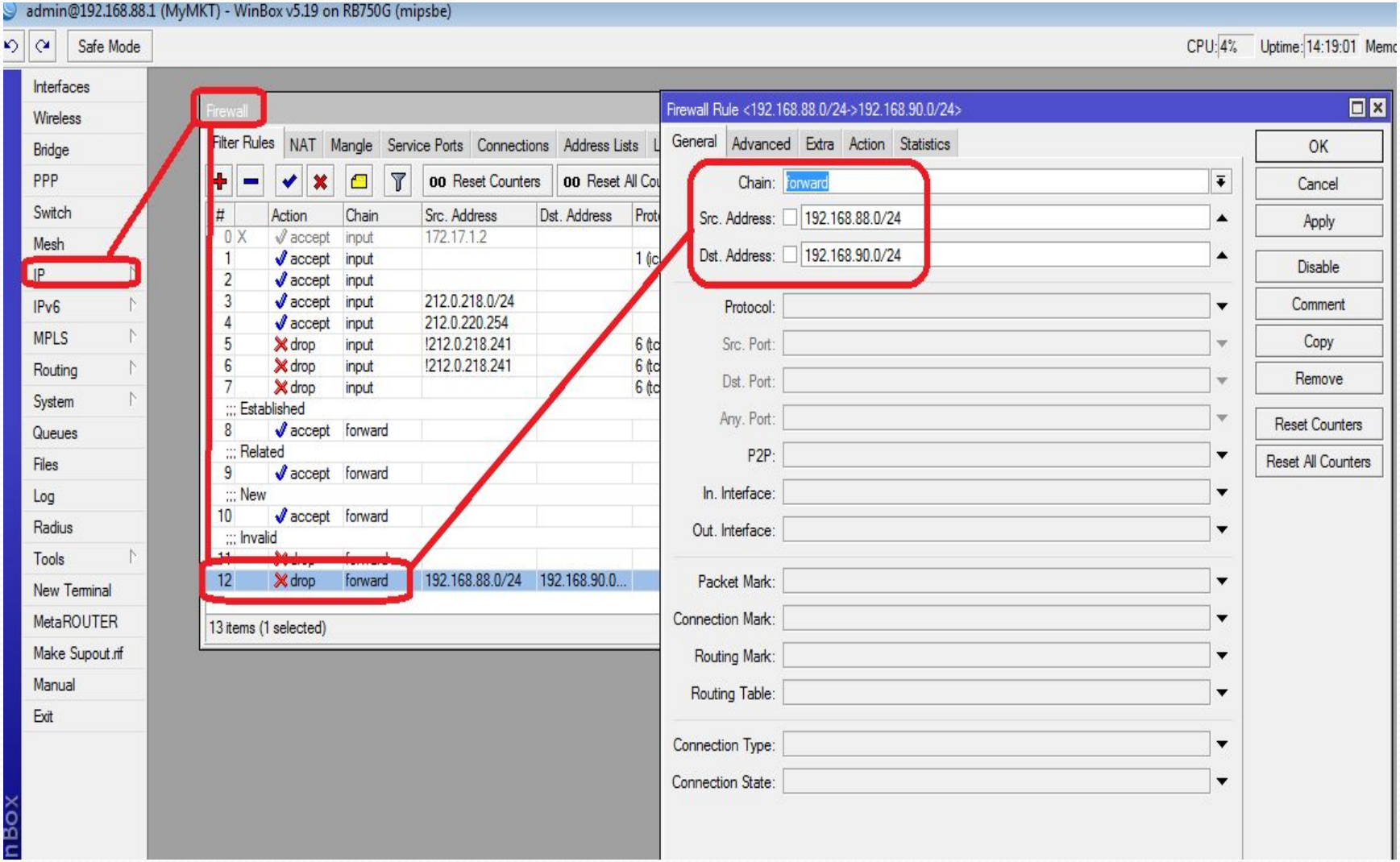
Firewall. Input chain



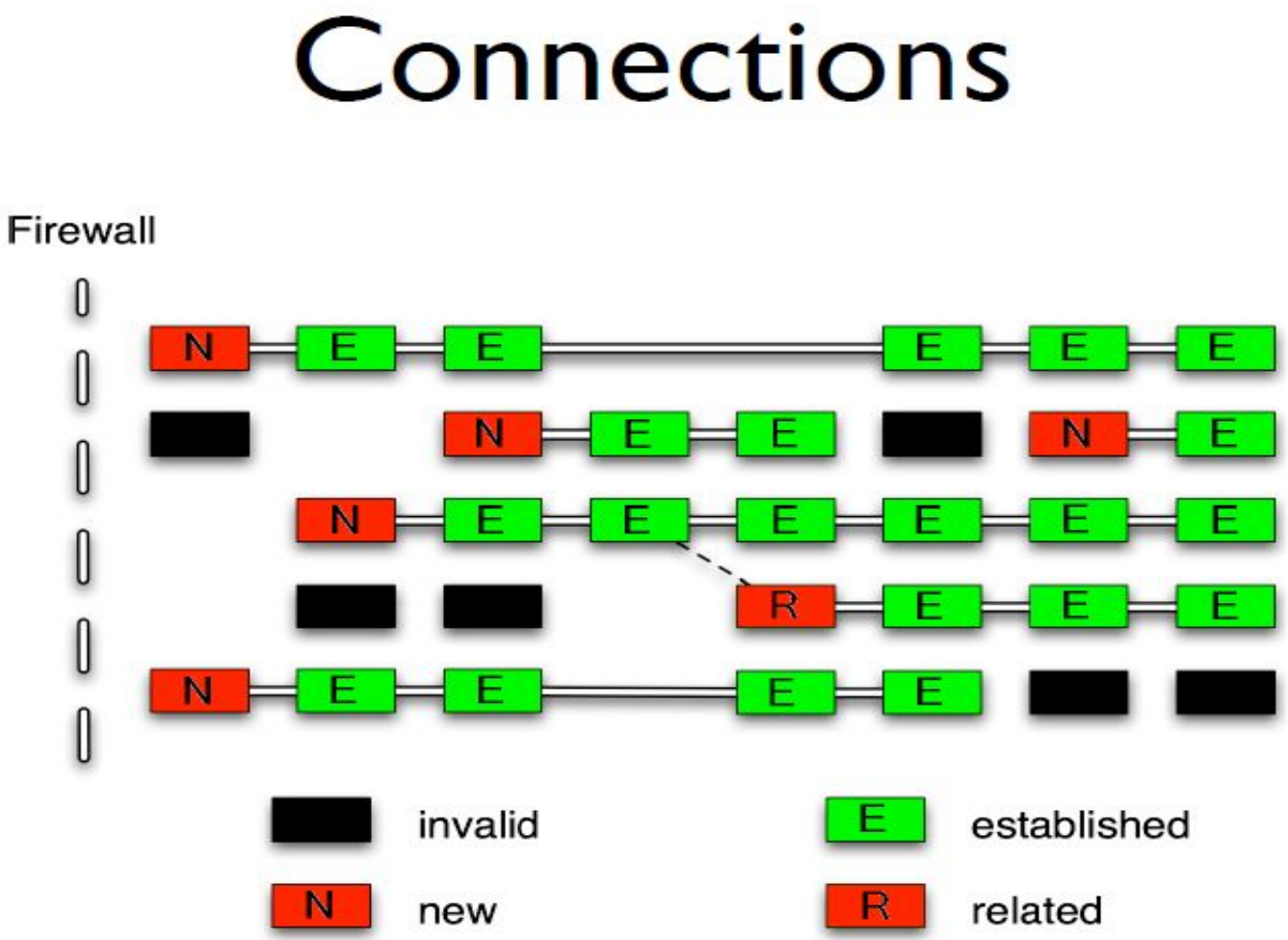
Firewall. Input chain



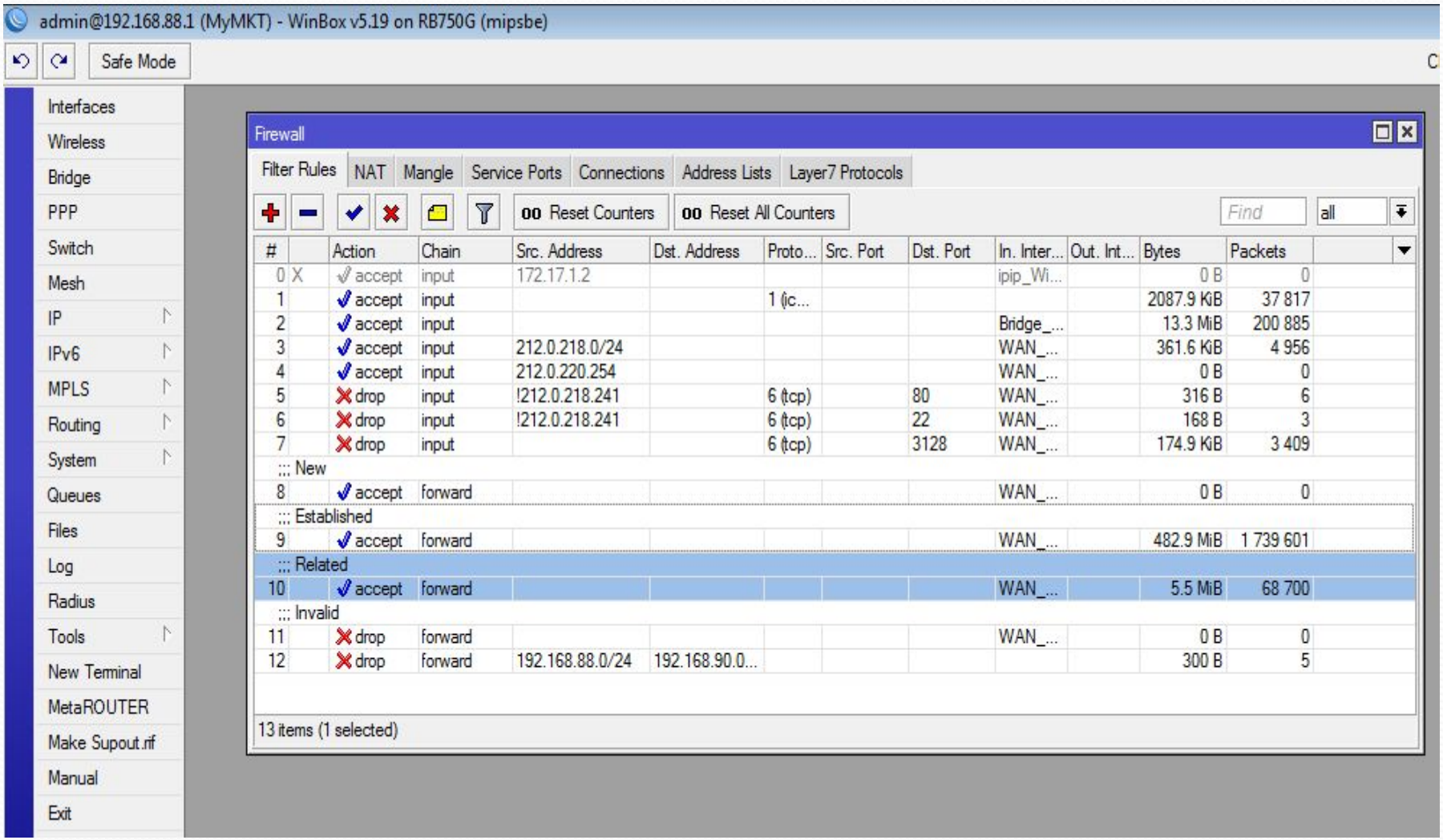
Firewall. Forward chain



Firewall. Connections state



Firewall. Connections state

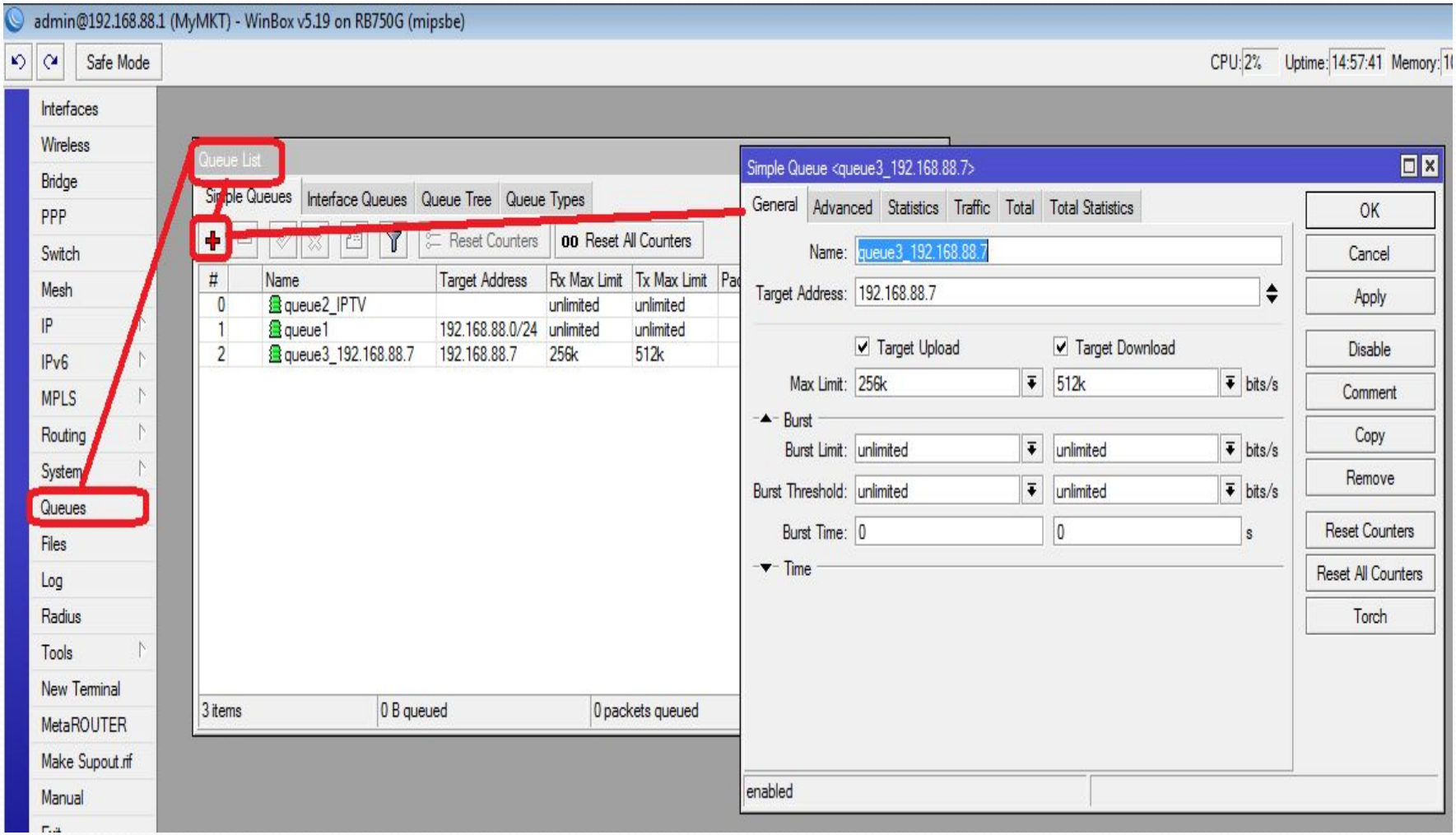


Bandwidth limit

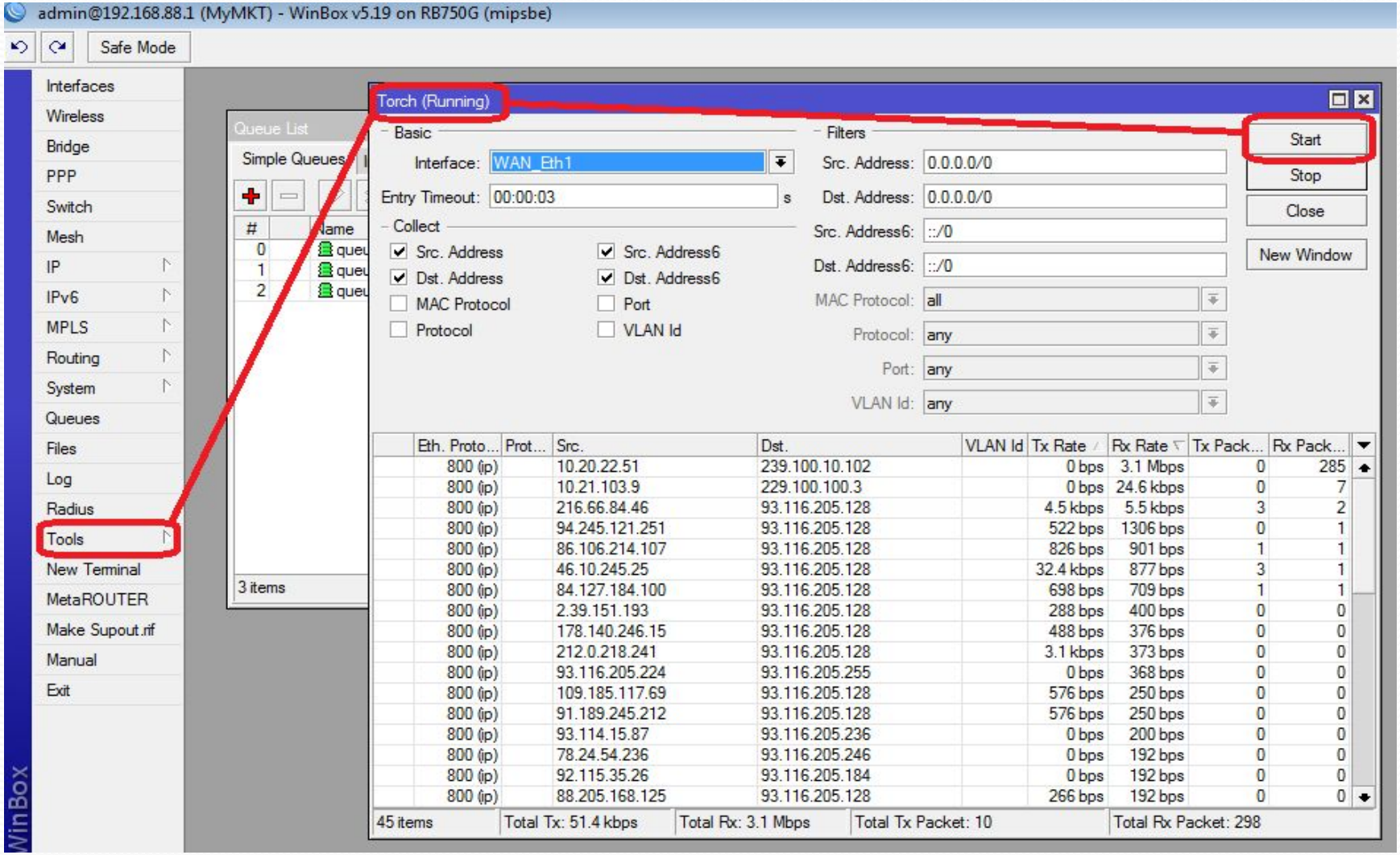
Simple Queue

- The easiest way to limit bandwidth:
  - client download
  - client upload
  - client aggregate, download+upload
  - You must use **Target-Address** for Simple Queue
  - Rule order is important for queue rules

Bandwidth limit

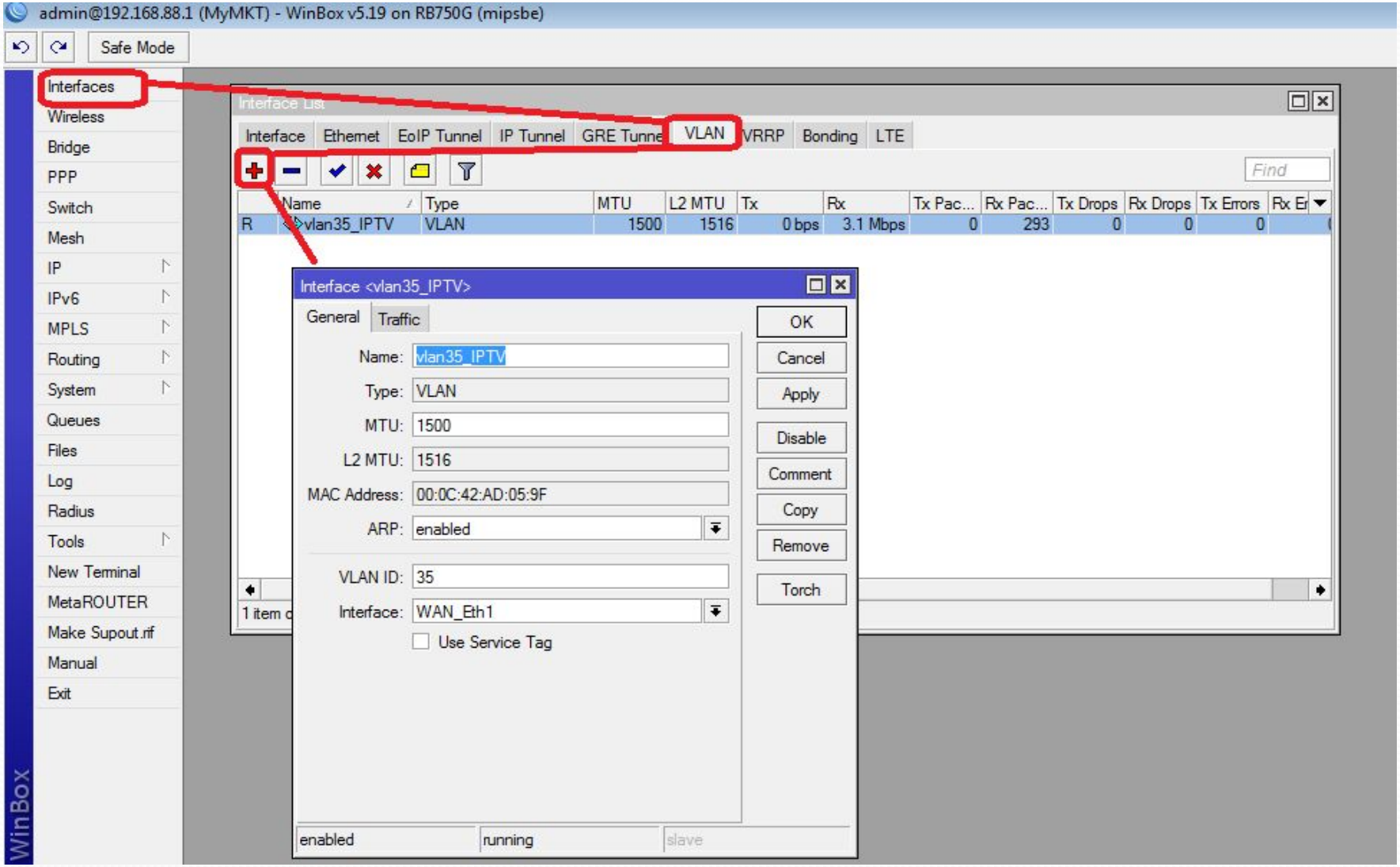


Check bandwidth rate

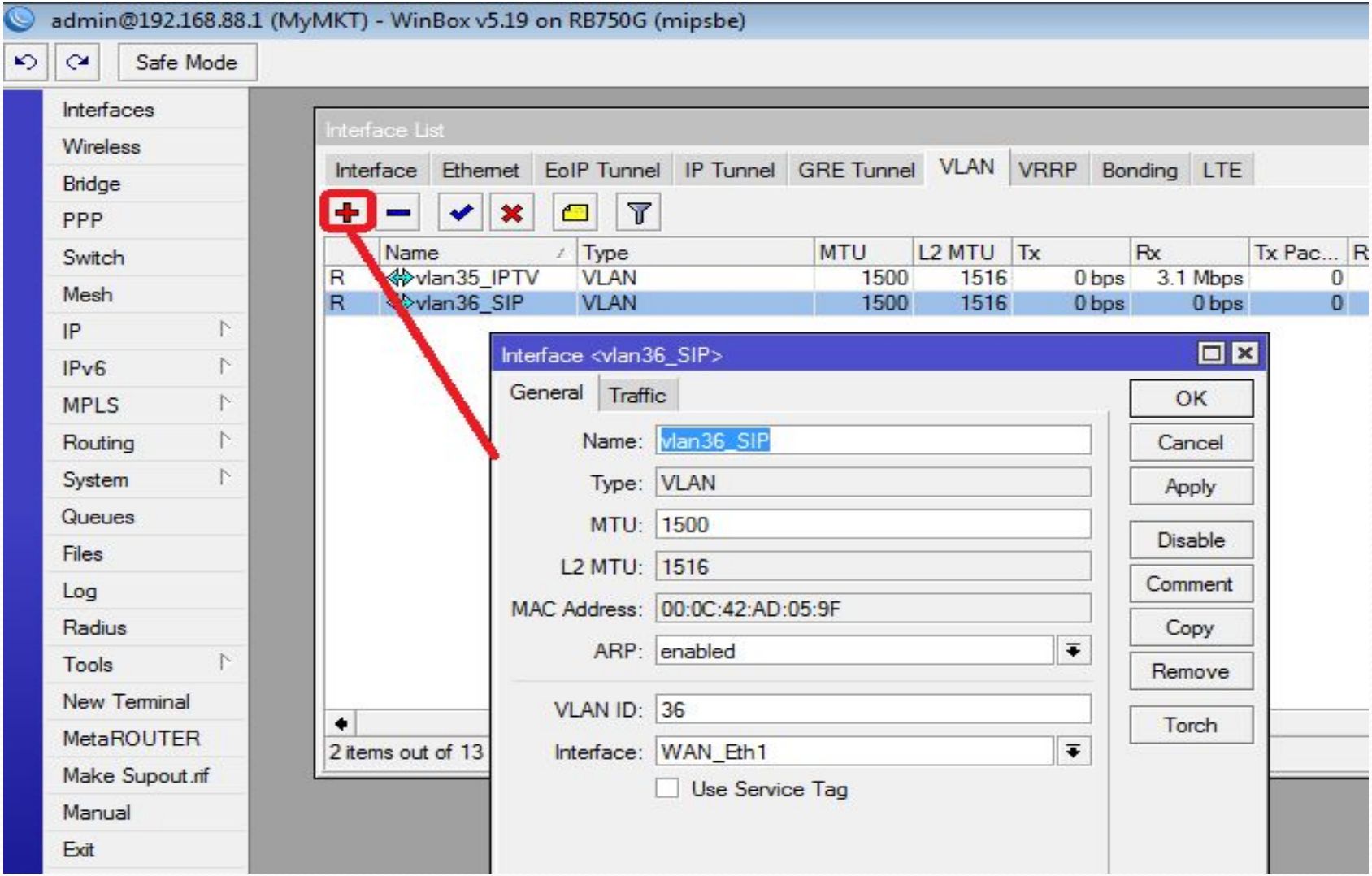


Eth. Proto...	Prot...	Src.	Dst.	VLAN Id	Tx Rate	Rx Rate	Tx Pack...	Rx Pack...
800 (ip)		10.20.22.51	239.100.10.102		0 bps	3.1 Mbps	0	285
800 (ip)		10.21.103.9	229.100.100.3		0 bps	24.6 kbps	0	7
800 (ip)		216.66.84.46	93.116.205.128		4.5 kbps	5.5 kbps	3	2
800 (ip)		94.245.121.251	93.116.205.128		522 bps	1306 bps	0	1
800 (ip)		86.106.214.107	93.116.205.128		826 bps	901 bps	1	1
800 (ip)		46.10.245.25	93.116.205.128		32.4 kbps	877 bps	3	1
800 (ip)		84.127.184.100	93.116.205.128		698 bps	709 bps	1	1
800 (ip)		2.39.151.193	93.116.205.128		288 bps	400 bps	0	0
800 (ip)		178.140.246.15	93.116.205.128		488 bps	376 bps	0	0
800 (ip)		212.0.218.241	93.116.205.128		3.1 kbps	373 bps	0	0
800 (ip)		93.116.205.224	93.116.205.255		0 bps	368 bps	0	0
800 (ip)		109.185.117.69	93.116.205.128		576 bps	250 bps	0	0
800 (ip)		91.189.245.212	93.116.205.128		576 bps	250 bps	0	0
800 (ip)		93.114.15.87	93.116.205.236		0 bps	200 bps	0	0
800 (ip)		78.24.54.236	93.116.205.246		0 bps	192 bps	0	0
800 (ip)		92.115.35.26	93.116.205.184		0 bps	192 bps	0	0
800 (ip)		88.205.168.125	93.116.205.128		266 bps	192 bps	0	0

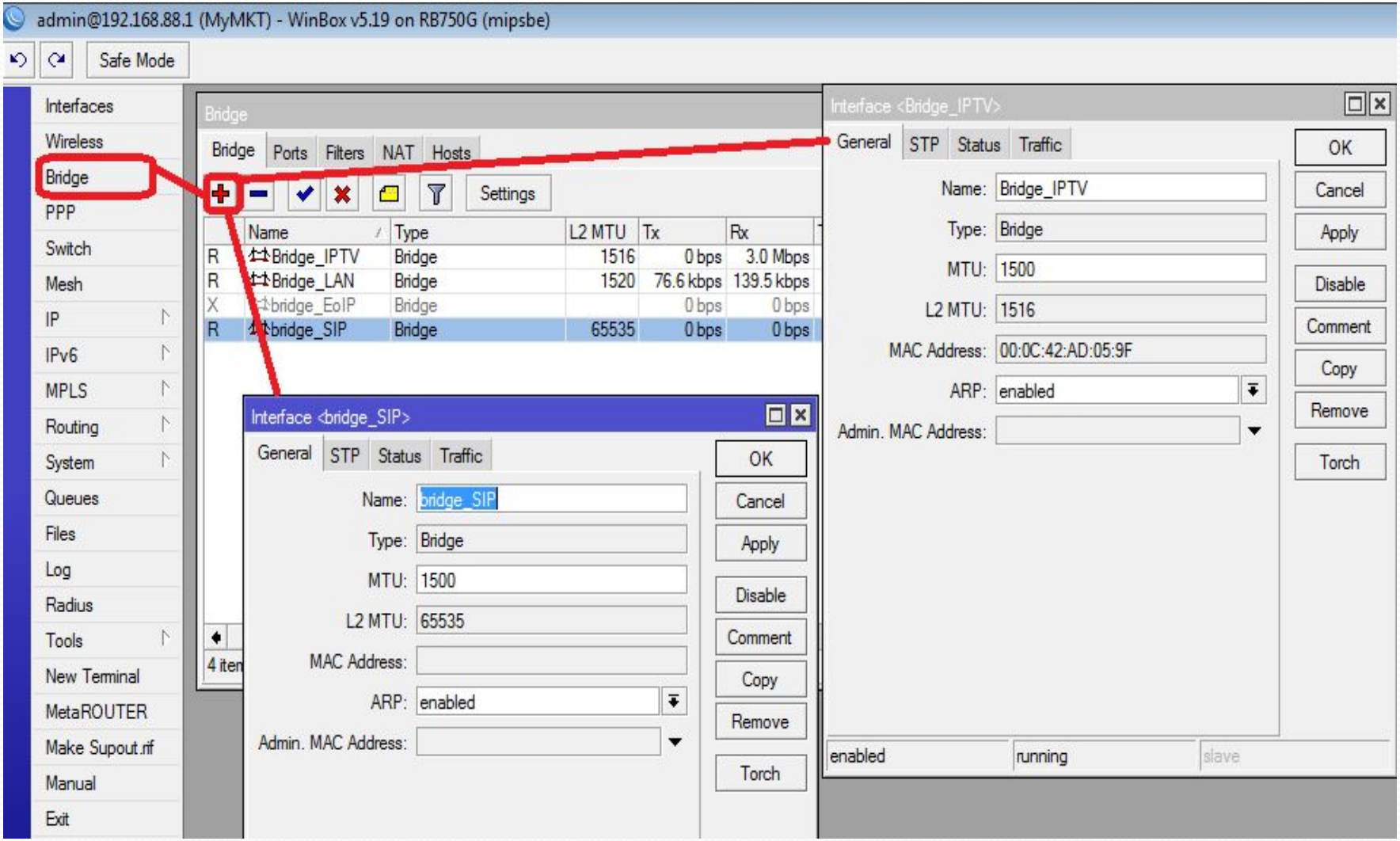
Add VLANs for IPTV and VoIP services



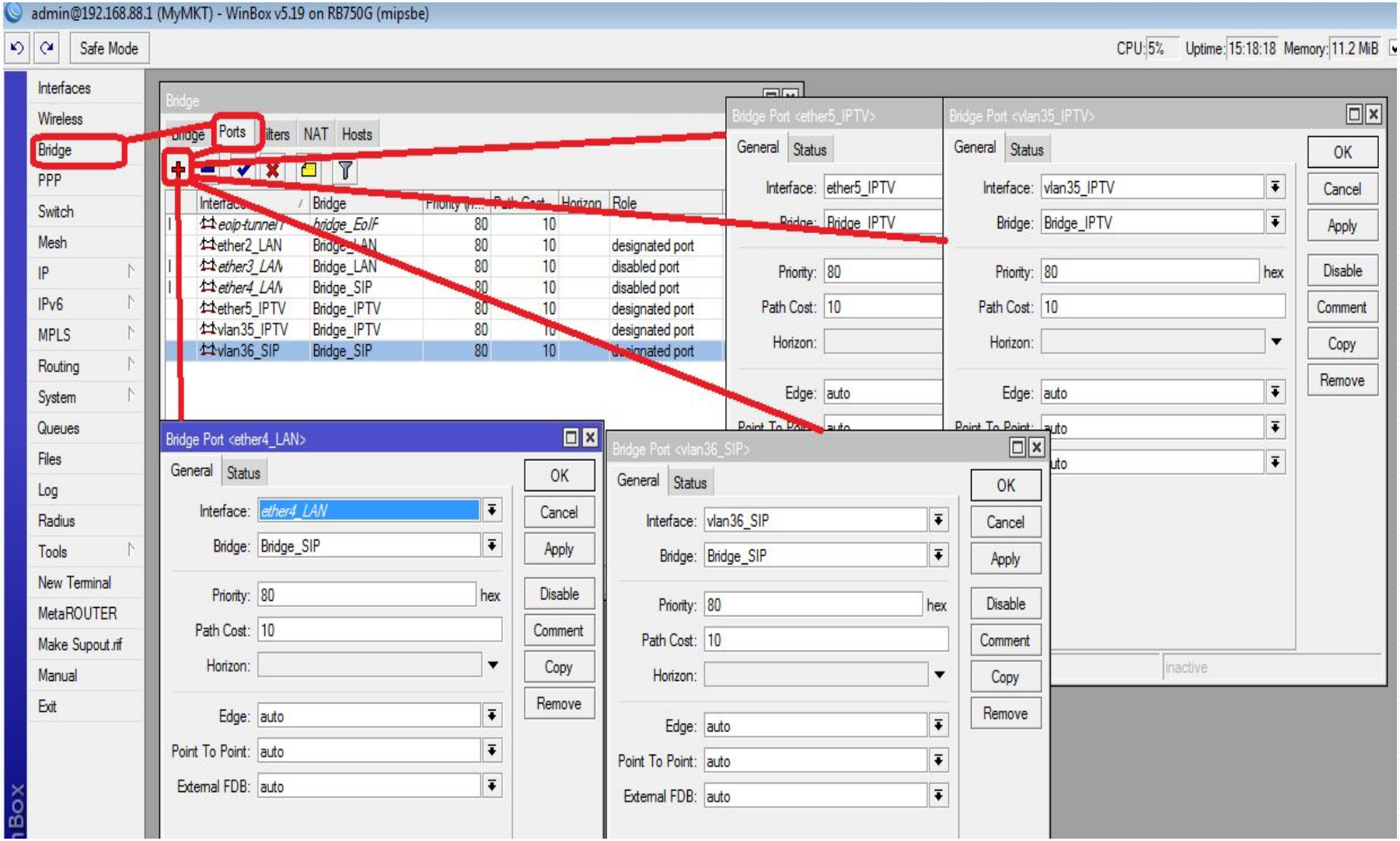
Add VLANs for IPTV and VoIP services



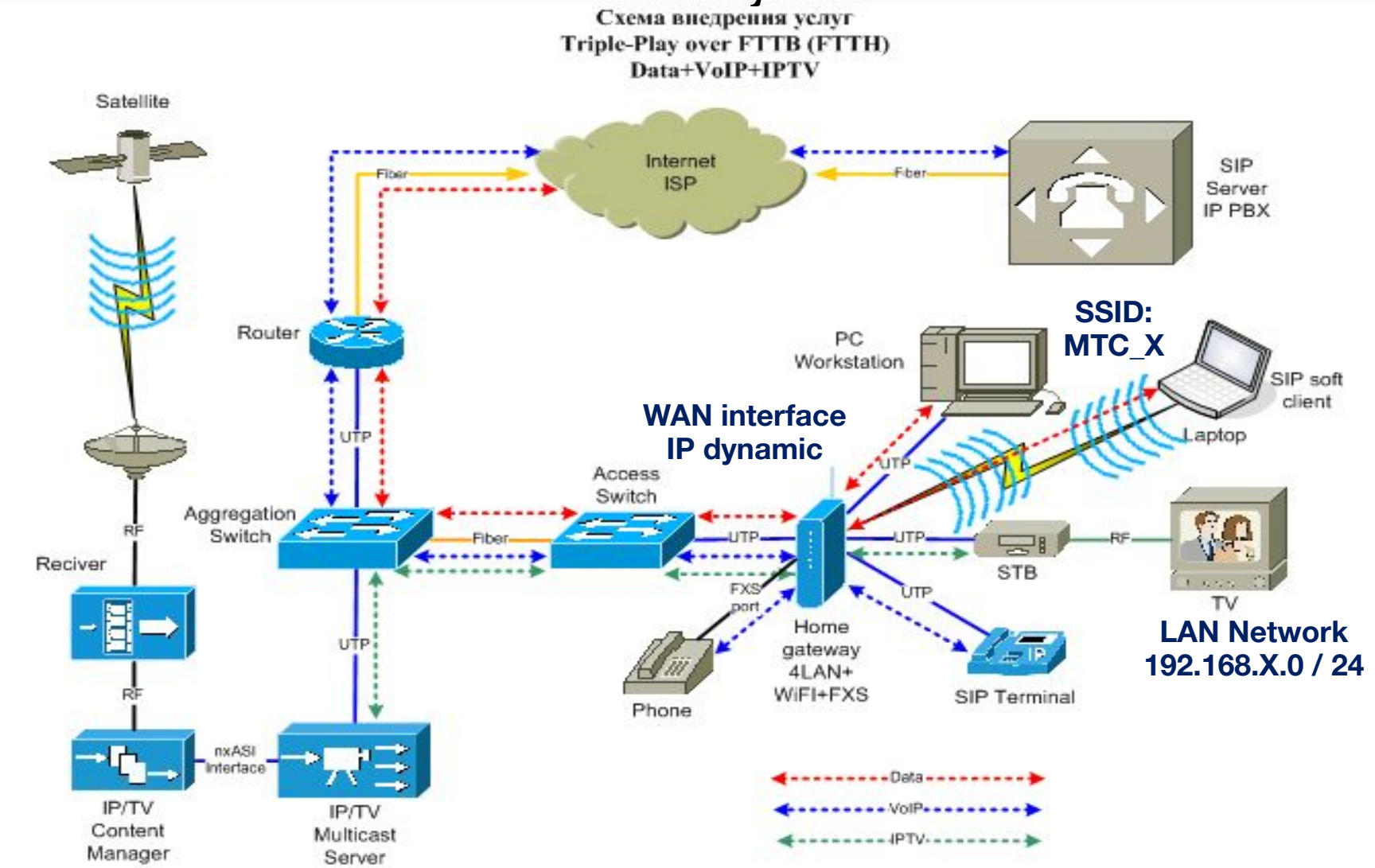
Create Bridge-interfaces for IPTV and VoIP services



Add ethernet ports to Bridge-interfaces



Laboratory work



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