Certified Network Associate (MTCNA)

Riga, Latvia

January 1 - January 3, 2016

About the Trainer

- Name
- Experience
- …

Your photo

Course Objectives

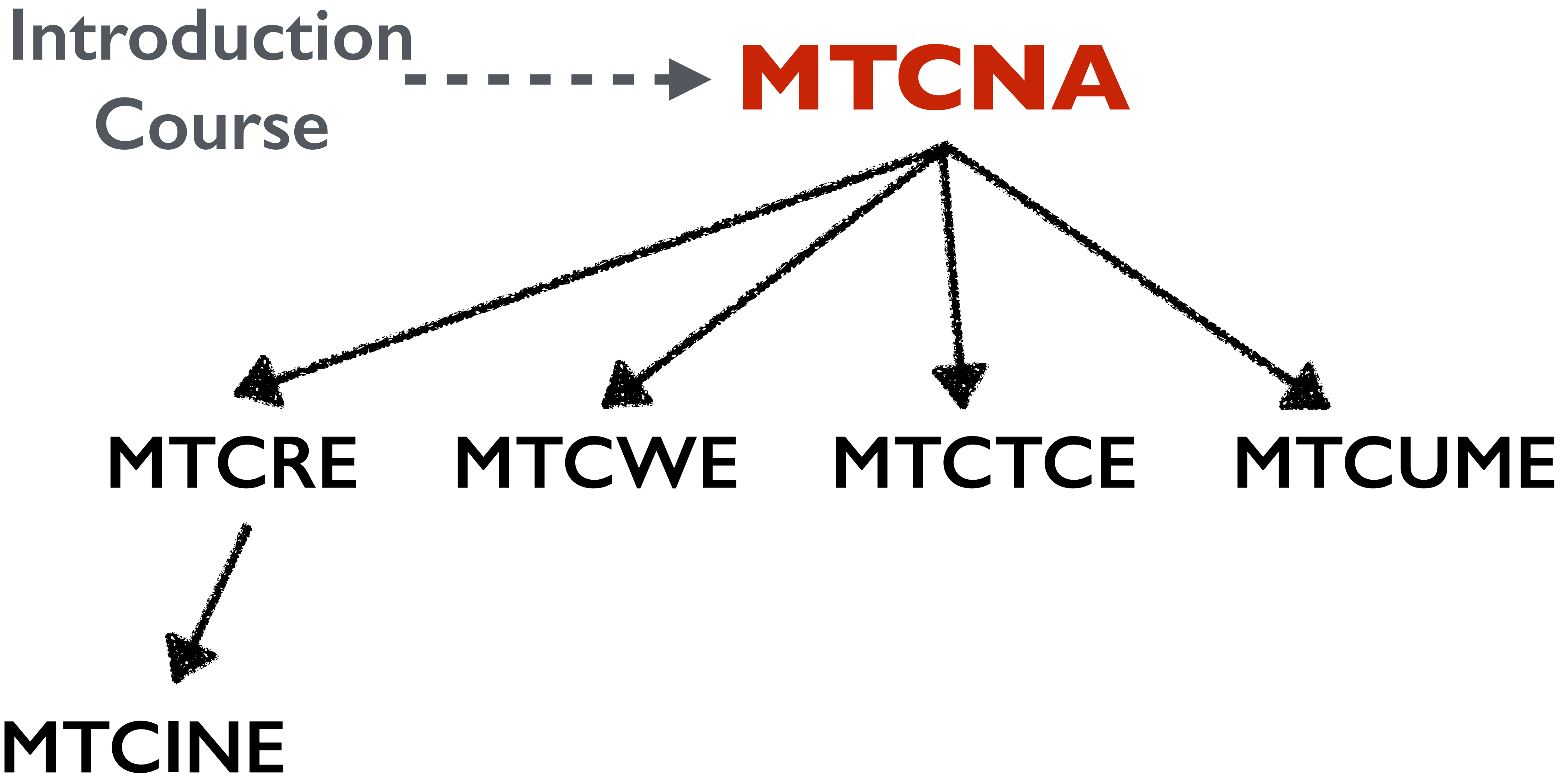
- Provide an overview of RouterOS software and RouterBOARD products
- Hands-on training for MikroTik router configuration, maintenance and basic troubleshooting

Learning Outcomes

The student will:

- Be able to configure, manage and do basic troubleshooting of a MikroTik RouterOS device
- Be able to provide basic services to clients
- Have a solid foundation and valuable tools to manage a network

MikroTik Certified Courses



Introduction Course

MTCNA

MTCRE

MTCWE

MTCTCE

MTCUME

MTCINE

For more info see: http://training.mikrotik.com

MTCNA Outline

- Module 1: Introduction
- Module 2: DHCP
- Module 3: Bridging
- Module 4: Routing
- Module 5: Wireless
- Module 6: Firewall

MTCNA Outline

- Module 7: QoS
- Module 8: Tunnels
- Module 9: Misc
- Hands on LABs during each module (more than 40 in total)
- Detailed outline available on mikrotik.com

Schedule

- Training day: 9AM - 5PM
- 30 minute breaks: 10:30AM and 3PM
- 1 hour lunch: 12:30PM
- Certification test: last day, 1 hour

Housekeeping

- Emergency exits
- Bathroom location
- Food and drinks while in class
- Please set phone to 'silence' and take calls outside the classroom

Introduce Yourself

- Your name and company
- Your prior knowledge about networking
- Your prior knowledge about RouterOS
- What do you expect from this course?
- Please, note your number (XY): ____

Certified Network Associate (MTCNA)

Module 1

Introduction

About MikroTik

- Router software and hardware manufacturer
- Products used by ISPs, companies and individuals
- Mission: to make Internet technologies faster, more powerful and affordable to a wider range of users

About MikroTik

- 1996: Established
- 1997: RouterOS software for x86 (PC)
- 2002: First RouterBOARD device
- 2006: First MikroTik User Meeting (MUM)
  - Prague, Czech Republic
- 2015: Biggest MUM: Indonesia, 2500+

About MikroTik

- Located in Latvia
- 160+ employees
- mikrotik.com
- routerboard.com

Norwegian Sea
North Atlantic Ocean
Gulf of Bothnia
North Sea
Baltic Sea
Latvia
English Channel
Bay of Biscay
Black Sea
Adriatic Sea
Tyrrhenian Sea
Aegean Sea
Ionian Sea
Mediterranean Sea
250 Km
250 Mi

MikroTik RouterOS

- Is the operating system of MikroTik RouterBOARD hardware
- Can also be installed on a PC or as a virtual machine (VM)
- Stand-alone operating system based on the Linux kernel

RouterOS Features

- Full 802.11 a/b/g/n/ac support
- Firewall/bandwidth shaping
- Point-to-Point tunnelling (PPTP, PPPoE, SSTP, OpenVPN)
- DHCP/Proxy/HotSpot
- And many more… see: wiki.mikrotik.com

MikroTik RouterBOARD

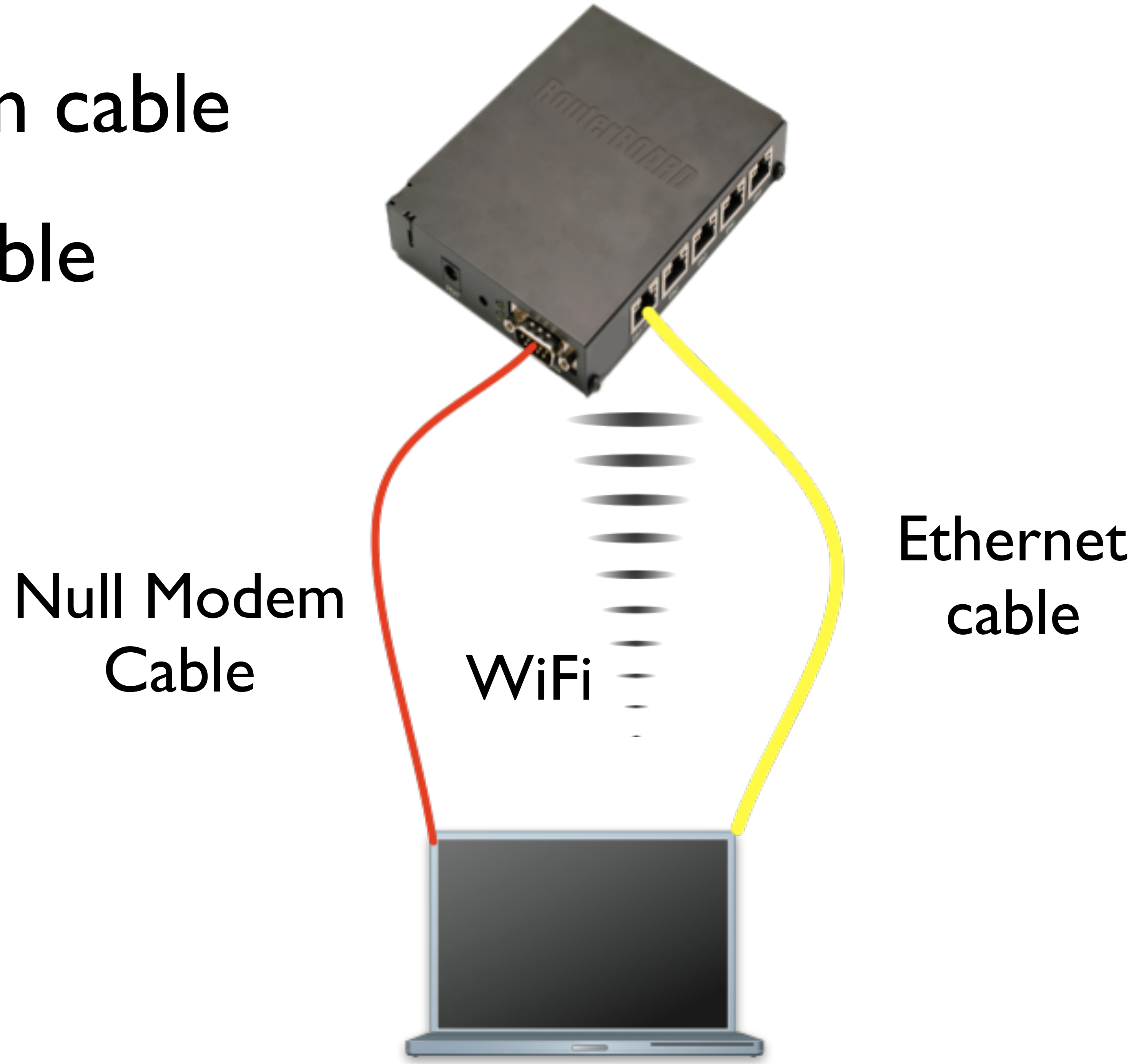
- A family of hardware solutions created by MikroTik that run RouterOS
- Ranging from small home routers to carrier-class access concentrators
- Millions of RouterBOARDs are currently routing the world

MikroTik RouterBOARD

- Integrated solutions - ready to use
- Boards only - for assembling own system
- Enclosures - for custom RouterBOARD builds
- Interfaces - for expanding functionality
- Accessories

First Time Access

- Null modem cable
- Ethernet cable
- WiFi

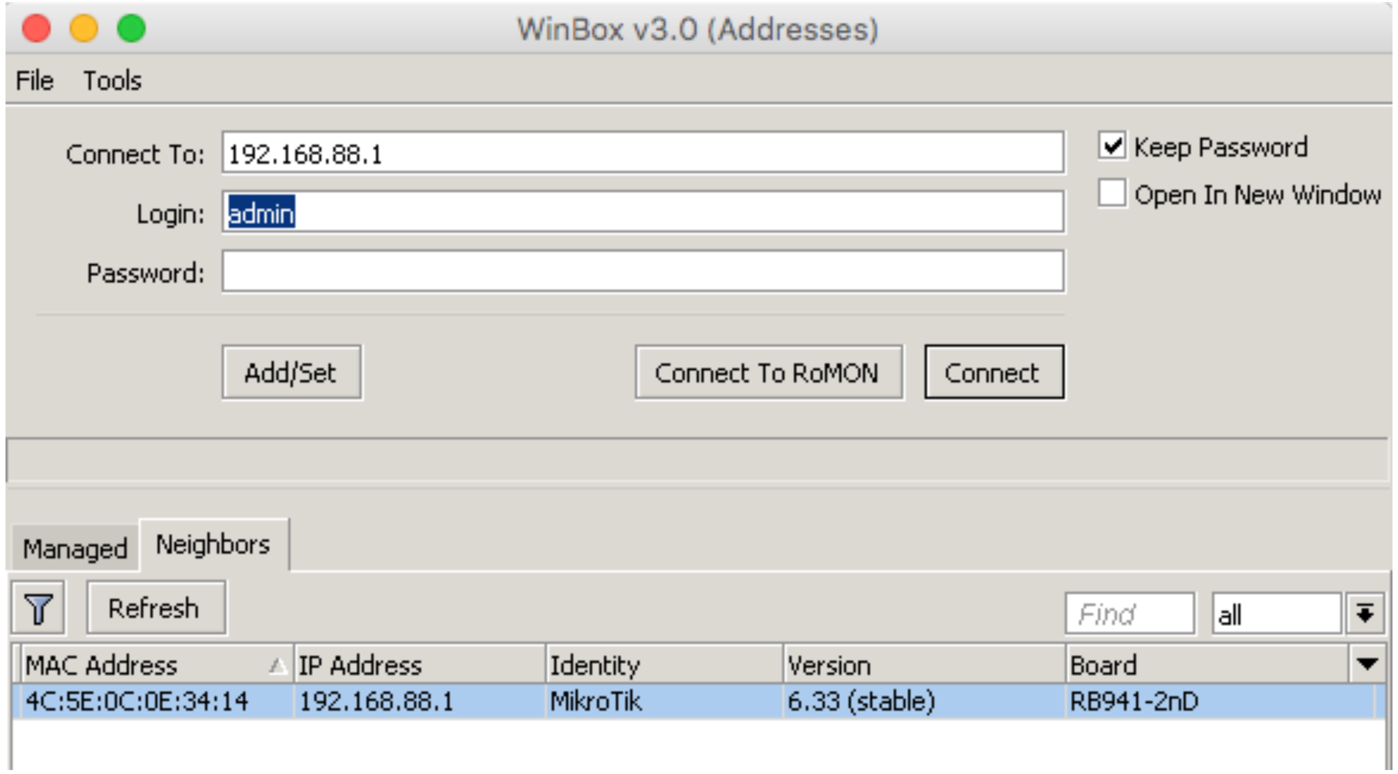


First Time Access

- WinBox - http://www.mikrotik.com/download/winbox.exe
- WebFig
- SSH
- Telnet
- Terminal emulator in case of serial port connection

WinBox

- Default IP address (LAN side): 192.168.88.1
- User: admin
- Password: (blank)



Connect To: 192.168.88.1

Login: admin

Password:

☑ Keep Password

☐ Open In New Window

MAC Address	IP Address	Identity	Version	Board
4C:5E:0C:0E:34:14	192.168.88.1	MikroTik	6.33 (stable)	RB941-2nD

MikroTik
MTCNA

LAB

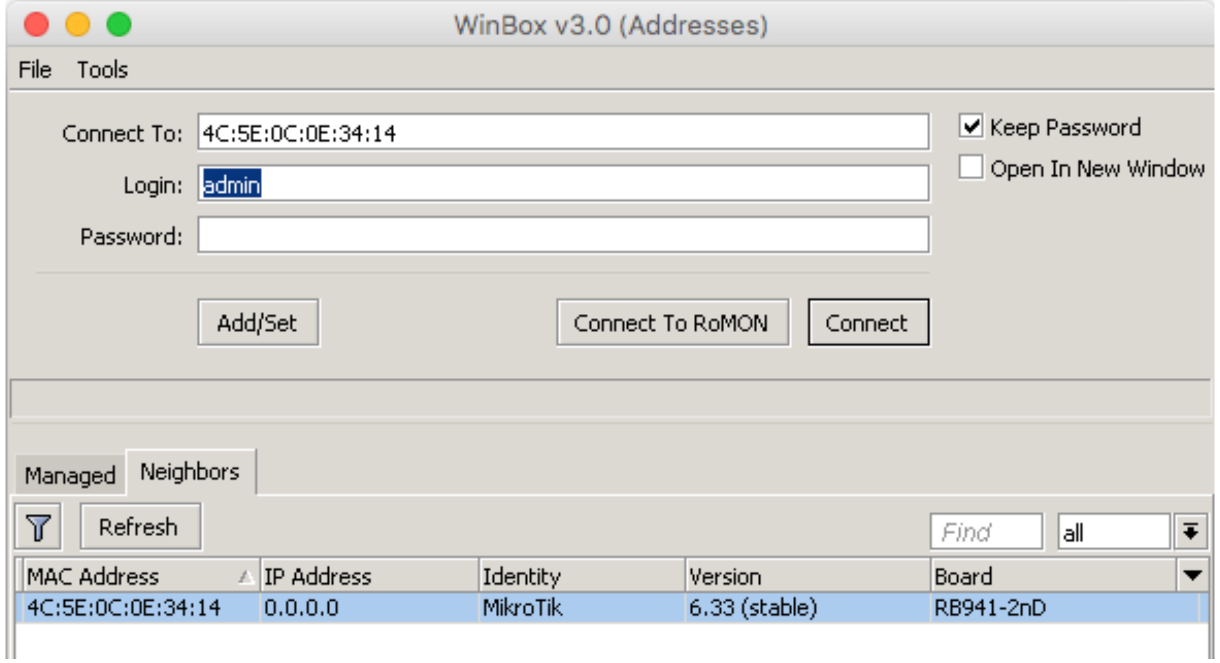
MAC WinBox

- Observe WinBox title when connected using IP address
- Connect to the router using MAC address
- Observe WinBox title

MikroTik MTCNA

MAC WinBox

- Disable IP address on the bridge interface
- Try to log in the router using IP address (not possible)
- Try to log in the router using MAC WinBox (works)



WinBox v3.0 (Addresses)

Connect To: 4C:5E:0C:0E:34:14

Login: admin

Password:

☑ Keep Password

□ Open In New Window

MAC Address	IP Address	Identity	Version	Board
4C:5E:0C:0E:34:14	0.0.0.0	MikroTik	6.33 (stable)	RB941-2nD

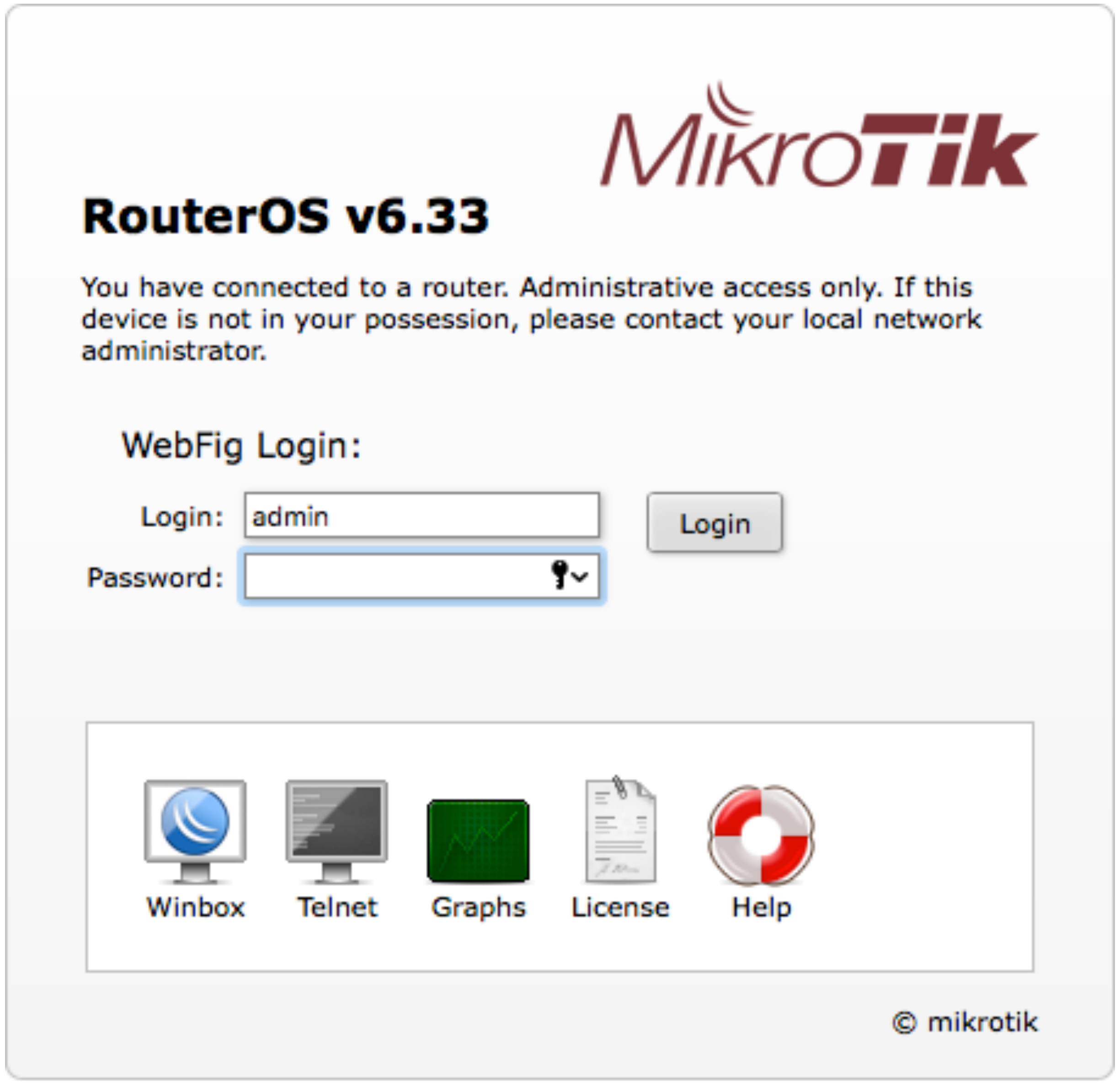
Optional LAB

MAC WinBox

- Enable IP address on the bridge interface
- Log in the router using IP address

WebFig

- Browser - http://192.168.88.1



RouterOS v6.33

You have connected to a router. Administrative access only. If this device is not in your possession, please contact your local network administrator.

WebFig Login:

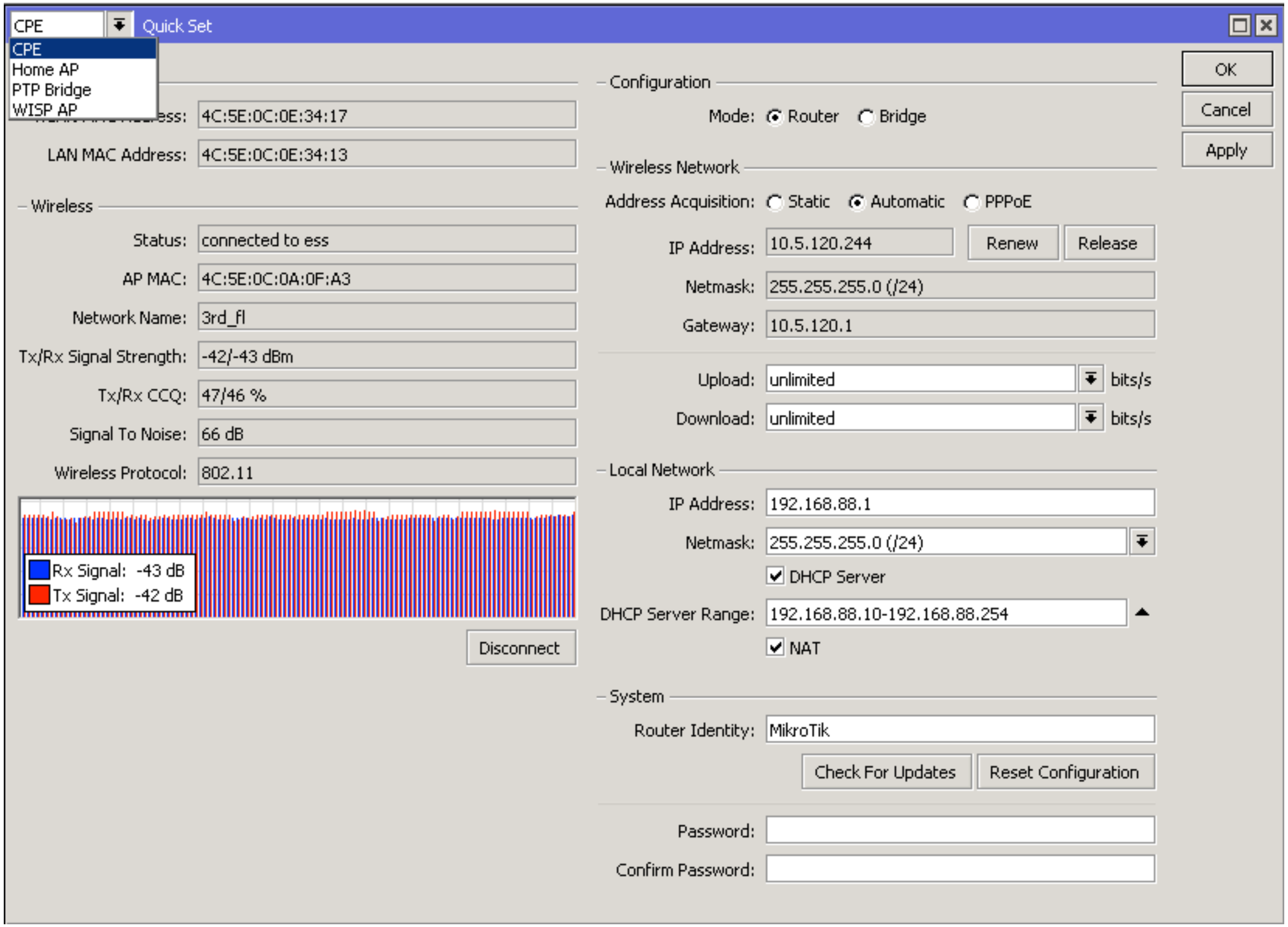
Login: admin

Password:

Quick Set

- Basic router configuration in one window
- Accessible from both WinBox and WebFig
- In more detail described in “Introduction to MikroTik RouterOS and RouterBOARDs” course

Quick Set



CPE — Quick Set

CPE
Home AP
PTP Bridge
WISP AP

OK

Cancel

Apply

ess: 4C:5E:0C:0E:34:17

LAN MAC Address: 4C:5E:0C:0E:34:13

Wireless

Status: connected to ess

AP MAC: 4C:5E:0C:0A:0F:A3

Network Name: 3rd_fl

Tx/Rx Signal Strength: -42/-43 dBm

Tx/Rx CCQ: 47/46 %

Signal To Noise: 66 dB

Wireless Protocol: 802.11

Disconnect

Configuration

Mode: ● Router ○ Bridge

Wireless Network

Address Acquisition: ○ Static ● Automatic ○ PPPoE

IP Address: 10.5.120.244 Renew Release

Netmask: 255.255.255.0 (/24)

Gateway: 10.5.120.1

Upload: unlimited bits/s

Download: unlimited bits/s

Local Network

IP Address: 192.168.88.1

Netmask: 255.255.255.0 (/24)

☑ DHCP Server

DHCP Server Range: 192.168.88.10-192.168.88.254

☑ NAT

System

Router Identity: MikroTik

Check For Updates Reset Configuration

Password:

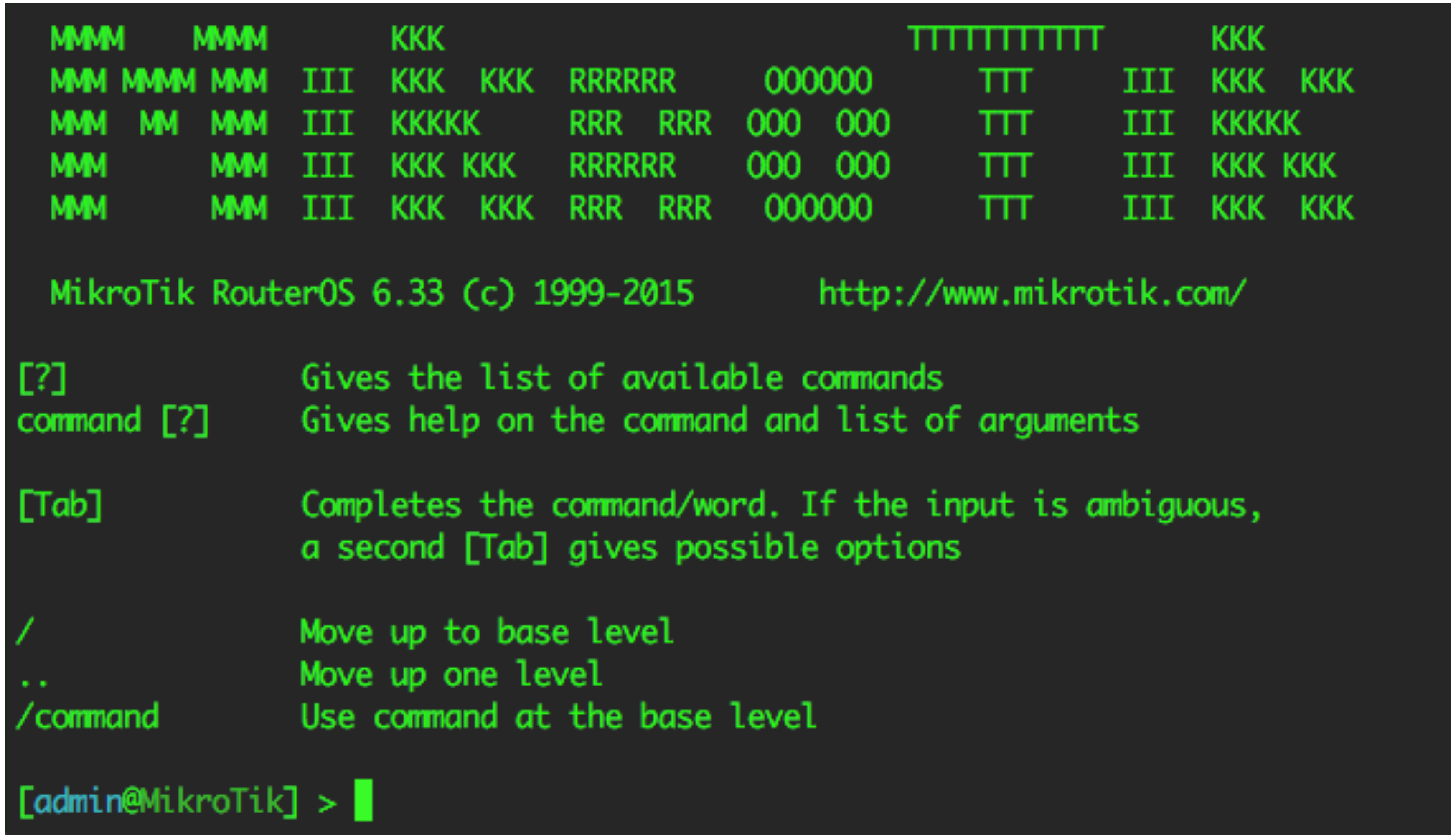
Confirm Password:

Default Configuration

- Different default configuration applied
- For more info see default configuration wiki page
- Example: SOHO routers - DHCP client on Ether1, DHCP server on rest of ports + WiFi
- Can be discarded and ‘blank’ used instead

Command Line Interface

- Available via SSH, Telnet or ‘New Terminal’ in WinBox and WebFig



```
  MMMM    MMMM       KKK                          TTTTTTTTTTT      KKK
  MMM MMMM MMM  III  KKK  KKK  RRRRRR     OOOOOO      TTT     III  KKK  KKK
  MMM  MM  MMM  III  KKKKK     RRR  RRR  OOO  OOO     TTT     III  KKKKK
  MMM      MMM  III  KKK KKK   RRRRRR    OOO  OOO     TTT     III  KKK KKK
  MMM      MMM  III  KKK  KKK  RRR  RRR   OOOOOO      TTT     III  KKK  KKK

  MikroTik RouterOS 6.33 (c) 1999-2015       http://www.mikrotik.com/

[?]             Gives the list of available commands
command [?]     Gives help on the command and list of arguments

[Tab]           Completes the command/word. If the input is ambiguous,
                a second [Tab] gives possible options

/               Move up to base level
..              Move up one level
/command        Use command at the base level

[admin@MikroTik] >
```

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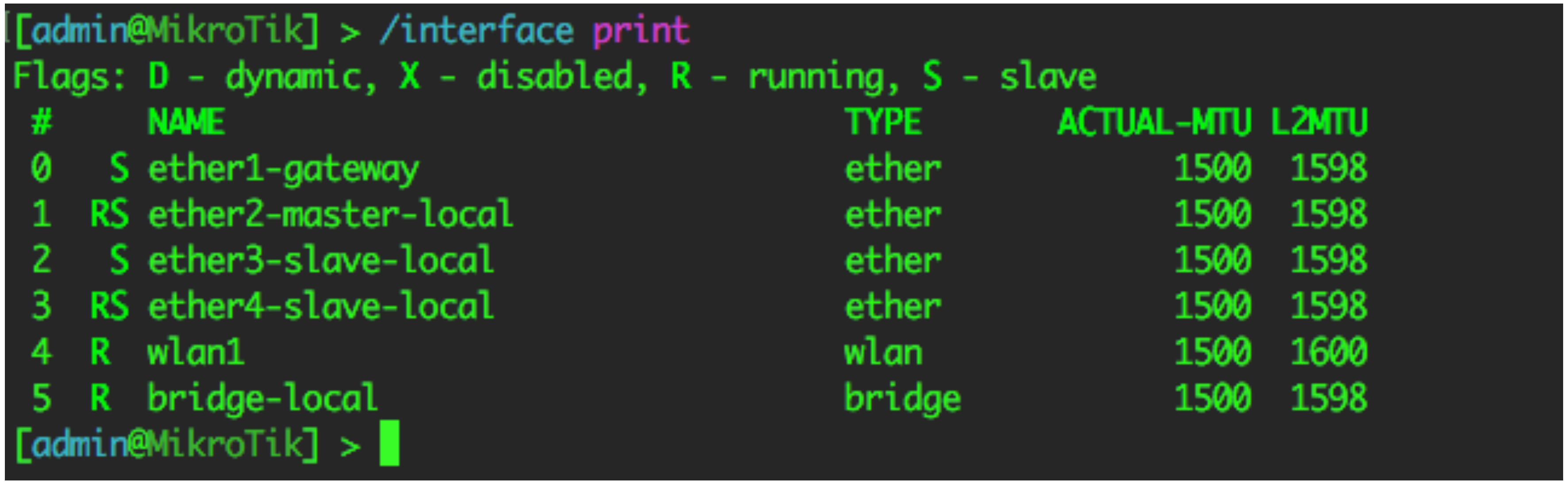
Command Line Interface

- **<tab>** completes command
- **double <tab>** shows available commands
- ‘?’ shows help
- Navigate previous commands with <↑>, <↓> buttons

Command Line Interface

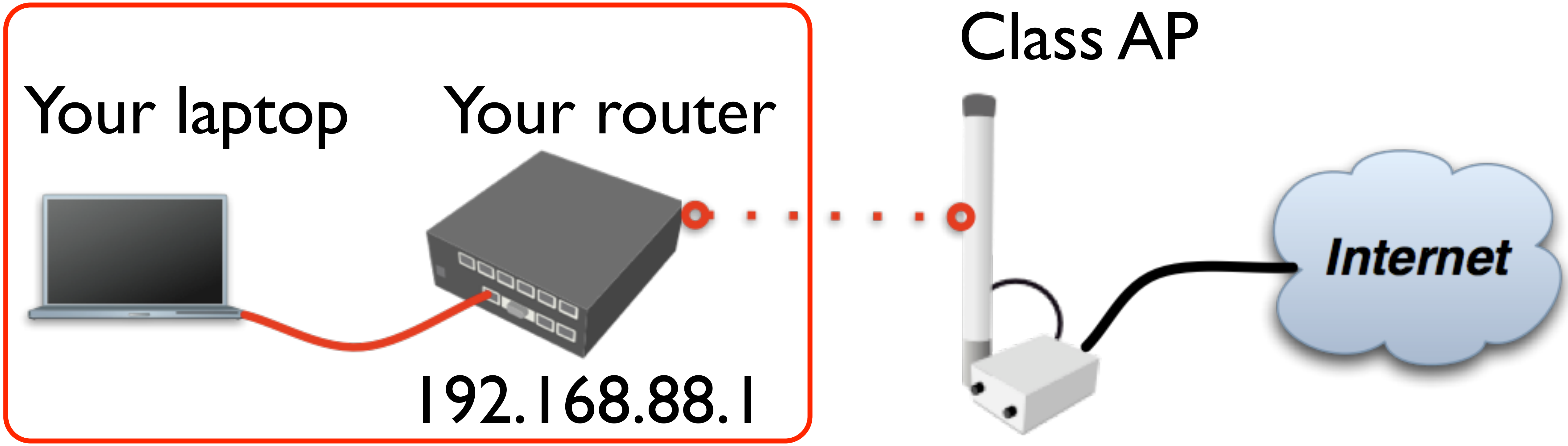
- Hierarchical structure (similar to WinBox menu)
- For more info see console wiki page



```
[admin@MikroTik] > /interface print
Flags: D - dynamic, X - disabled, R - running, S - slave
 #     NAME                                TYPE       ACTUAL-MTU L2MTU
 0   S ether1-gateway                      ether            1500  1598
 1  RS ether2-master-local                 ether            1500  1598
 2   S ether3-slave-local                  ether            1500  1598
 3  RS ether4-slave-local                  ether            1500  1598
 4  R  wlan1                               wlan             1500  1600
 5  R  bridge-local                        bridge           1500  1598
[admin@MikroTik] >
```

In WinBox: Interfaces menu

Internet Access



LAB

LAB

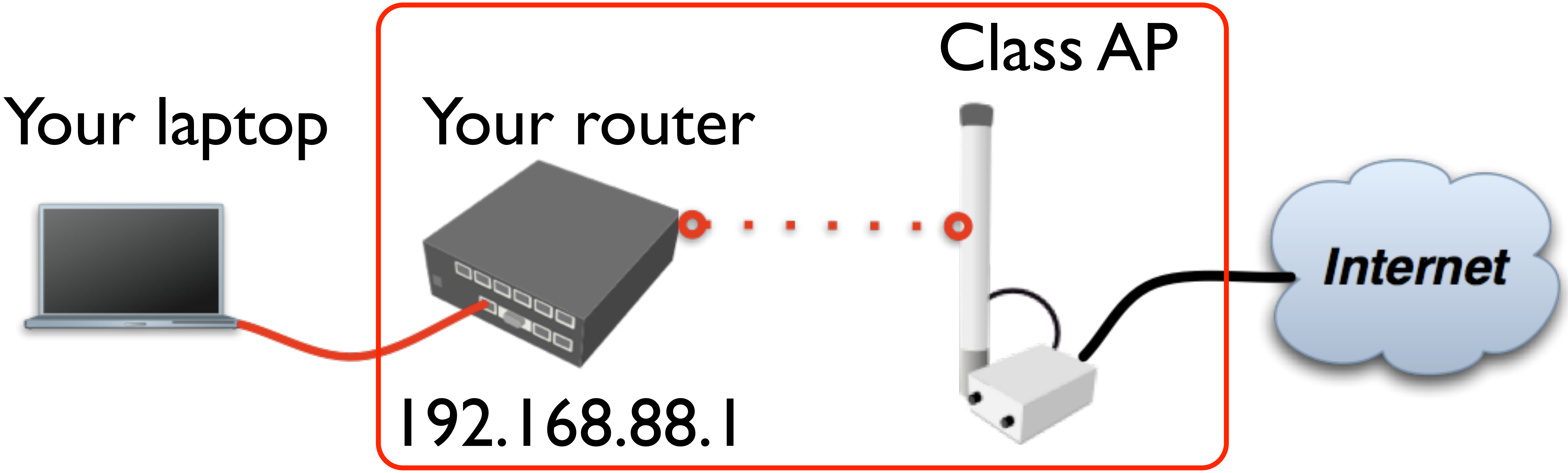
Laptop - Router

- Connect laptop to the router with a cable, plug it in any of LAN ports (2-5)
- Disable other interfaces (wireless) on your laptop
- Make sure that Ethernet interface is set to obtain IP configuration automatically (via DHCP)

LAB

Router - Internet

- The Internet gateway of your class is accessible over wireless - it is an access point (AP)



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LAB

Router - Internet

- To connect to the AP you have to:
  - Remove the wireless interface from the bridge interface (used in default configuration)
  - Configure **DHCP client** to the wireless interface

Router - Internet

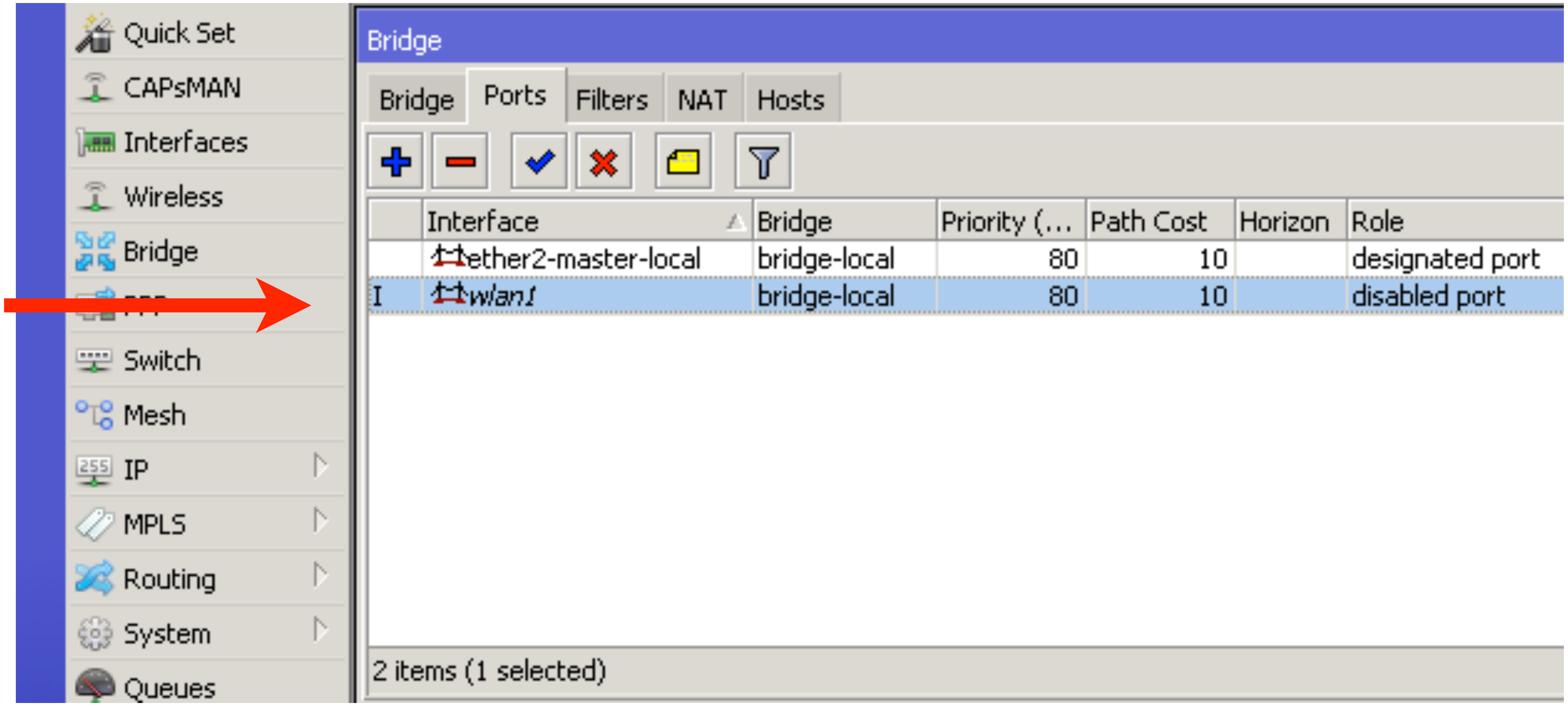
LAB

- To connect to the AP you have to:
  - Create and configure a wireless **security profile**
  - Set the wireless interface to **station** mode
  - And configure **NAT masquerade**

LAB

Router - Internet

Remove the WiFi interface from the bridge



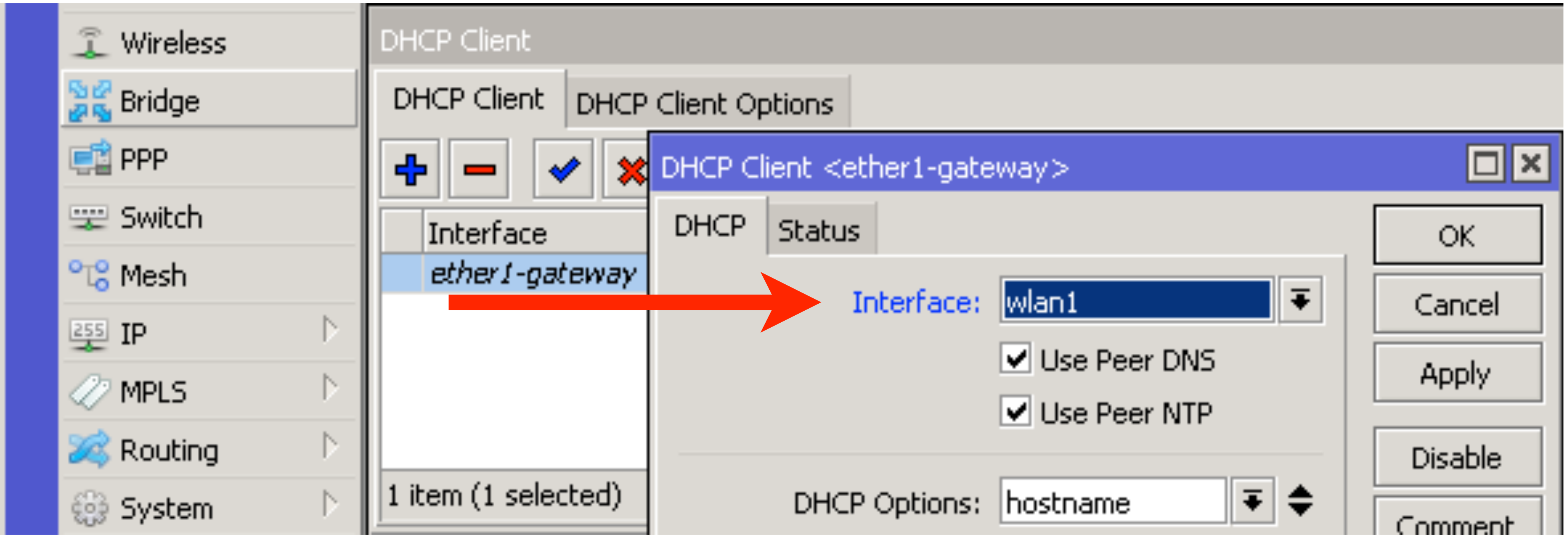
	Interface	Bridge	Priority (...	Path Cost	Horizon	Role
	ether2-master-local	bridge-local	80	10		designated port
I	wlan1	bridge-local	80	10		disabled port

2 items (1 selected)

Bridge → Ports

Router - Internet

Set DHCP client to the WiFi interface



Interface: wlan1

☑ Use Peer DNS

☑ Use Peer NTP

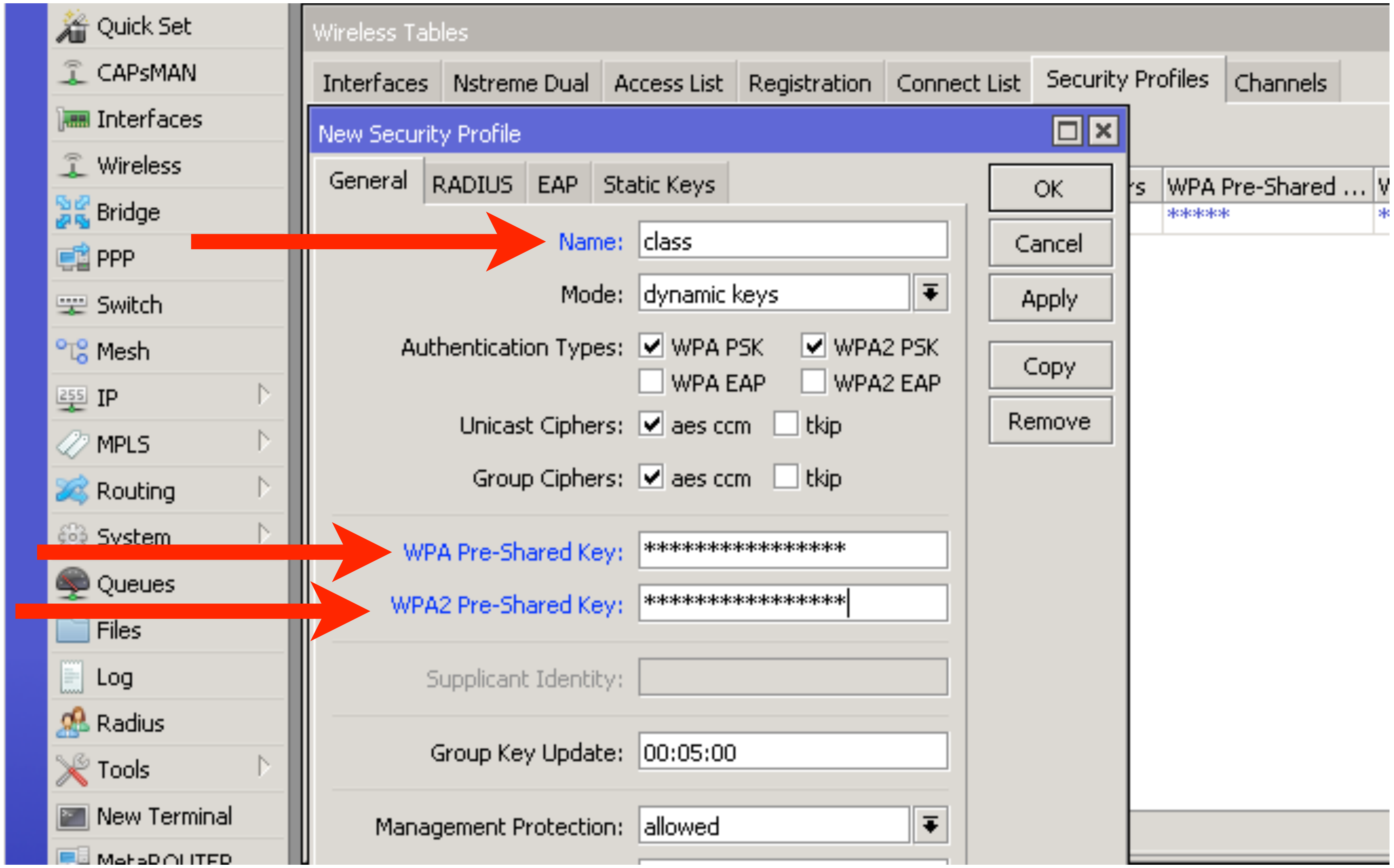
DHCP Options: hostname

IP → DHCP Client

Router - Internet

LAB

Set Name and Pre-Shared Keys



Name: class

Mode: dynamic keys

Authentication Types: ☑ WPA PSK ☑ WPA2 PSK ☐ WPA EAP ☐ WPA2 EAP

Unicast Ciphers: ☑ aes ccm ☐ tkip

Group Ciphers: ☑ aes ccm ☐ tkip

WPA Pre-Shared Key: ****************

WPA2 Pre-Shared Key: ****************

Supplicant Identity:

Group Key Update: 00:05:00

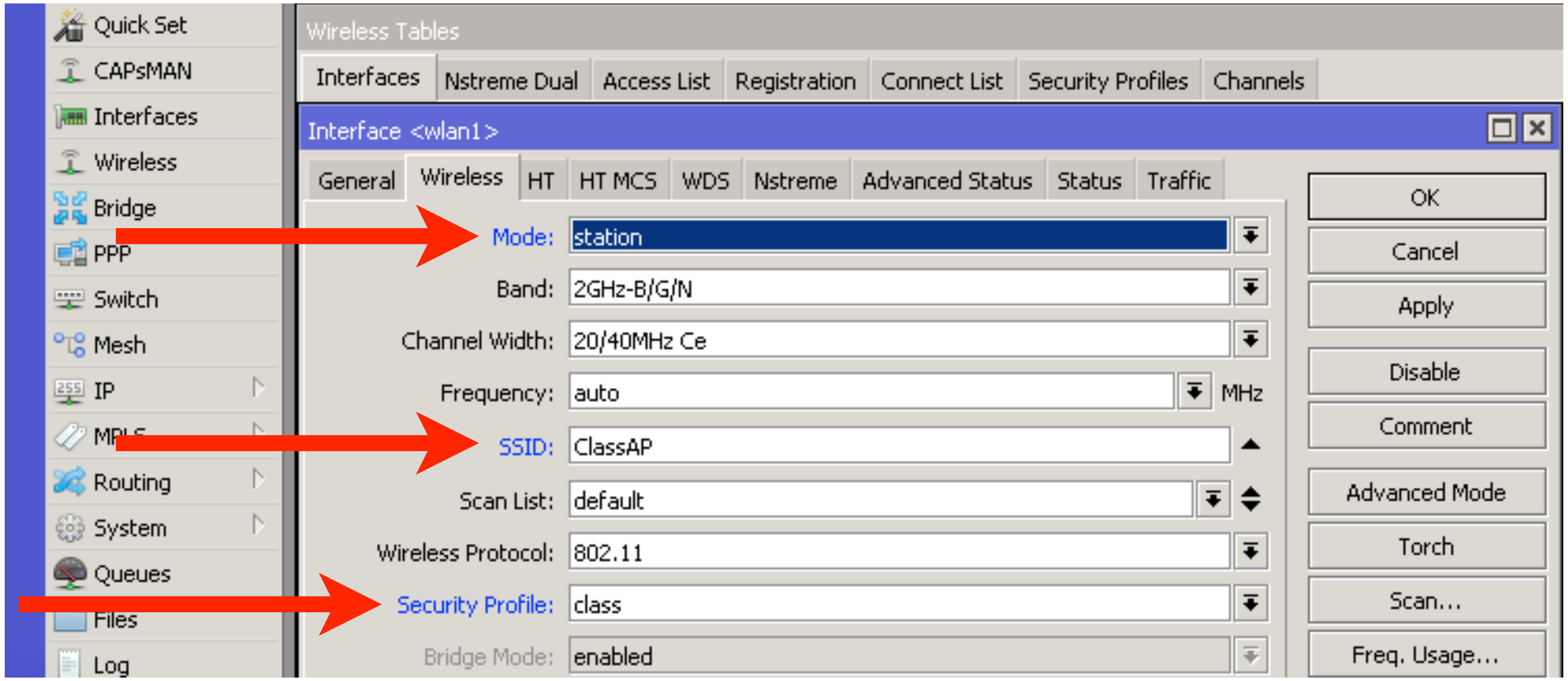
Management Protection: allowed

Wireless → Security Profiles

LAB

Router - Internet

Set Mode to 'station', SSID to 'ClassAP' and Security Profile to 'class'



Mode: station

Band: 2GHz-B/G/N

Channel Width: 20/40MHz Ce

Frequency: auto MHz

SSID: ClassAP

Scan List: default

Wireless Protocol: 802.11

Security Profile: class

Bridge Mode: enabled

Wireless → Interfaces

- "Scan..." tool can be used to see and connect to available APs

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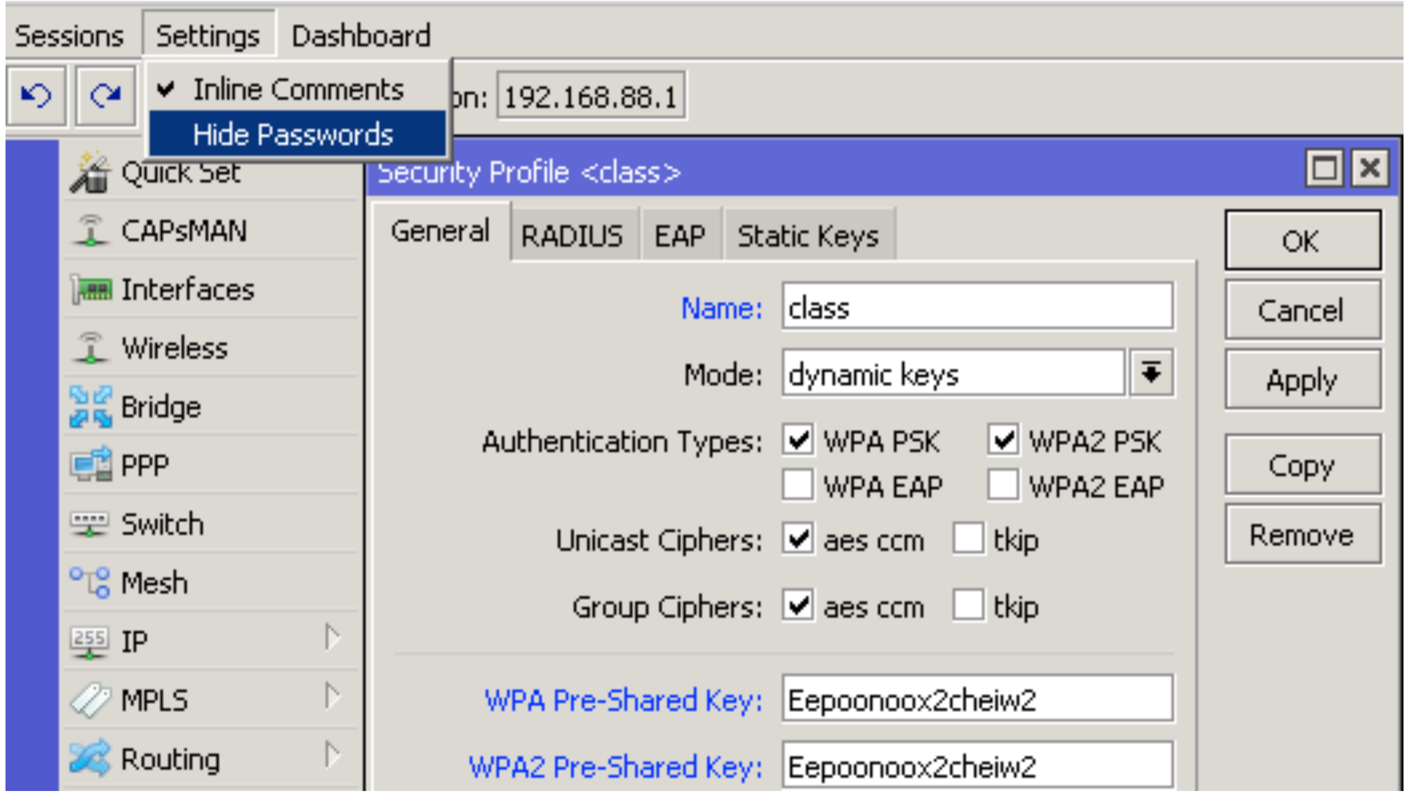
WinBox Tip

- To view hidden information (except user password), select Settings → Hide Passwords



Name: class

Mode: dynamic keys

Authentication Types: ☑ WPA PSK ☑ WPA2 PSK
☐ WPA EAP ☐ WPA2 EAP

Unicast Ciphers: ☑ aes ccm ☐ tkip

Group Ciphers: ☑ aes ccm ☐ tkip

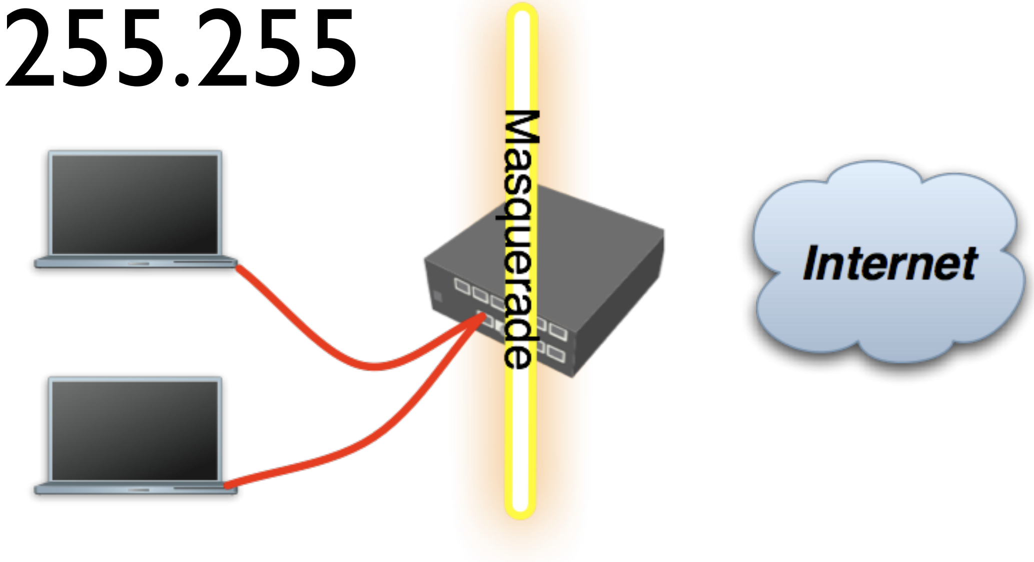
WPA Pre-Shared Key: Eepoonoox2cheiw2

WPA2 Pre-Shared Key: Eepoonoox2cheiw2

Wireless → Security Profiles

Private and Public Space

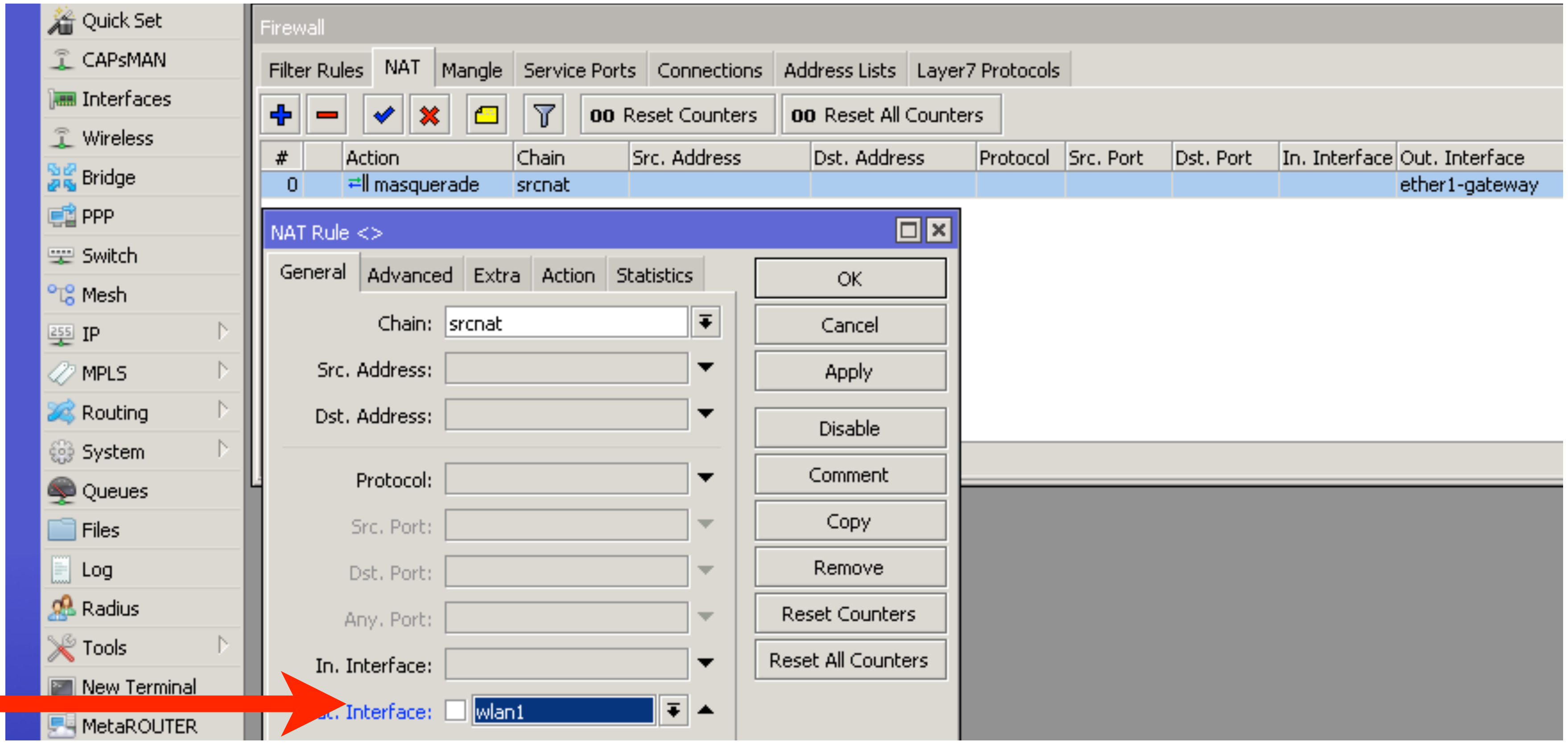
- **Masquerade** is used for Public network access, where private addresses are present
- Private networks include 10.0.0.0-10.255.255.255, 172.16.0.0-172.31.255.255, 192.168.0.0-192.168.255.255



LAB

Router - Internet

Configure masquerade on the WiFi interface



#	Action	Chain	Src. Address	Dst. Address	Protocol	Src. Port	Dst. Port	In. Interface	Out. Interface
0	masquerade	srcnat							ether1-gateway

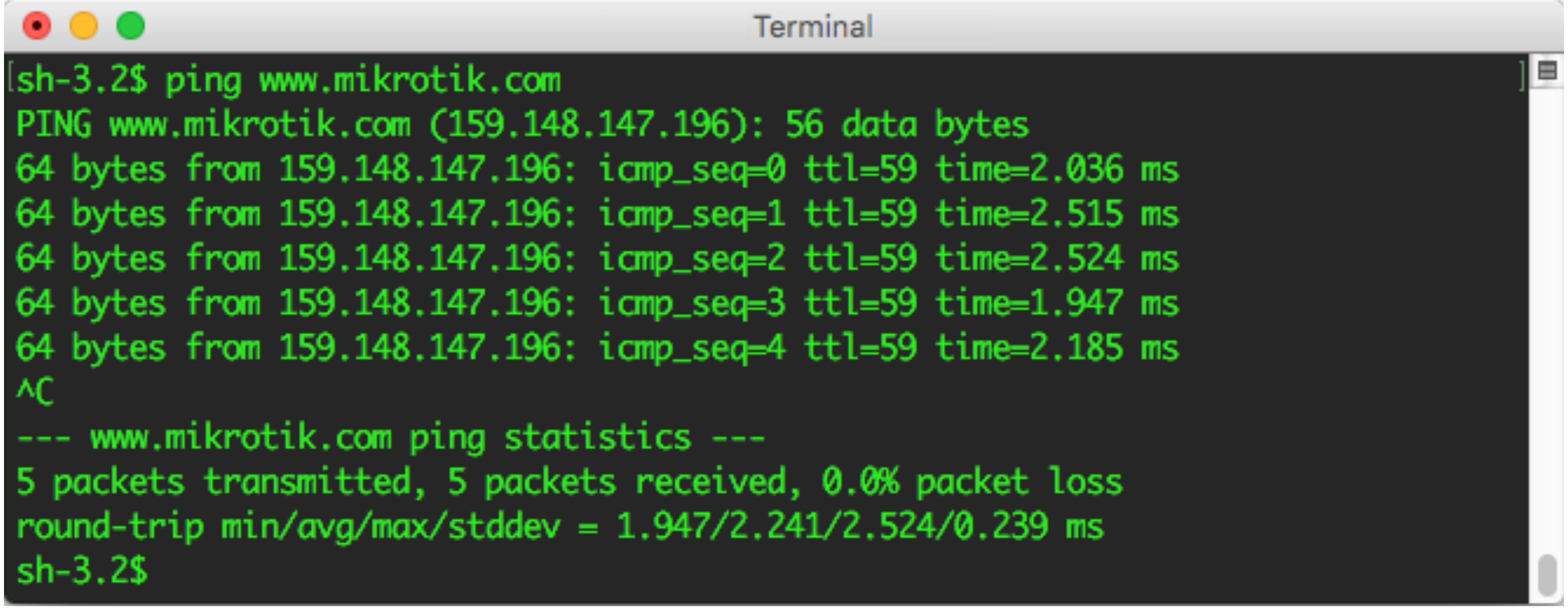
Chain: srcnat
Src. Address:
Dst. Address:
Protocol:
Src. Port:
Dst. Port:
Any. Port:
In. Interface:
Out. Interface: □ wlan1

IP → Firewall → NAT

Check Connectivity

LAB

- Ping www.mikrotik.com from your laptop



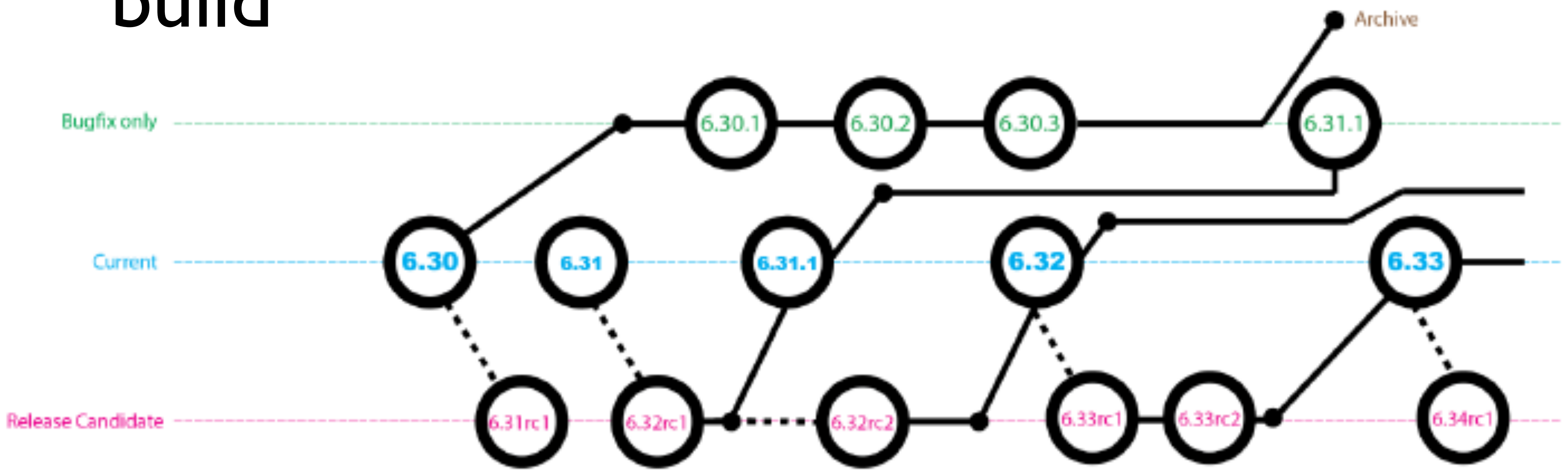
```
sh-3.2$ ping www.mikrotik.com
PING www.mikrotik.com (159.148.147.196): 56 data bytes
64 bytes from 159.148.147.196: icmp_seq=0 ttl=59 time=2.036 ms
64 bytes from 159.148.147.196: icmp_seq=1 ttl=59 time=2.515 ms
64 bytes from 159.148.147.196: icmp_seq=2 ttl=59 time=2.524 ms
64 bytes from 159.148.147.196: icmp_seq=3 ttl=59 time=1.947 ms
64 bytes from 159.148.147.196: icmp_seq=4 ttl=59 time=2.185 ms
^C
--- www.mikrotik.com ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 1.947/2.241/2.524/0.239 ms
sh-3.2$
```

Troubleshooting

- The router cannot ping further than AP
- The router cannot resolve names
- The laptop cannot ping further than the router
- The laptop cannot resolve domain names
- Masquerade rule is not working

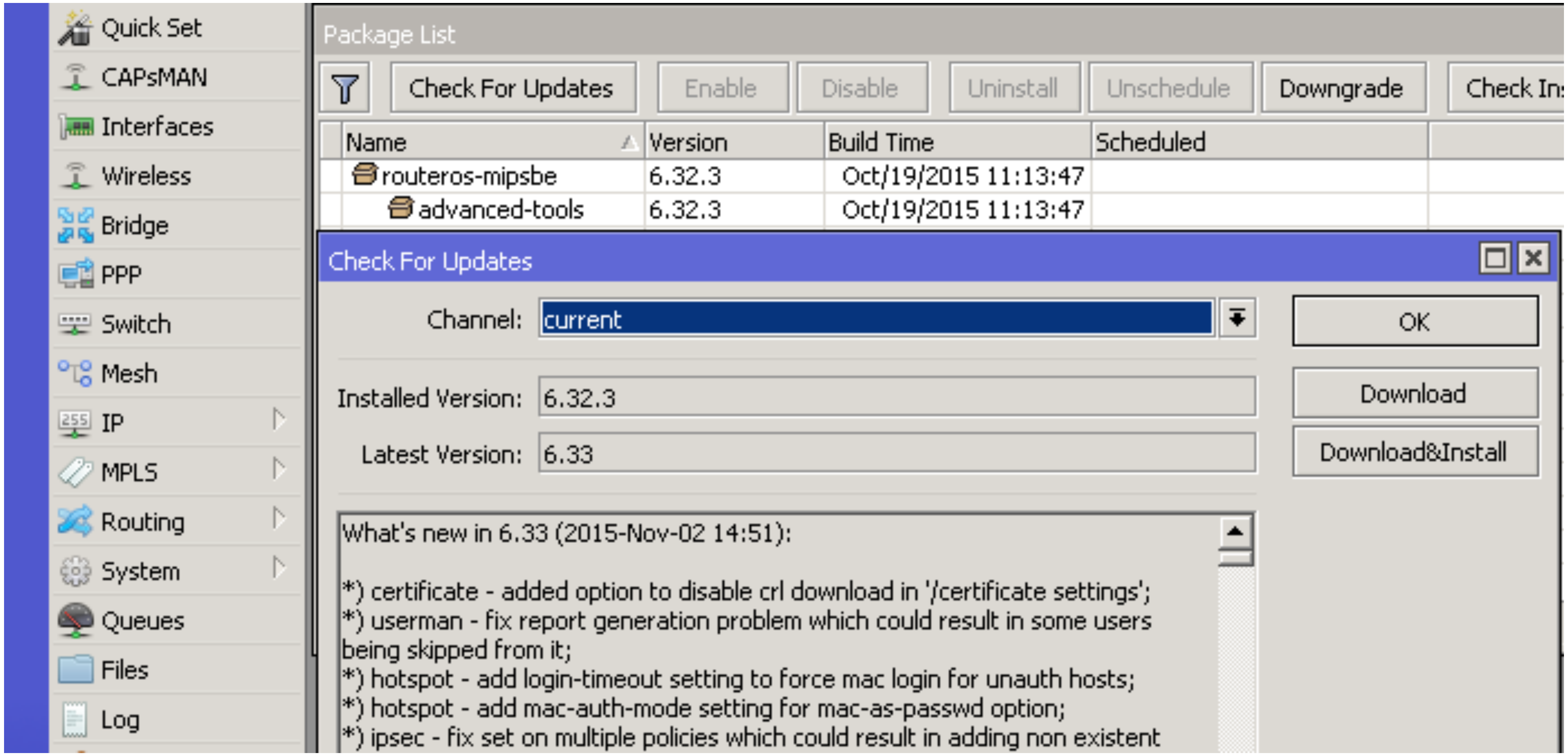
RouterOS Releases

- **Bugfix only** - fixes, no new features
- **Current** - same fixes + new features
- **Release Candidate** - consider as a 'nightly build'



Upgrading the RouterOS

- The easiest way to upgrade



Name	Version	Build Time	Scheduled
routeros-mipsbe	6.32.3	Oct/19/2015 11:13:47	
advanced-tools	6.32.3	Oct/19/2015 11:13:47	

Check For Updates

Channel: current

Installed Version: 6.32.3

Latest Version: 6.33

What's new in 6.33 (2015-Nov-02 14:51):

*) certificate - added option to disable crl download in '/certificate settings';
*) userman - fix report generation problem which could result in some users being skipped from it;
*) hotspot - add login-timeout setting to force mac login for unauth hosts;
*) hotspot - add mac-auth-mode setting for mac-as-passwd option;
*) ipsec - fix set on multiple policies which could result in adding non existent

System → Packages → Check For Updates

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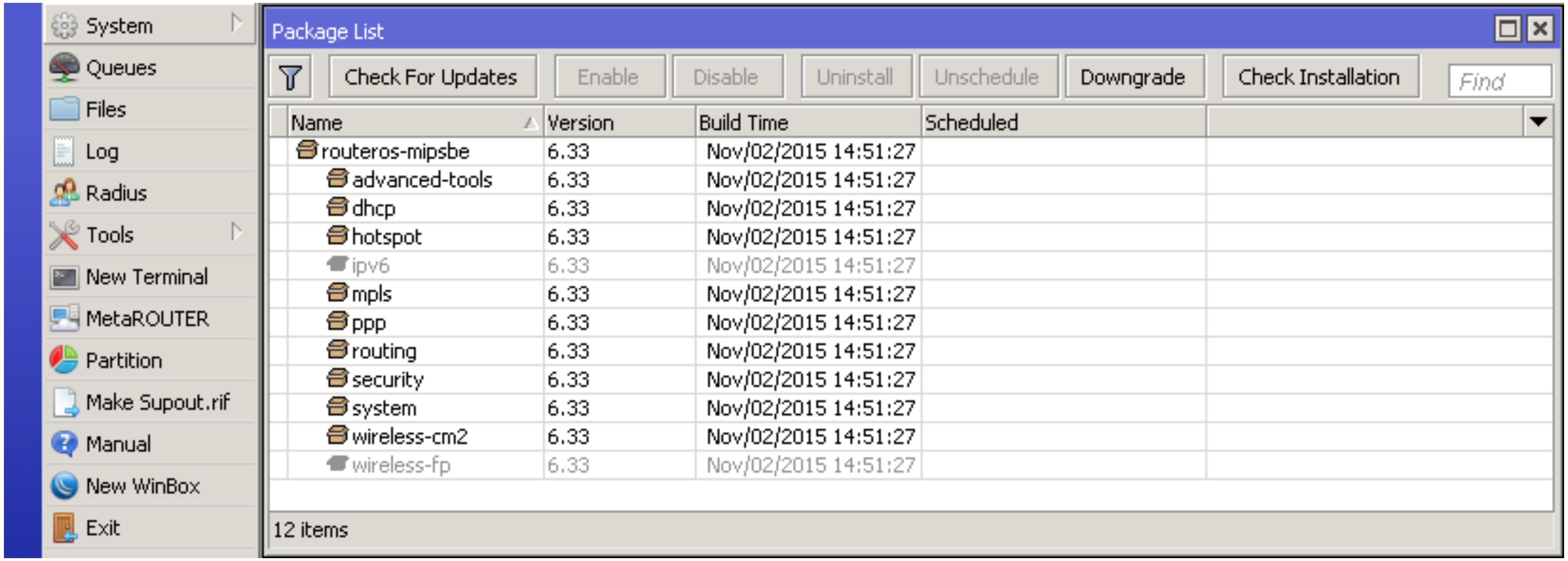
Upgrading the RouterOS

- Download the update from **www.mikrotik.com/download** page
  - Check the architecture of your router's CPU
- Drag&drop into the WinBox window
  - Other ways: WebFig Files menu, FTP, sFTP
- Reboot the router

Package Management

- RouterOS functions are enabled/disabled by packages



Name	Version	Build Time	Scheduled
routeros-mipsbe	6.33	Nov/02/2015 14:51:27	
advanced-tools	6.33	Nov/02/2015 14:51:27	
dhcp	6.33	Nov/02/2015 14:51:27	
hotspot	6.33	Nov/02/2015 14:51:27	
ipv6	6.33	Nov/02/2015 14:51:27	
mpls	6.33	Nov/02/2015 14:51:27	
ppp	6.33	Nov/02/2015 14:51:27	
routing	6.33	Nov/02/2015 14:51:27	
security	6.33	Nov/02/2015 14:51:27	
system	6.33	Nov/02/2015 14:51:27	
wireless-cm2	6.33	Nov/02/2015 14:51:27	
wireless-fp	6.33	Nov/02/2015 14:51:27	

12 items

System → Packages

RouterOS Packages

Package	Functionality
advanced-tools	Netwatch, wake-on-LAN
dhcp	DHCP client and server
hotspot	HotSpot captive portal server
ipv6	IPv6 support
ppp	PPP, PPTP, L2TP, PPPoE clients and servers
routing	Dynamic routing: RIP, BGP, OSPF
security	Secure WinBox, SSH, IPsec
system	Basic features: static routing, firewall, bridging, etc.
wireless-cm2	802.11 a/b/g/n/ac support, CAPsMAN v2

- For more info see packages wiki page

RouterOS Packages

- Each CPU architecture has a combined package, e.g. ‘**routeros-mipsbe**’, ‘**routeros-tile**’
- Contains all the standard RouterOS features (wireless, dhcp, ppp, routing, etc.)
- Extra packages can be downloaded from www.mikrotik.com/download page

RouterOS Extra Packages

- Provides additional functionality
- Upload package file to the router and reboot

Package	Functionality
gps	GPS device support
ntp	Network Time Protocol server
ups	APC UPS management support
user-manager	MikroTik User Manager for managing HotSpot users

Package Management

LAB

- Disable the wireless package
- Reboot the router
- Observe the interface list
- Enable the wireless package
- Reboot the router

Optional LAB

Package Management

- Observe WinBox System menu (no NTP client/server)
- Download extra packages file for your router’s CPU architecture
- Install **ntp** package and reboot the router
- Observe WinBox System menu

Downgrading Packages

- From System → Packages menu
- ‘Check For Updates’ and choose different Channel (e.g. **bugfix-only**)
- Click ‘Download’
- Click ‘Downgrade’ in ‘Package List’ window

Optional LAB

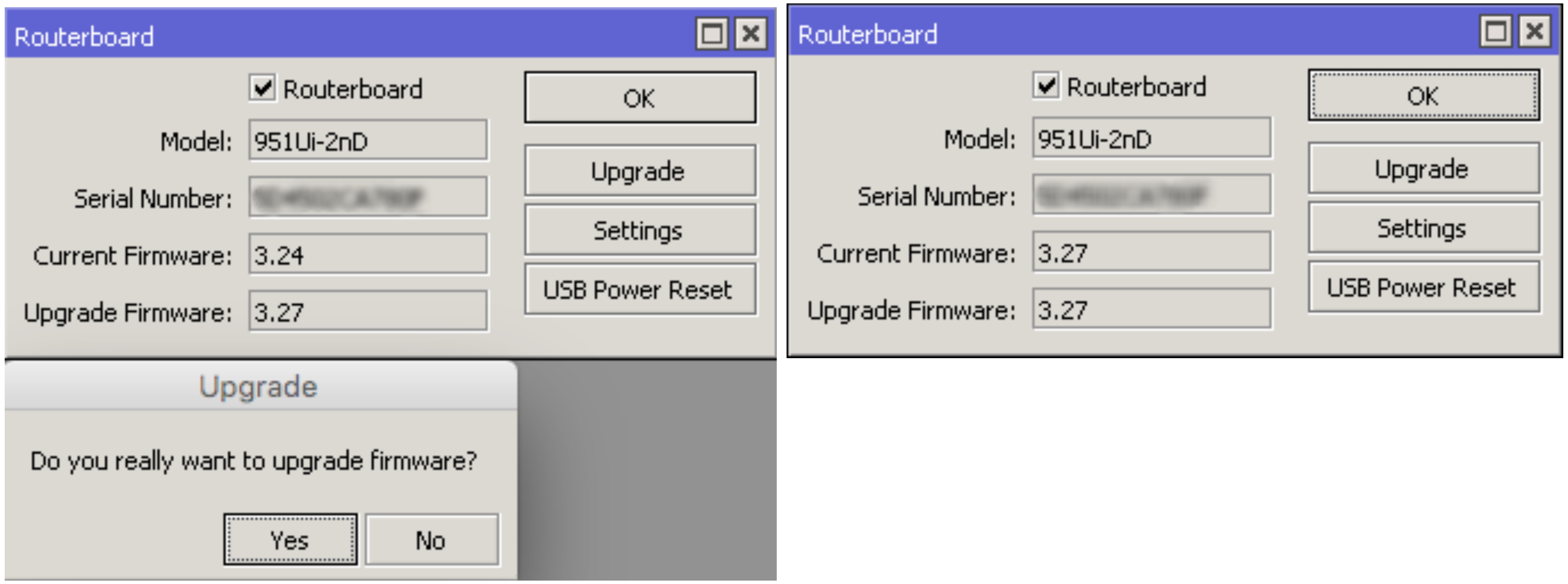
Downgrading Packages

- Downgrade RouterOS from **current** to **bugfix-only** version
- Upgrade it back to the **current** version

RouterBOOT

- Firmware responsible for starting RouterOS on RouterBOARD devices
- Two boot loaders on RouterBOARD - **main** and **backup**
- Main can be updated
- Backup loader can be loaded if needed

RouterBOOT



☑ Routerboard

Model: 951Ui-2nD

Serial Number: [redacted]

Current Firmware: 3.24

Upgrade Firmware: 3.27

Do you really want to upgrade firmware?

☑ Routerboard

Model: 951Ui-2nD

Serial Number: [redacted]

Current Firmware: 3.27

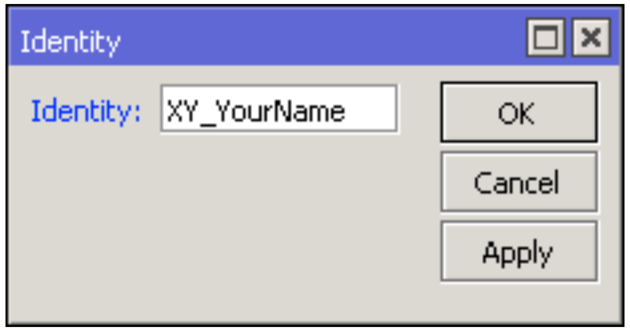
Upgrade Firmware: 3.27

System → Routerboard

- For more info see RouterBOOT wiki page

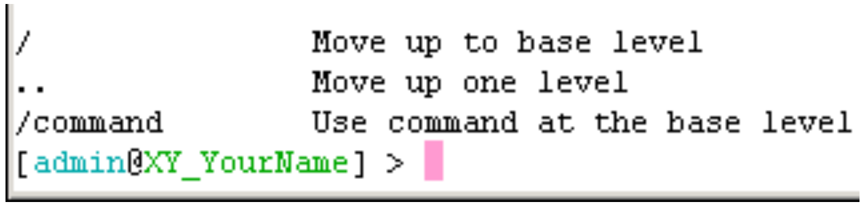
Router Identity

- Option to set a name for each router
- Identity information available in different places

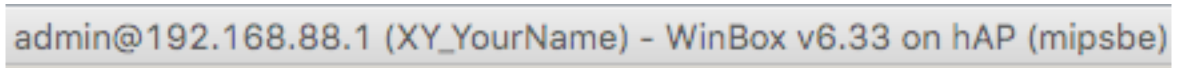


Identity: XY_YourName

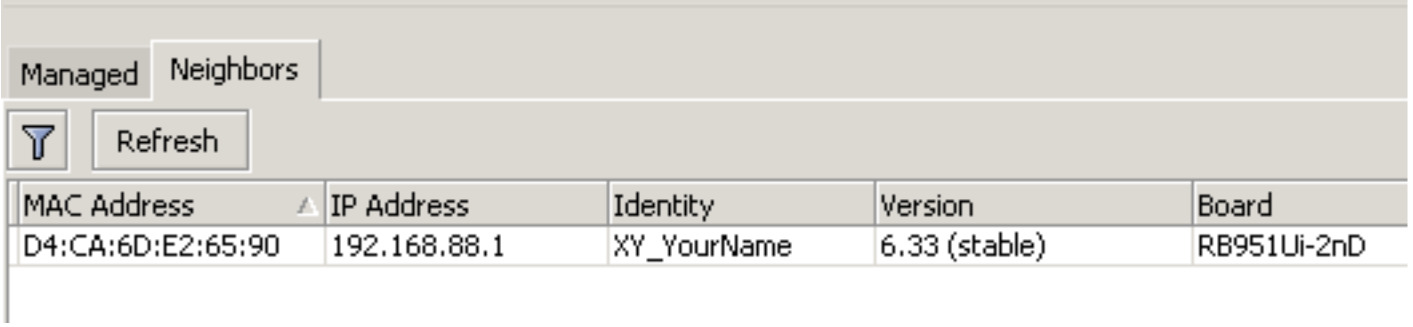
System → Identity



```
/                  Move up to base level
..                 Move up one level
/command           Use command at the base level
[admin@XY_YourName] >
```



admin@192.168.88.1 (XY_YourName) - WinBox v6.33 on hAP (mipsbe)



MAC Address	IP Address	Identity	Version	Board
D4:CA:6D:E2:65:90	192.168.88.1	XY_YourName	6.33 (stable)	RB951Ui-2nD

LAB

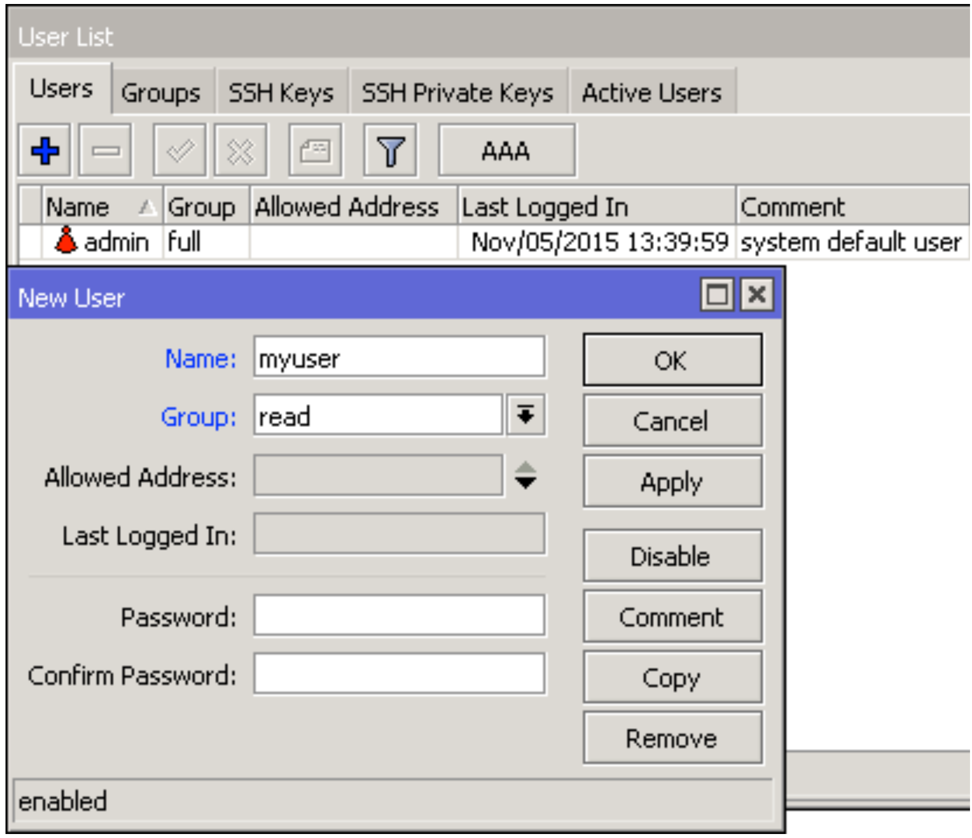
Router Identity

- Set the identity of your router as follows: **YourNumber(XY)_YourName**
- For example: **13_JohnDoe**
- Observe the WinBox title menu

RouterOS Users

- Default user **admin**, group **full**
- Additional groups - **read** and **write**
- Can create your own group and fine tune access

RouterOS Users



Name	Group	Allowed Address	Last Logged In	Comment
admin	full		Nov/05/2015 13:39:59	system default user

Name: myuser

Group: read

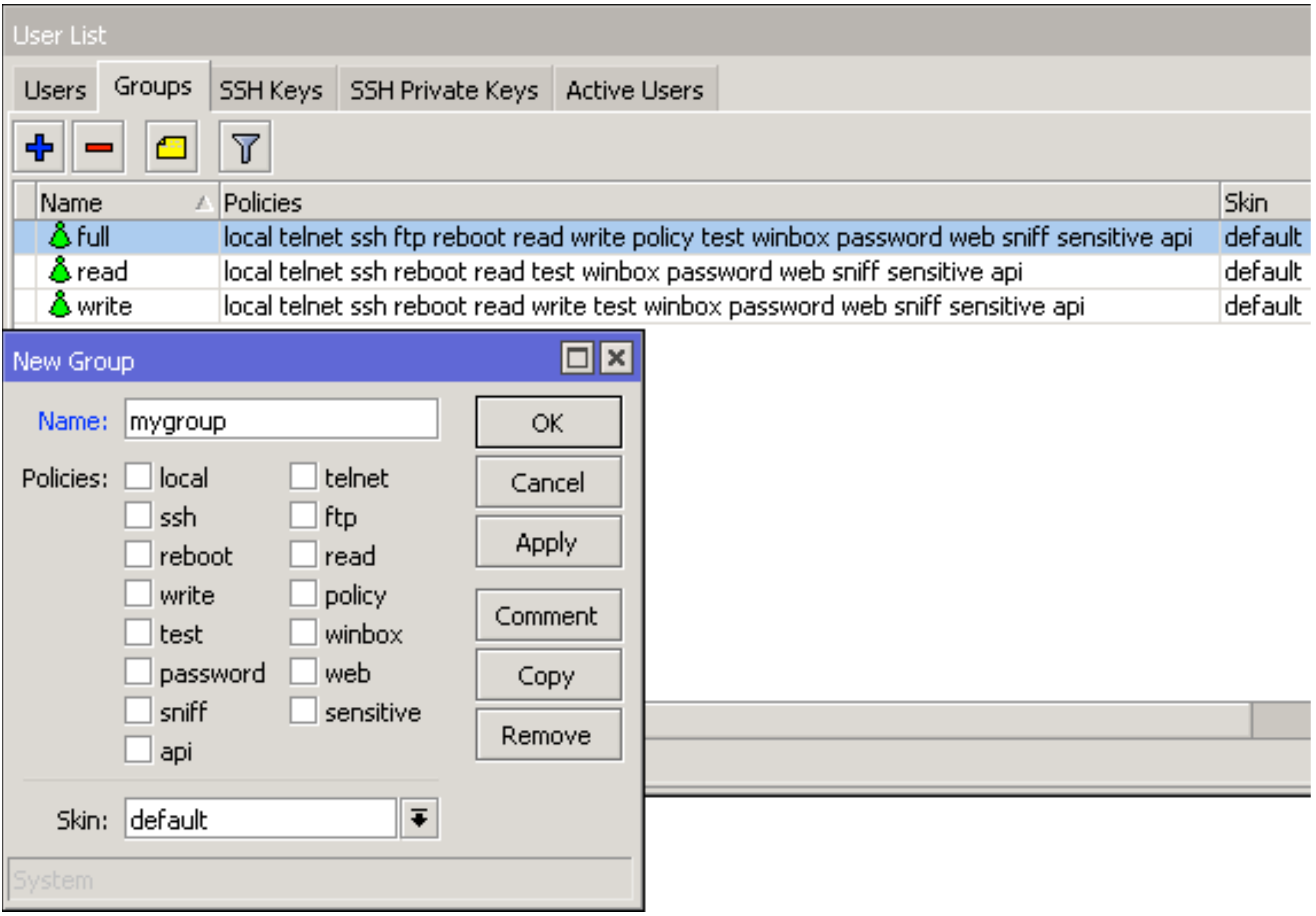
Allowed Address:

Last Logged In:

Password:

Confirm Password:

enabled



Name	Policies	Skin
full	local telnet ssh ftp reboot read write policy test winbox password web sniff sensitive api	default
read	local telnet ssh reboot read test winbox password web sniff sensitive api	default
write	local telnet ssh reboot read write test winbox password web sniff sensitive api	default

Name: mygroup

Policies:

☐ local	☐ telnet
☐ ssh	☐ ftp
☐ reboot	☐ read
☐ write	☐ policy
☐ test	☐ winbox
☐ password	☐ web
☐ sniff	☐ sensitive
☐ api	

Skin: default

System

System → Users

LAB

RouterOS Users

- Add a new user to the RouterOS with **full** access *(note name and password)*
- Change **admin** user group to **read**
- Login with the new user
- Login with the admin user and try to change router's settings (not possible)

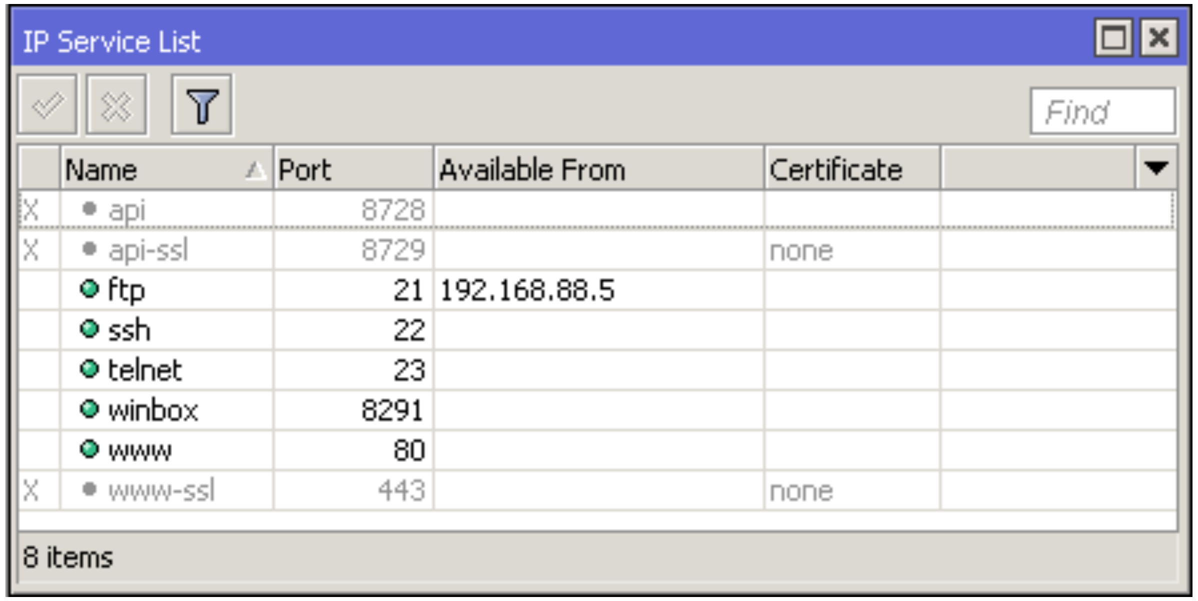
Optional LAB

RouterOS Users

- Generate SSH private/public key pair using ‘ssh-keygen’ (OS X and Linux) or ‘puttygen’ (Windows)
- Upload the public part of the key to the router
- Import and attach it to the user
- Login to the router using the private key

RouterOS Services

- Different ways to connect to the RouterOS
- API - Application Programming Interface
- FTP - for uploading/downloading files to/from the RouterOS



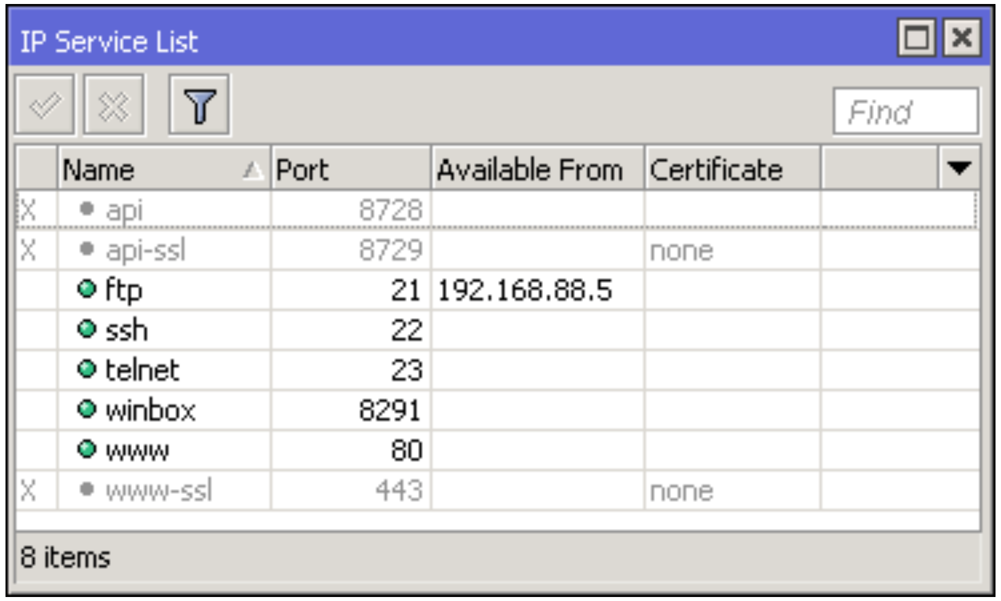
	Name	Port	Available From	Certificate
X	● api	8728		
X	● api-ssl	8729		none
	● ftp	21	192.168.88.5	
	● ssh	22		
	● telnet	23		
	● winbox	8291		
	● www	80		
X	● www-ssl	443		none

8 items

IP → Services

RouterOS Services

- SSH - secure command line interface
- Telnet - insecure command line interface
- WinBox - GUI access
- WWW - access from the web browser



IP Service List

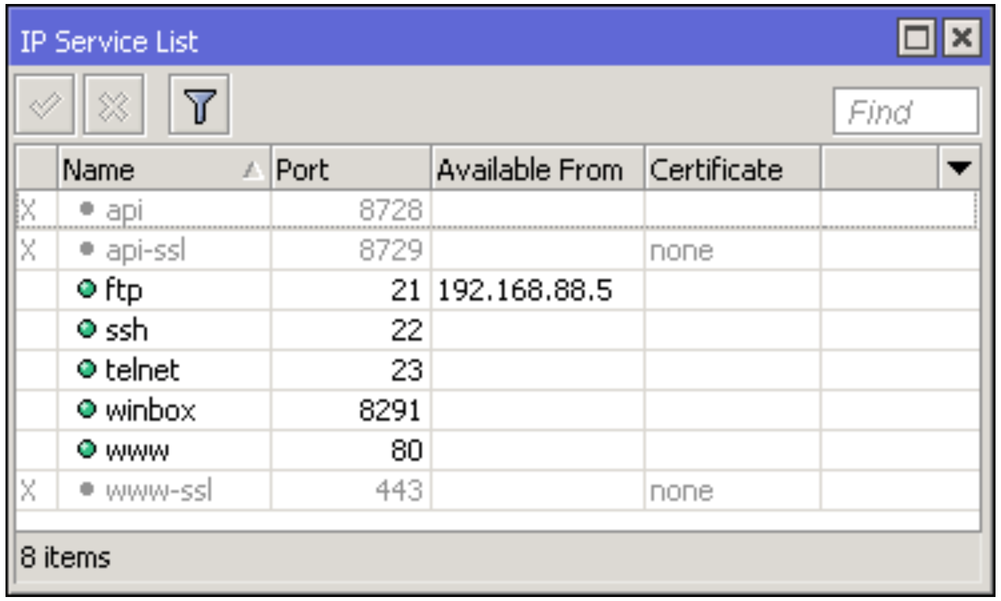
	Name	Port	Available From	Certificate
X	● api	8728		
X	● api-ssl	8729		none
	● ftp	21	192.168.88.5	
	● ssh	22		
	● telnet	23		
	● winbox	8291		
	● www	80		
X	● www-ssl	443		none

8 items

IP → Services

RouterOS Services

- Disable services which are not used
- Restrict access with ‘available from’ field
- Default ports can be changed



	Name	Port	Available From	Certificate
X	api	8728		
X	api-ssl	8729		none
	ftp	21	192.168.88.5	
	ssh	22		
	telnet	23		
	winbox	8291		
	www	80		
X	www-ssl	443		none

8 items

IP → Services

LAB

RouterOS Services

- Open RouterOS web interface - http://192.168.88.1
- In WinBox disable **www** service
- Refresh browser page

Configuration Backup

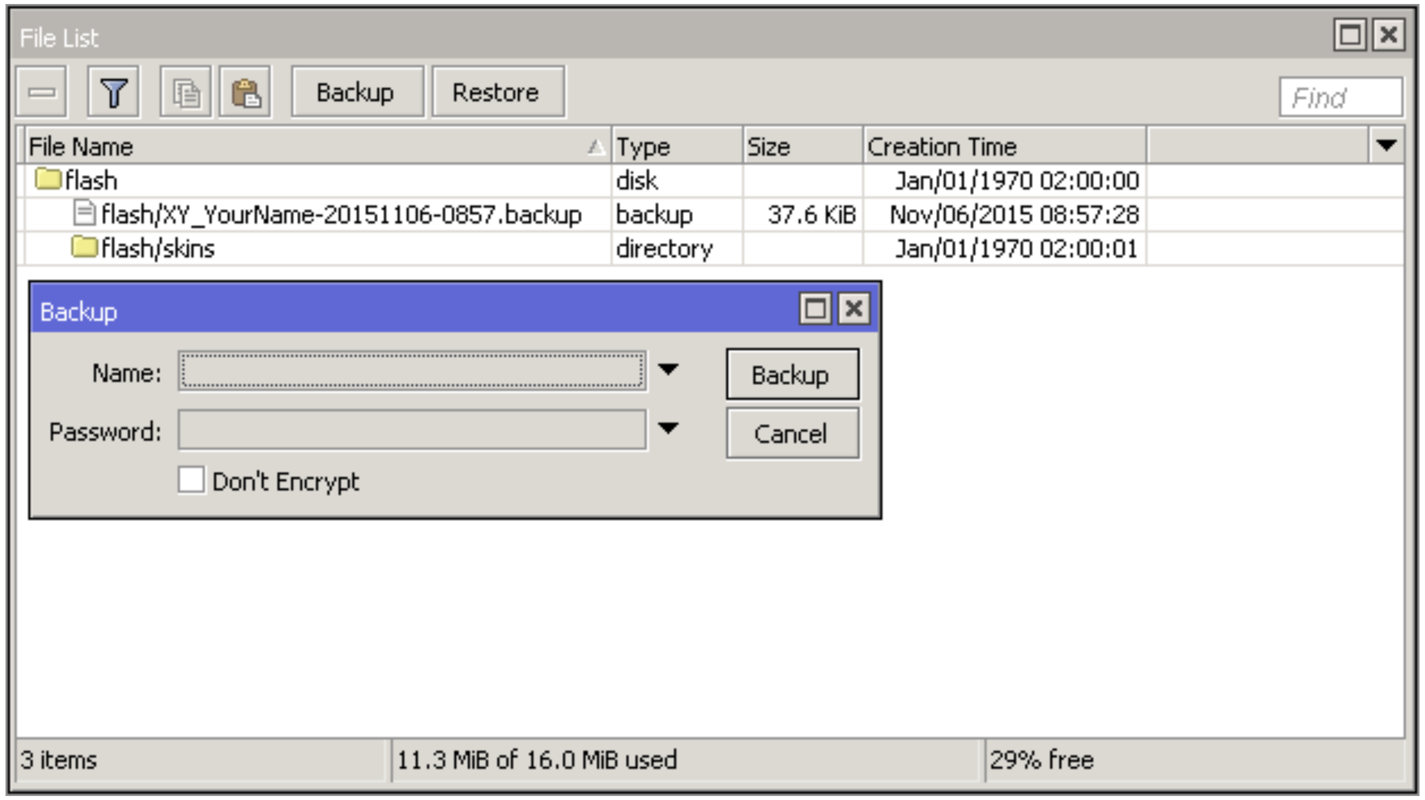
- Two types of backups
- Backup (.backup) file - used for restoring configuration **on the same router**
- Export (.rsc) file - used for moving configuration to **another router**

Configuration Backup

- Backup file can be created and restored under Files menu in WinBox
- Backup file is binary, by default encrypted with user password. Contains a full router configuration (passwords, keys, etc.)

Configuration Backup

- Custom name and password can be entered
- Router identity and current date is used as a backup file name



File Name	Type	Size	Creation Time
flash	disk		Jan/01/1970 02:00:00
flash/XY_YourName-20151106-0857.backup	backup	37.6 KiB	Nov/06/2015 08:57:28
flash/skins	directory		Jan/01/1970 02:00:01

Name:

Password:

□ Don't Encrypt

3 items | 11.3 MiB of 16.0 MiB used | 29% free

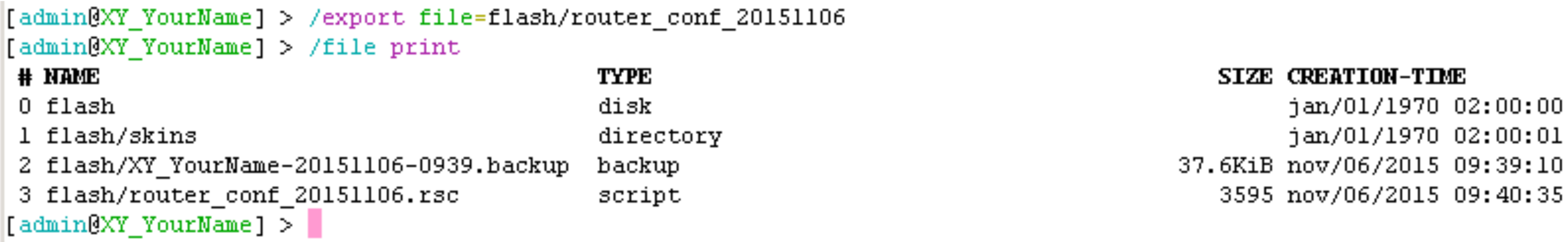
Configuration Backup

- Export (.rsc) file is a script with which router configuration can be backed up and restored
- Plain-text file (editable)
- Contains only configuration that is different than the factory default configuration

Configuration Backup

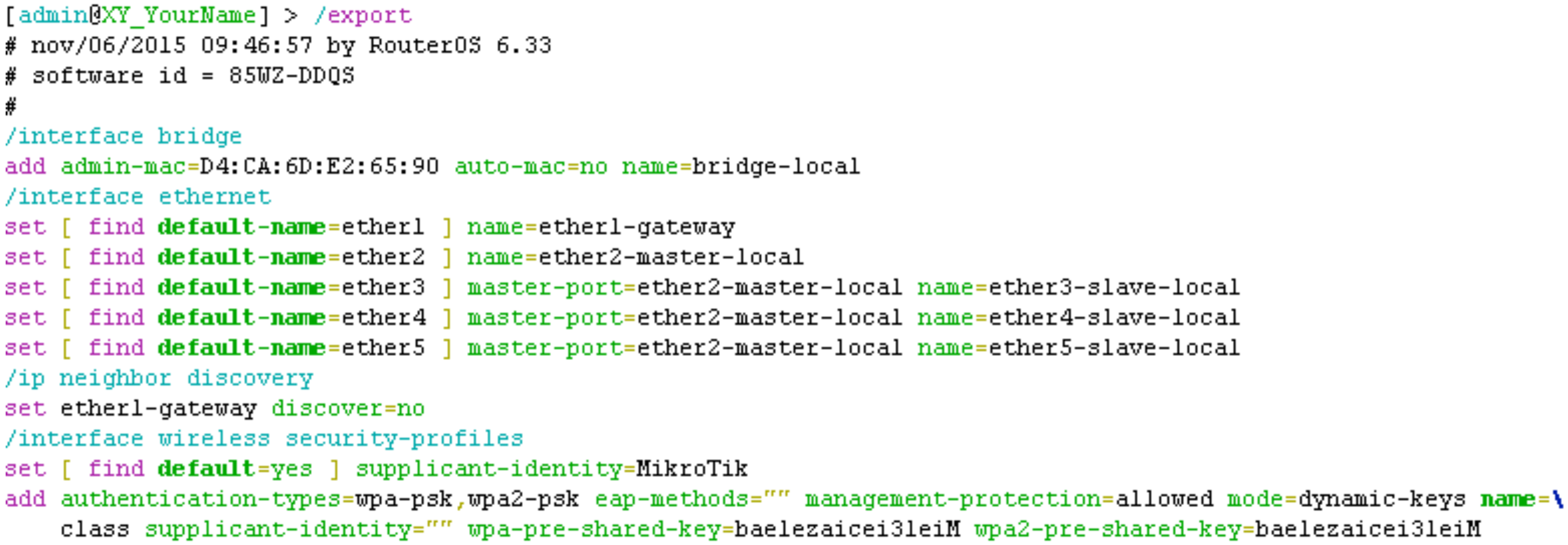
- Export file is created using 'export' command in CLI
- Whole or partial router configuration can be saved to an export file
- RouterOS user passwords are not saved when using export

Configuration Backup



```
[admin@XY_YourName] > /export file=flash/router_conf_20151106
[admin@XY_YourName] > /file print
 # NAME                                    TYPE                                          SIZE CREATION-TIME
 0 flash                                   disk                                               jan/01/1970 02:00:00
 1 flash/skins                             directory                                          jan/01/1970 02:00:01
 2 flash/XY_YourName-20151106-0939.backup  backup                                    37.6KiB nov/06/2015 09:39:10
 3 flash/router_conf_20151106.rsc          script                                       3595 nov/06/2015 09:40:35
[admin@XY_YourName] >
```

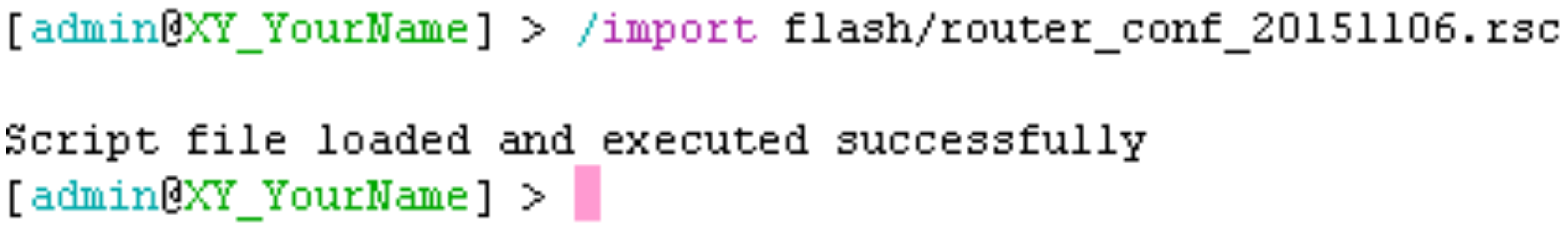
- Store files in 'flash' folder
- Contains ready to use RouterOS commands



```
[admin@XY_YourName] > /export
# nov/06/2015 09:46:57 by RouterOS 6.33
# software id = 85WZ-DDQS
#
/interface bridge
add admin-mac=D4:CA:6D:E2:65:90 auto-mac=no name=bridge-local
/interface ethernet
set [ find default-name=ether1 ] name=ether1-gateway
set [ find default-name=ether2 ] name=ether2-master-local
set [ find default-name=ether3 ] master-port=ether2-master-local name=ether3-slave-local
set [ find default-name=ether4 ] master-port=ether2-master-local name=ether4-slave-local
set [ find default-name=ether5 ] master-port=ether2-master-local name=ether5-slave-local
/ip neighbor discovery
set ether1-gateway discover=no
/interface wireless security-profiles
set [ find default=yes ] supplicant-identity=MikroTik
add authentication-types=wpa-psk,wpa2-psk eap-methods="" management-protection=allowed mode=dynamic-keys name=\
    class supplicant-identity="" wpa-pre-shared-key=baelezaicei3leiM wpa2-pre-shared-key=baelezaicei3leiM
```

Configuration Backup

- Export file can be edited by hand
- Can be used to move configuration to a different RouterBOARD
- Restore using '/import' command



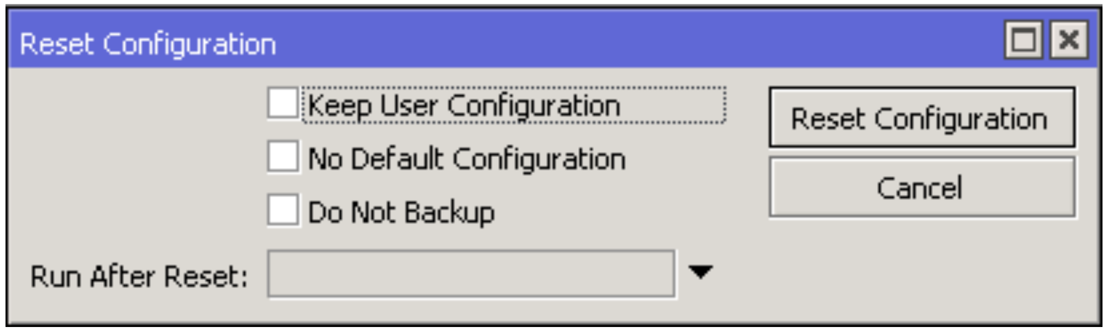
```
[admin@XY_YourName] > /import flash/router_conf_20151106.rsc

Script file loaded and executed successfully
[admin@XY_YourName] >
```

Configuration Backup

- Download to a computer using WinBox (drag&drop), FTP or WebFig
- Don’t store the copy of the backup only on the router! It is not a good backup strategy!

Reset Configuration

- Reset to default configuration
- Retain RouterOS users after reset
- Reset to a router without any configuration (‘blank’)
- Run a script after reset



Reset Configuration

□ Keep User Configuration

□ No Default Configuration

□ Do Not Backup

Run After Reset:

Reset Configuration

Cancel

System → Reset Configuration

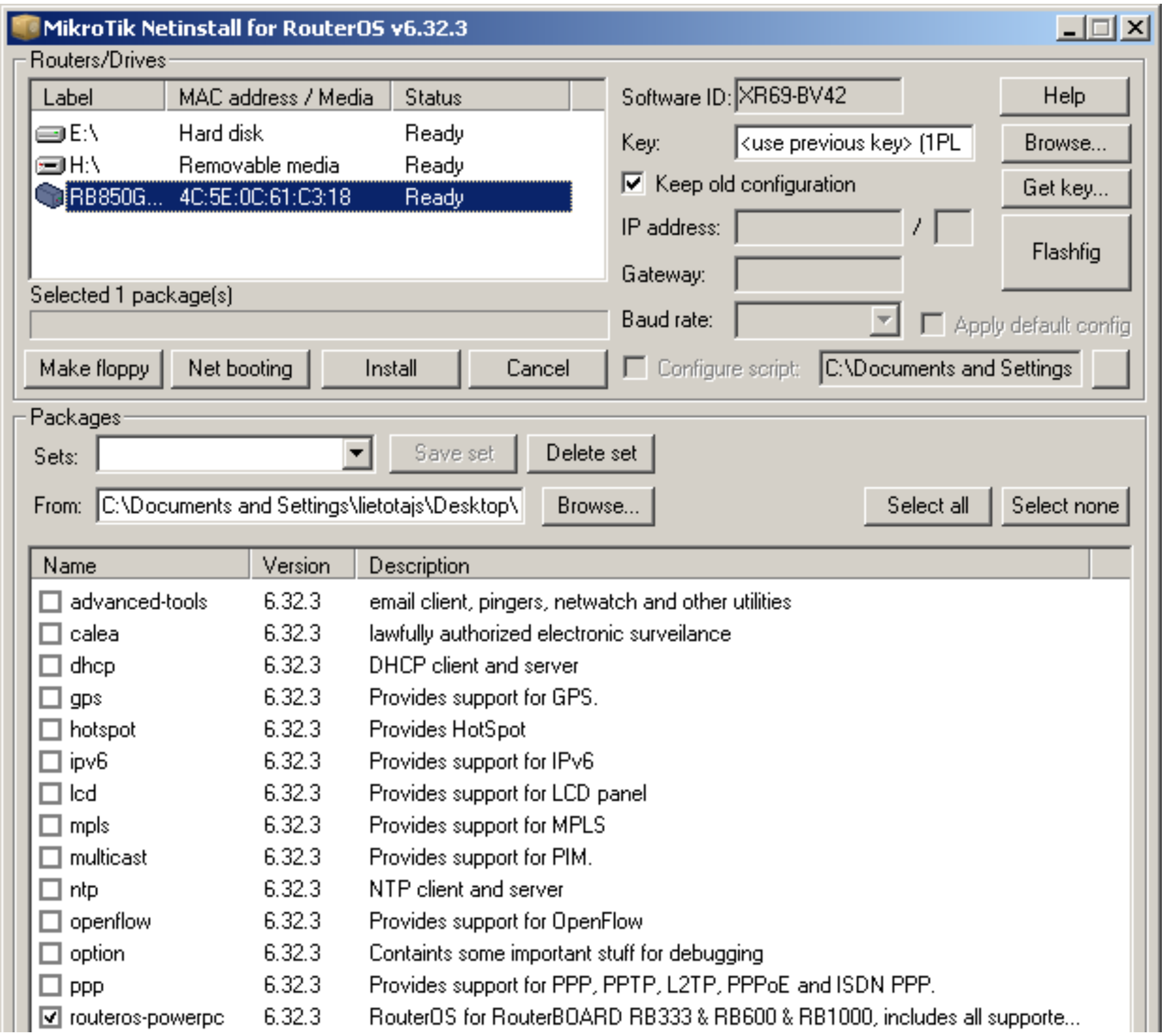
Reset Configuration

- Using physical ‘reset’ button on the router
  - Load backup RouterBOOT loader
  - Reset router configuration
  - Enable CAPs mode (Controlled AP)
  - Start in Netinstall mode
- For more info see reset button wiki page

Netinstall

- Used for installing and reinstalling RouterOS
- Direct network connection to the router is required (can be used over switched LAN)
- Cable must be connected to Ether1 port (except CCR and RB1xxx - last port)
- Runs on Windows
- For more info see Netinstall wiki page

Netinstall



MikroTik Netinstall for RouterOS v6.32.3

Routers/Drives

Label	MAC address / Media	Status
E:\	Hard disk	Ready
H:\	Removable media	Ready
RB850G...	4C:5E:0C:61:C3:18	Ready

Selected 1 package(s)

Software ID: XR69-BV42

Key: <use previous key> (1PL

☑ Keep old configuration

IP address: /

Gateway:

Baud rate:

□ Apply default config

□ Configure script: C:\Documents and Settings

Packages

Sets:

From: C:\Documents and Settings\lietotajs\Desktop\

	Name	Version	Description
□	advanced-tools	6.32.3	email client, pingers, netwatch and other utilities
□	calea	6.32.3	lawfully authorized electronic surveilance
□	dhcp	6.32.3	DHCP client and server
□	gps	6.32.3	Provides support for GPS.
□	hotspot	6.32.3	Provides HotSpot
□	ipv6	6.32.3	Provides support for IPv6
□	lcd	6.32.3	Provides support for LCD panel
□	mpls	6.32.3	Provides support for MPLS
□	multicast	6.32.3	Provides support for PIM.
□	ntp	6.32.3	NTP client and server
□	openflow	6.32.3	Provides support for OpenFlow
□	option	6.32.3	Containts some important stuff for debugging
□	ppp	6.32.3	Provides support for PPP, PPTP, L2TP, PPPoE and ISDN PPP.
☑	routeros-powerpc	6.32.3	RouterOS for RouterBOARD RB333 & RB600 & RB1000, includes all supporte...

- Available at www.mikrotik.com/download

LAB

Configuration Backup

- Create a .backup file
- Copy it to your laptop
- Delete the .backup file from the router
- Reset router configuration
- Copy .backup file back to the router
- Restore router configuration

Optional LAB

Configuration Backup

- Create a backup using ‘export’ command
- Copy it to your laptop
- Delete the export file from the router
- Reset router configuration
- Copy export file back to the router
- Restore router configuration

Optional LAB

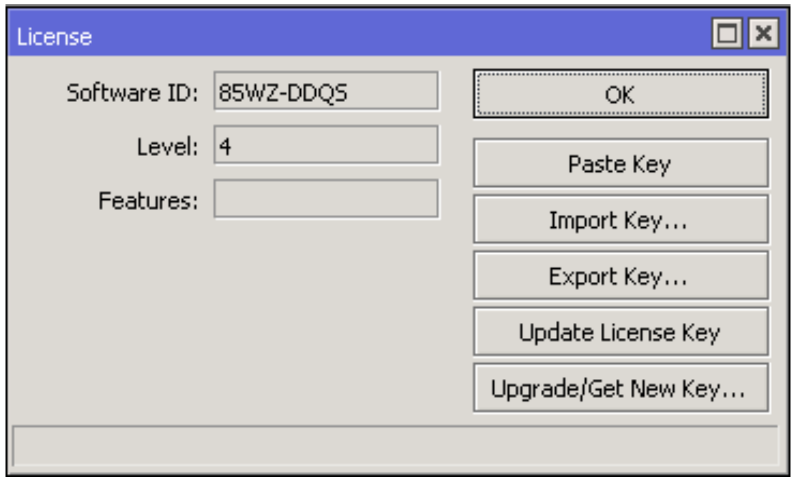
Netinstall

- Download Netinstall
- Boot your router in Netinstall mode
- Install RouterOS on your router using Netinstall
- Restore configuration from previously saved backup file

MikroTik MTCNA

RouterOS License

- All RouterBOARDs are shipped with a license
- Different license levels (features)
- RouterOS updates for life
- x86 license can be purchased from www.mikrotik.com or distributors



License

Software ID: 85WZ-DDQS

Level: 4

Features:

System → License

RouterOS License

Level	Type	Typical Use
0	Trial Mode	24h trial
1	Free Demo	
3	CPE	Wireless client (station), volume only
4	AP	Wireless AP: WISP, HOME, Office
5	ISP	Supports more tunnels than L4
6	Controller	Unlimited RouterOS features

Additional Information

- wiki.mikrotik.com - RouterOS documentation and examples
- forum.mikrotik.com - communicate with other RouterOS users
- mum.mikrotik.com - MikroTik User Meeting page
- Distributor and consultant support
- support@mikrotik.com

Module 1 Summary

Certified Network Associate (MTCNA)

Module 2

DHCP

DHCP

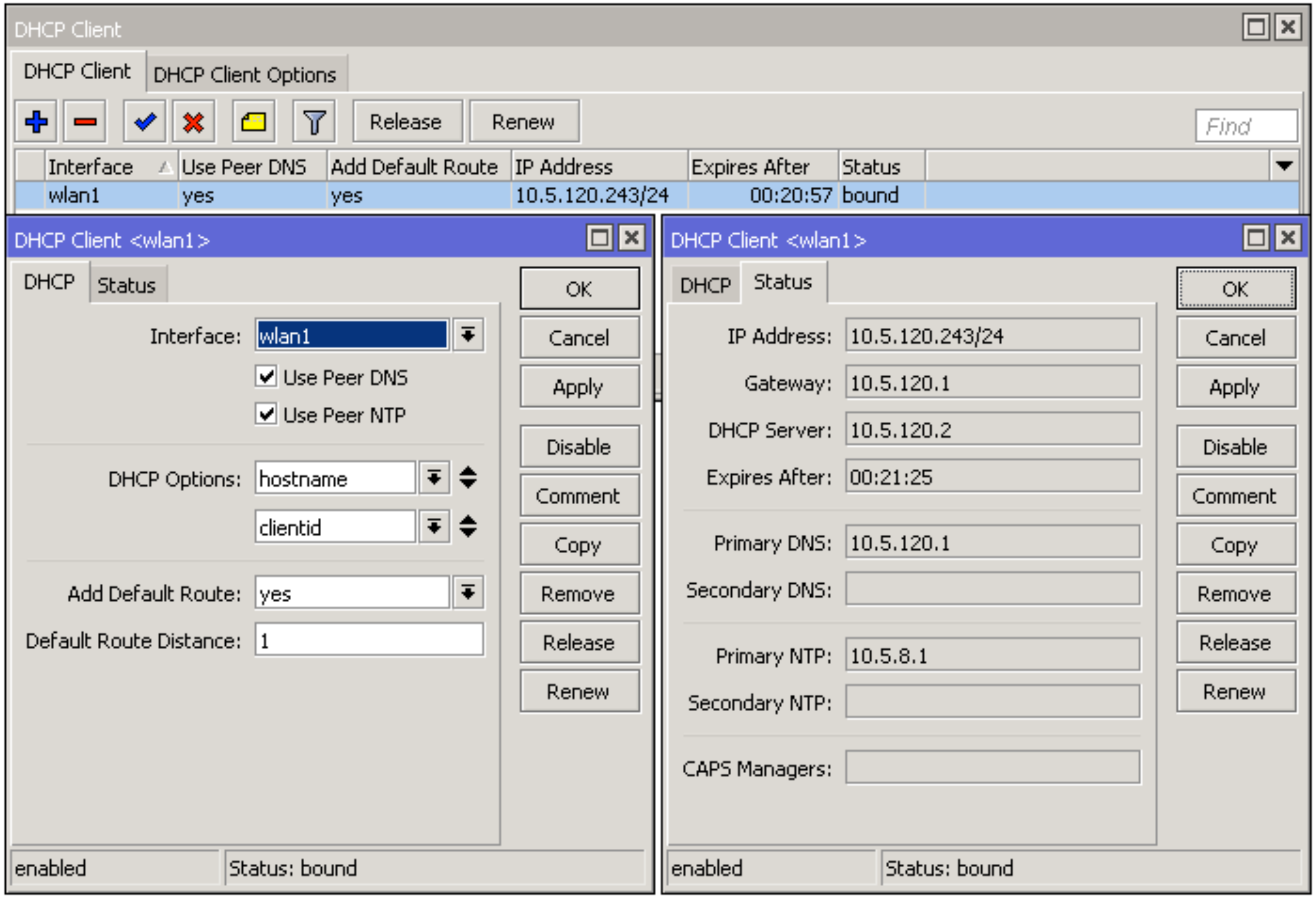
- Dynamic Host Configuration Protocol
- Used for automatic IP address distribution over a local network
- Use DHCP only in trusted networks
- Works within a broadcast domain
- RouterOS supports both DHCP client and server

MikroTik
MTCNA

DHCP Client

- Used for automatic acquiring of IP address, subnet mask, default gateway, DNS server address and additional settings if provided
- MikroTik SOHO routers by default have DHCP client configured on ether1(WAN) interface

DHCP Client



Interface	Use Peer DNS	Add Default Route	IP Address	Expires After	Status
wlan1	yes	yes	10.5.120.243/24	00:20:57	bound

Interface: wlan1

☑ Use Peer DNS

☑ Use Peer NTP

DHCP Options: hostname

clientid

Add Default Route: yes

Default Route Distance: 1

enabled   Status: bound

IP Address: 10.5.120.243/24

Gateway: 10.5.120.1

DHCP Server: 10.5.120.2

Expires After: 00:21:25

Primary DNS: 10.5.120.1

Secondary DNS:

Primary NTP: 10.5.8.1

Secondary NTP:

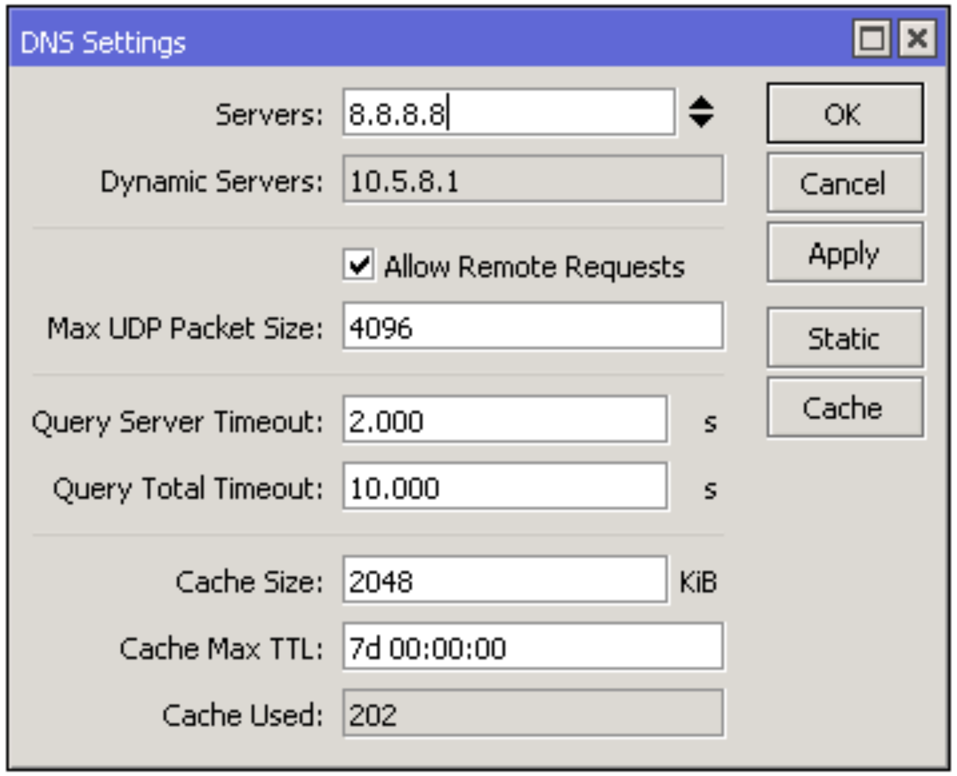
CAPS Managers:

enabled   Status: bound

IP → DHCP Client

DNS

- By default DHCP client asks for a DNS server IP address
- It can also be entered manually if other DNS server is needed or DHCP is not used

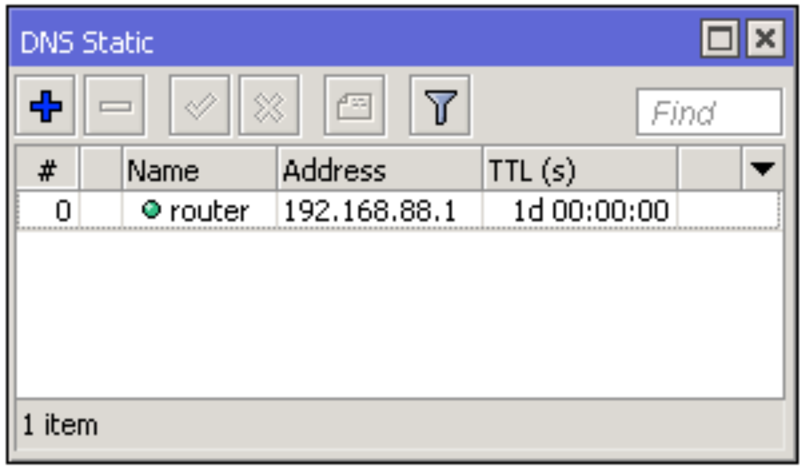

DNS Settings

Servers: 8.8.8.8
Dynamic Servers: 10.5.8.1
☑ Allow Remote Requests
Max UDP Packet Size: 4096
Query Server Timeout: 2.000 s
Query Total Timeout: 10.000 s
Cache Size: 2048 KiB
Cache Max TTL: 7d 00:00:00
Cache Used: 202

IP → DNS

DNS

- RouterOS supports static DNS entries
- By default there’s a static DNS A record named **router** which points to 192.168.88.1
- That means you can access the router by using DNS name instead of IP
- http://router



#	Name	Address	TTL (s)
0	router	192.168.88.1	1d 00:00:00

1 item

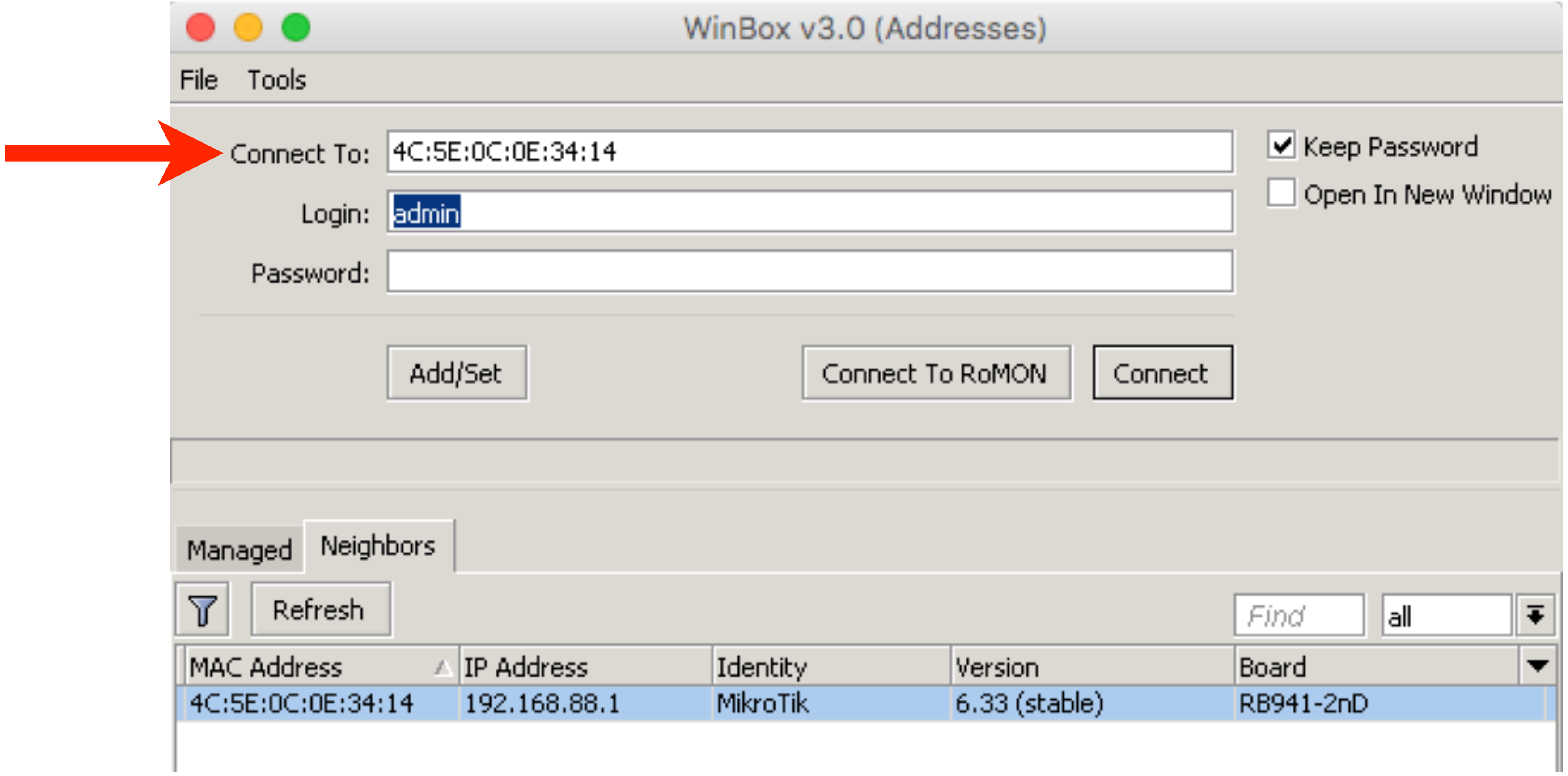
IP → DNS → Static

DHCP Server

- Automatically assigns IP addresses to requesting hosts
- IP address should be configured on the interface which DHCP Server will use
- To enable use ‘DHCP Setup’ command

DHCP Server

- Disconnect from the router
- Reconnect using the router’s MAC address



Connect To: 4C:5E:0C:0E:34:14

Login: admin

Password:

☑ Keep Password

□ Open In New Window

all

MAC Address	IP Address	Identity	Version	Board
4C:5E:0C:0E:34:14	192.168.88.1	MikroTik	6.33 (stable)	RB941-2nD

LAB

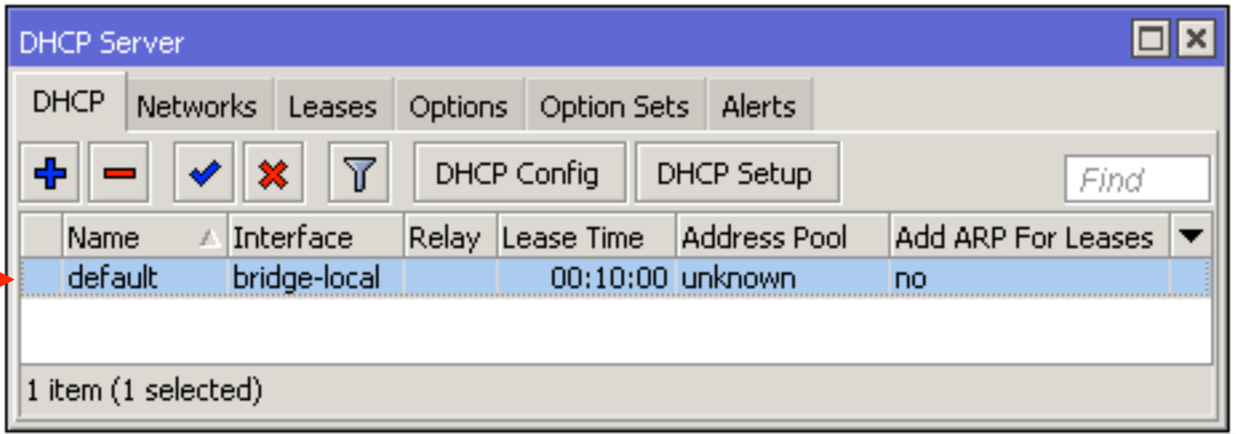
DHCP Server

- We're going to remove existing DHCP Server and setup a new one
- Will use your number (XY) for the subnet, e.g. 192.168.XY.0/24
- To enable DHCP Server on the bridge, it must be configured on the **bridge interface** (not on the bridge port)

LAB

DHCP Server

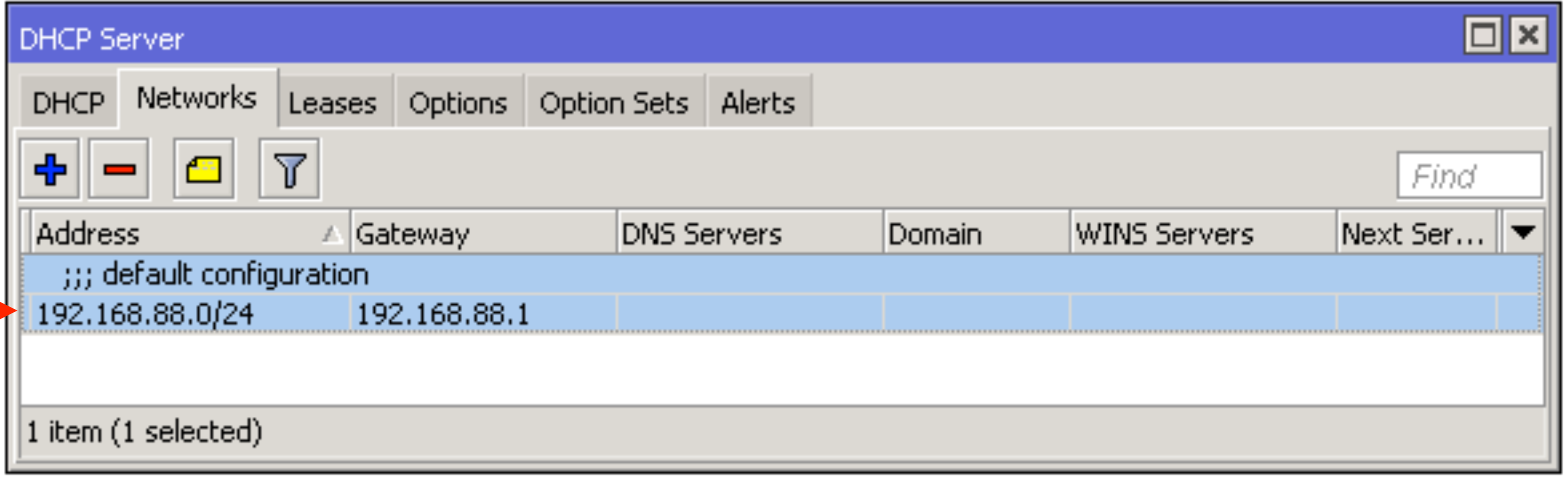
Remove DHCP Server



Name	Interface	Relay	Lease Time	Address Pool	Add ARP For Leases
default	bridge-local		00:10:00	unknown	no

1 item (1 selected)

Remove DHCP Network



Address	Gateway	DNS Servers	Domain	WINS Servers	Next Ser...
;;; default configuration					
192.168.88.0/24	192.168.88.1				

1 item (1 selected)

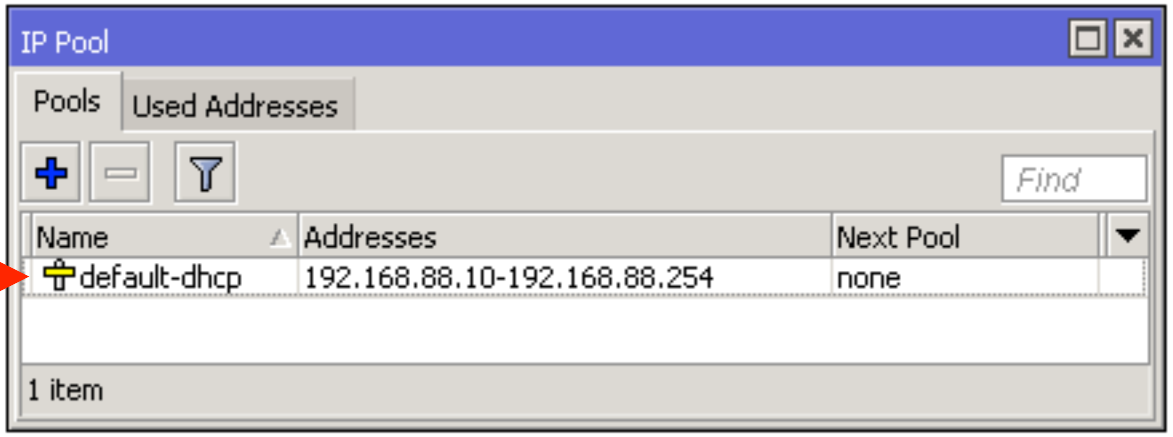
IP → DHCP Server

MikroTik MTCNA

LAB

DHCP Server

Remove IP Pool

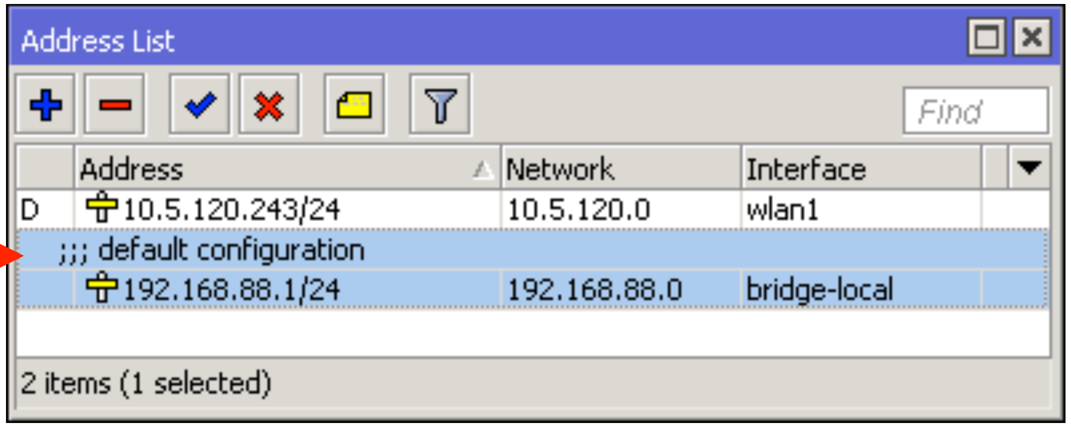


Name	Addresses	Next Pool
default-dhcp	192.168.88.10-192.168.88.254	none

1 item

IP → Pool

Remove IP Address



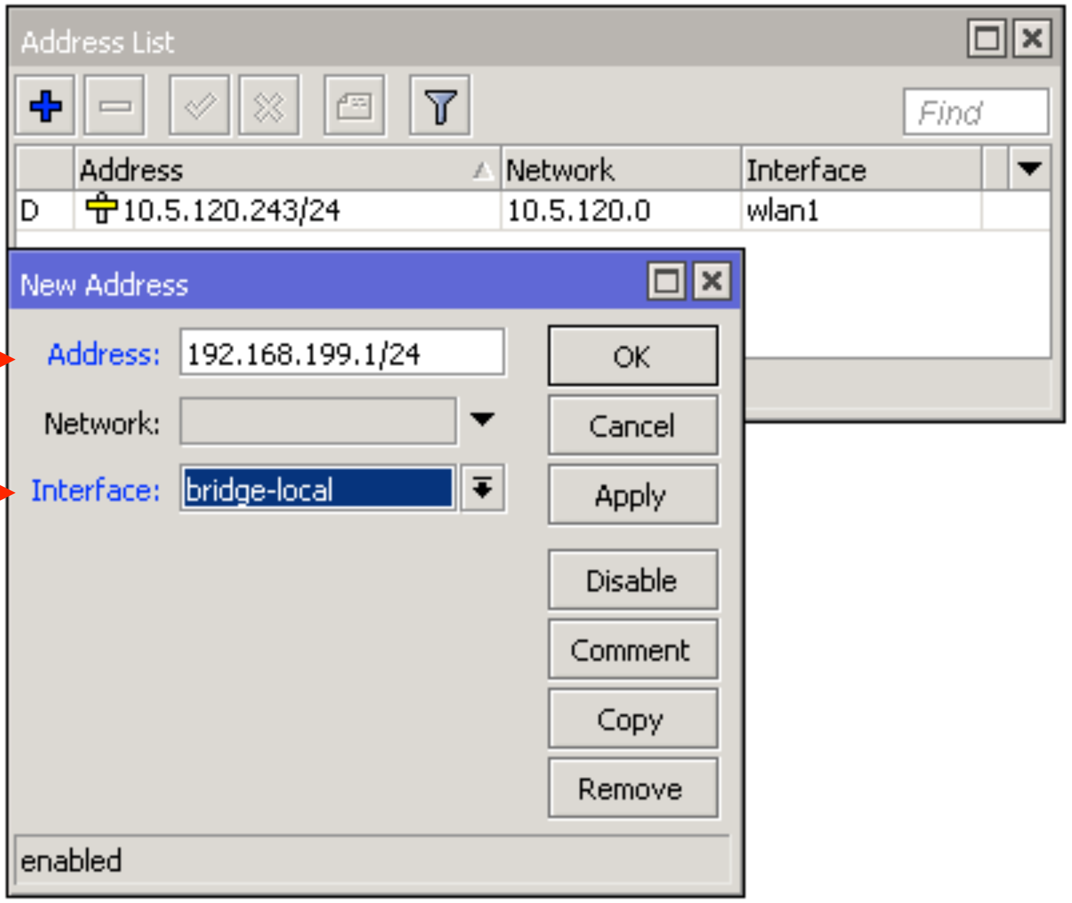
	Address	Network	Interface
D	10.5.120.243/24	10.5.120.0	wlan1
	;;; default configuration		
	192.168.88.1/24	192.168.88.0	bridge-local

2 items (1 selected)

IP → Address

DHCP Server

Add IP Address 192.168.XY.1/24 on the bridge interface



Address List

	Address	Network	Interface
D	10.5.120.243/24	10.5.120.0	wlan1

New Address

Address: 192.168.199.1/24

Network:

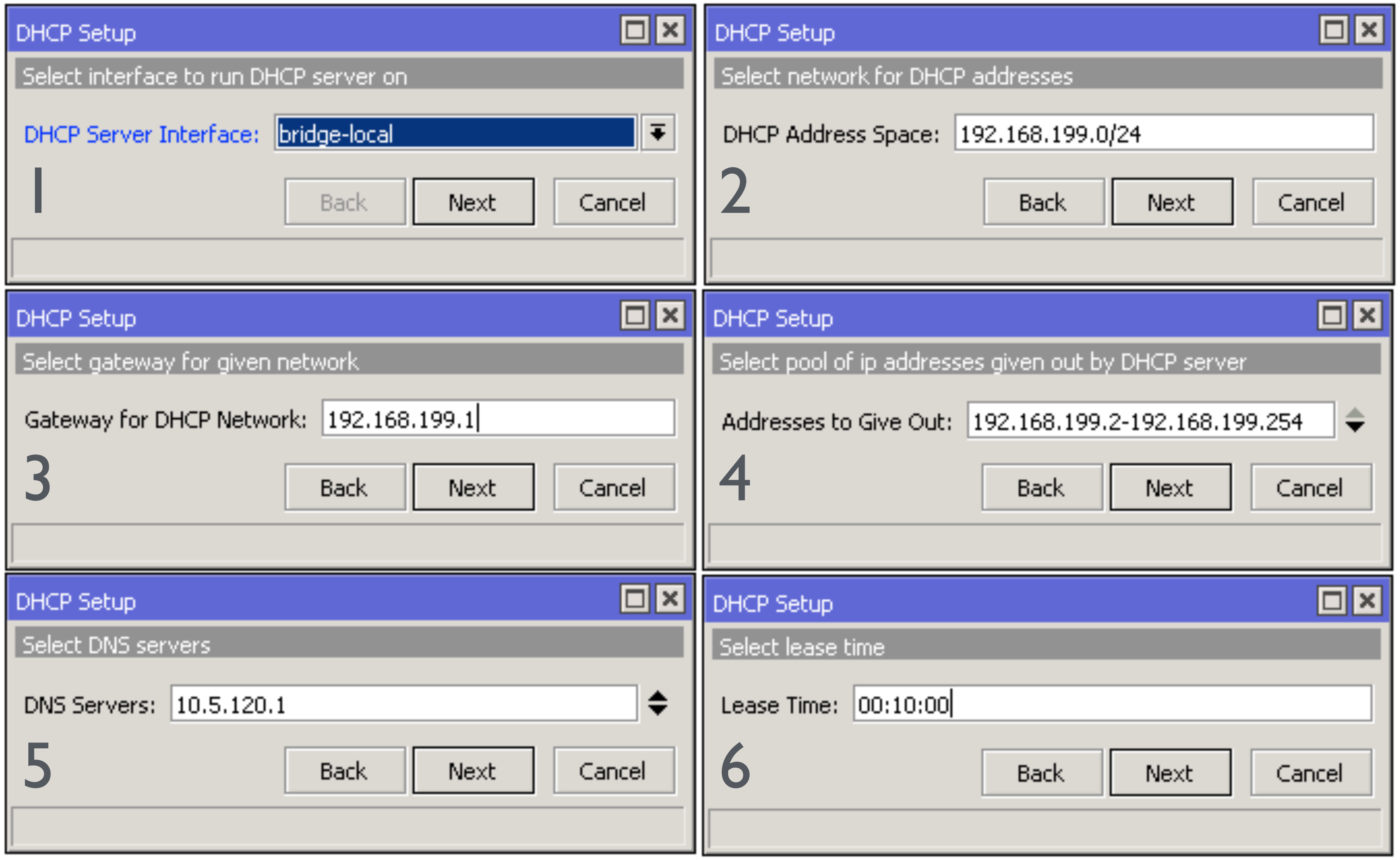
Interface: bridge-local

enabled

- For example, XY=199

LAB

DHCP Server



1 Select interface to run DHCP server on
DHCP Server Interface: bridge-local

2 Select network for DHCP addresses
DHCP Address Space: 192.168.199.0/24

3 Select gateway for given network
Gateway for DHCP Network: 192.168.199.1

4 Select pool of ip addresses given out by DHCP server
Addresses to Give Out: 192.168.199.2-192.168.199.254

5 Select DNS servers
DNS Servers: 10.5.120.1

6 Select lease time
Lease Time: 00:10:00

IP → DHCP Server → DHCP Setup

MikroTik MTCNA

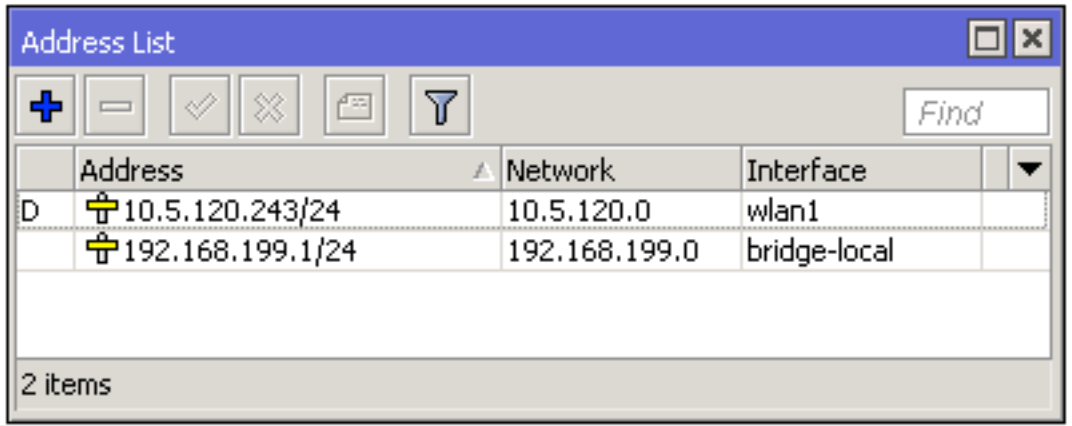
LAB

DHCP Server

- Disconnect from the router
- Renew the IP address of your laptop
- Connect to the router's new IP address 192.168.XY.1
- Check that the connection to the Internet is available

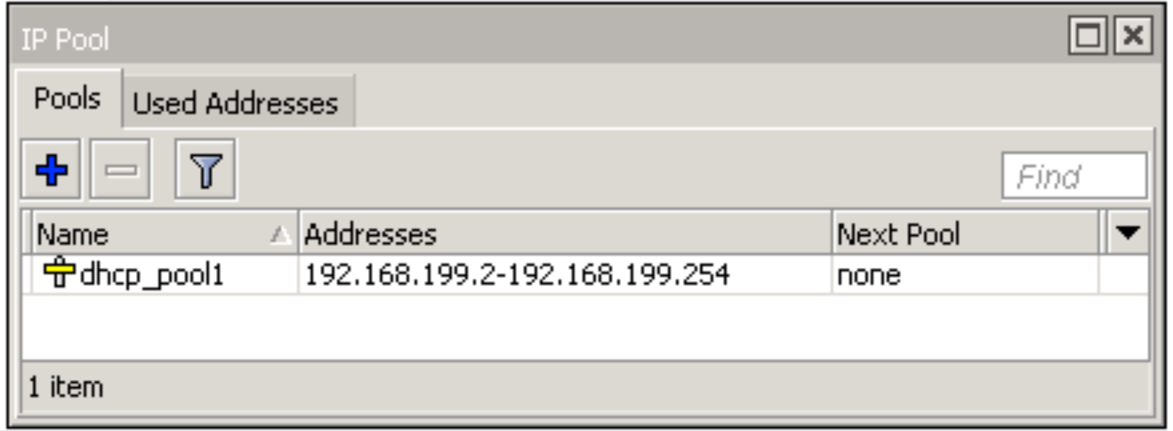
DHCP Server

- DHCP Server Setup wizard has created a new IP pool and DHCP Server



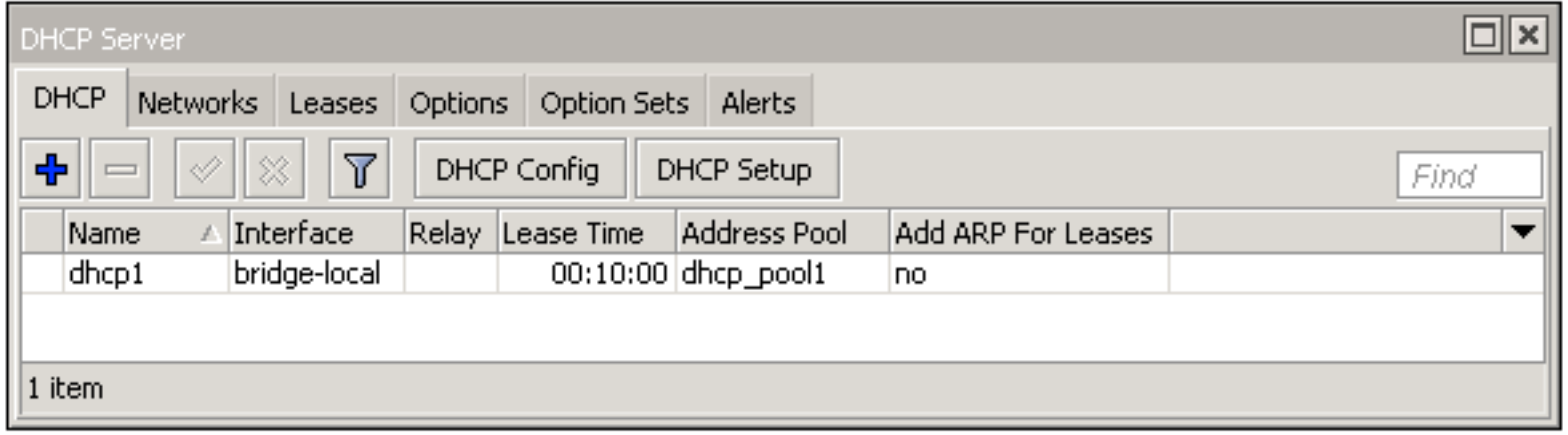
	Address	Network	Interface
D	10.5.120.243/24	10.5.120.0	wlan1
	192.168.199.1/24	192.168.199.0	bridge-local

2 items



Name	Addresses	Next Pool
dhcp_pool1	192.168.199.2-192.168.199.254	none

1 item



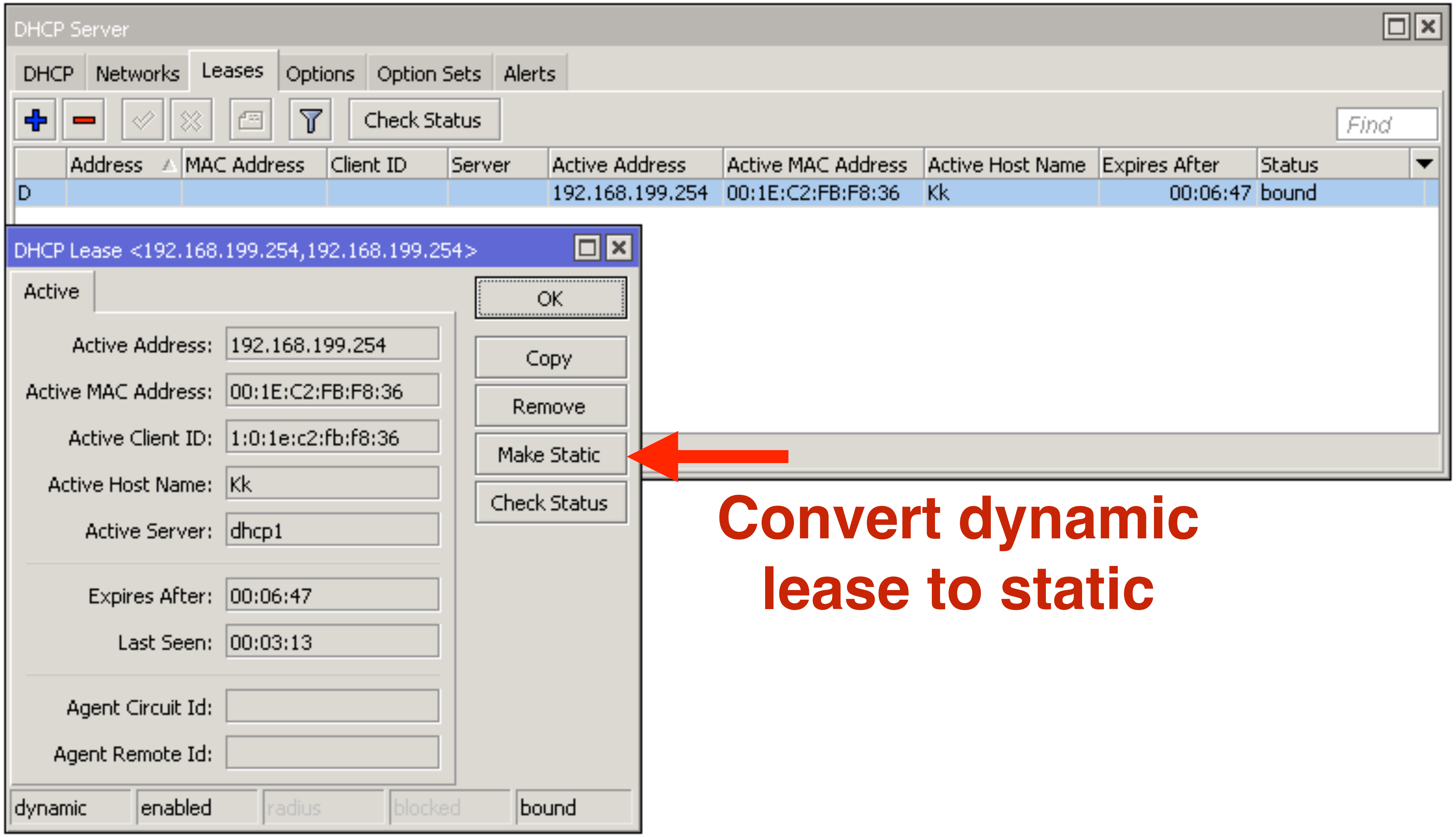
Name	Interface	Relay	Lease Time	Address Pool	Add ARP For Leases
dhcp1	bridge-local		00:10:00	dhcp_pool1	no

1 item

DHCP Static Leases

- It is possible to always assign the same IP address to the same device (identified by MAC address)
- DHCP Server could even be used without dynamic IP pool and assign only preconfigured addresses

DHCP Static Leases



	Address	MAC Address	Client ID	Server	Active Address	Active MAC Address	Active Host Name	Expires After	Status
D					192.168.199.254	00:1E:C2:FB:F8:36	Kk	00:06:47	bound

Active Address: 192.168.199.254

Active MAC Address: 00:1E:C2:FB:F8:36

Active Client ID: 1:0:1e:c2:fb:f8:36

Active Host Name: Kk

Active Server: dhcp1

Expires After: 00:06:47

Last Seen: 00:03:13

Agent Circuit Id:

Agent Remote Id:

dynamic | enabled | radius | blocked | bound

Convert dynamic lease to static

IP → DHCP Server → Leases

LAB

DHCP Static Leases

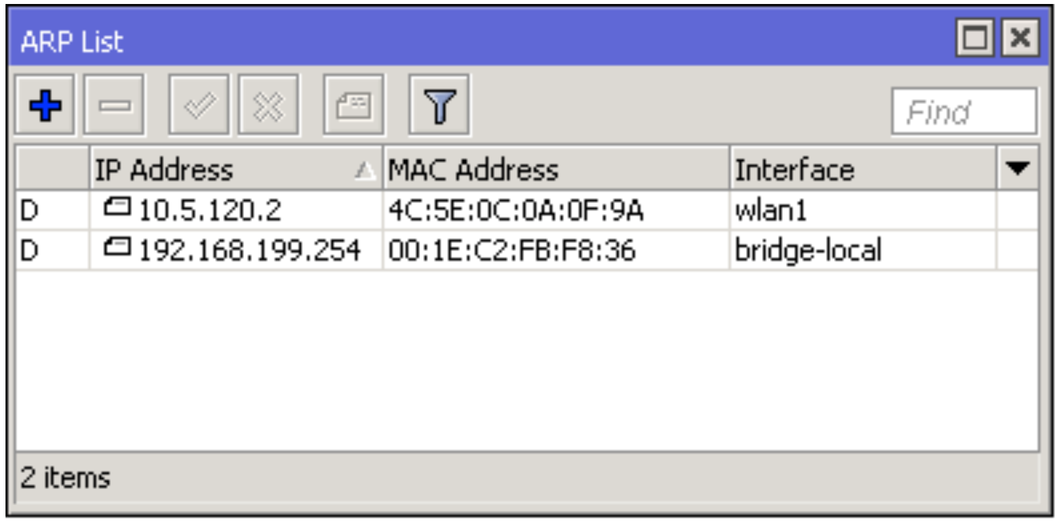
- Set DHCP Address Pool to static-only
- Create a static lease for your laptop
- Change the IP address assigned to your laptop by DHCP server to 192.168.XY.123
- Renew the IP address of your laptop
- Ask your neighbor to connect his/her laptop to your router (will not get an IP address)

ARP

- Address Resolution Protocol
- ARP joins together client's IP address (Layer3) with MAC address (Layer2)
- ARP operates dynamically
- Can also be configured manually

ARP Table

- Provides information about IP address, MAC address and the interface to which the device is connected



ARP List

	IP Address	MAC Address	Interface
D	10.5.120.2	4C:5E:0C:0A:0F:9A	wlan1
D	192.168.199.254	00:1E:C2:FB:F8:36	bridge-local

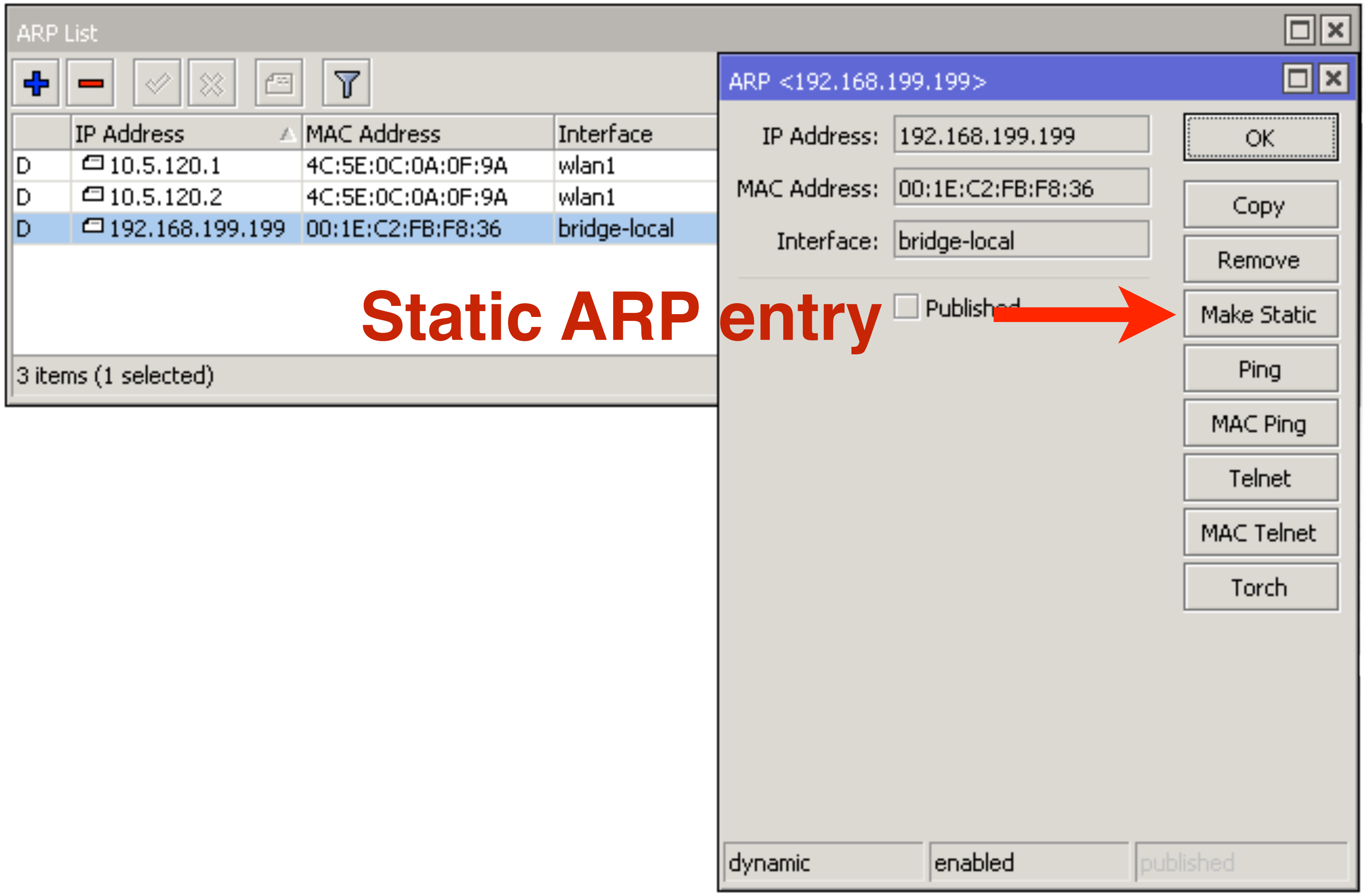
2 items

IP → ARP

Static ARP

- For increased security ARP entries can be added manually
- Network interface can be configured to **reply-only** to known ARP entries
- Router’s client will not be able to access the Internet using a different IP address

Static ARP



ARP List

	IP Address	MAC Address	Interface
D	10.5.120.1	4C:5E:0C:0A:0F:9A	wlan1
D	10.5.120.2	4C:5E:0C:0A:0F:9A	wlan1
D	192.168.199.199	00:1E:C2:FB:F8:36	bridge-local

3 items (1 selected)

ARP <192.168.199.199>

IP Address: 192.168.199.199

MAC Address: 00:1E:C2:FB:F8:36

Interface: bridge-local

□ Published

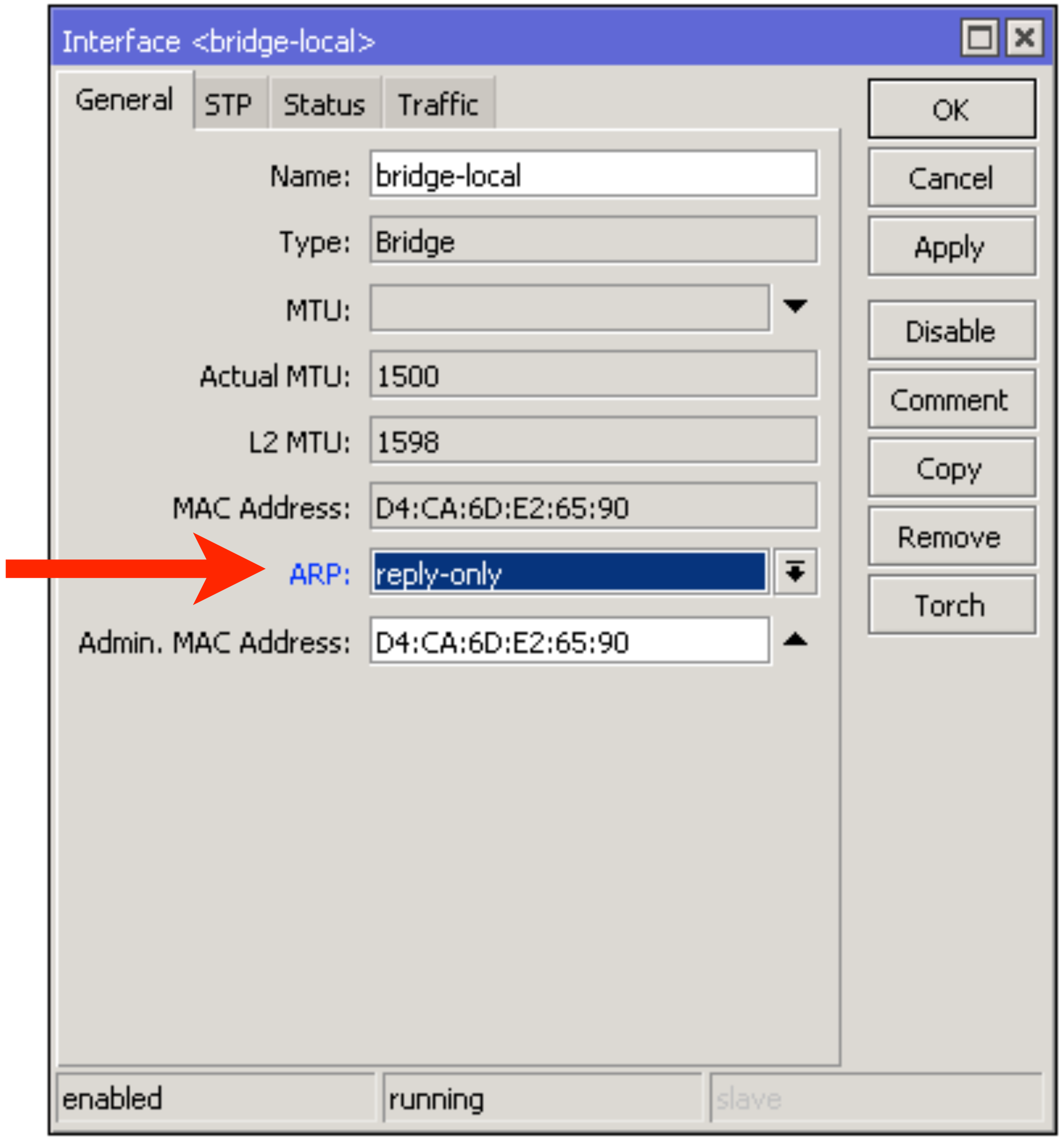
dynamic | enabled | published

Static ARP entry

IP → ARP

Static ARP

Interface will reply only to known ARP entries



Interface <bridge-local>

General | STP | Status | Traffic

Name: bridge-local

Type: Bridge

MTU:

Actual MTU: 1500

L2 MTU: 1598

MAC Address: D4:CA:6D:E2:65:90

ARP: reply-only

Admin. MAC Address: D4:CA:6D:E2:65:90

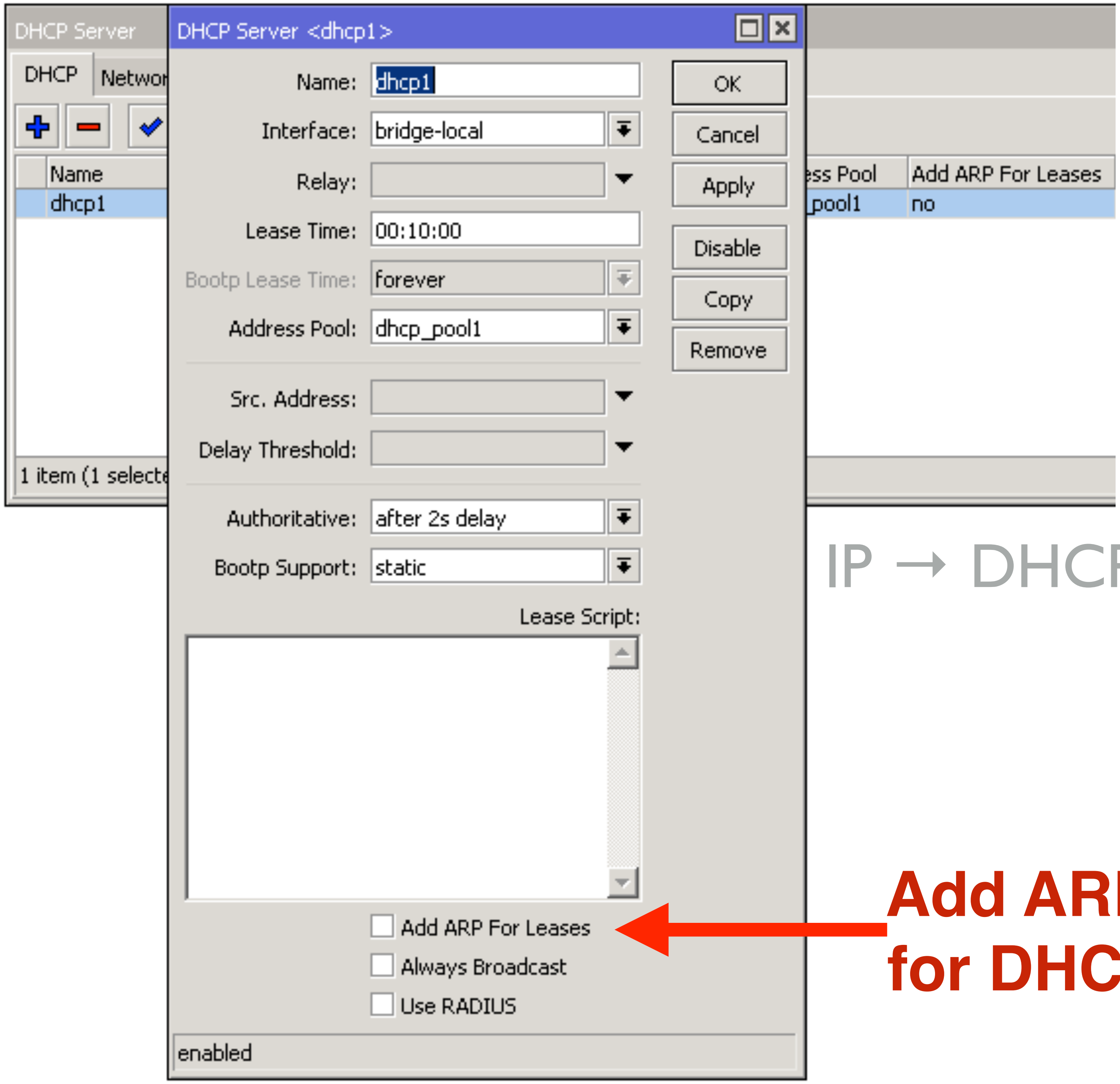
enabled | running | slave

Interfaces → bridge-local

DHCP and ARP

- DHCP Server can add ARP entries automatically
- Combined with **static leases** and **reply-only** ARP can increase network security while retaining the ease of use for users

DHCP and ARP



DHCP Server <dhcp1>

Name: dhcp1

Interface: bridge-local

Relay:

Lease Time: 00:10:00

Bootp Lease Time: forever

Address Pool: dhcp_pool1

Src. Address:

Delay Threshold:

Authoritative: after 2s delay

Bootp Support: static

Lease Script:

□ Add ARP For Leases

□ Always Broadcast

□ Use RADIUS

enabled

IP → DHCP Server

Add ARP entries for DHCP leases

Static ARP

LAB

- Make your laptop’s ARP entry static
- Set the bridge interface ARP to reply-only to disable adding dynamic ARP entries
- You should still have the DHCP server to static-only and a static lease for the laptop. If not, repeat the previous LAB
- Enable ‘Add ARP For Leases’ on DHCP server

LAB

Static ARP

- Remove your laptop's static entry from the ARP table
- Check the Internet connection (not working)
- Renew the IP address of your laptop
- Check the Internet connection (should work)
- Connect to the router and observe the ARP table

Module 2
Summary

MikroTik

Certified Network Associate (MTCNA)

Module 3

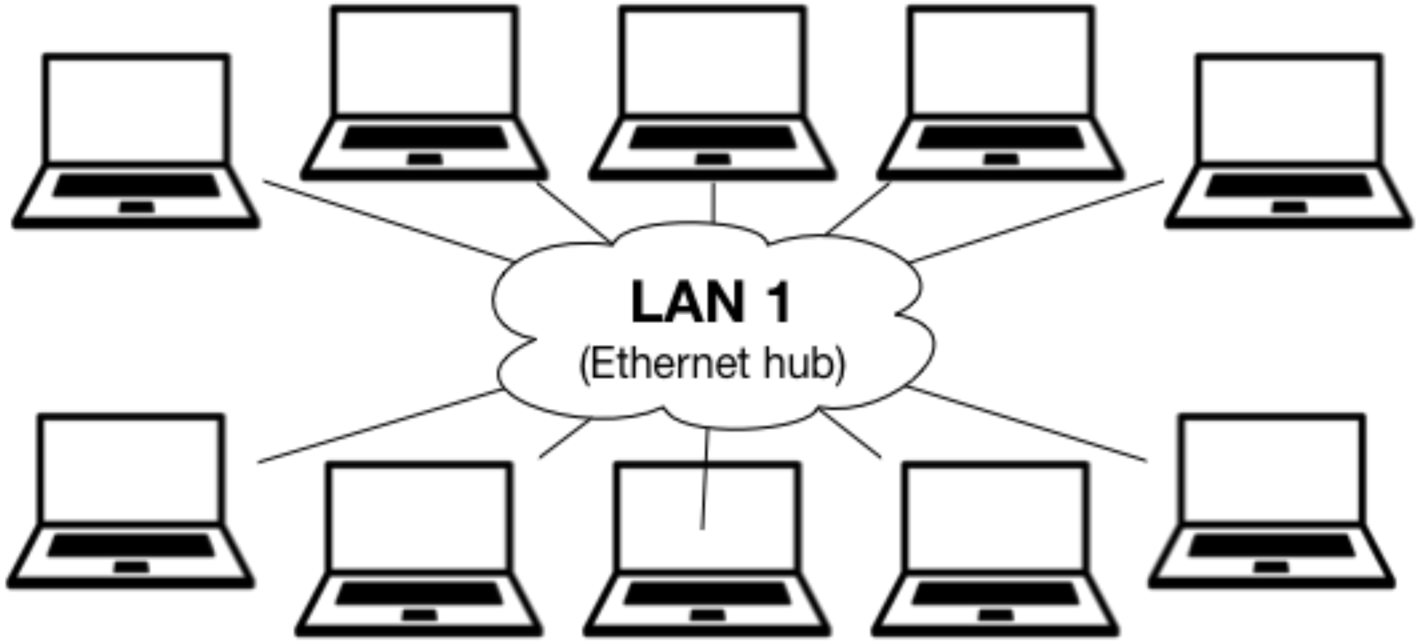
Bridging

Bridge

- Bridges are OSI layer 2 devices
- Bridge is a transparent device
- Traditionally used to join two network segments
- Bridge splits collision domain in two parts
- Network switch is multi-port bridge - each port is a collision domain of one device

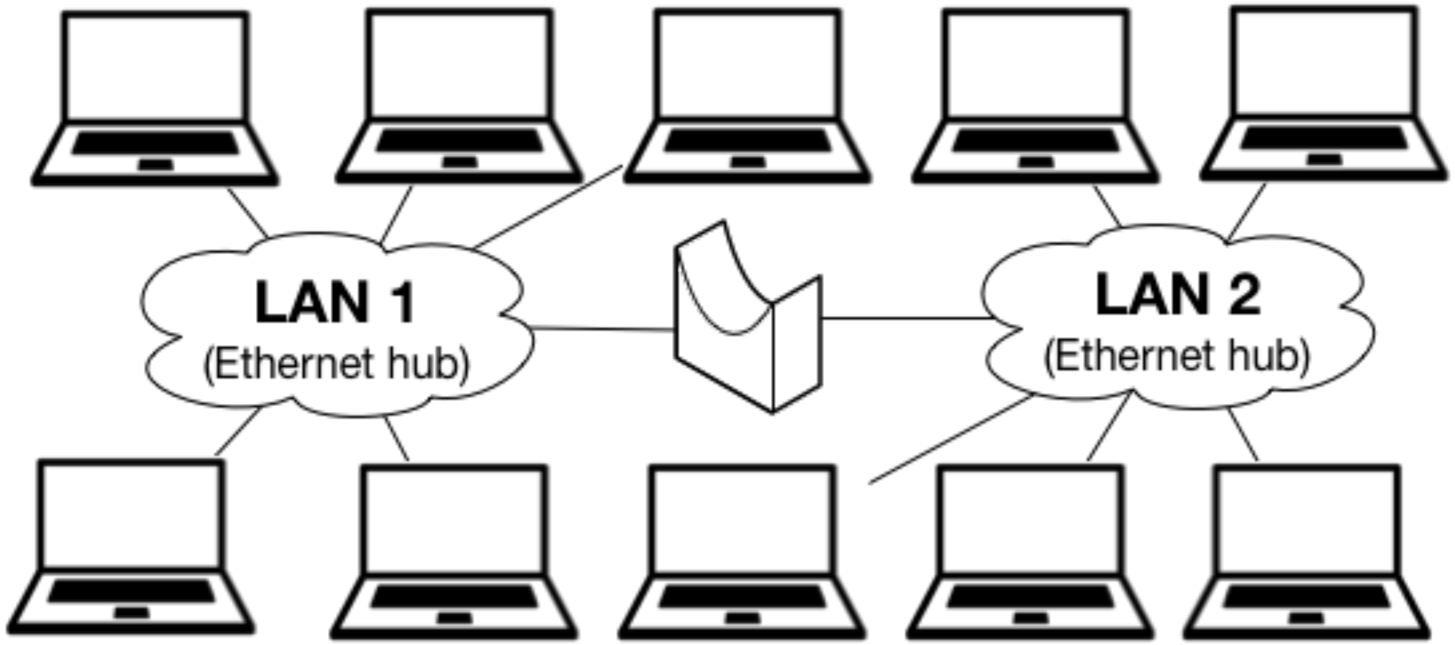
Bridge

- All hosts can communicate with each other
- All share the same collision domain



Bridge

- All hosts still can communicate with each other
- Now there are 2 collision domains



Bridge

- RouterOS implements software bridge
- Ethernet, wireless, SFP and tunnel interfaces can be added to a bridge
- Default configuration on SOHO routers bridge wireless with ether2 port
- Ether2-5 are combined together in a switch. Ether2 is master, 3-5 slave. Wire speed switching using switch chip

Bridge

- It is possible to remove master/slave configuration and use bridge instead
- Switch chip will not be used, higher CPU usage
- More control - can use IP firewall for bridge ports

Bridge

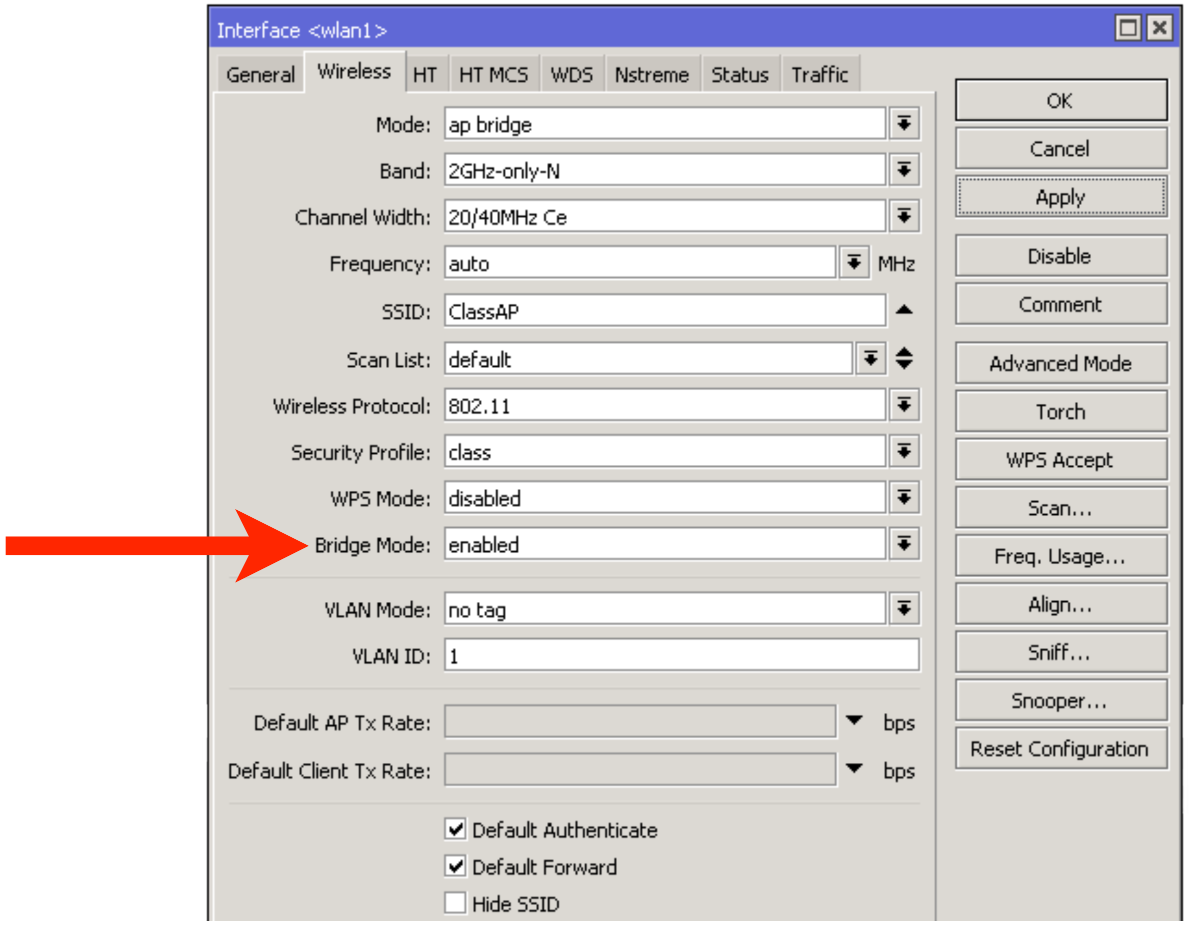
- Due to limitations of 802.11 standard, wireless clients (mode: station) do not support bridging
- RouterOS implements several modes to overcome this limitation

Wireless Bridge

- **station bridge** - RouterOS to RouterOS
- **station pseudobridge** - RouterOS to other
- **station wds** (Wireless Distribution System) - RouterOS to RouterOS

Wireless Bridge

- To use **station bridge**, 'Bridge Mode' has to be enabled on the AP



Interface <wlan1>

General | Wireless | HT | HT MCS | WDS | Nstreme | Status | Traffic

Mode: ap bridge

Band: 2GHz-only-N

Channel Width: 20/40MHz Ce

Frequency: auto MHz

SSID: ClassAP

Scan List: default

Wireless Protocol: 802.11

Security Profile: class

WPS Mode: disabled

Bridge Mode: enabled

VLAN Mode: no tag

VLAN ID: 1

Default AP Tx Rate: bps

Default Client Tx Rate: bps

☑ Default Authenticate

☑ Default Forward

☐ Hide SSID

LAB

Bridge

- We are going to create **one big network** by bridging local Ethernet with wireless (Internet) interface
- All the laptops will be in the same network
- Note: be careful when bridging networks!
- **Create a backup before starting this LAB!**

MikroTik
MTCNA

LAB

Bridge

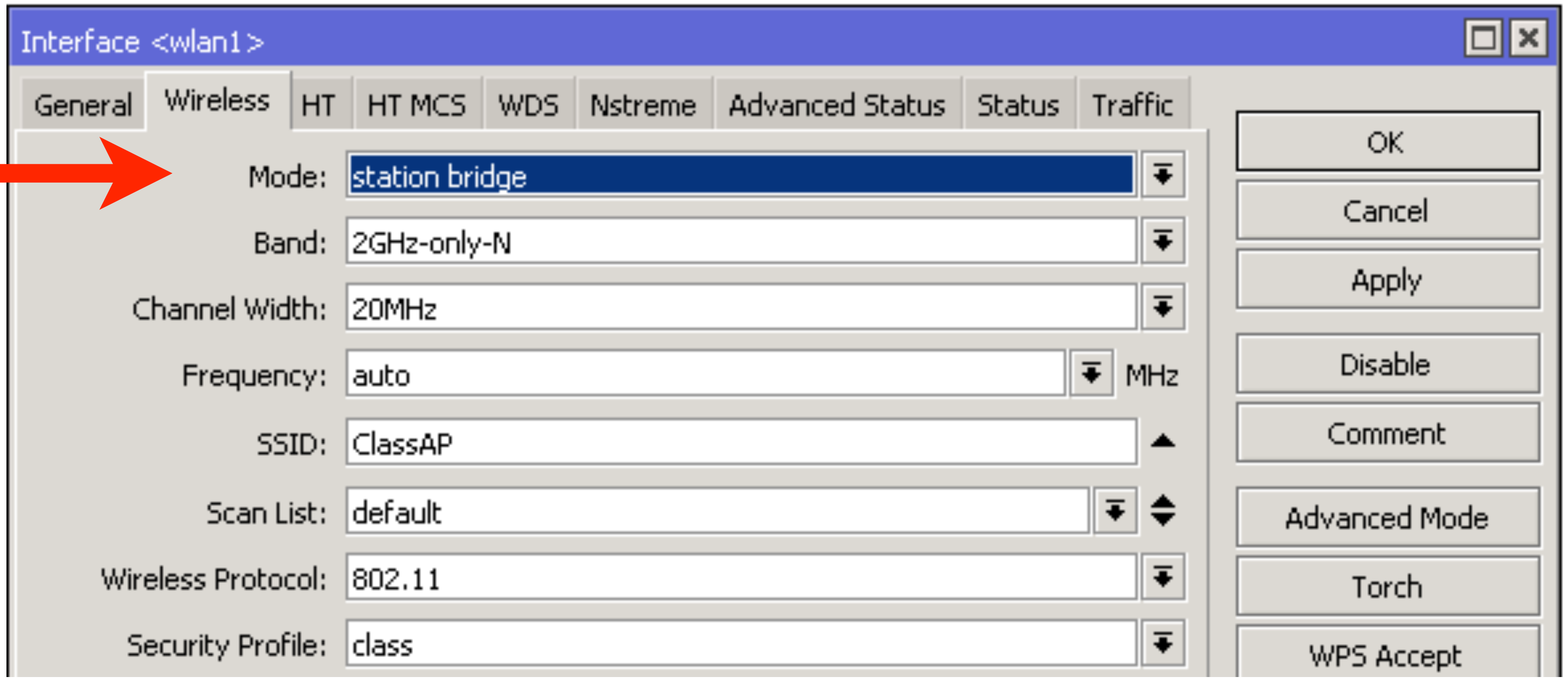
- Change wireless to **station bridge** mode
- Disable DHCP server
- Add wireless interface to existing bridge-local interface as a port

MikroTik MTCNA

LAB

Bridge

Set mode to station bridge



Mode: station bridge

Band: 2GHz-only-N

Channel Width: 20MHz

Frequency: auto MHz

SSID: ClassAP

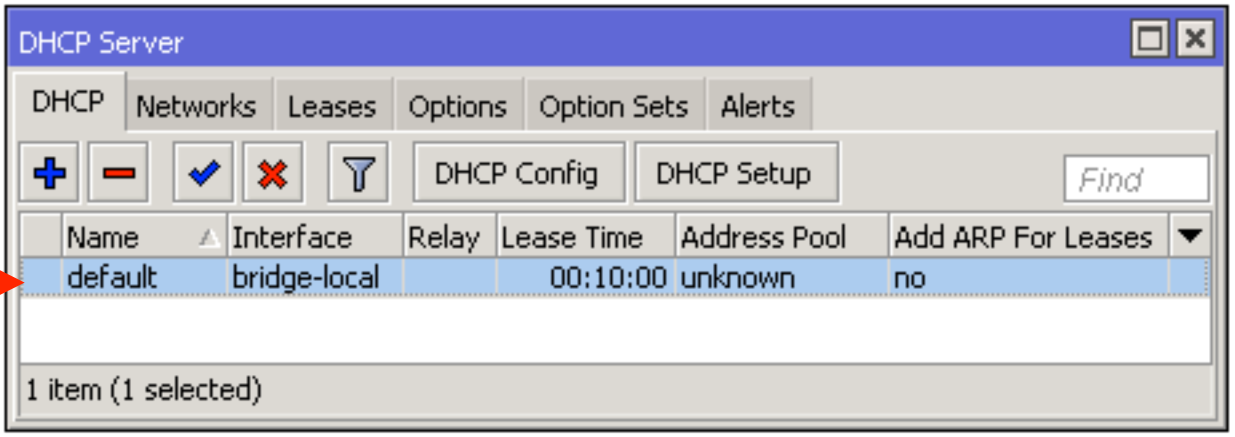
Scan List: default

Wireless Protocol: 802.11

Security Profile: class

Wireless → wlan1

Disable DHCP Server



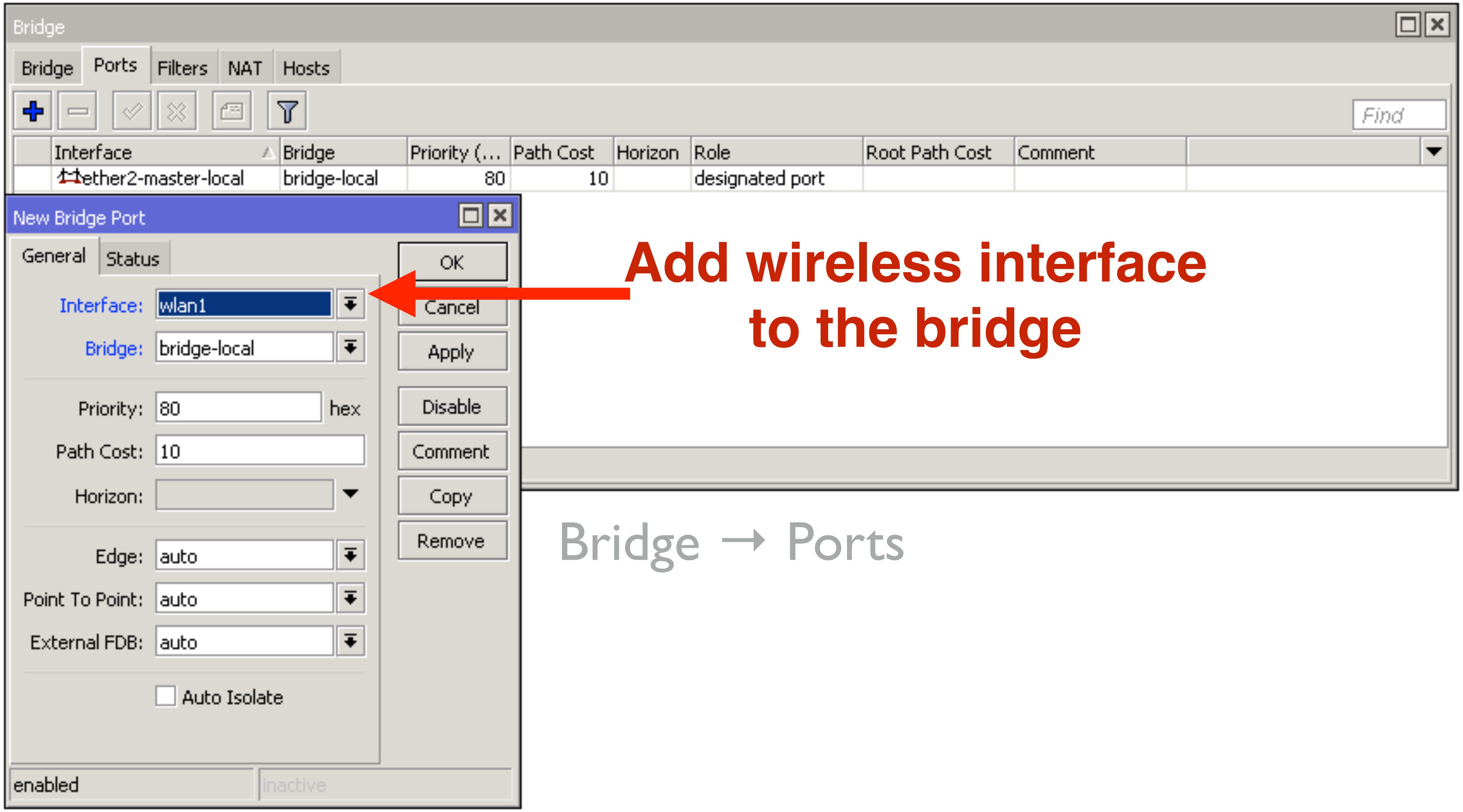
Name	Interface	Relay	Lease Time	Address Pool	Add ARP For Leases
default	bridge-local		00:10:00	unknown	no

1 item (1 selected)

IP → DHCP Server

MikroTik MTCNA

Bridge



Interface	Bridge	Priority (...	Path Cost	Horizon	Role	Root Path Cost	Comment
ether2-master-local	bridge-local	80	10		designated port		

Interface: wlan1

Bridge: bridge-local

Priority: 80 hex

Path Cost: 10

Horizon:

Edge: auto

Point To Point: auto

External FDB: auto

□ Auto Isolate

enabled | inactive

Add wireless interface to the bridge

Bridge → Ports

LAB

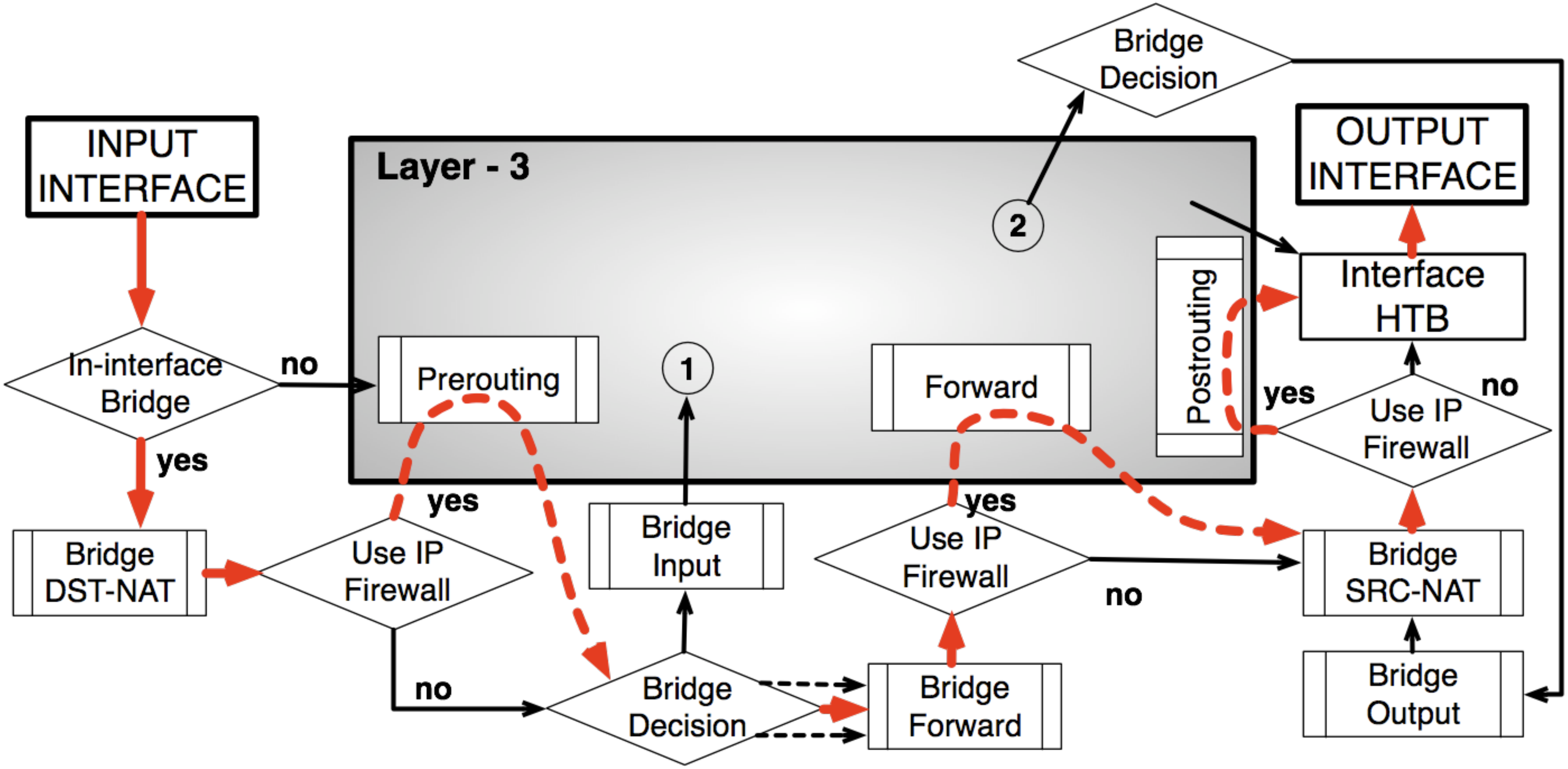
Bridge

- Renew the IP address of your laptop
- You should acquire IP from the trainer’s router
- Ask your neighbor his/her laptop IP address and try to ping it
- Your router now is a **transparent bridge**

Bridge Firewall

- RouterOS bridge interface supports firewall
- Traffic which flows through the bridge can be processed by the firewall
- To enable: Bridge → Settings → Use IP Firewall

Bridge Firewall



Bridge

- Restore your router’s configuration from the backup you created before bridging LAB
- Or restore previous configuration by hand

Module 3
Summary

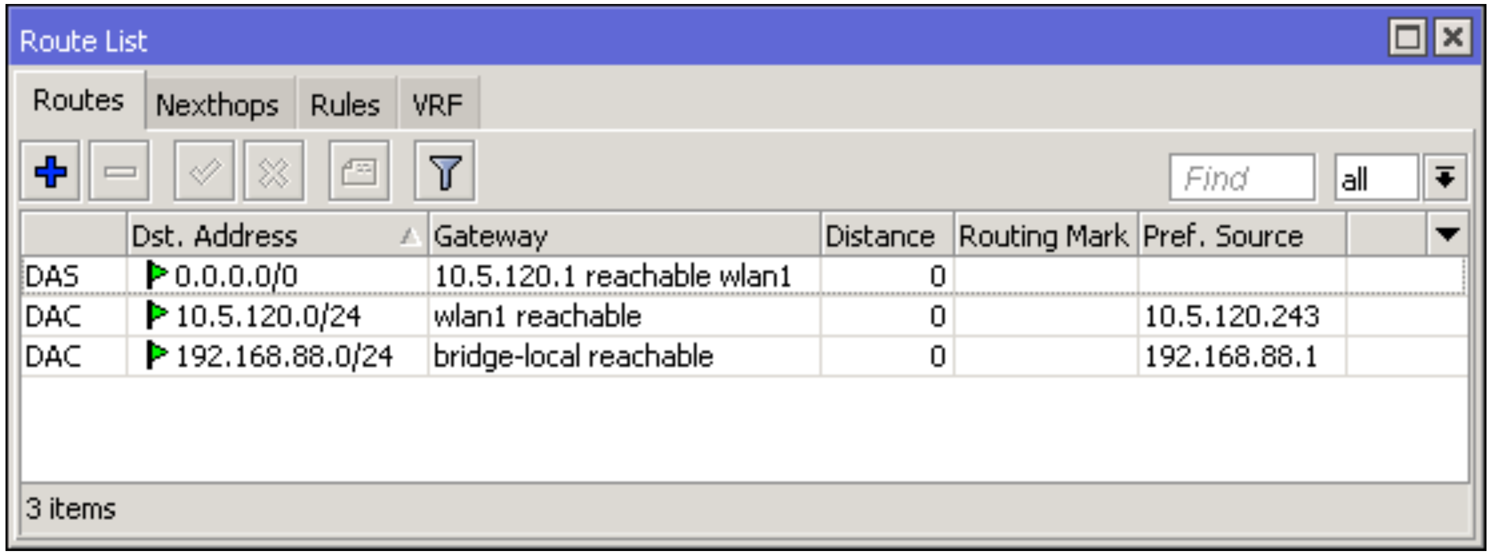
Certified Network Associate (MTCNA)

Module 4

Routing

Routing

- Works in OSI network layer (L3)
- RouterOS routing rules define where the packets should be sent

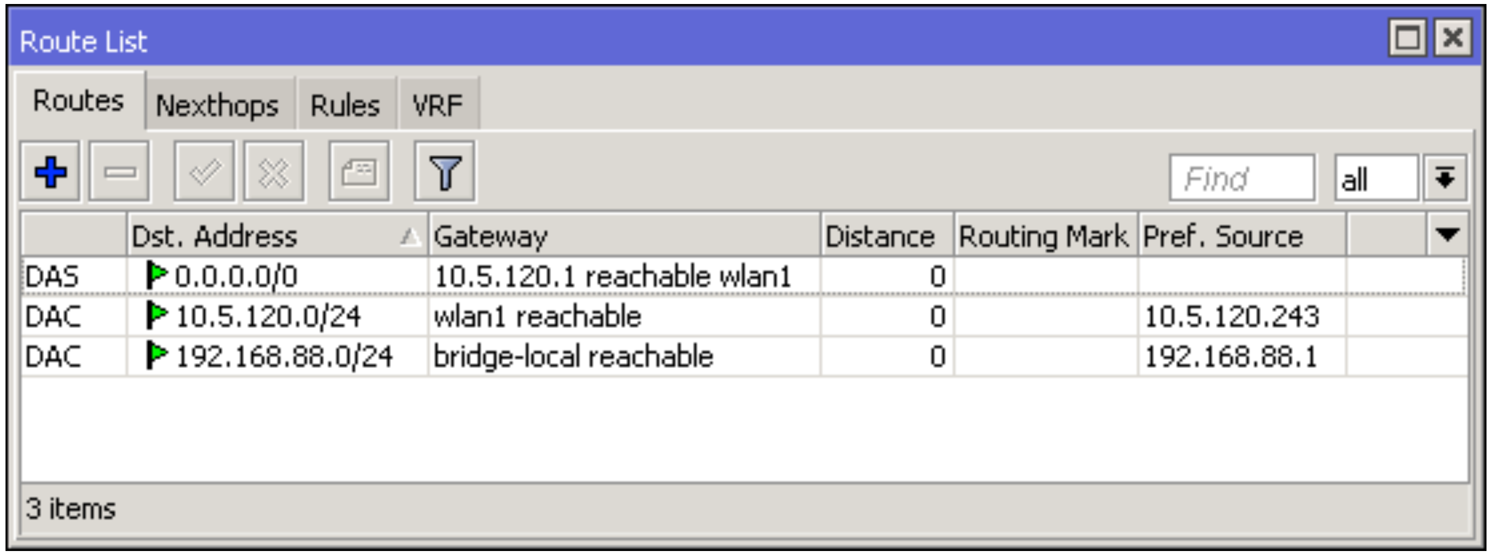


	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
DAS	0.0.0.0/0	10.5.120.1 reachable wlan1	0		
DAC	10.5.120.0/24	wlan1 reachable	0		10.5.120.243
DAC	192.168.88.0/24	bridge-local reachable	0		192.168.88.1

IP → Routes

Routing

- **Dst. Address:** networks which can be reached
- **Gateway**: IP address of the next router to reach the **destination**



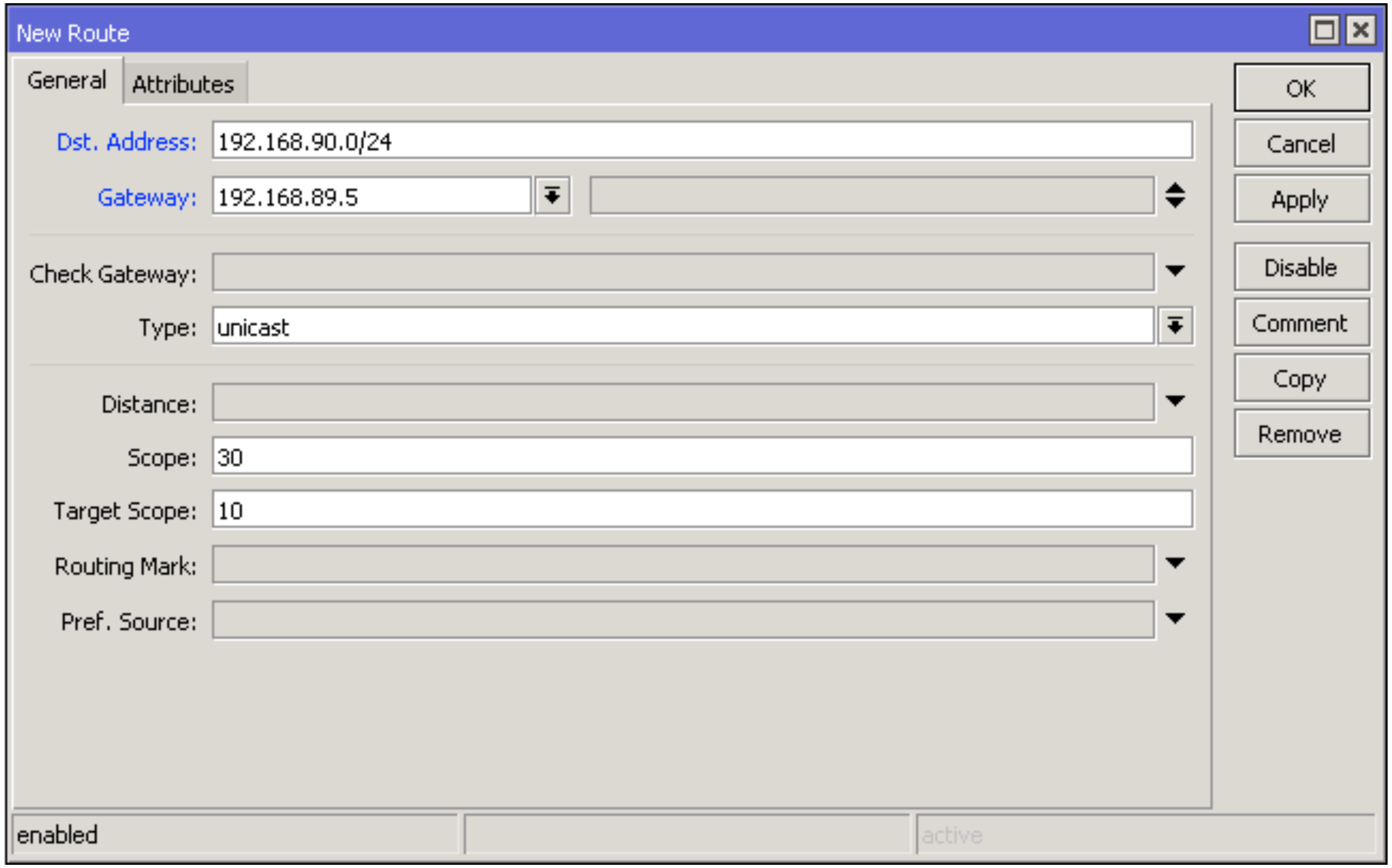
	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
DAS	0.0.0.0/0	10.5.120.1 reachable wlan1	0		
DAC	10.5.120.0/24	wlan1 reachable	0		10.5.120.243
DAC	192.168.88.0/24	bridge-local reachable	0		192.168.88.1

3 items

IP → Routes

MikroTik MTCNA

New Static Route



Dst. Address: 192.168.90.0/24

Gateway: 192.168.89.5

Check Gateway:

Type: unicast

Distance:

Scope: 30

Target Scope: 10

Routing Mark:

Pref. Source:

enabled

active

IP → Routes

Routing

- Check gateway - every 10 seconds send either ICMP echo request (ping) or ARP request.
- If several routes use the same gateway and there is one that has **check-gateway** option enabled, all routes will be subjected to the behaviour of check-gateway

Routing

- If there are two or more routes pointing to the same address, the more precise one will be used
  - Dst: 192.168.90.0/24, gateway: 1.2.3.4
  - Dst: 192.168.90.128/25, gateway: 5.6.7.8
  - If a packet needs to be sent to 192.168.90.135, gateway 5.6.7.8 will be used

Default Gateway

- Default gateway: a router (next hop) where all the traffic for which there is no specific destination defined will be sent
- It is distinguished by 0.0.0.0 destination network

LAB

Default Gateway

- Currently the default gateway for your router is configured automatically using DHCP-Client
- Disable ‘Add Default Route’ in DHCP-Client settings
- Check the Internet connection (not working)

LAB

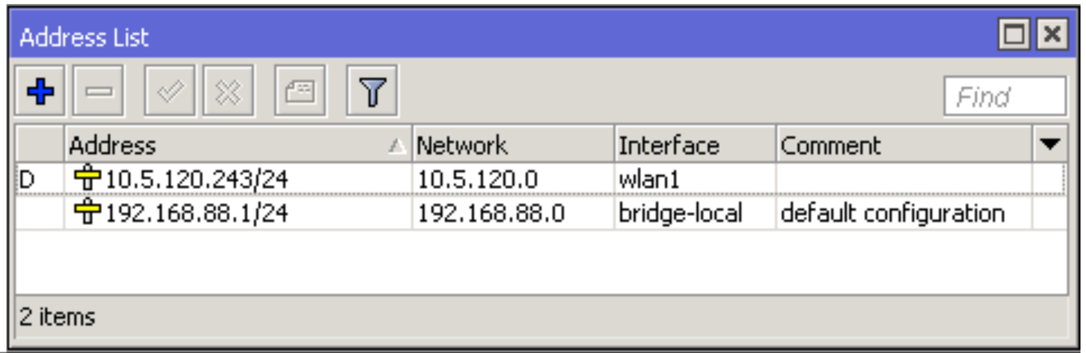
Default Gateway

- Add default gateway manually (trainer's router)
- Check that the connection to the Internet is available

MikroTik MTCNA

Dynamic Routes

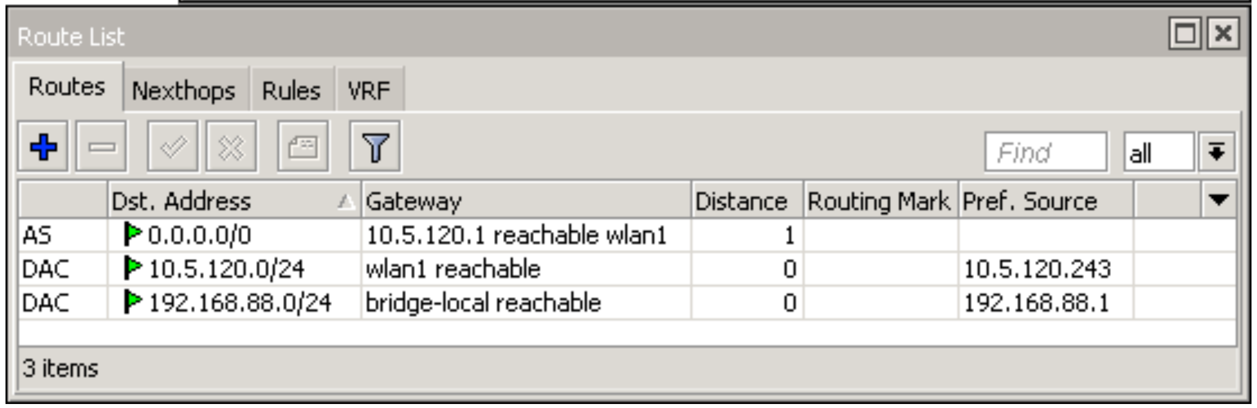
- Routes with flags **DAC** are added automatically
- **DAC** route originates from IP address configuration



	Address	Network	Interface	Comment
D	10.5.120.243/24	10.5.120.0	wlan1	
	192.168.88.1/24	192.168.88.0	bridge-local	default configuration

2 items

IP → Addresses



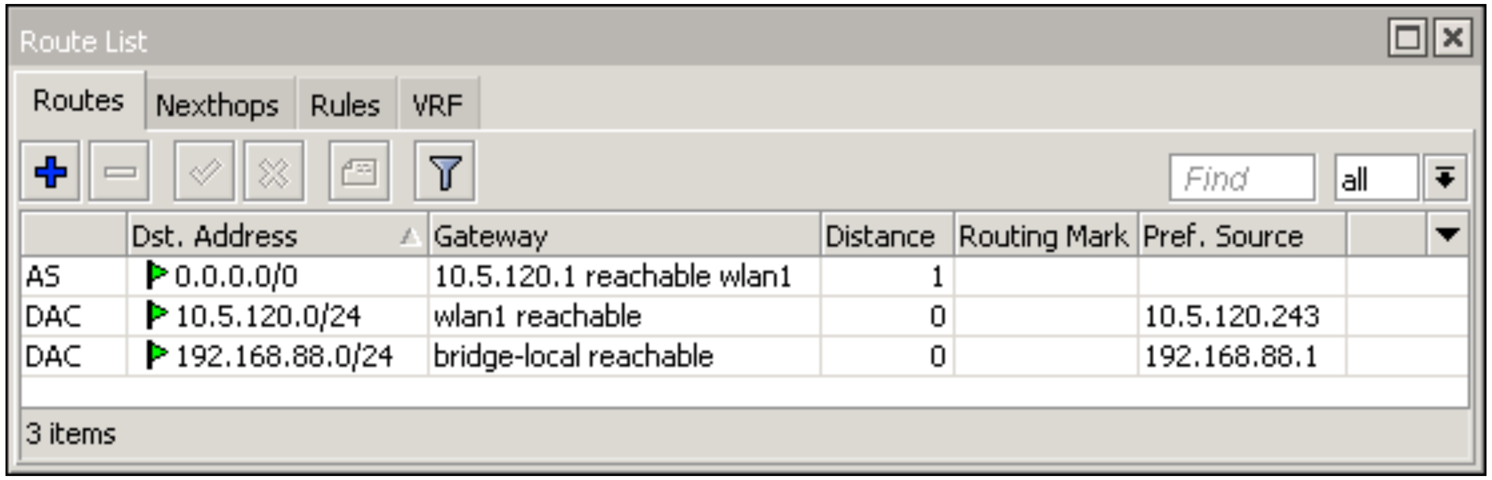
	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
AS	0.0.0.0/0	10.5.120.1 reachable wlan1	1		
DAC	10.5.120.0/24	wlan1 reachable	0		10.5.120.243
DAC	192.168.88.0/24	bridge-local reachable	0		192.168.88.1

3 items

IP → Routes

Route Flags

- A - active
- C - connected
- D - dynamic
- S - static



	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
AS	0.0.0.0/0	10.5.120.1 reachable wlan1	1		
DAC	10.5.120.0/24	wlan1 reachable	0		10.5.120.243
DAC	192.168.88.0/24	bridge-local reachable	0		192.168.88.1

3 items

IP → Routes

Static Routing

- Static route defines how to reach a specific destination network
- **Default gateway** is also a static route. It directs all traffic to the gateway

LAB

Static Routing

- The goal is to ping your neighbor’s laptop
- Static route will be used to achieve this
- Ask your neighbor the IP address of his/her wireless interface
- And the subnet address of his/her internal network (192.168.XY.0/24)

LAB

Static Routing

- Add a new route rule
- Set **Dst. Address** - your neighbor’s local network address (eg. 192.168.37.0/24)
- Set **Gateway** - the address of your neighbor’s wireless interface (eg. 192.168.250.37)
- Now you should be able to ping your neighbor’s laptop

Optional LAB

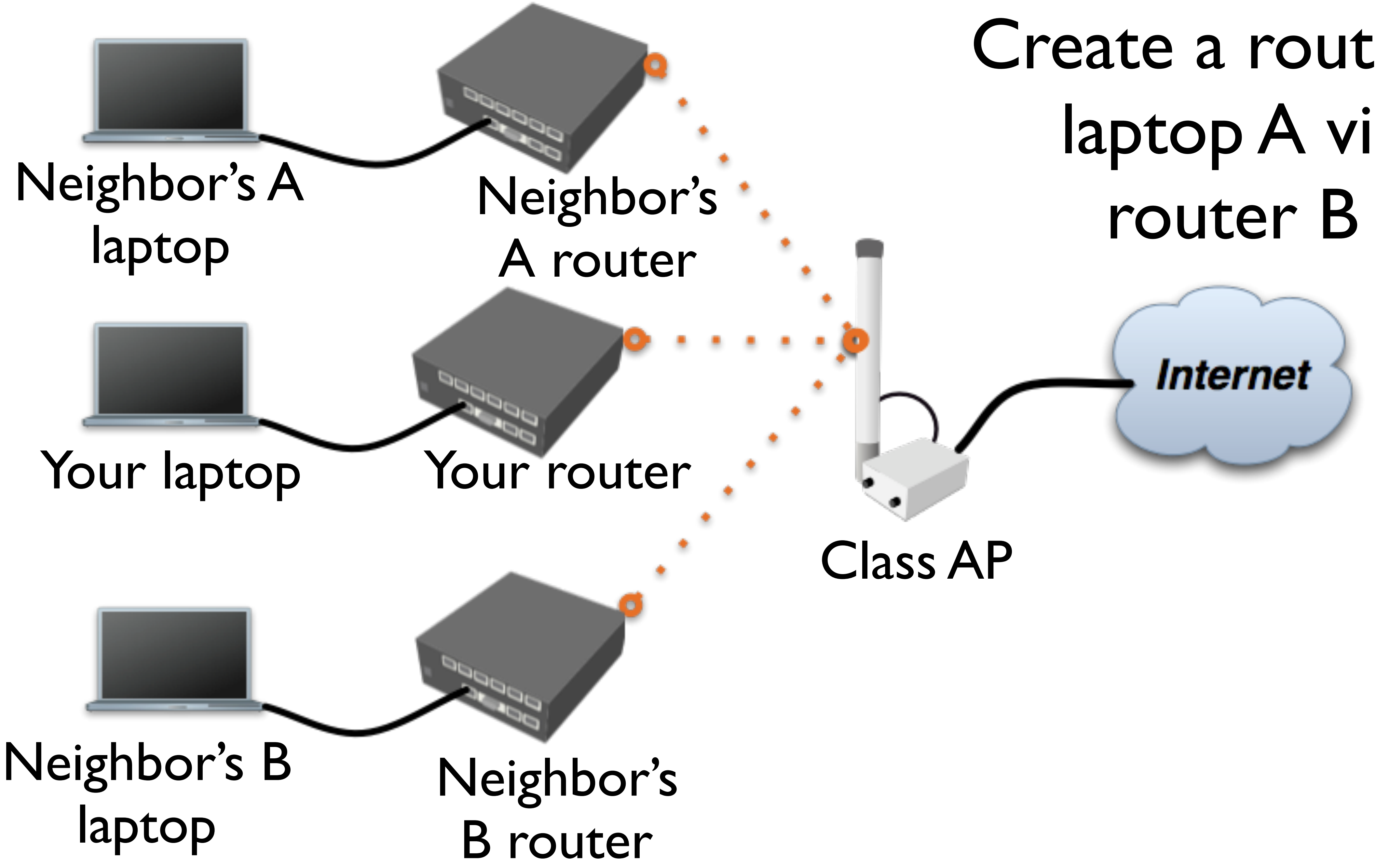
Static Routing

- Team up with 2 of your neighbors
- Create a static route to one of your neighbor's (A) laptop via the other neighbor's router (B)
- Ask your neighbor B to make a static route to neighbor's A laptop
- Ping your neighbor's A laptop

Optional LAB

Static Routing

Create a route to laptop A via router B



MikroTik MTCNA

Static Routing

- Easy to configure on a small network
- Limits the use of router’s resources
- Does not scale well
- Manual configuration is required every time a new subnet needs to be reached

Module 4
Summary

Certified Network Associate (MTCNA)

Module 5

Wireless

Wireless

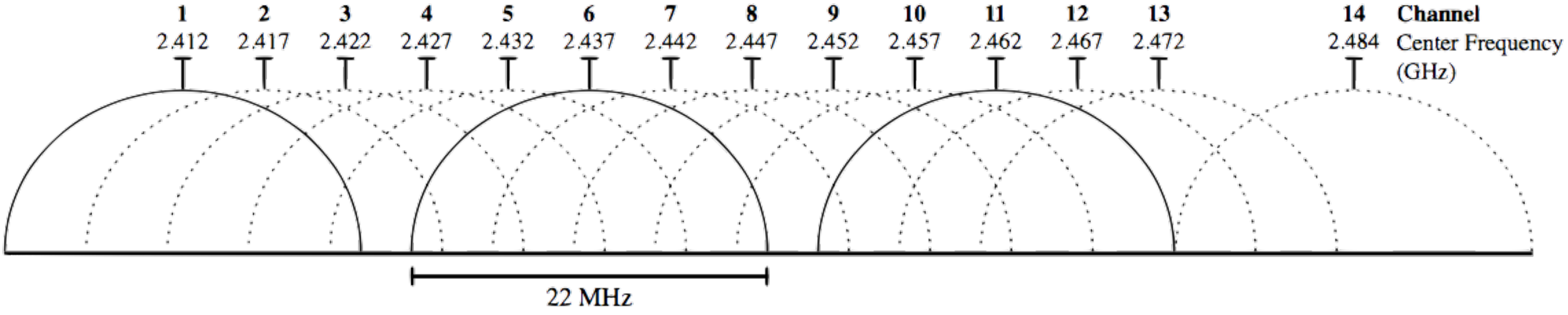
- MikroTik RouterOS provides a complete support for IEEE 802.11a/n/ac (5GHz) and 802.11b/g/n (2.4GHz) wireless networking standards

Wireless Standards

IEEE Standard	Frequency	Speed
802.11a	5GHz	54Mbps
802.11b	2.4GHz	11Mbps
802.11g	2.4GHz	54Mbps
802.11n	2.4 and 5GHz	Up to 450 Mbps*
802.11ac	5GHz	Up to 1300 Mbps*

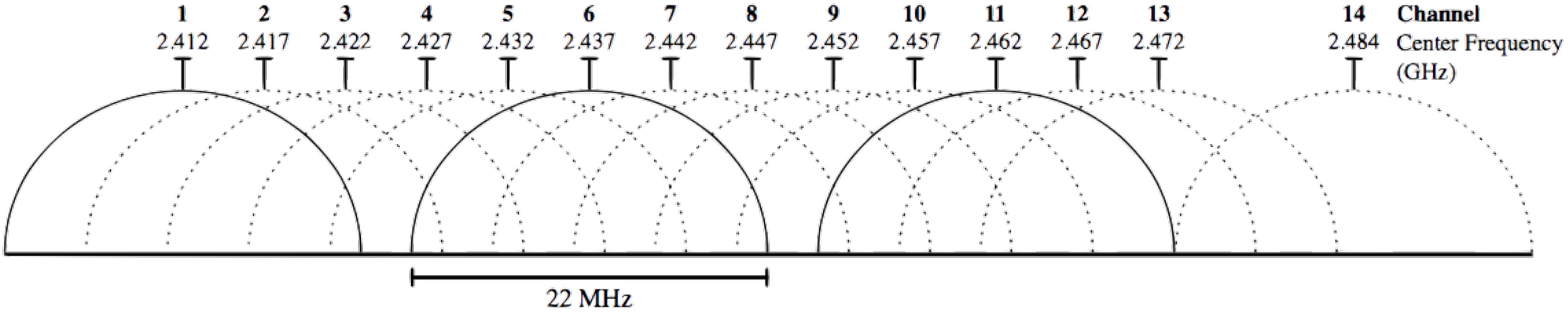
* Depending on RouterBOARD model

2.4GHz Channels



- 13x 22MHz channels (most of the world)
- 3 non-overlapping channels (1, 6, 11)
- 3 APs can occupy the same area without interfering

2.4GHz Channels



- US: 11 channels, 14th Japan-only
- Channel width = 20MHz, 2MHz left as a guard band (802.11b)
- 802.11g 20MHz, 802.11n 20/40MHz width

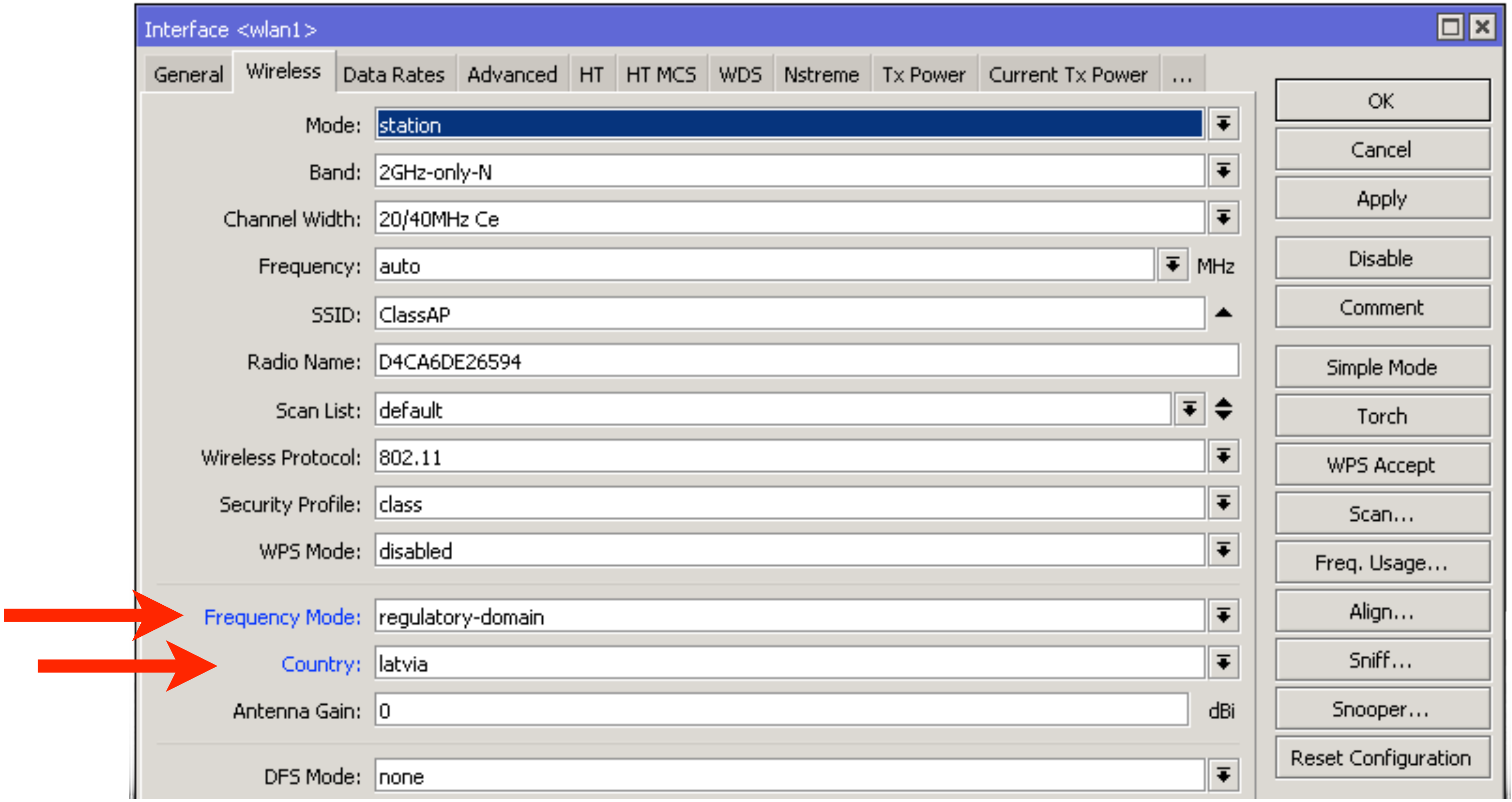
5GHz Channels

- RouterOS supports full range of 5GHz frequencies
- 5180-5320MHz (channels 36-64)
- 5500-5720MHz (channels 100-144)
- 5745-5825MHz (channels 149-165)
- Varies depending on country regulations

5GHz Channels

IEEE Standard	Channel Width
802.11a	20MHz
802.11n	20MHz
	40MHz
802.11ac	20MHz
	40MHz
	80MHz
	160MHz

Country Regulations



Mode:	station
Band:	2GHz-only-N
Channel Width:	20/40MHz Ce
Frequency:	auto MHz
SSID:	ClassAP
Radio Name:	D4CA6DE26594
Scan List:	default
Wireless Protocol:	802.11
Security Profile:	class
WPS Mode:	disabled
Frequency Mode:	regulatory-domain
Country:	latvia
Antenna Gain:	0 dBi
DFS Mode:	none

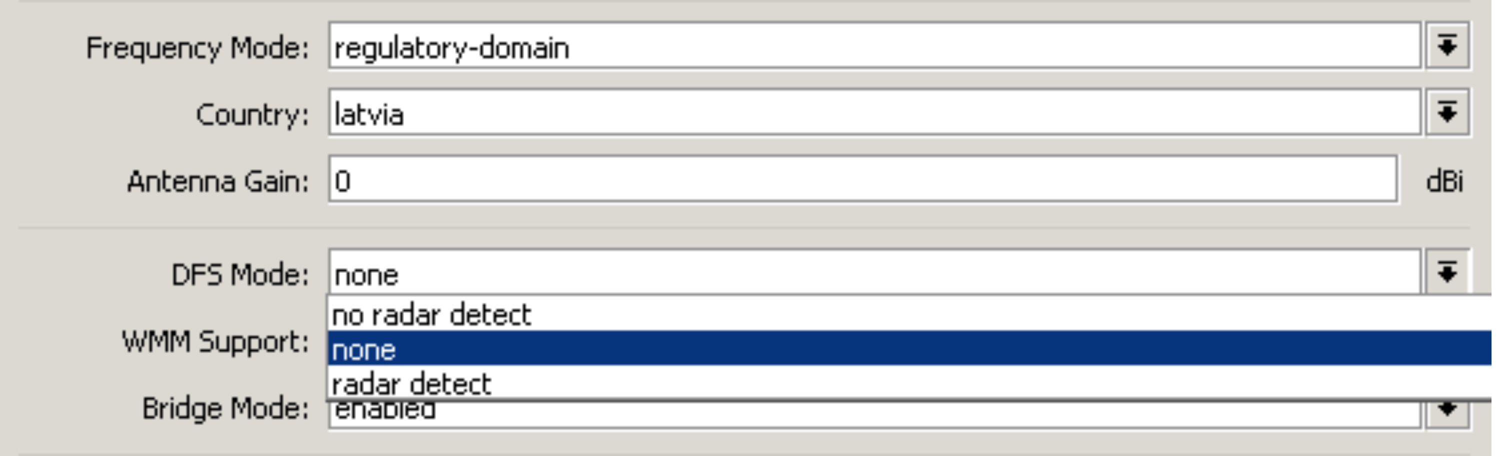
- Switch to 'Advanced Mode' and select your country to apply regulations

Country Regulations

- Dynamic Frequency Selection (DFS) is a feature which is meant to identify radars when using 5GHz band and choose a different channel if a radar is found
- Some channels can only be used when DFS is enabled (in EU: 52-140, US: 50-144)

Country Regulations

- DFS Mode **radar detect** will select a channel with the lowest number of detected networks and use it if no radar is detected on it for 60s
- Switch to ‘Advanced Mode’ to enable DFS



Frequency Mode: regulatory-domain

Country: latvia

Antenna Gain: 0 dBi

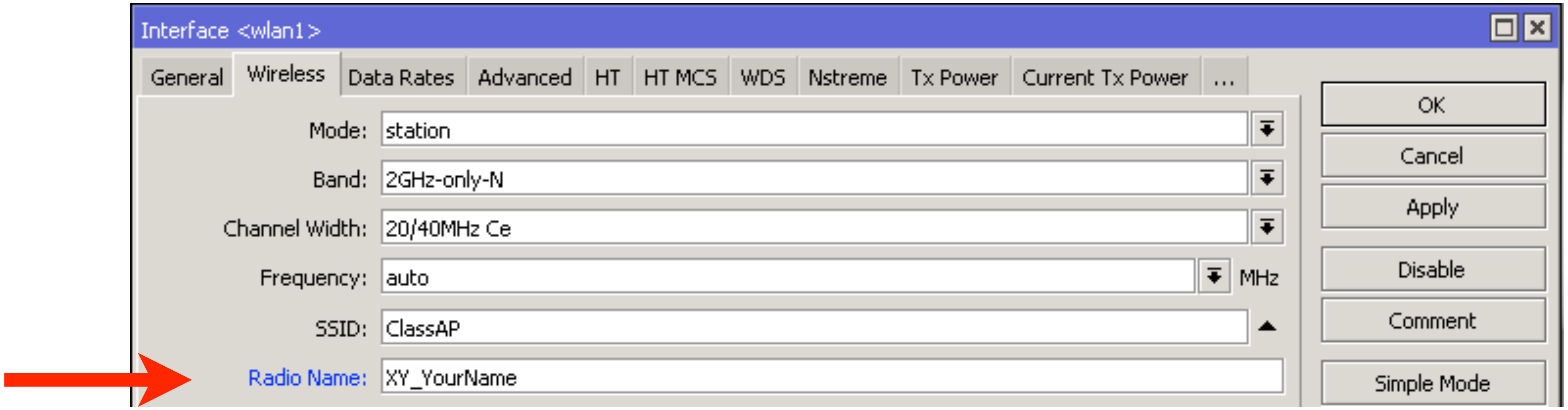
DFS Mode: none

WMM Support:

Bridge Mode: enabled

Radio Name

- Wireless interface “name”
- RouterOS-RouterOS only
- Can be seen in Wireless tables



Interface <wlan1>

Mode: station

Band: 2GHz-only-N

Channel Width: 20/40MHz Ce

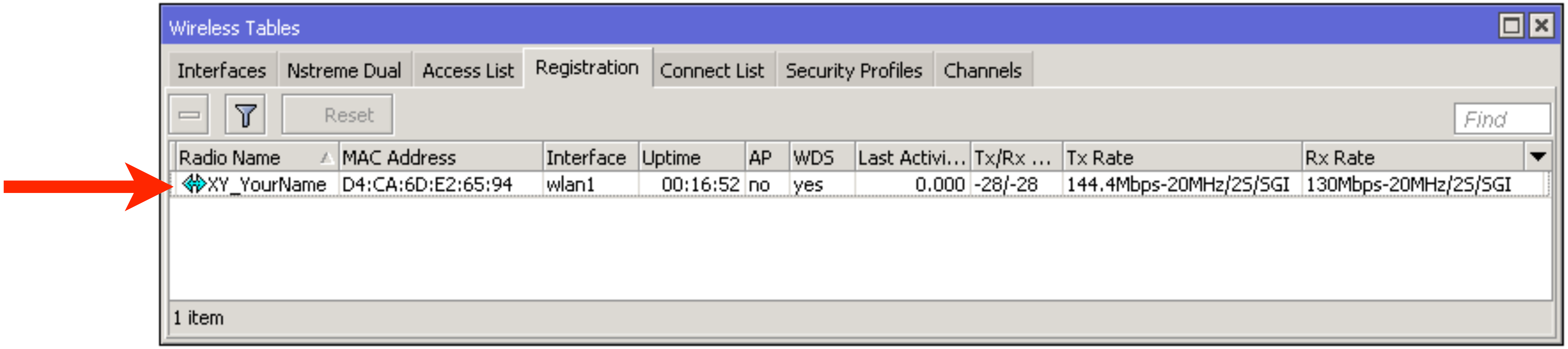
Frequency: auto MHz

SSID: ClassAP

Radio Name: XY_YourName

Radio Name

- Wireless interface “name”
- RouterOS-RouterOS only
- Can be seen in Wireless tables



Radio Name	MAC Address	Interface	Uptime	AP	WDS	Last Activi...	Tx/Rx ...	Tx Rate	Rx Rate
XY_YourName	D4:CA:6D:E2:65:94	wlan1	00:16:52	no	yes	0.000	-28/-28	144.4Mbps-20MHz/2S/SGI	130Mbps-20MHz/2S/SGI

1 item

Wireless → Registration

LAB

Radio Name

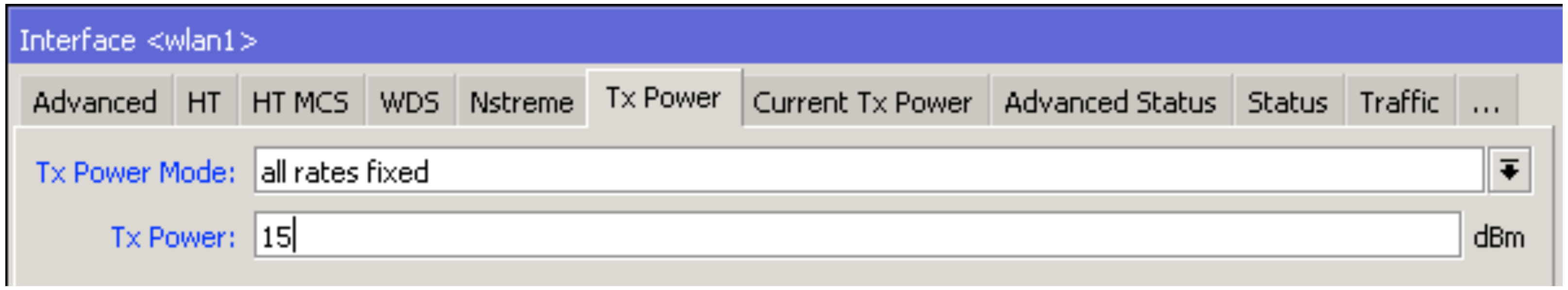
- Set the radio name of your wireless interface as follows: **YourNumber(XY)_YourName**
- For example: **13_JohnDoe**

Wireless Chains

- 802.11n introduced the concept of MIMO (Multiple In and Multiple Out)
- Send and receive data using multiple radios in parallel
- Without MIMO 802.11n can only achieve 72.2Mbps

Tx Power

- Use to adjust transmit power of the wireless card
- Change to **all rates fixed** and adjust the power



Tx Power Mode: all rates fixed

Tx Power: 15 dBm

Wireless → Tx Power

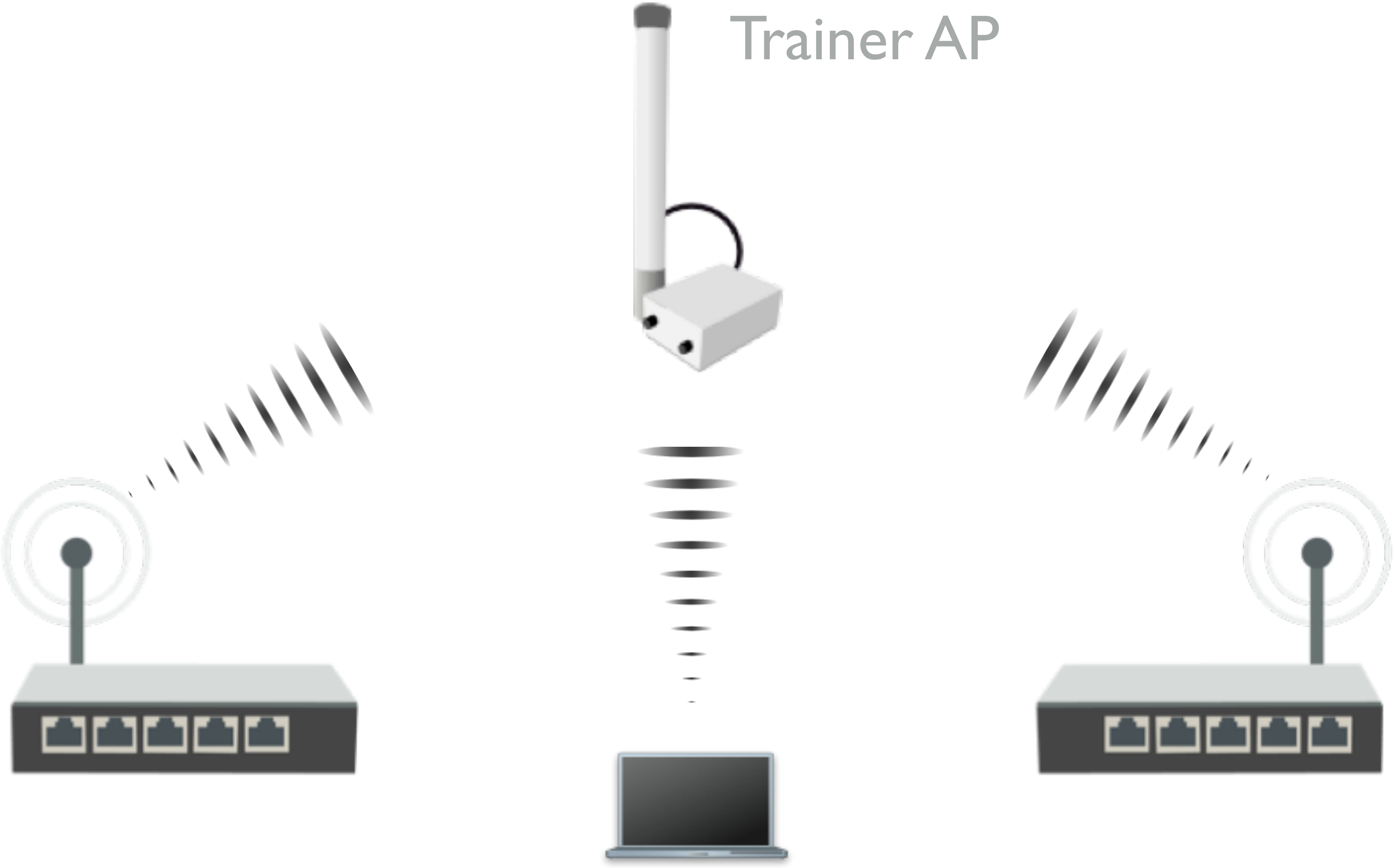
Tx Power

Wireless card	Enabled Chains	Power per Chain	Total Power
802.11n	1	Equal to the selected Tx Power	Equal to the selected Tx Power
	2		+3dBm
	3		+5dBm
802.11ac	1	Equal to the selected Tx Power	Equal to the selected Tx Power
	2	-3dBm	
	3	-5dBm	

Rx Sensitivity

- Receiver sensitivity is the lowest power level at which the interface can detect a signal
- When comparing RouterBOARDS this value should be taken into account depending on planned usage
- Smaller Rx sensitivity threshold means better signal detection

Wireless Network



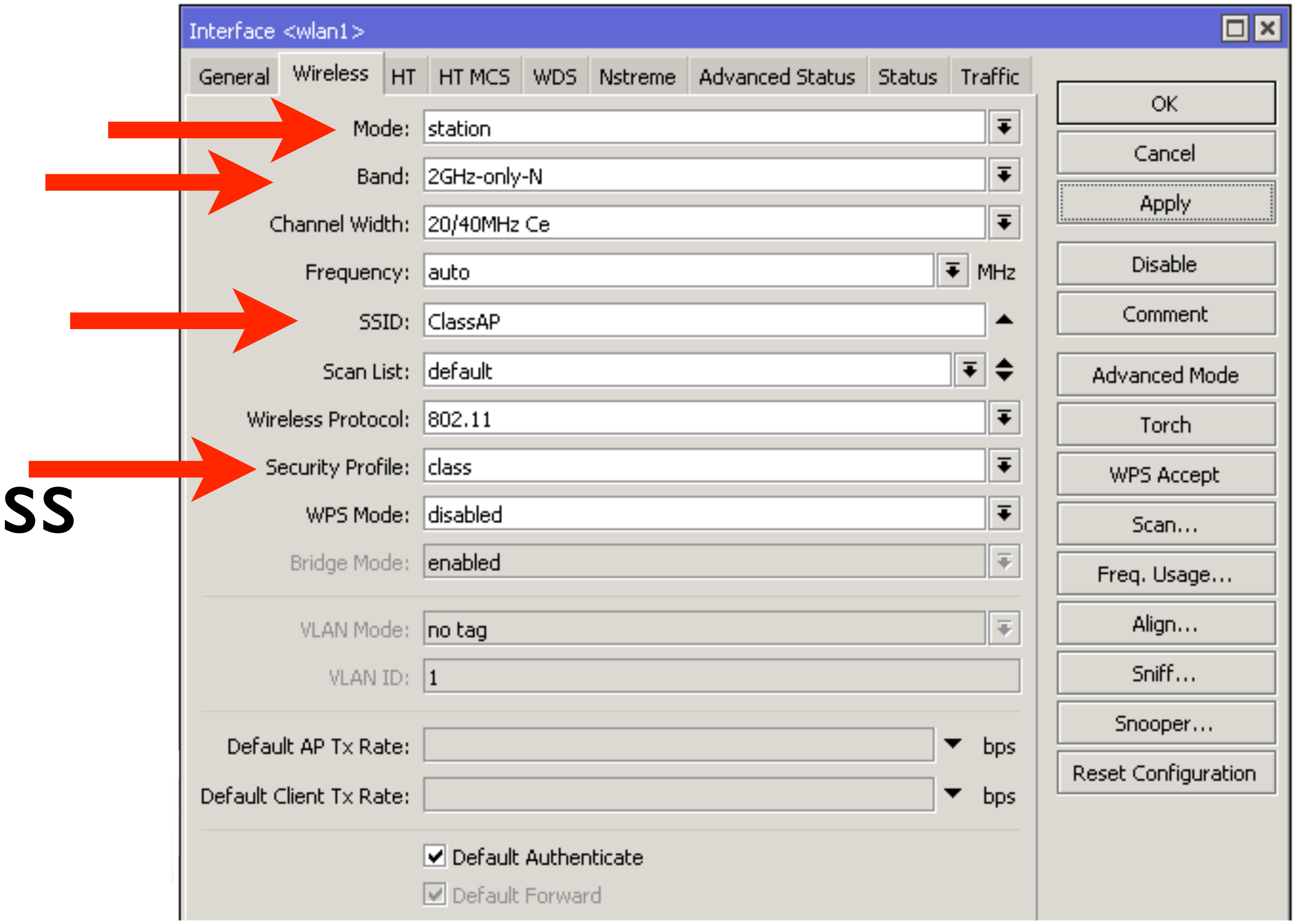
Wireless stations

Wireless Station

- Wireless station is client (laptop, phone, router)
- On RouterOS wireless mode **station**

Wireless Station

- Set interface **mode=station**
- Select **band**
- Set **SSID** (wireless network ID)
- Frequency is not important for client, use **scan-list**


Interface <wlan1>

Mode: station
Band: 2GHz-only-N
Channel Width: 20/40MHz Ce
Frequency: auto MHz
SSID: ClassAP
Scan List: default
Wireless Protocol: 802.11
Security Profile: class
WPS Mode: disabled
Bridge Mode: enabled
VLAN Mode: no tag
VLAN ID: 1
Default AP Tx Rate: bps
Default Client Tx Rate: bps
☑ Default Authenticate
☑ Default Forward

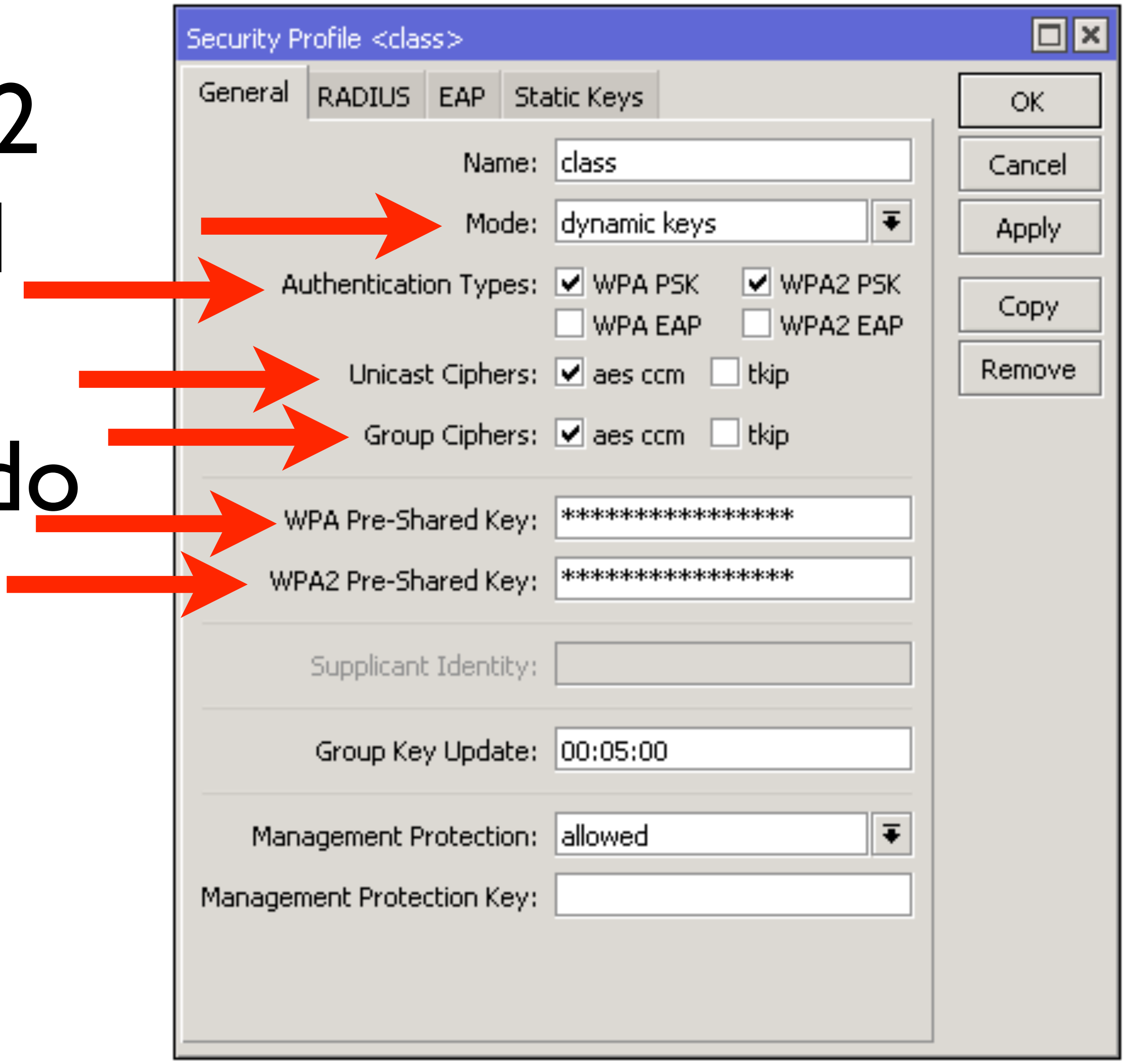
Security

- Only WPA (WiFi Protected Access) or WPA2 should be used
- WPA-PSK or WPA2-PSK with AES-CCM encryption
- Trainer AP already is using WPA-PSK/ WPA2-PSK

Security

- Both WPA and WPA2 keys can be specified to allow connection from devices which do not support WPA2

- Choose strong key!



Name: class

Mode: dynamic keys

Authentication Types: ☑ WPA PSK ☑ WPA2 PSK ☐ WPA EAP ☐ WPA2 EAP

Unicast Ciphers: ☑ aes ccm ☐ tkip

Group Ciphers: ☑ aes ccm ☐ tkip

WPA Pre-Shared Key: ****************

WPA2 Pre-Shared Key: ****************

Supplicant Identity:

Group Key Update: 00:05:00

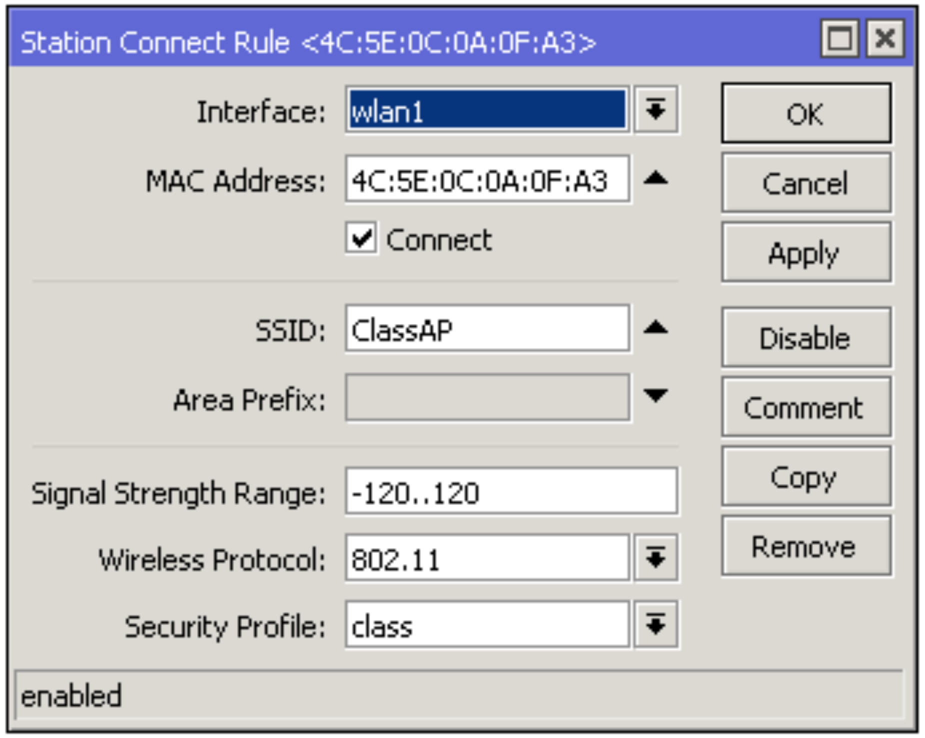
Management Protection: allowed

Management Protection Key:

Wireless → Security Profiles

Connect List

- Rules used by **station** to select (or not to select) an AP



Station Connect Rule <4C:5E:0C:0A:0F:A3>

Interface: wlan1

MAC Address: 4C:5E:0C:0A:0F:A3

☑ Connect

SSID: ClassAP

Area Prefix:

Signal Strength Range: -120..120

Wireless Protocol: 802.11

Security Profile: class

enabled

Wireless → Connect List

LAB

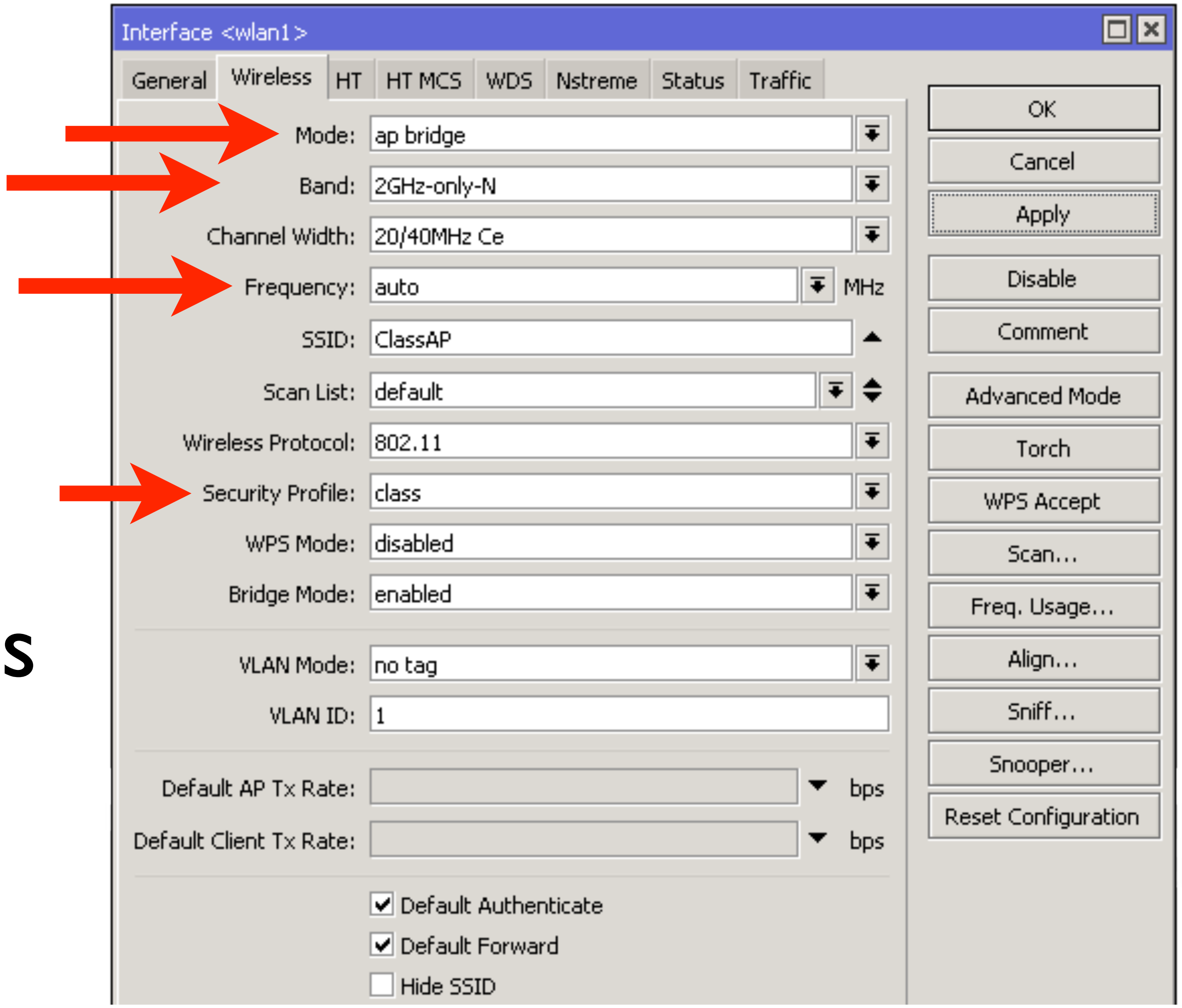
Connect List

- Currently your router is connected to the class AP
- Create a rule to disallow connection to the class AP

MikroTik MTCNA

Access Point

- Set interface **mode=ap bridge**
- Select **band**
- Set **frequency**
- Set **SSID** (wireless network ID)
- Set **Security Profile**



Mode: ap bridge
Band: 2GHz-only-N
Channel Width: 20/40MHz Ce
Frequency: auto MHz
SSID: ClassAP
Scan List: default
Wireless Protocol: 802.11
Security Profile: class
WPS Mode: disabled
Bridge Mode: enabled
VLAN Mode: no tag
VLAN ID: 1
Default AP Tx Rate: bps
Default Client Tx Rate: bps

☑ Default Authenticate
☑ Default Forward
□ Hide SSID

WPS

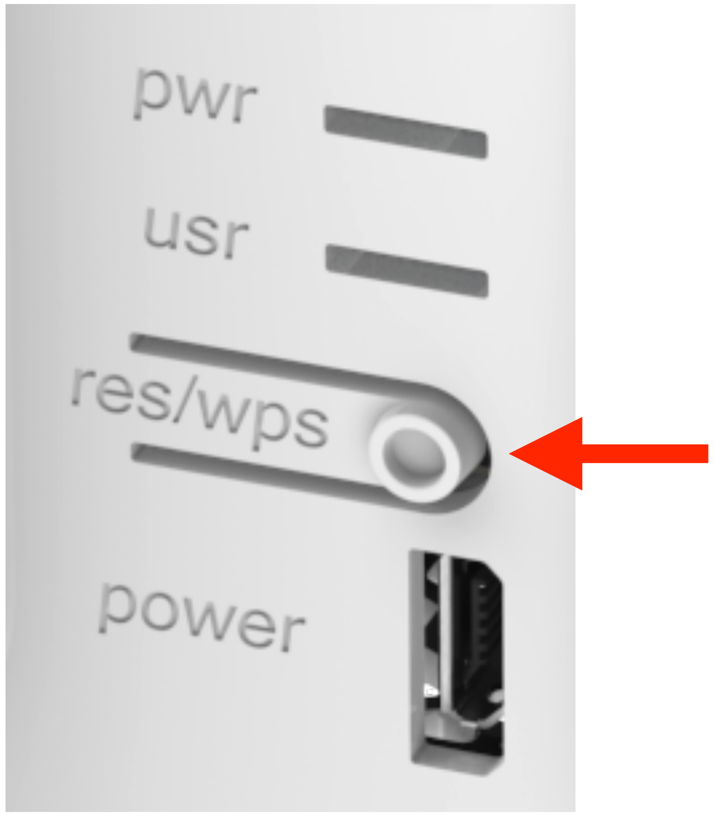
- WiFi Protected Setup (WPS) is a feature for convenient access to the WiFi without the need of entering the passphrase
- RouterOS supports both WPS accept (for AP) and WPS client (for station) modes

WPS Accept

- To easily allow guest access to your access point WPS accept button can be used
- When pushed, it will grant an access to connect to the AP for 2min or until a device (station) connects
- The WPS accept button has to be pushed each time when a new device needs to be connected

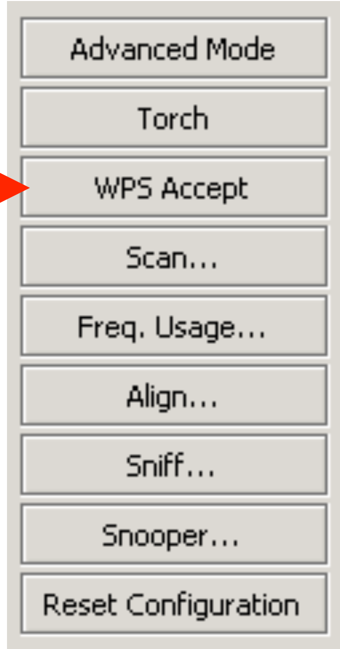
WPS Accept

- For each device it has to be done only once
- All RouterOS devices with WiFi interface have virtual WPS push button
- Some have physical, check for **wps** button on the router



WPS Accept

- Virtual WPS button is available in QuickSet and in wireless interface menu
- It can be disabled if needed
- WPS client is supported by most operating systems
- RouterOS does not support the insecure PIN mode



LAB

Access Point

- Create a new security profile for your access point
- Set wireless interface mode to **ap bridge**, set **SSID** to your class number and name, select the security profile
- Disable DHCP client on the wireless interface (will lose Internet connection)

Access Point

LAB

- Add wireless interface to the bridge
- Disconnect the cable from the laptop
- Connect to your wireless AP with your laptop
- Connect to the router using WinBox and observe wireless registration table
- When done, restore previous configuration

Optional LAB

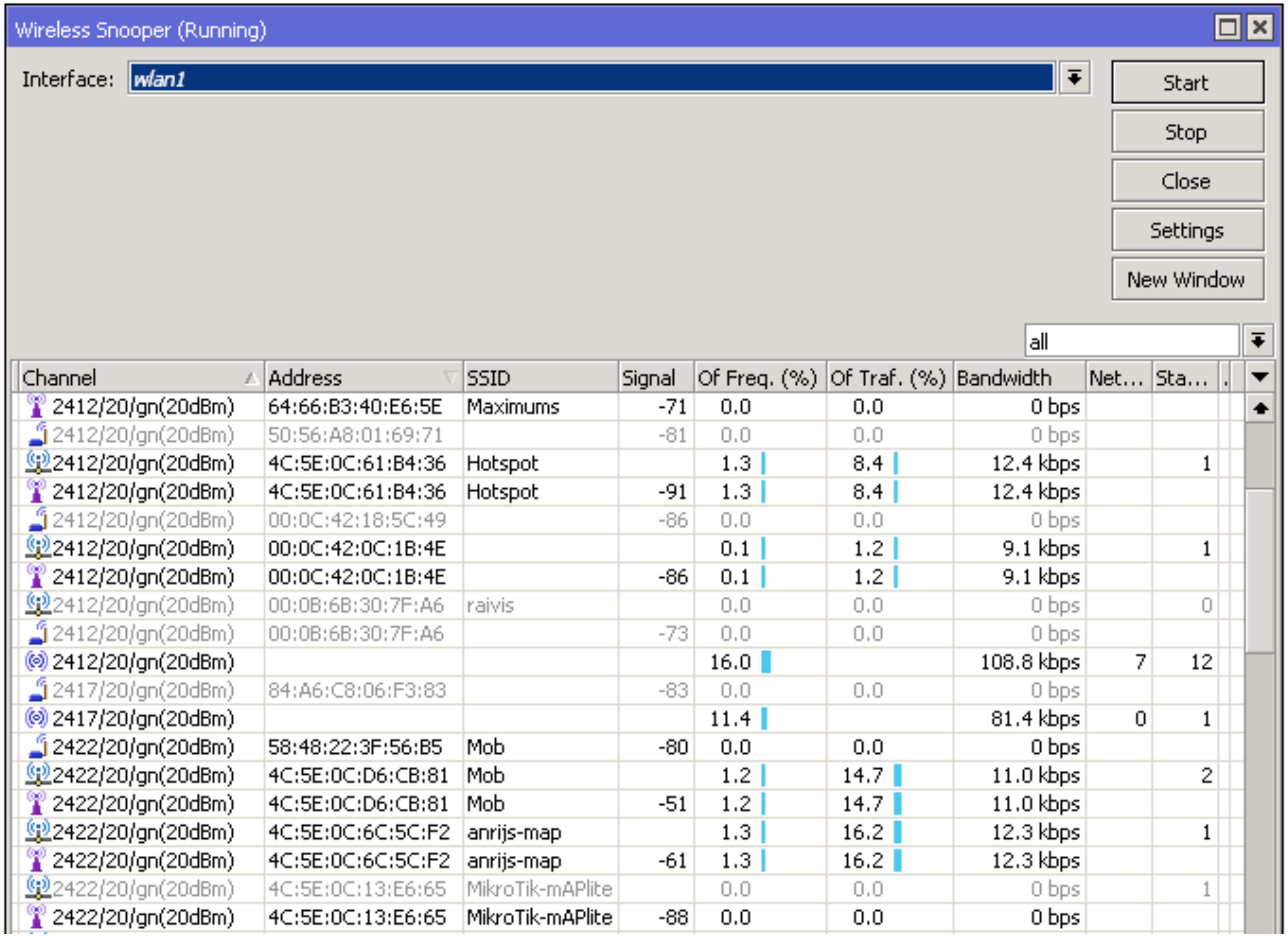
WPS

- If you have a device that supports WPS client mode connect it to your AP using WPS accept button on your router (either physical or virtual)
- Check router logs during the process
- When done, restore previous configuration

Snooper

- Get full overview of the wireless networks on selected band
- **Wireless interface is disconnected** during scanning!
- Use to decide which channel to choose

Snooper



Wireless Snooper (Running)

Interface: wlan1

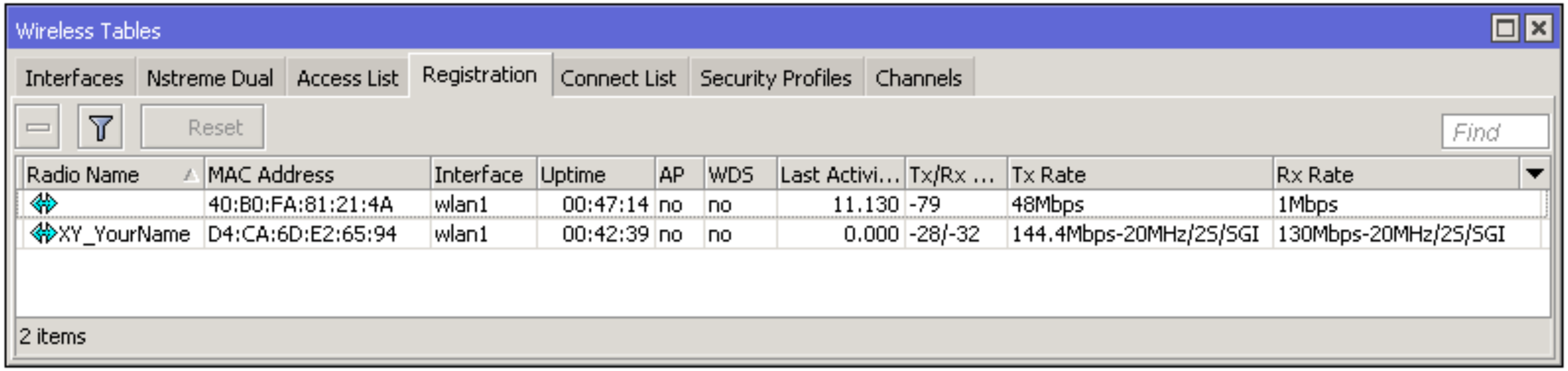
all

Channel	Address	SSID	Signal	Of Freq. (%)	Of Traf. (%)	Bandwidth	Net...	Sta...
2412/20/gn(20dBm)	64:66:B3:40:E6:5E	Maximums	-71	0.0	0.0	0 bps		
2412/20/gn(20dBm)	50:56:A8:01:69:71		-81	0.0	0.0	0 bps		
2412/20/gn(20dBm)	4C:5E:0C:61:B4:36	Hotspot		1.3	8.4	12.4 kbps		1
2412/20/gn(20dBm)	4C:5E:0C:61:B4:36	Hotspot	-91	1.3	8.4	12.4 kbps		
2412/20/gn(20dBm)	00:0C:42:18:5C:49		-86	0.0	0.0	0 bps		
2412/20/gn(20dBm)	00:0C:42:0C:1B:4E			0.1	1.2	9.1 kbps		1
2412/20/gn(20dBm)	00:0C:42:0C:1B:4E		-86	0.1	1.2	9.1 kbps		
2412/20/gn(20dBm)	00:0B:6B:30:7F:A6	raivis		0.0	0.0	0 bps		0
2412/20/gn(20dBm)	00:0B:6B:30:7F:A6		-73	0.0	0.0	0 bps		
2412/20/gn(20dBm)				16.0		108.8 kbps	7	12
2417/20/gn(20dBm)	84:A6:C8:06:F3:83		-83	0.0	0.0	0 bps		
2417/20/gn(20dBm)				11.4		81.4 kbps	0	1
2422/20/gn(20dBm)	58:48:22:3F:56:B5	Mob	-80	0.0	0.0	0 bps		
2422/20/gn(20dBm)	4C:5E:0C:D6:CB:81	Mob		1.2	14.7	11.0 kbps		2
2422/20/gn(20dBm)	4C:5E:0C:D6:CB:81	Mob	-51	1.2	14.7	11.0 kbps		
2422/20/gn(20dBm)	4C:5E:0C:6C:5C:F2	anrijs-map		1.3	16.2	12.3 kbps		1
2422/20/gn(20dBm)	4C:5E:0C:6C:5C:F2	anrijs-map	-61	1.3	16.2	12.3 kbps		
2422/20/gn(20dBm)	4C:5E:0C:13:E6:65	MikroTik-mAPlite		0.0	0.0	0 bps		1
2422/20/gn(20dBm)	4C:5E:0C:13:E6:65	MikroTik-mAPlite	-88	0.0	0.0	0 bps		

Wireless → Snooper

Registration Table

- View all connected wireless interfaces
- Or connected access point if the router is a station



Radio Name	MAC Address	Interface	Uptime	AP	WDS	Last Activi...	Tx/Rx ...	Tx Rate	Rx Rate
	40:B0:FA:81:21:4A	wlan1	00:47:14	no	no	11.130	-79	48Mbps	1Mbps
XY_YourName	D4:CA:6D:E2:65:94	wlan1	00:42:39	no	no	0.000	-28/-32	144.4Mbps-20MHz/2S/SGI	130Mbps-20MHz/2S/SGI

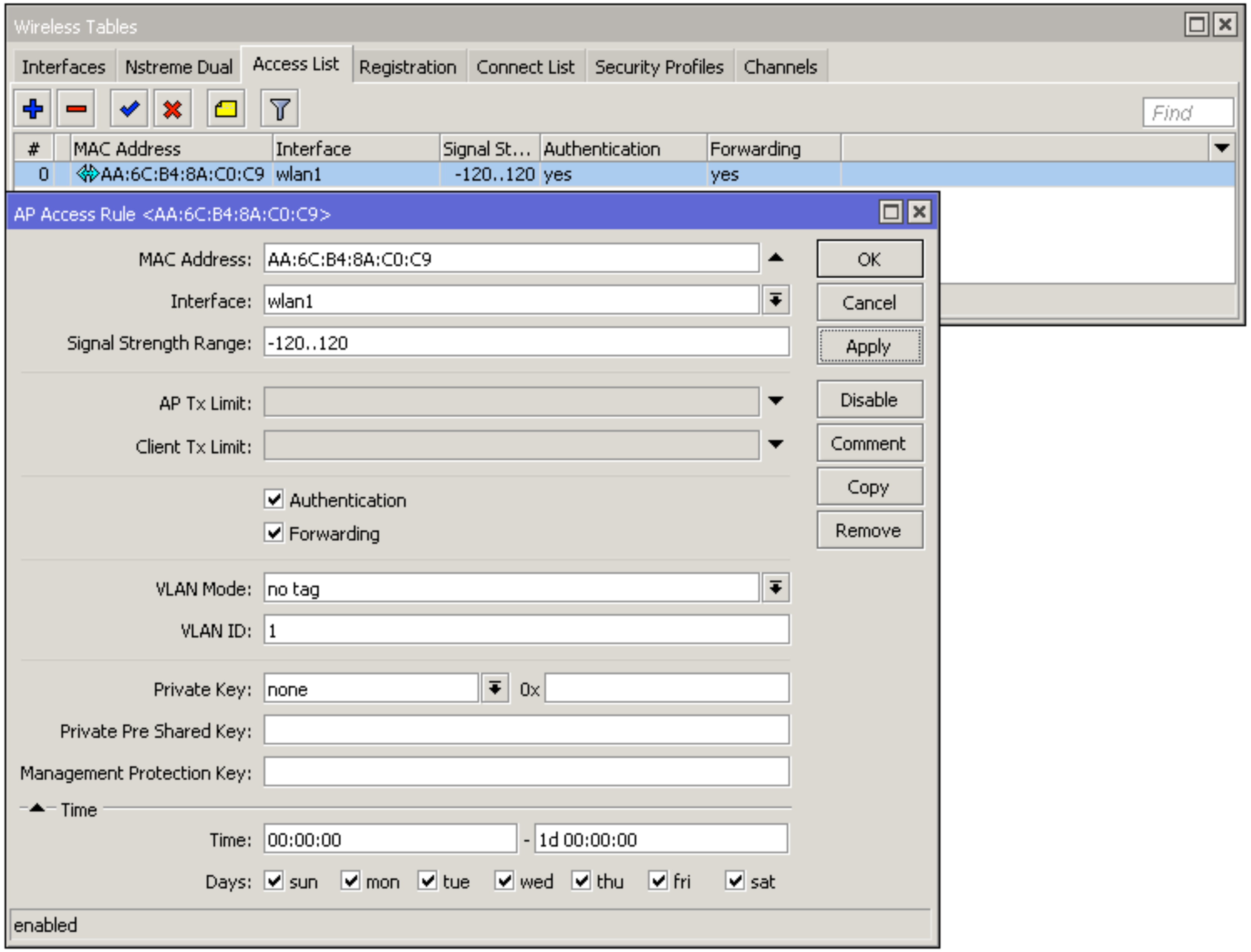
2 items

Wireless → Registration

Access List

- Used by **access point** to control allowed connections from stations
- Identify device MAC address
- Configure whether the station can authenticate to the AP
- Limit time of the day when it can connect

Access List



#	MAC Address	Interface	Signal St...	Authentication	Forwarding
0	AA:6C:B4:8A:C0:C9	wlan1	-120..120	yes	yes

AP Access Rule <AA:6C:B4:8A:C0:C9>

MAC Address: AA:6C:B4:8A:C0:C9
Interface: wlan1
Signal Strength Range: -120..120

AP Tx Limit:
Client Tx Limit:

☑ Authentication
☑ Forwarding

VLAN Mode: no tag
VLAN ID: 1

Private Key: none 0x
Private Pre Shared Key:
Management Protection Key:

Time

Time: 00:00:00 - 1d 00:00:00
Days: ☑ sun ☑ mon ☑ tue ☑ wed ☑ thu ☑ fri ☑ sat

enabled

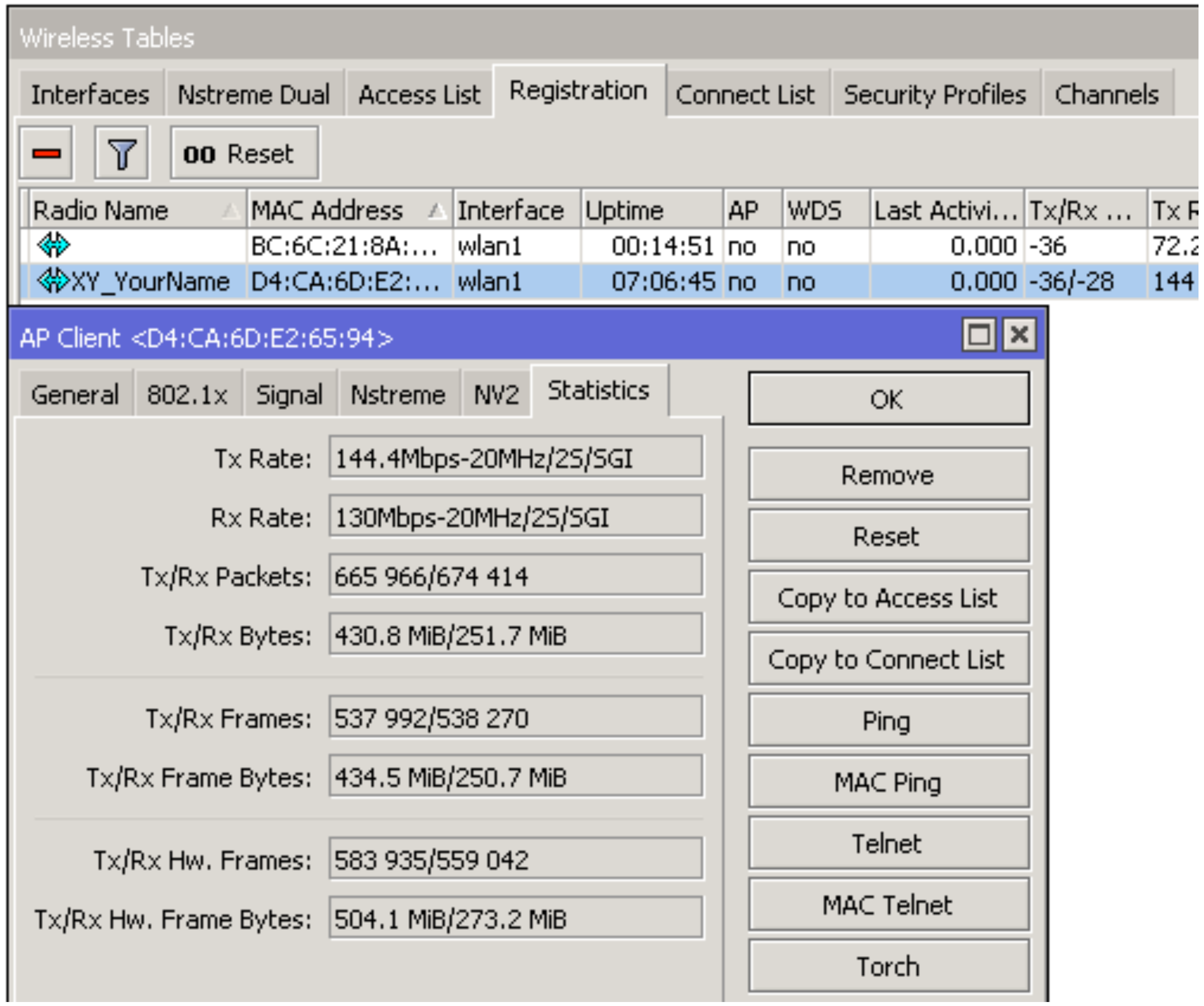
Wireless → Access List

Access List

- If there are no matching rules in the access list, default values from the wireless interface will be used

Registration Table

- Can be used to create connect or access list entries from currently connected devices



Radio Name	MAC Address	Interface	Uptime	AP	WDS	Last Activi...	Tx/Rx ...	Tx R
	BC:6C:21:8A:...	wlan1	00:14:51	no	no	0.000	-36	72.2
XY_YourName	D4:CA:6D:E2:...	wlan1	07:06:45	no	no	0.000	-36/-28	144

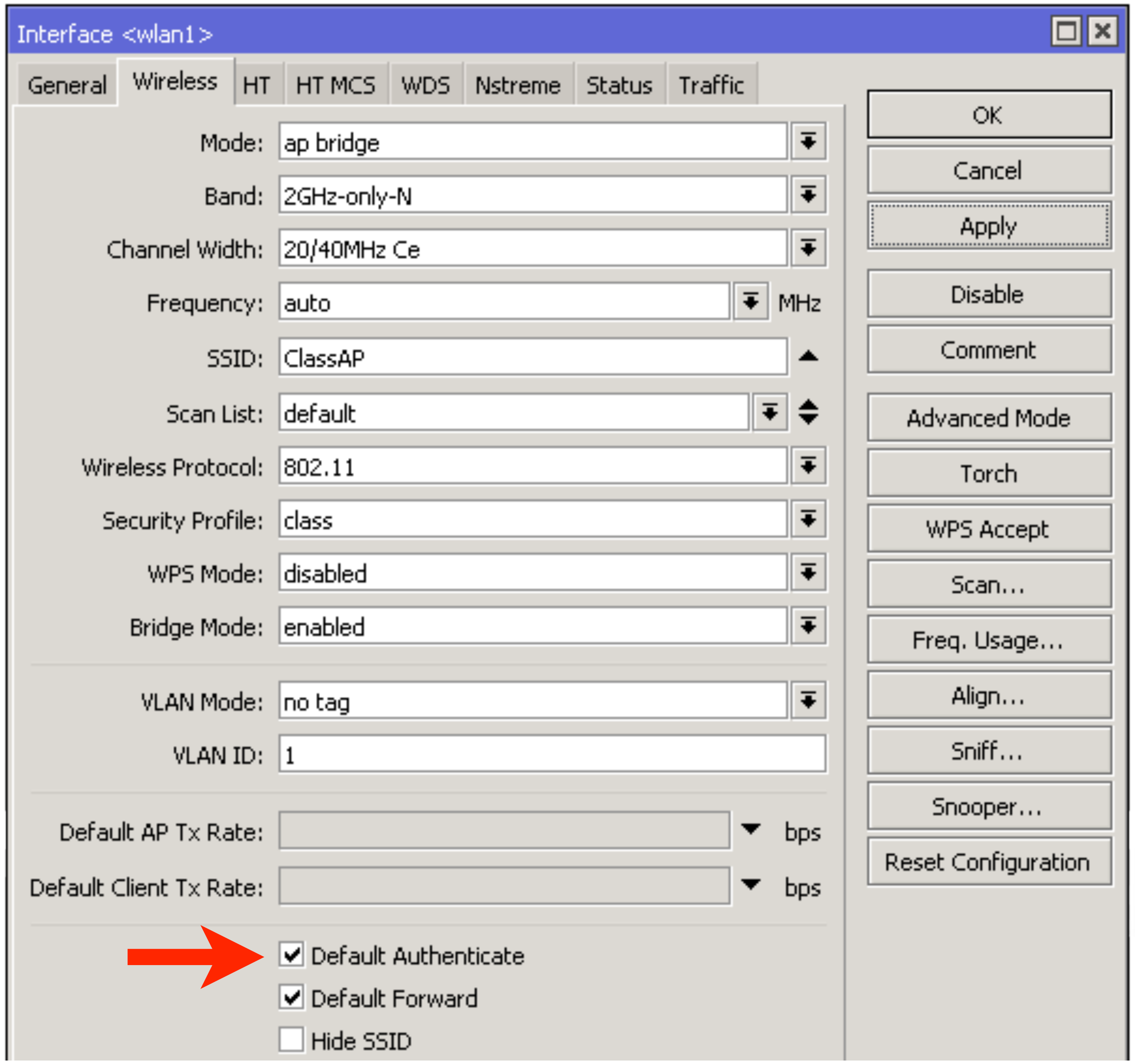
Tx Rate: 144.4Mbps-20MHz/2S/SGI
Rx Rate: 130Mbps-20MHz/2S/SGI
Tx/Rx Packets: 665 966/674 414
Tx/Rx Bytes: 430.8 MiB/251.7 MiB

Tx/Rx Frames: 537 992/538 270
Tx/Rx Frame Bytes: 434.5 MiB/250.7 MiB

Tx/Rx Hw. Frames: 583 935/559 042
Tx/Rx Hw. Frame Bytes: 504.1 MiB/273.2 MiB

Wireless → Registration

Default Authenticate



Mode: ap bridge

Band: 2GHz-only-N

Channel Width: 20/40MHz Ce

Frequency: auto MHz

SSID: ClassAP

Scan List: default

Wireless Protocol: 802.11

Security Profile: class

WPS Mode: disabled

Bridge Mode: enabled

VLAN Mode: no tag

VLAN ID: 1

Default AP Tx Rate: bps

Default Client Tx Rate: bps

☑ Default Authenticate

☑ Default Forward

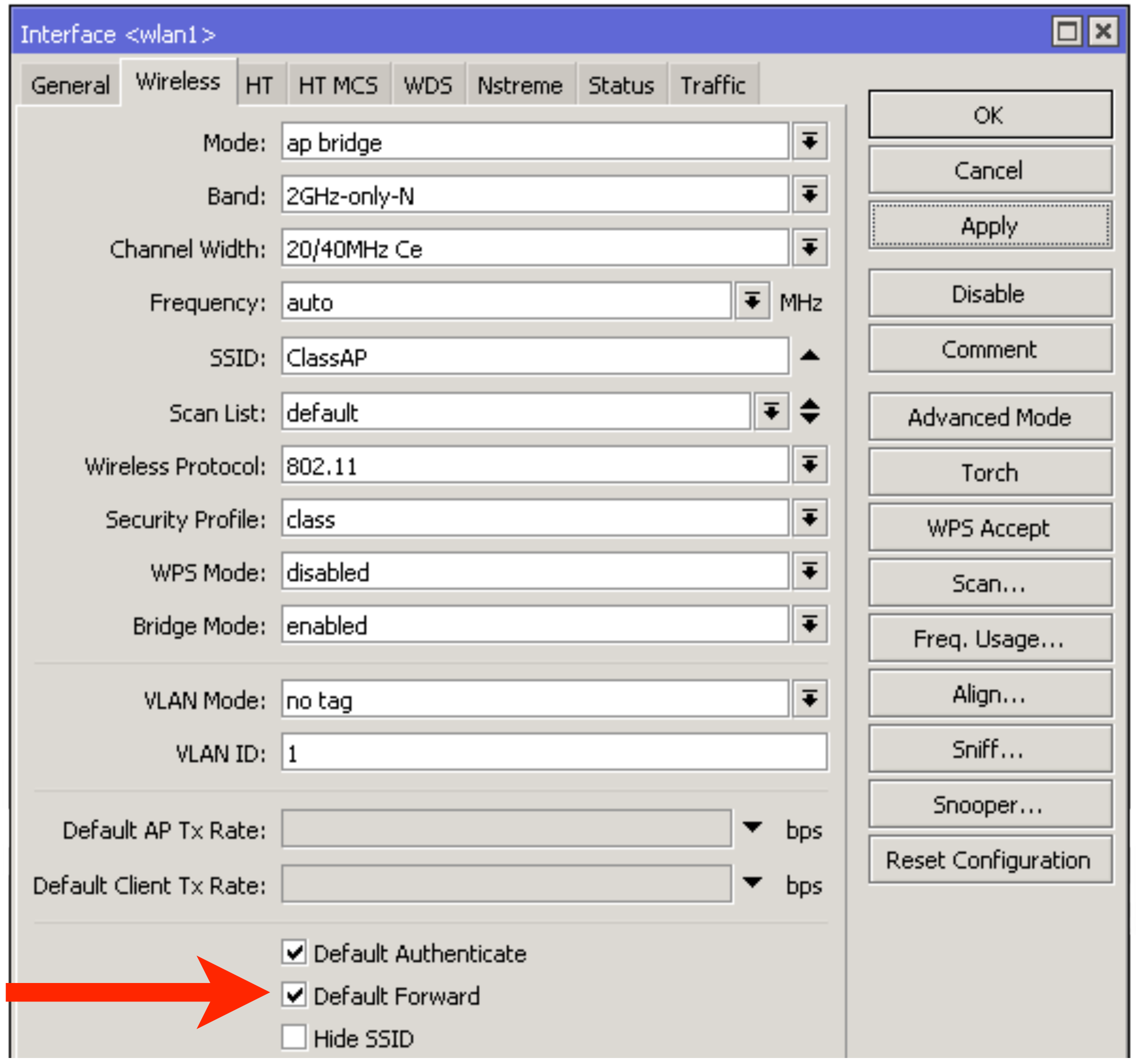
☐ Hide SSID

Default Authenticate

Default Authentication	Access/Connect List Entry	Behavior
✓	+	Based on access/connect list settings
	-	Authenticate
×	+	Based on access/connect list settings
	-	Don’t authenticate

Default Forward

- Use to allow or forbid communication between stations
- Enabled by default
- Forwarding can be overridden for specific clients in the access list



Interface <wlan1>

Mode: ap bridge
Band: 2GHz-only-N
Channel Width: 20/40MHz Ce
Frequency: auto MHz
SSID: ClassAP
Scan List: default
Wireless Protocol: 802.11
Security Profile: class
WPS Mode: disabled
Bridge Mode: enabled
VLAN Mode: no tag
VLAN ID: 1
Default AP Tx Rate: bps
Default Client Tx Rate: bps

☑ Default Authenticate
☑ Default Forward
□ Hide SSID

Module 5
Summary

Certified Network Associate (MTCNA)

Module 6

Firewall

Firewall

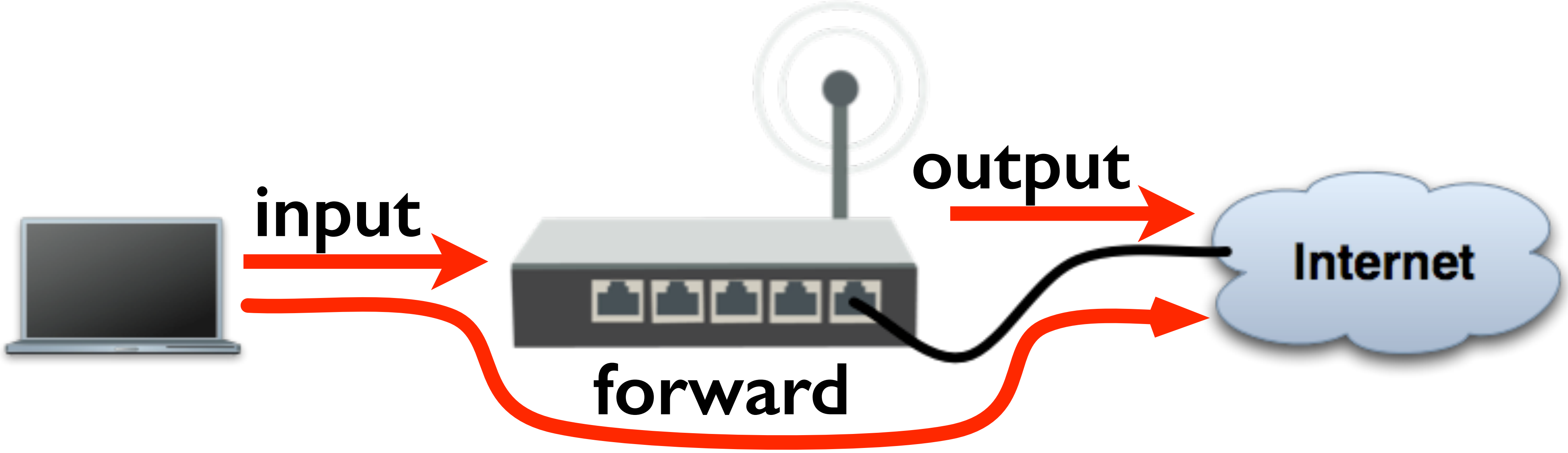
- A network security system that protects internal network from outside (e.g. the Internet)
- Based on rules which are analysed sequentially until first match is found
- RouterOS firewall rules are managed in Filter and NAT sections

Firewall Rules

- Work on **If-Then** principle
- Ordered in chains
- There are predefined chains
- Users can create new chains

Firewall Filter

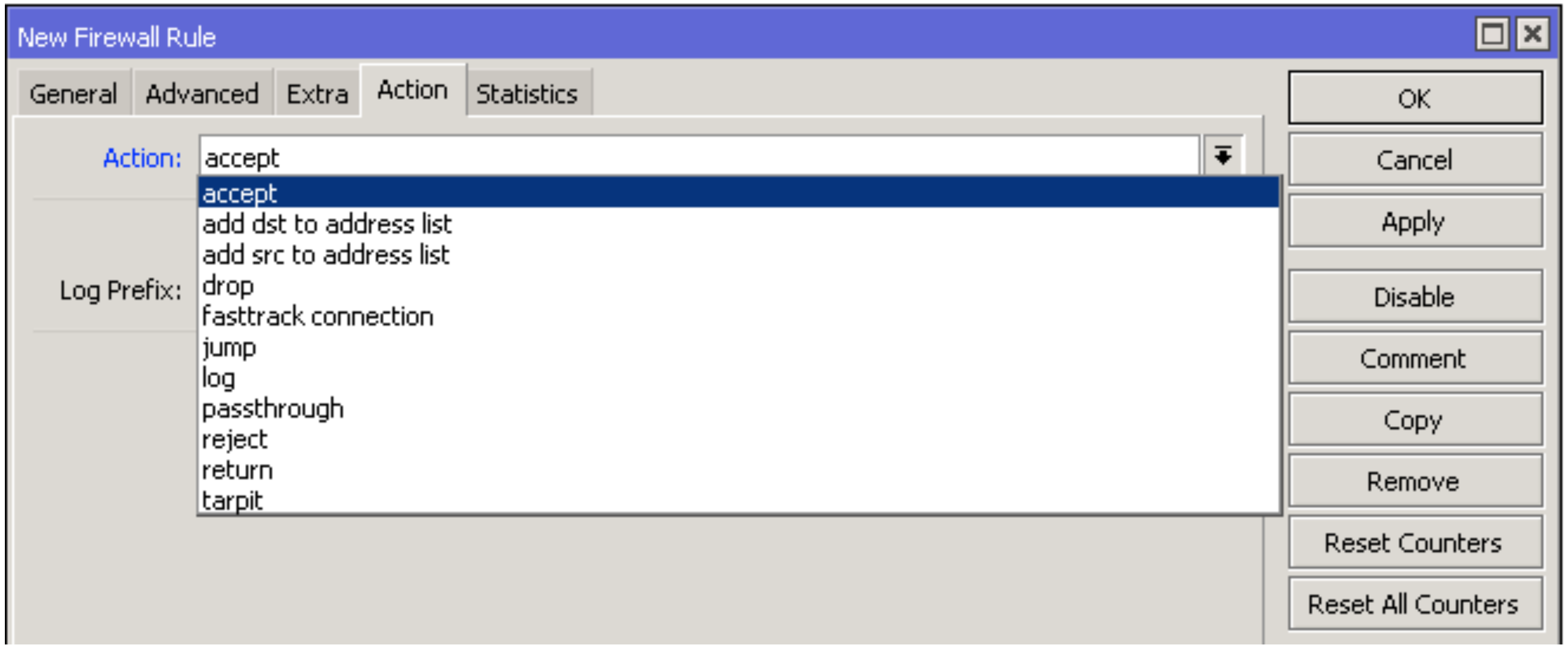
- There are three default chains
  - **input** (to the router)
  - **output** (from the router)
  - **forward** (through the router)



Filter Actions

- Each rule has an action - what to do when a packet is matched
- **accept**
- **drop** silently or **reject** - drop and send ICMP reject message
- **jump/return** to/from a user defined chain
- And other - see firewall wiki page

Filter Actions



New Firewall Rule

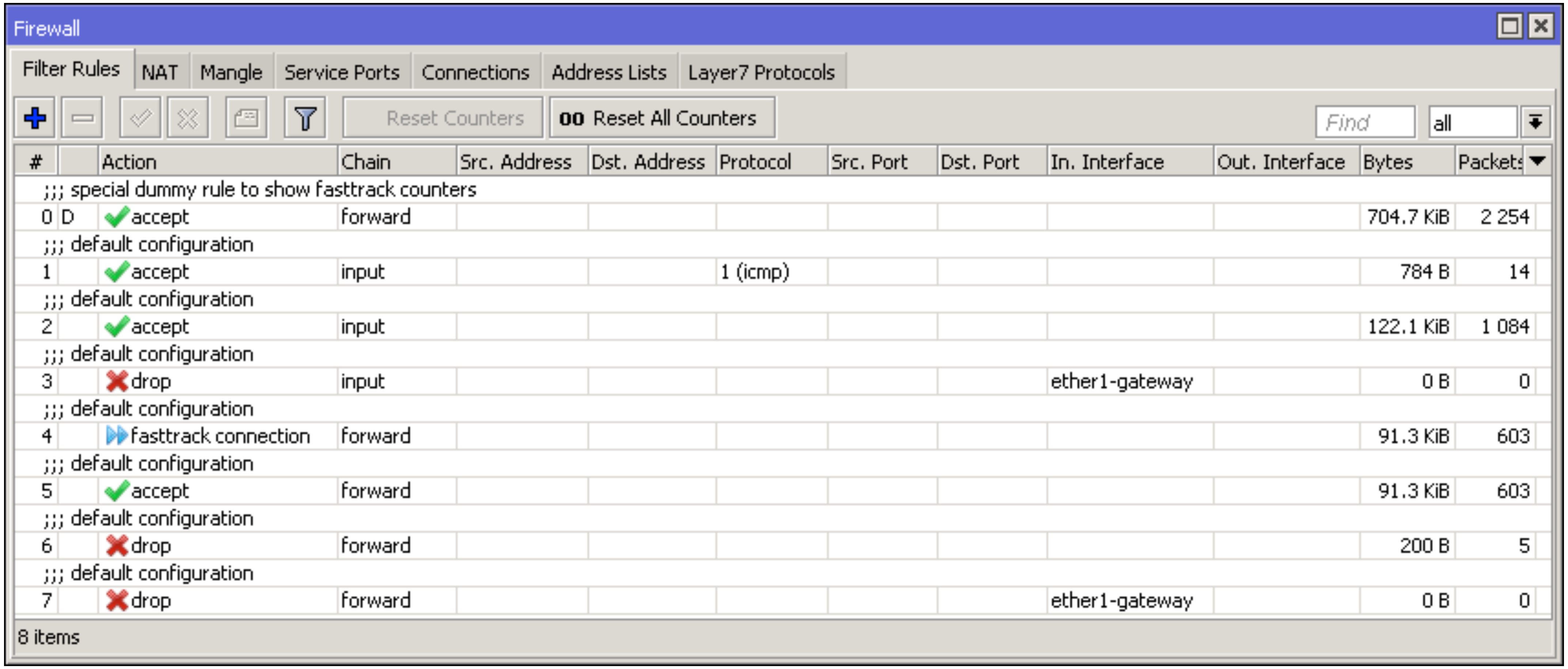
Action: accept

- accept
- add dst to address list
- add src to address list
- drop
- fasttrack connection
- jump
- log
- passthrough
- reject
- return
- tarpit

Log Prefix:

IP → Firewall → New Firewall Rule (+) → Action

Filter Chains



#		Action	Chain	Src. Address	Dst. Address	Protocol	Src. Port	Dst. Port	In. Interface	Out. Interface	Bytes	Packets
;;; special dummy rule to show fasttrack counters												
0	D	✓ accept	forward								704.7 KiB	2 254
;;; default configuration												
1		✓ accept	input			1 (icmp)					784 B	14
;;; default configuration												
2		✓ accept	input								122.1 KiB	1 084
;;; default configuration												
3		✗ drop	input						ether1-gateway		0 B	0
;;; default configuration												
4		▶▶ fasttrack connection	forward								91.3 KiB	603
;;; default configuration												
5		✓ accept	forward								91.3 KiB	603
;;; default configuration												
6		✗ drop	forward								200 B	5
;;; default configuration												
7		✗ drop	forward						ether1-gateway		0 B	0

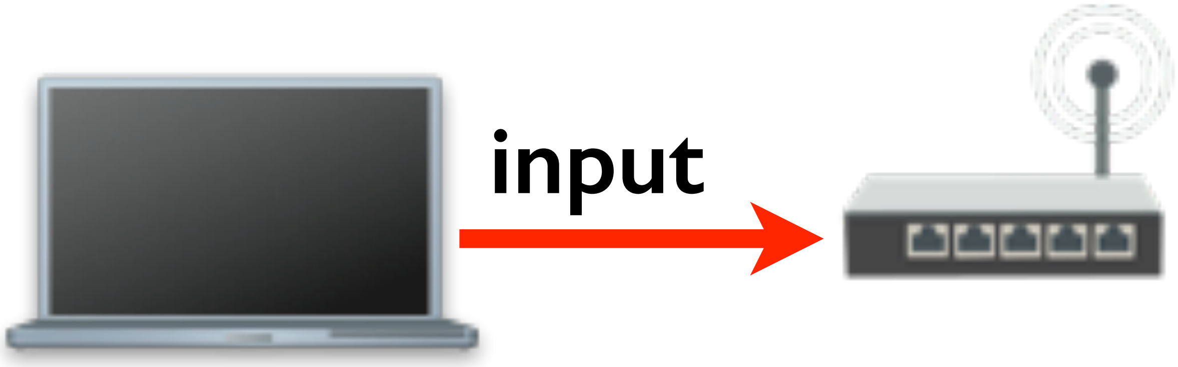
8 items

IP → Firewall

- TIP: to improve readability of firewall rules, order them sequentially by chains and add comments

Chain: input

- Protects the router itself
- Either from the Internet or the internal network



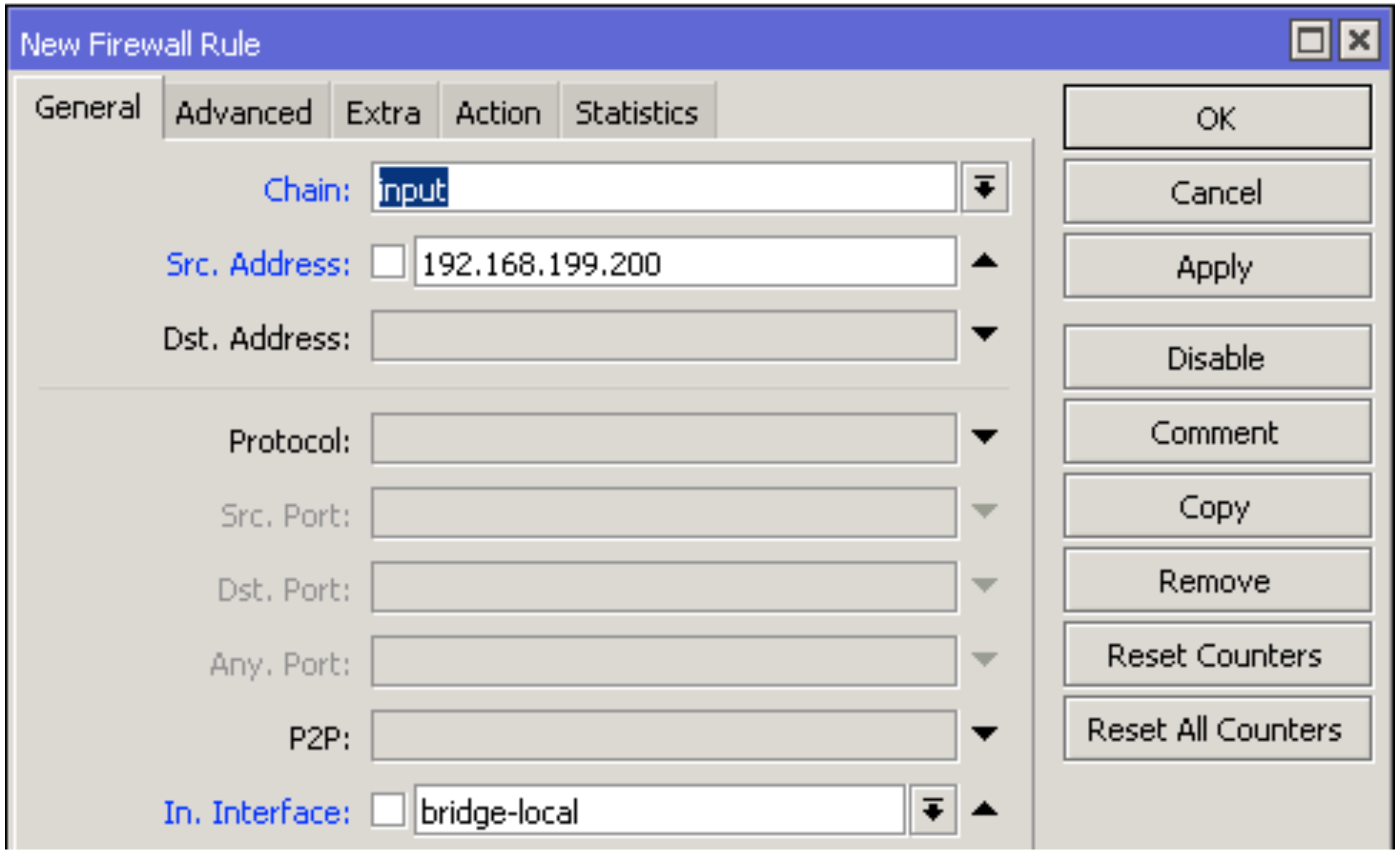
Chain: input

LAB

- Add an **accept input** filter rule on the **bridge** interface for your laptop IP address (Src. Address = 192.168.XY.200)
- Add a **drop input** filter rule on the **bridge** interface for everyone else

MikroTik MTCNA

Chain: input



New Firewall Rule

General | Advanced | Extra | Action | Statistics

Chain: input

Src. Address: □ 192.168.199.200

Dst. Address:

Protocol:

Src. Port:

Dst. Port:

Any. Port:

P2P:

In. Interface: □ bridge-local

IP → Firewall → New Firewall Rule (+)

LAB

Chain: input

- Change the IP address of your laptop to static, assign 192.168.XY.199, DNS and gateway: 192.168.XY.1
- Disconnect from the router
- Try to connect to the router (not possible)
- Try to connect to the internet (not possible)

LAB

Chain: input

- Although traffic to the Internet is controlled with firewall **forward** chain, web pages cannot be opened
- WHY? (answer on the next slide)

MikroTik
MTCNA

LAB

Chain: input

- Your laptop is using the router for domain name resolving (DNS)
- Connect to the router using MAC WinBox
- Add an **accept input** filter rule on the **bridge** interface to allow DNS requests, port: **53/udp** and place it above the drop rule
- Try to connect to the Internet (works)

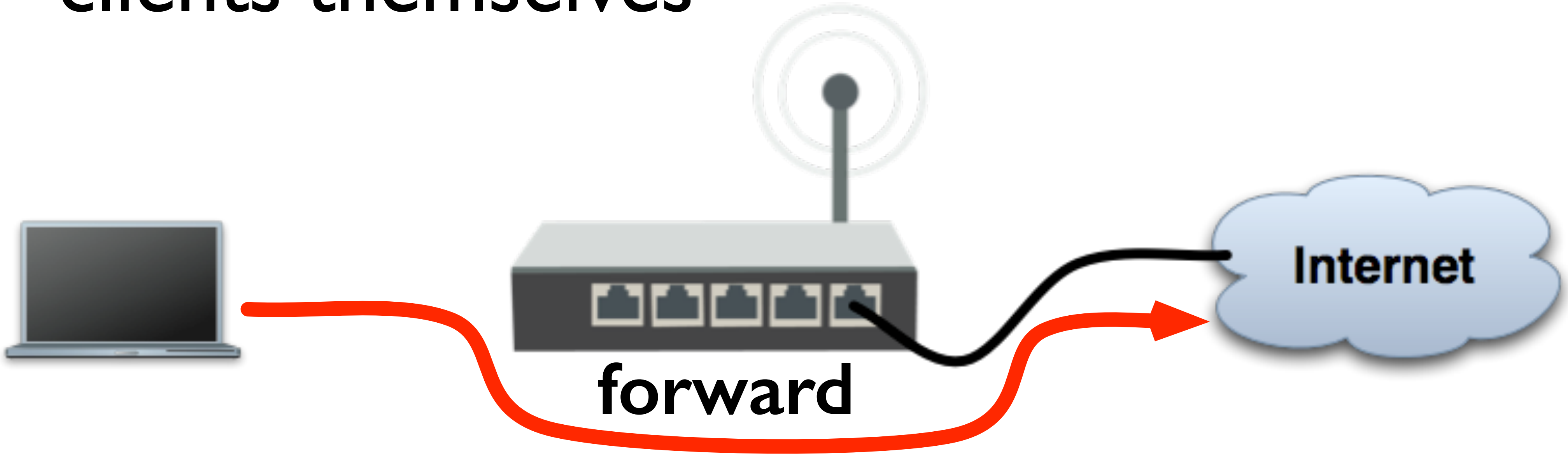
LAB

Chain: input

- Change back your laptop IP to dynamic (DHCP)
- Connect to the router
- Disable (or remove) the rules you just added

Chain: forward

- Contains rules that control packets going **through** the router
- Forward controls traffic between the clients and the Internet and between the clients themselves



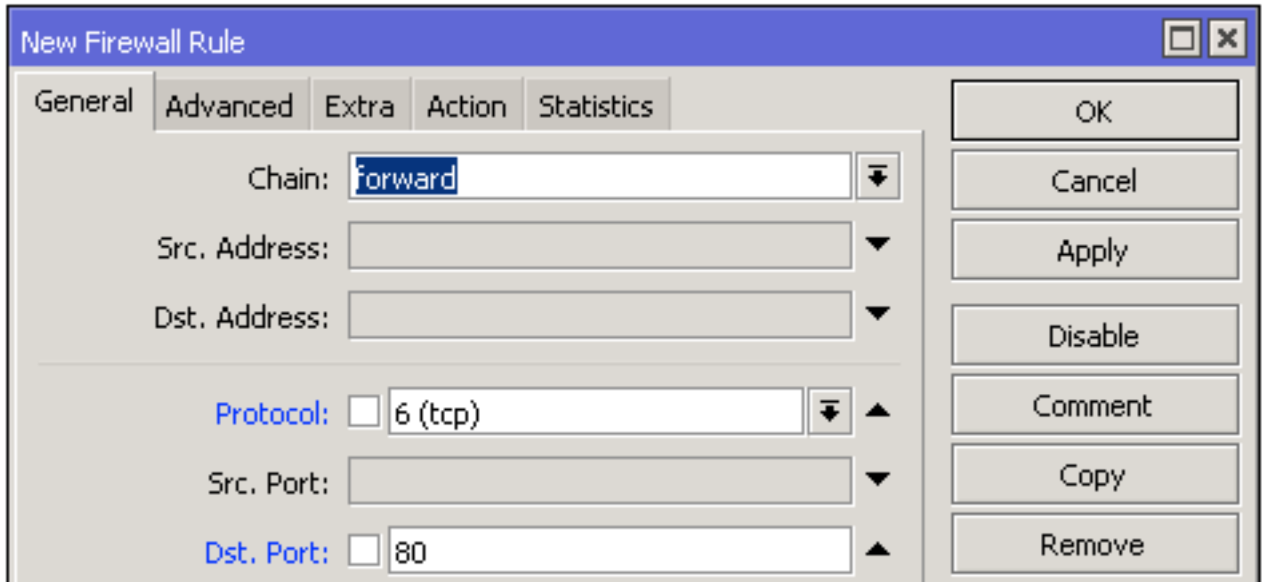
Chain: forward

- By default internal traffic between the clients connected to the router is allowed
- Traffic between the clients and the Internet is not restricted

LAB

Chain: forward

- Add a **drop forward** filter rule for http port (80/tcp)
- When specifying ports, IP protocol must be selected



Chain: forward

Src. Address:

Dst. Address:

Protocol: □ 6 (tcp)

Src. Port:

Dst. Port: □ 80

IP → Firewall → New Firewall Rule (+)

LAB

Chain: forward

- Try to open www.mikrotik.com (not possible)
- Try to open router WebFig http://192.168.XY.1 (works)
- Router web page works because it is traffic going to the router (**input**), not through (**forward**)

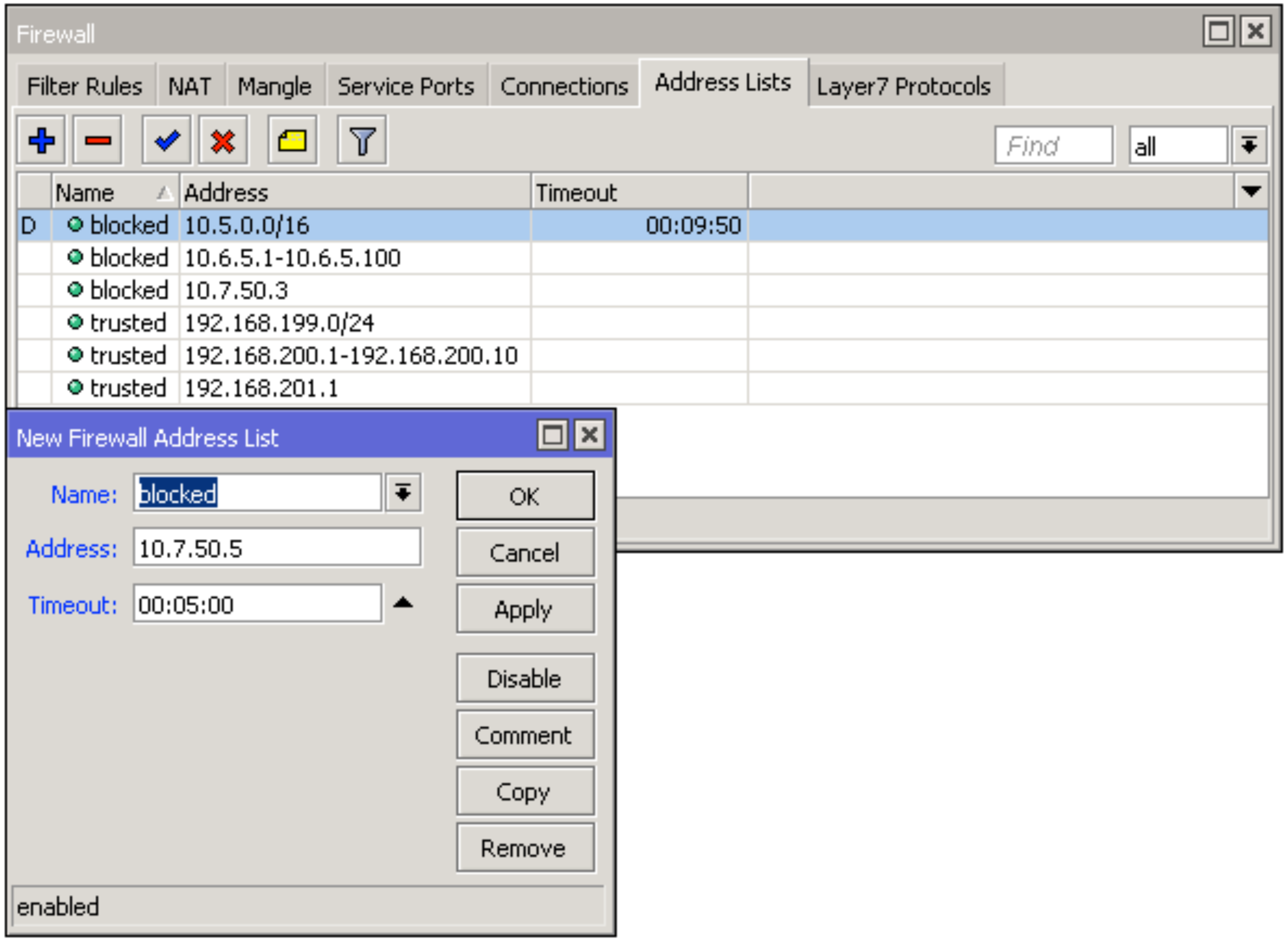
Frequently Used Ports

Port	Service
80/tcp	HTTP
443/tcp	HTTPS
22/tcp	SSH
23/tcp	Telnet
20,21/tcp	FTP
8291/tcp	WinBox
5678/udp	MikroTik Neighbor Discovery
20561/udp	MAC WinBox

Address List

- Address list allows to create an action for multiple IPs at once
- It is possible to automatically add an IP address to the address list
- IP can be added to the list permanently or for a predefined amount of time
- Address list can contain one IP address, IP range or whole subnet

Address List



	Name	Address	Timeout
D	blocked	10.5.0.0/16	00:09:50
	blocked	10.6.5.1-10.6.5.100	
	blocked	10.7.50.3	
	trusted	192.168.199.0/24	
	trusted	192.168.200.1-192.168.200.10	
	trusted	192.168.201.1	

Name: blocked

Address: 10.7.50.5

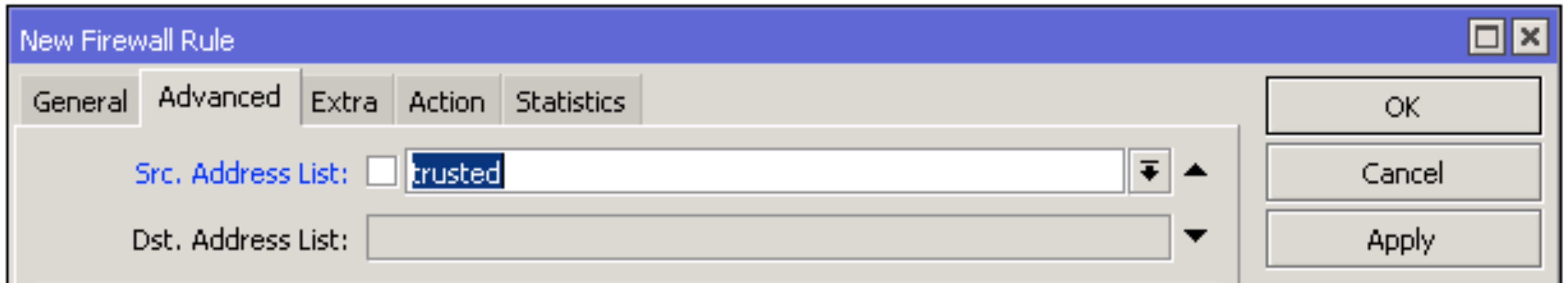
Timeout: 00:05:00

enabled

IP → Firewall → Address Lists → New Firewall Address List (+)

Address List

- Instead of specifying address in General tab, switch to Advanced and choose Address List (Src. or Dst. depending on the rule)



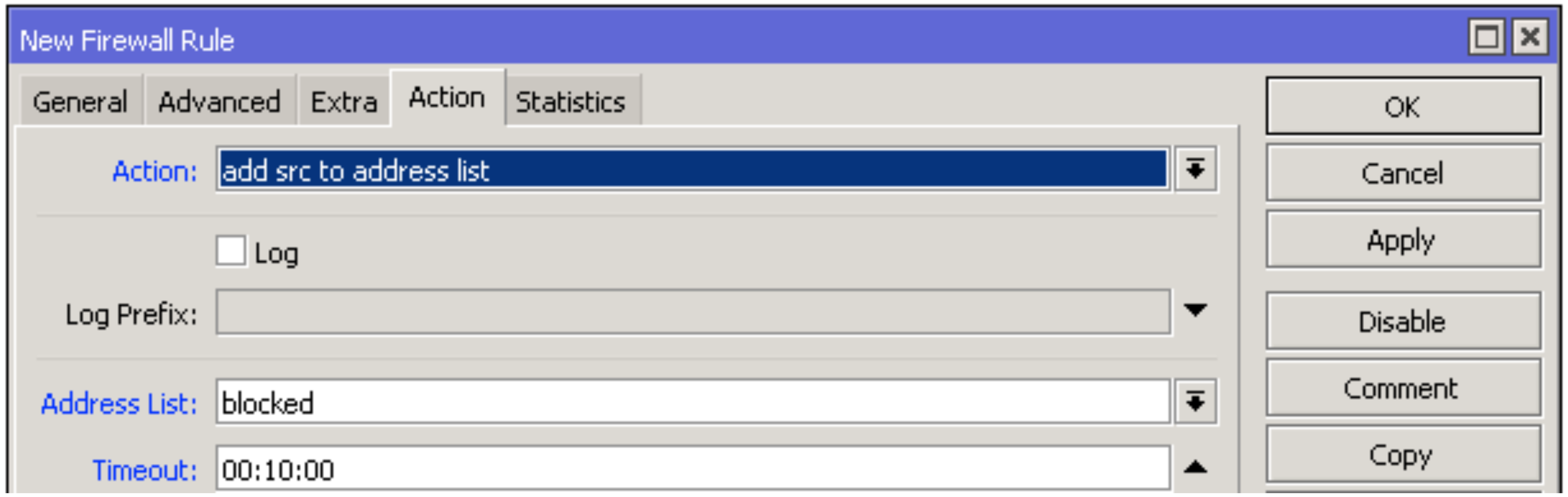
Src. Address List: □ trusted

Dst. Address List:

IP → Firewall → New Firewall Rule (+) → Advanced

Address List

- Firewall action can be used to automatically add an address to the address list
- Permanently or for a while



Action: add src to address list

□ Log

Log Prefix:

Address List: blocked

Timeout: 00:10:00

IP → Firewall → New Firewall Rule (+) → Action

Address List

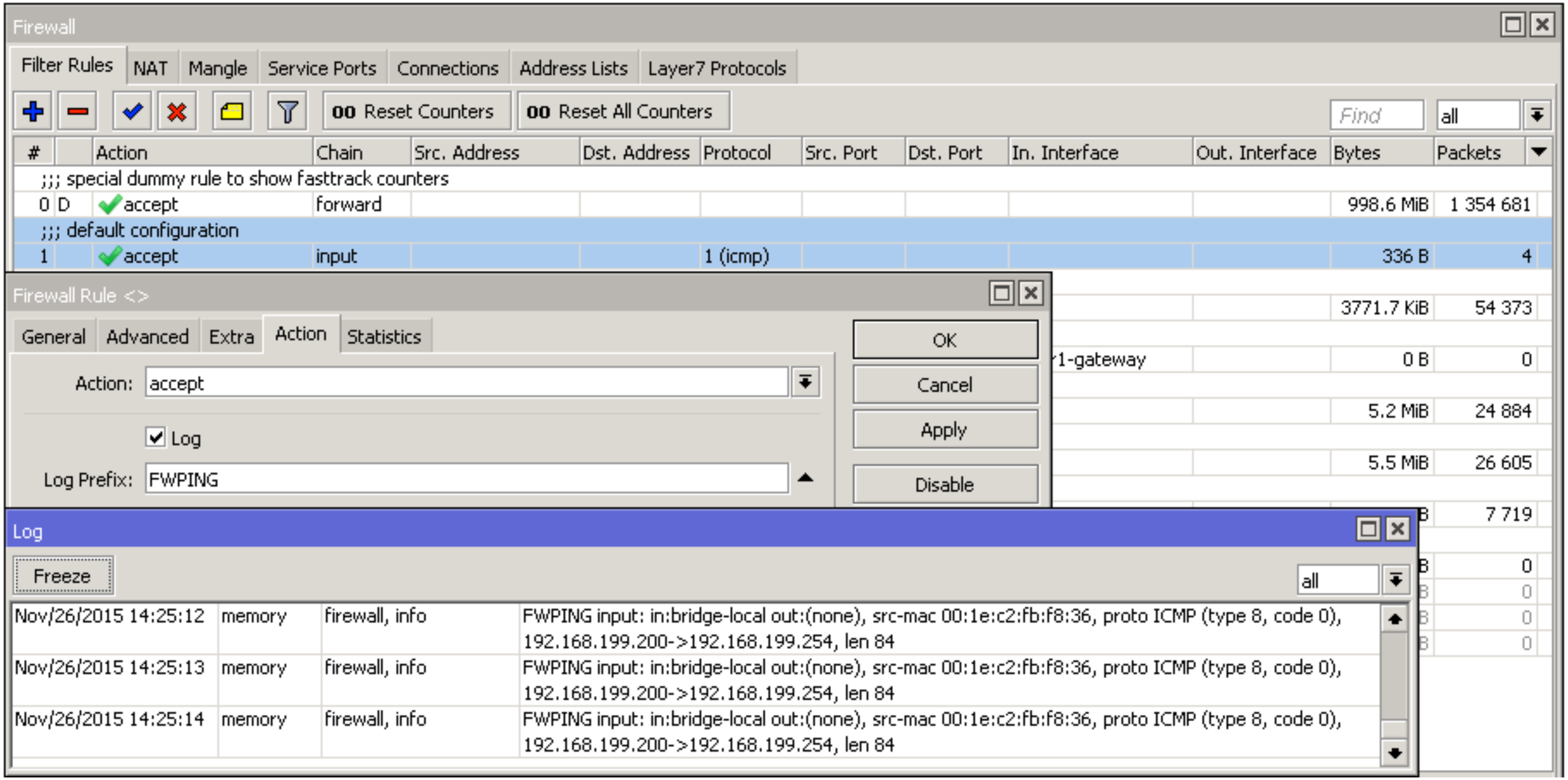
LAB

- Create an address list with allowed IPs, be sure to include your laptop IP
- Add an **accept input** filter rule on the **bridge** interface for WinBox port when connecting from the address which is included in the address list
- Create a **drop input** filter for everyone else connecting to the WinBox

Firewall Log

- Each firewall rule can be logged when matched
- Can add specific prefix to ease finding the records later

Firewall Log



#		Action	Chain	Src. Address	Dst. Address	Protocol	Src. Port	Dst. Port	In. Interface	Out. Interface	Bytes	Packets
;;; special dummy rule to show fasttrack counters												
0	D	accept	forward								998.6 MiB	1 354 681
;;; default configuration												
1		accept	input			1 (icmp)					336 B	4

Action: accept

☑ Log

Log Prefix: FWPING

```
Nov/26/2015 14:25:12 memory firewall, info FWPING input: in:bridge-local out:(none), src-mac 00:1e:c2:fb:f8:36, proto ICMP (type 8, code 0),
                                           192.168.199.200->192.168.199.254, len 84
Nov/26/2015 14:25:13 memory firewall, info FWPING input: in:bridge-local out:(none), src-mac 00:1e:c2:fb:f8:36, proto ICMP (type 8, code 0),
                                           192.168.199.200->192.168.199.254, len 84
Nov/26/2015 14:25:14 memory firewall, info FWPING input: in:bridge-local out:(none), src-mac 00:1e:c2:fb:f8:36, proto ICMP (type 8, code 0),
                                           192.168.199.200->192.168.199.254, len 84
```

IP → Firewall → Edit Firewall Rule → Action

Firewall Log

LAB

- Enable logging for both firewall rules that were created during Address List LAB
- Connect to WinBox using allowed IP address
- Disconnect and change the IP of your laptop to one which is not in the allowed list
- Try to connect to WinBox
- Change back the IP and observe log entries

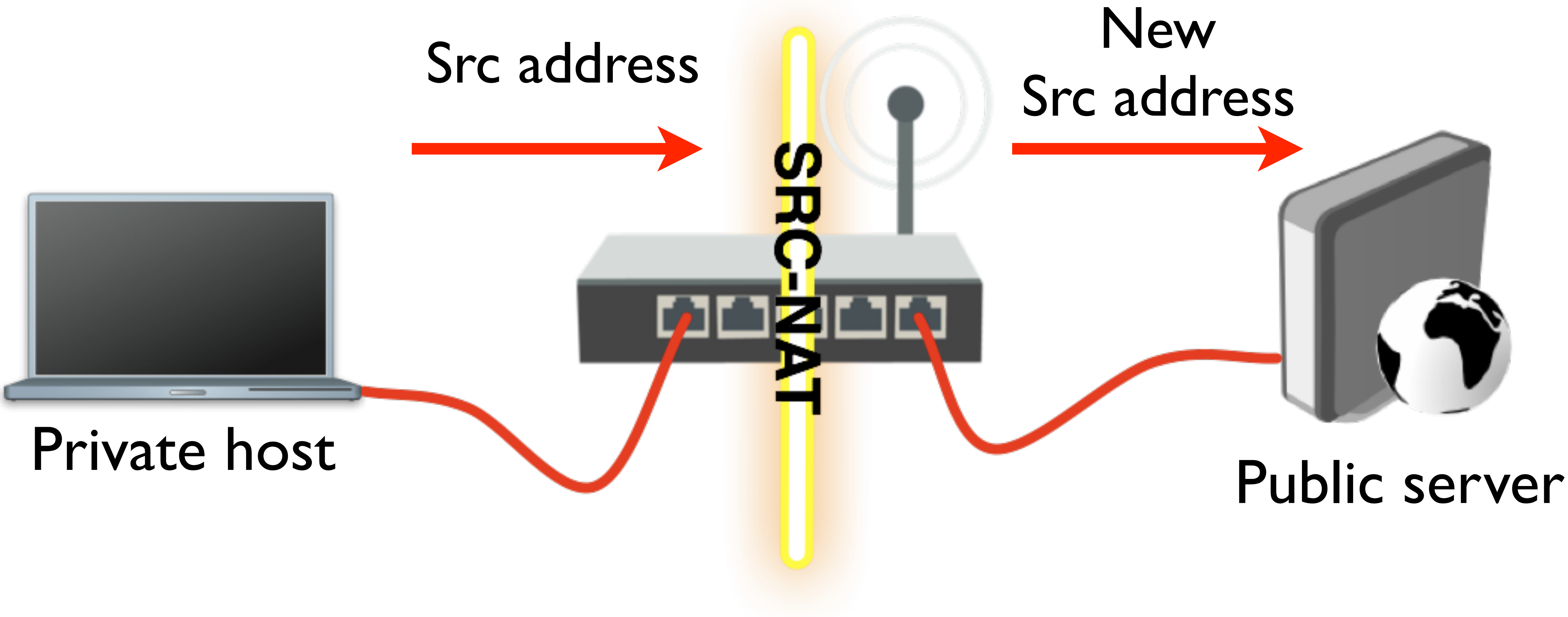
NAT

- Network Address Translation (NAT) is a method of modifying source or destination IP address of a packet
- There are two NAT types - ‘source NAT’ and ‘destination NAT’

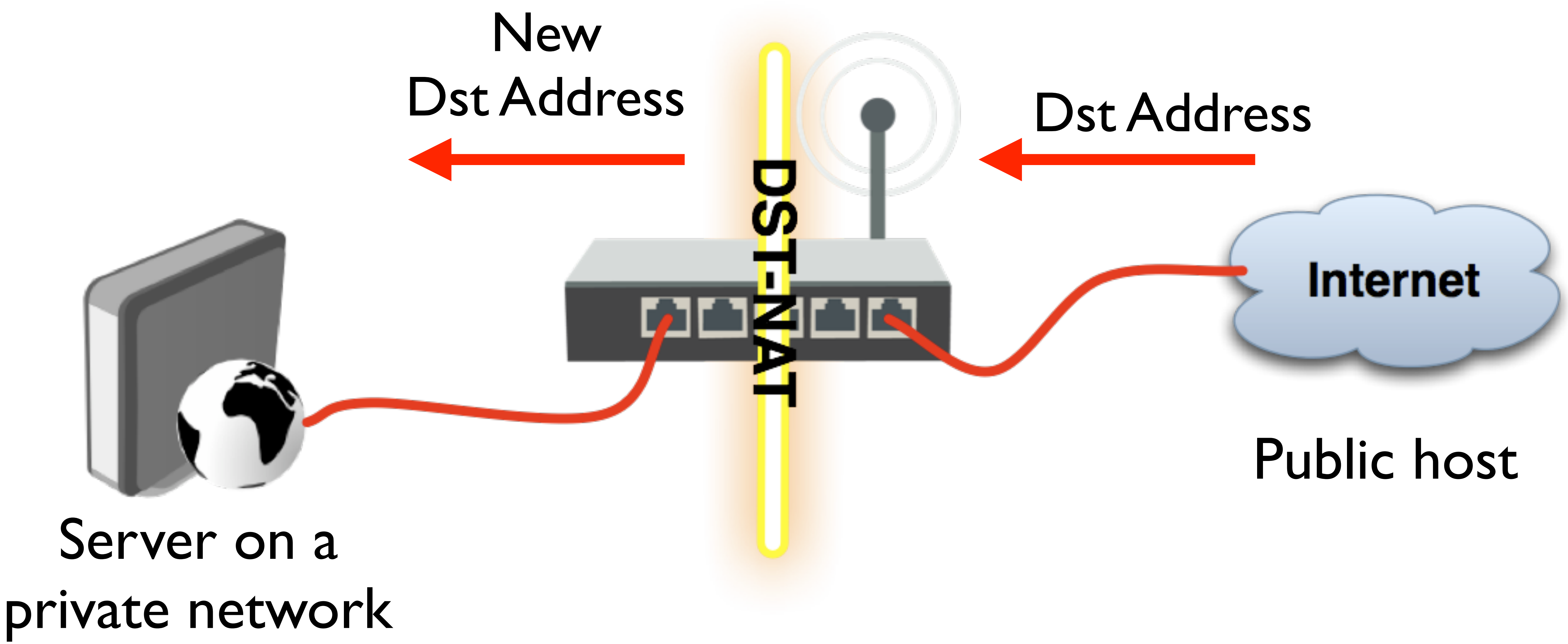
NAT

- NAT is usually used to provide access to an external network from a one which uses private IPs **(src-nat)**
- Or to allow access from an external network to a resource (e.g. web server) on an internal network **(dst-nat)**

NAT


Src address
New
Src address
SRC-NAT
Private host
Public server

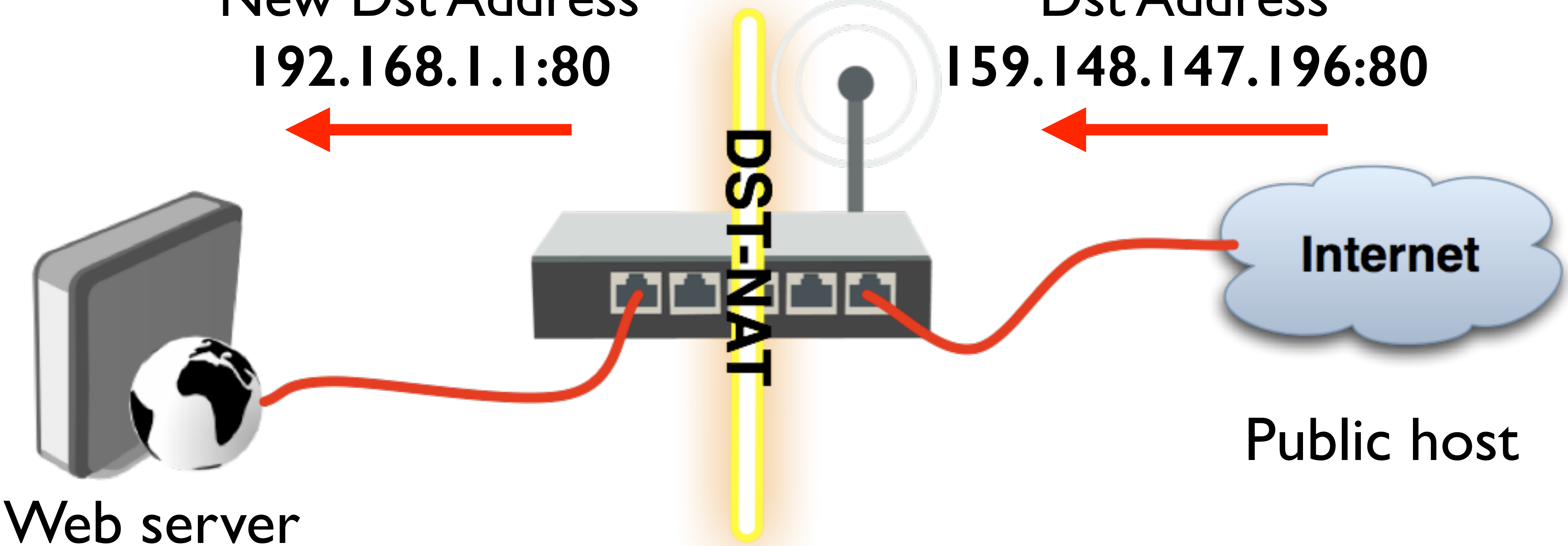
NAT


New
Dst Address
Dst Address
DST-NAT
Internet
Public host
Server on a
private network

NAT

- Firewall **srcnat** and **dstnat** chains are used to implement NAT functionality
- Same as Filter rules, work on **If-Then** principle
- Analysed sequentially until first match is found

Dst NAT



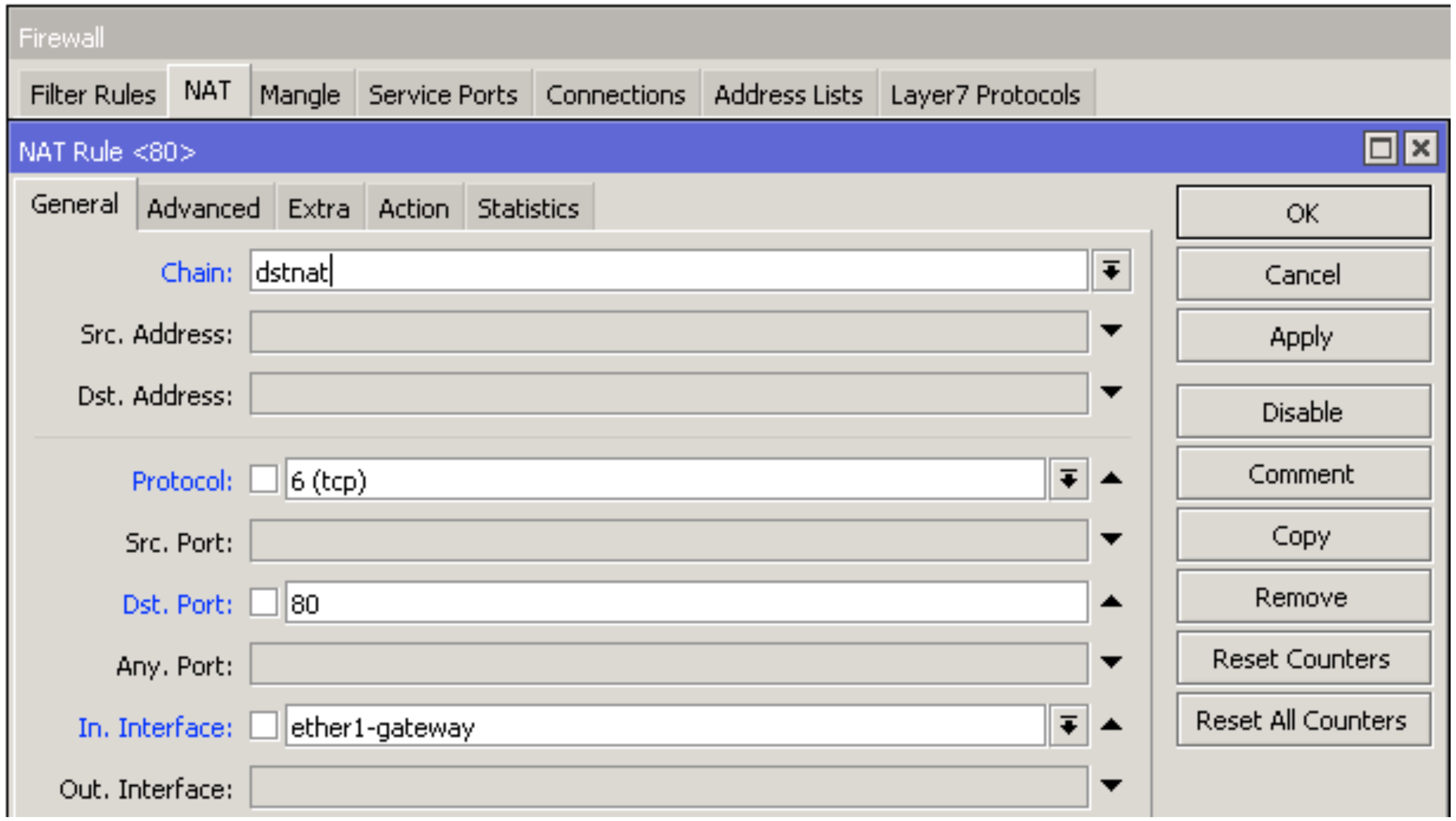
New Dst Address
192.168.1.1:80

Dst Address
159.148.147.196:80

Web server
192.168.1.1

Public host

Dst NAT



Chain: dstnat

Src. Address:

Dst. Address:

Protocol: □ 6 (tcp)

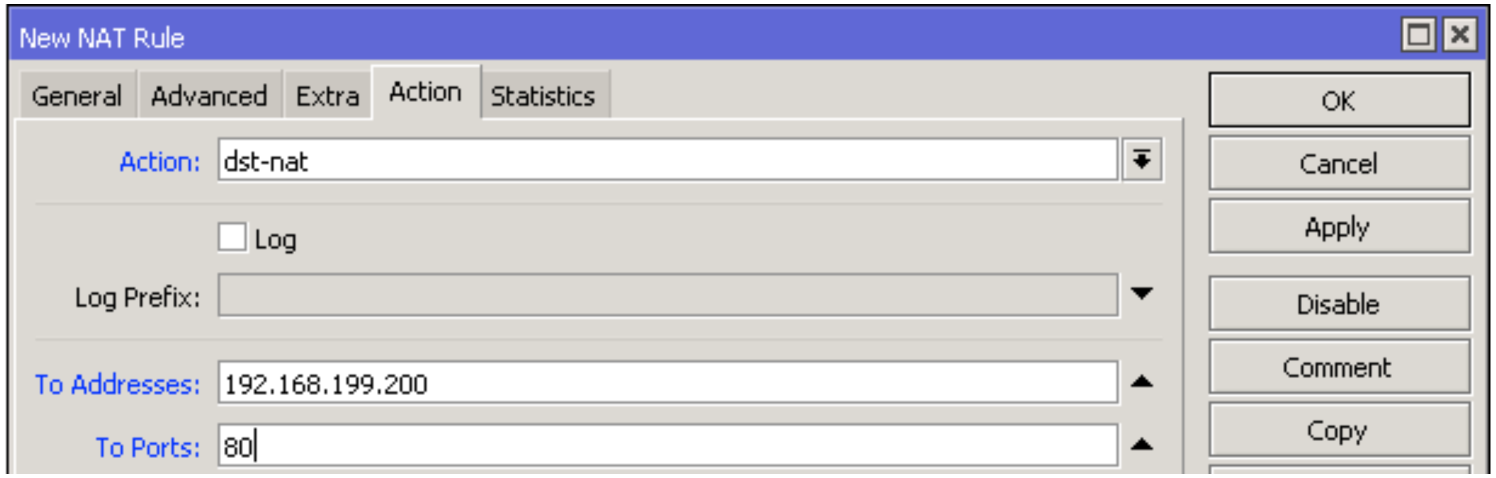
Src. Port:

Dst. Port: □ 80

Any. Port:

In. Interface: □ ether1-gateway

Out. Interface:



Action: dst-nat

□ Log

Log Prefix:

To Addresses: 192.168.199.200

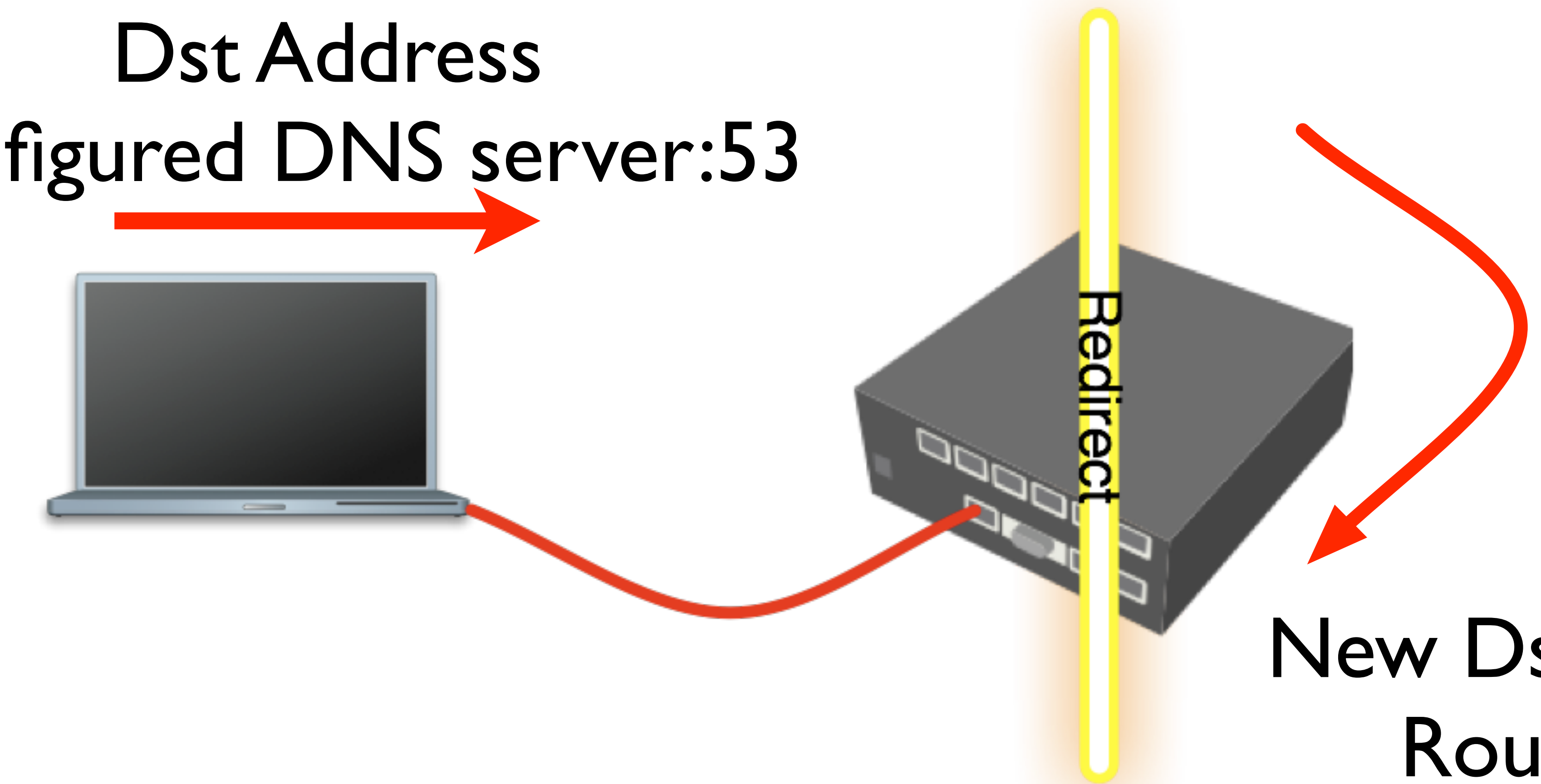
To Ports: 80

IP → Firewall → NAT → New NAT Rule (+)

Redirect

- Special type of **dstnat**
- This action redirects packets to the router itself
- Can be used to create transparent proxy services (e.g. DNS, HTTP)

Redirect



Dst Address
Configured DNS server:53

New Dst Address
Router:53

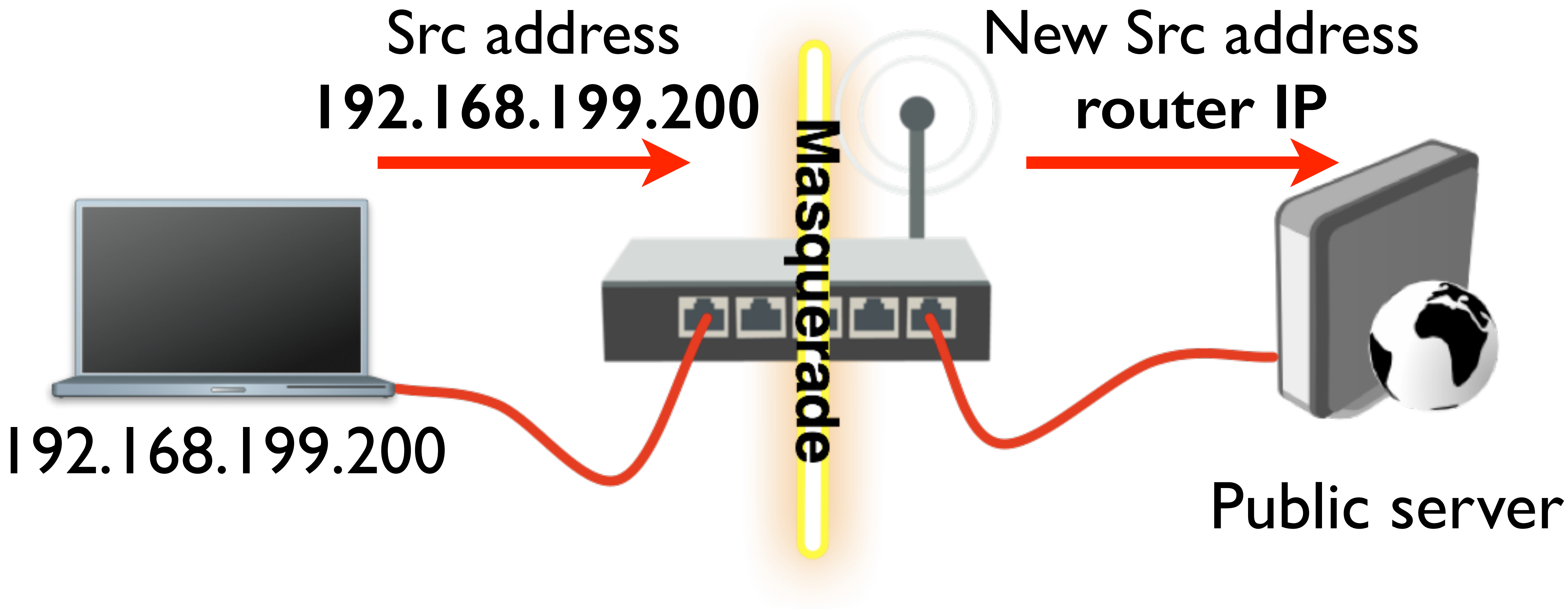
DNS
Cache

LAB

Redirect

- Create dstnat redirect rule to send all requests with a destination port HTTP (tcp/80) to the router port 80
- Try to open www.mikrotik.com or any other website that uses HTTP protocol
- When done disable or remove the rule

Src NAT



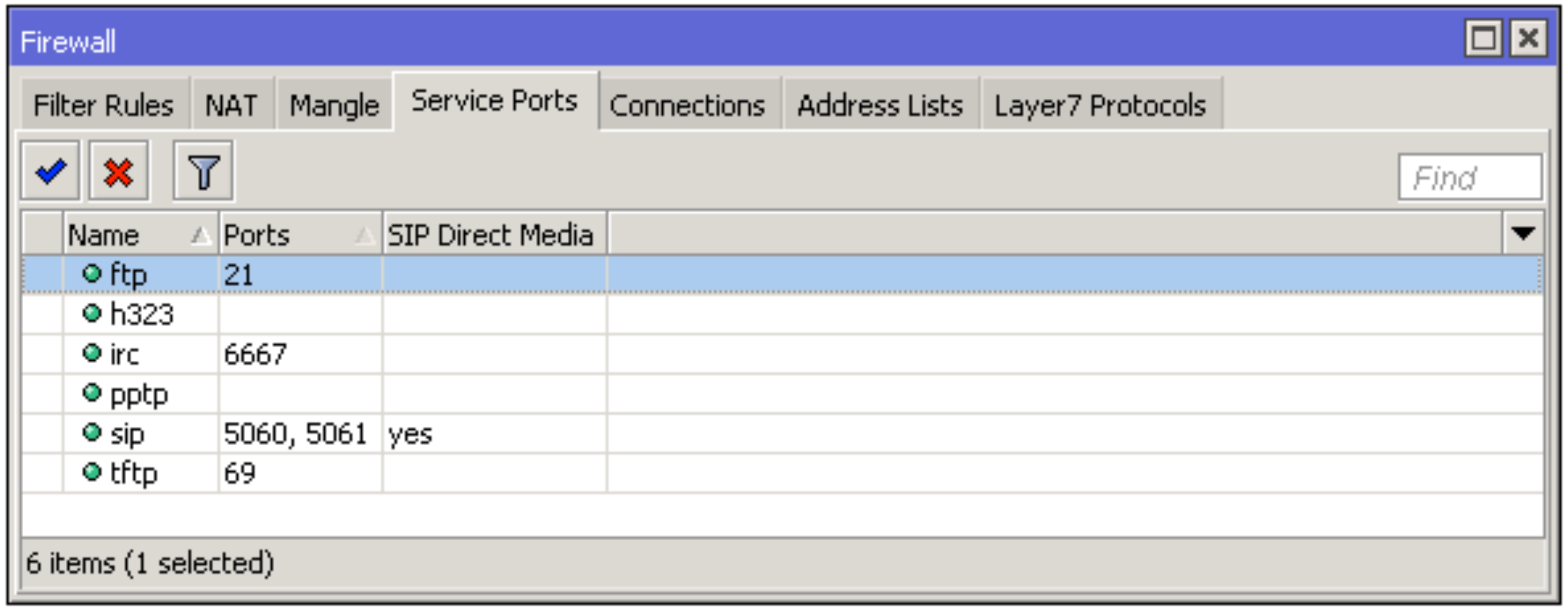
- **Masquerade** is a special type of srcnat

Src NAT

- srcnat action src-nat is meant for rewriting source IP address and/or port
- Example: two companies (A and B) have merged. Internally both use the same address space (172.16.0.0/16). They will set up a segment using a different address space as a buffer, both networks will require src-nat and dst-nat rules.

NAT Helpers

- Some protocols require so-called NAT helpers to work correctly in a NAT'd network



Name	Ports	SIP Direct Media
ftp	21	
h323		
irc	6667	
pptp		
sip	5060, 5061	yes
tftp	69	

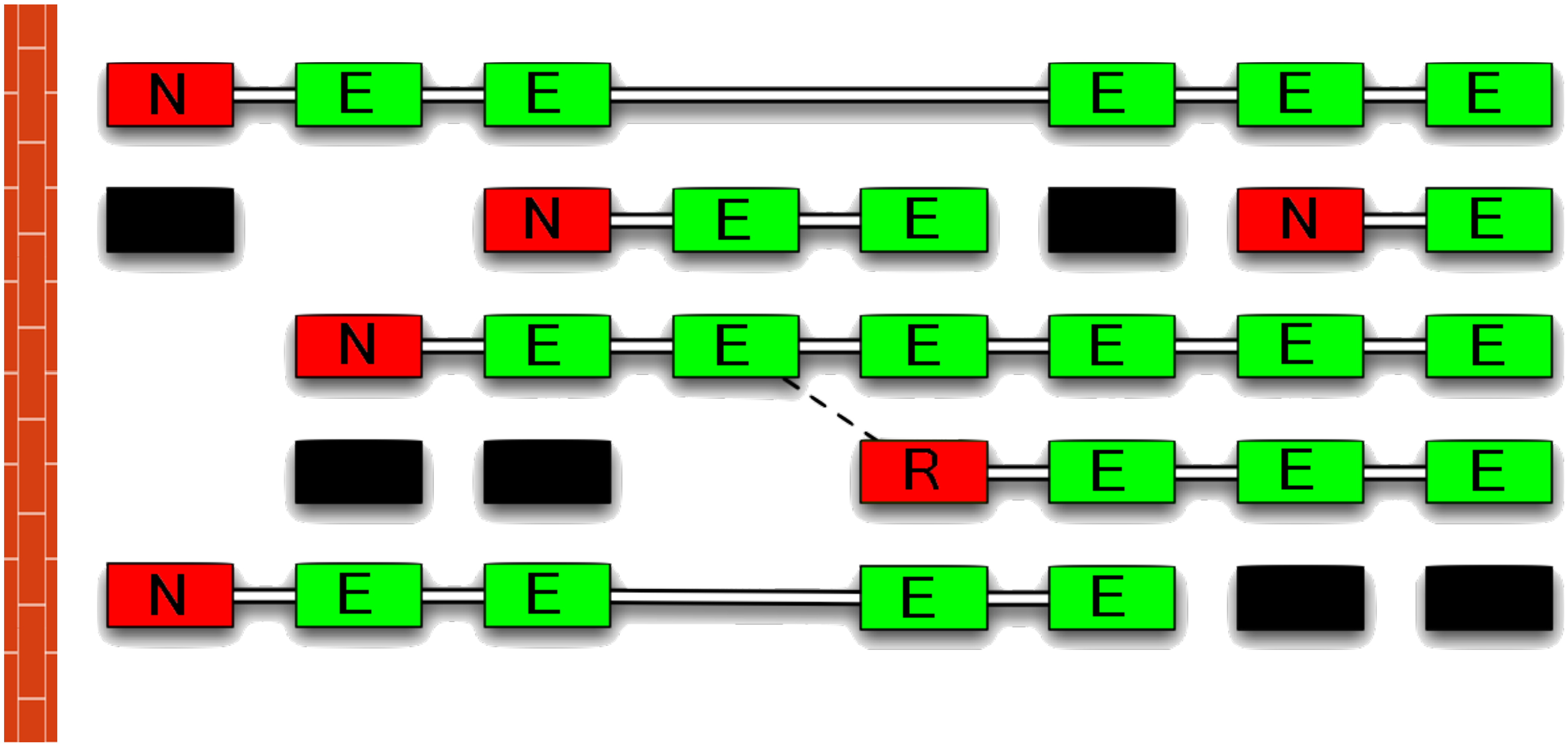
6 items (1 selected)

IP → Firewall → Service Ports

Connections

- **New -** packet is opening a new connection
- **Established -** packet belongs to already known connection
- **Related -** packet is opening a new connection but it has a relation to already known connection
- **Invalid -** packet does not belong to any of known connections

Connections



⬛ Invalid

E Established

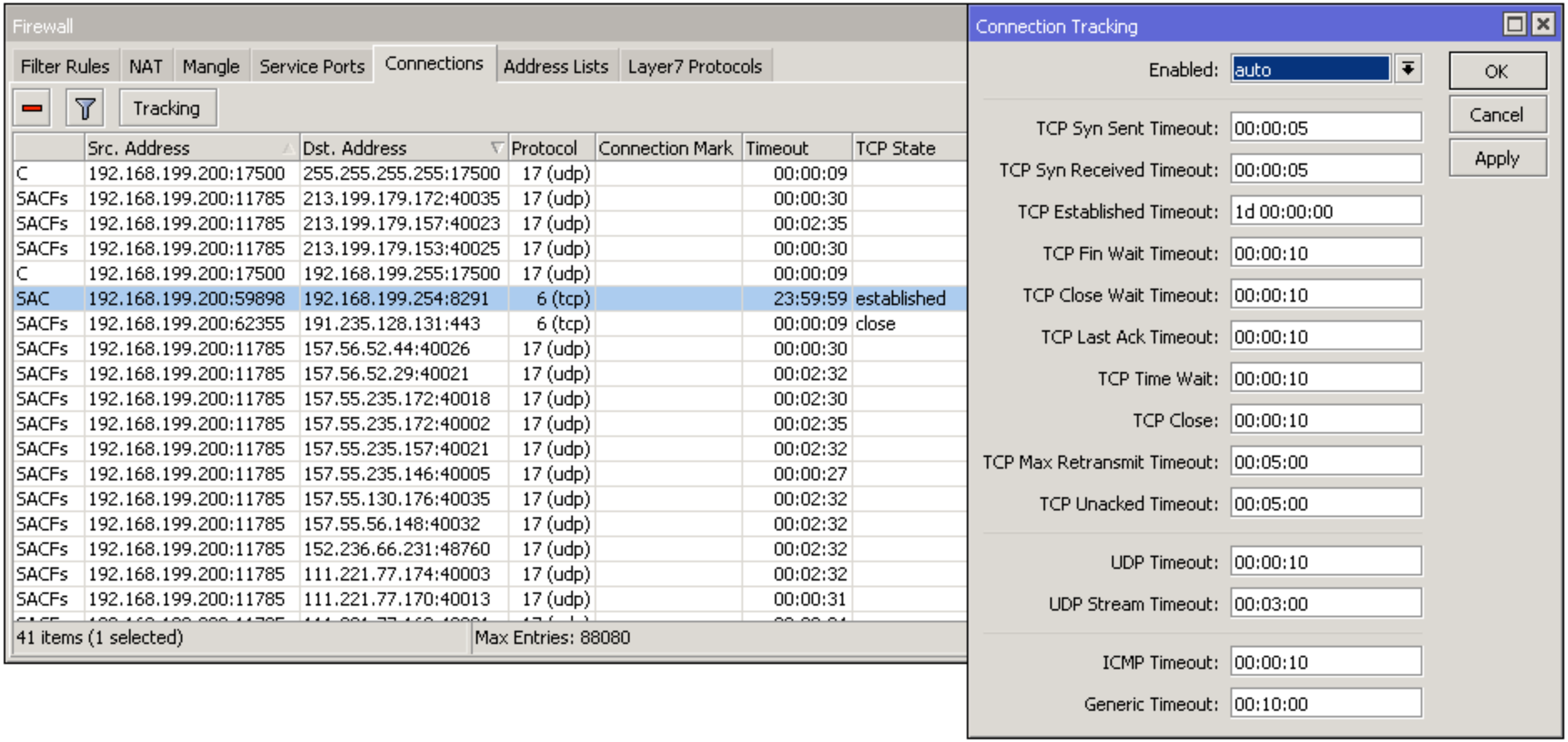
N New

R Related

Connection Tracking

- Manages information about all active connections
- Has to be enabled for NAT and Filter to work
- Note: connection state ≠ TCP state

Connection Tracking



	Src. Address	Dst. Address	Protocol	Connection Mark	Timeout	TCP State
C	192.168.199.200:17500	255.255.255.255:17500	17 (udp)		00:00:09	
SACFs	192.168.199.200:11785	213.199.179.172:40035	17 (udp)		00:00:30	
SACFs	192.168.199.200:11785	213.199.179.157:40023	17 (udp)		00:02:35	
SACFs	192.168.199.200:11785	213.199.179.153:40025	17 (udp)		00:00:30	
C	192.168.199.200:17500	192.168.199.255:17500	17 (udp)		00:00:09	
SAC	192.168.199.200:59898	192.168.199.254:8291	6 (tcp)		23:59:59	established
SACFs	192.168.199.200:62355	191.235.128.131:443	6 (tcp)		00:00:09	close
SACFs	192.168.199.200:11785	157.56.52.44:40026	17 (udp)		00:00:30	
SACFs	192.168.199.200:11785	157.56.52.29:40021	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	157.55.235.172:40018	17 (udp)		00:02:30	
SACFs	192.168.199.200:11785	157.55.235.172:40002	17 (udp)		00:02:35	
SACFs	192.168.199.200:11785	157.55.235.157:40021	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	157.55.235.146:40005	17 (udp)		00:00:27	
SACFs	192.168.199.200:11785	157.55.130.176:40035	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	157.55.56.148:40032	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	152.236.66.231:48760	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	111.221.77.174:40003	17 (udp)		00:02:32	
SACFs	192.168.199.200:11785	111.221.77.170:40013	17 (udp)		00:00:31	

41 items (1 selected) Max Entries: 88080

Connection Tracking

Enabled:	auto
TCP Syn Sent Timeout:	00:00:05
TCP Syn Received Timeout:	00:00:05
TCP Established Timeout:	1d 00:00:00
TCP Fin Wait Timeout:	00:00:10
TCP Close Wait Timeout:	00:00:10
TCP Last Ack Timeout:	00:00:10
TCP Time Wait:	00:00:10
TCP Close:	00:00:10
TCP Max Retransmit Timeout:	00:05:00
TCP Unacked Timeout:	00:05:00
UDP Timeout:	00:00:10
UDP Stream Timeout:	00:03:00
ICMP Timeout:	00:00:10
Generic Timeout:	00:10:00

IP → Firewall → Connections

FastTrack

- A method to accelerate packet flow through the router
- An established or related connection can be marked for **fasttrack connection**
- Bypasses firewall, connection tracking, simple queue and other features
- Currently supports only TCP and UDP protocols

FastTrack

Without	With
360Mbps	**890Mbps**
Total CPU usage 100%	Total CPU usage 86%
44% CPU usage on firewall	6% CPU usage on firewall

* Tested on RB2011 with a single TCP stream

- For more info see FastTrack wiki page

Module 6
Summary

Certified Network Associate (MTCNA)

Module 7

QoS

Quality of Service

- QoS is the overall performance of a network, particularly the performance seen by the users of the network
- RouterOS implements several QoS methods such as traffic speed limiting (shaping), traffic prioritisation and other

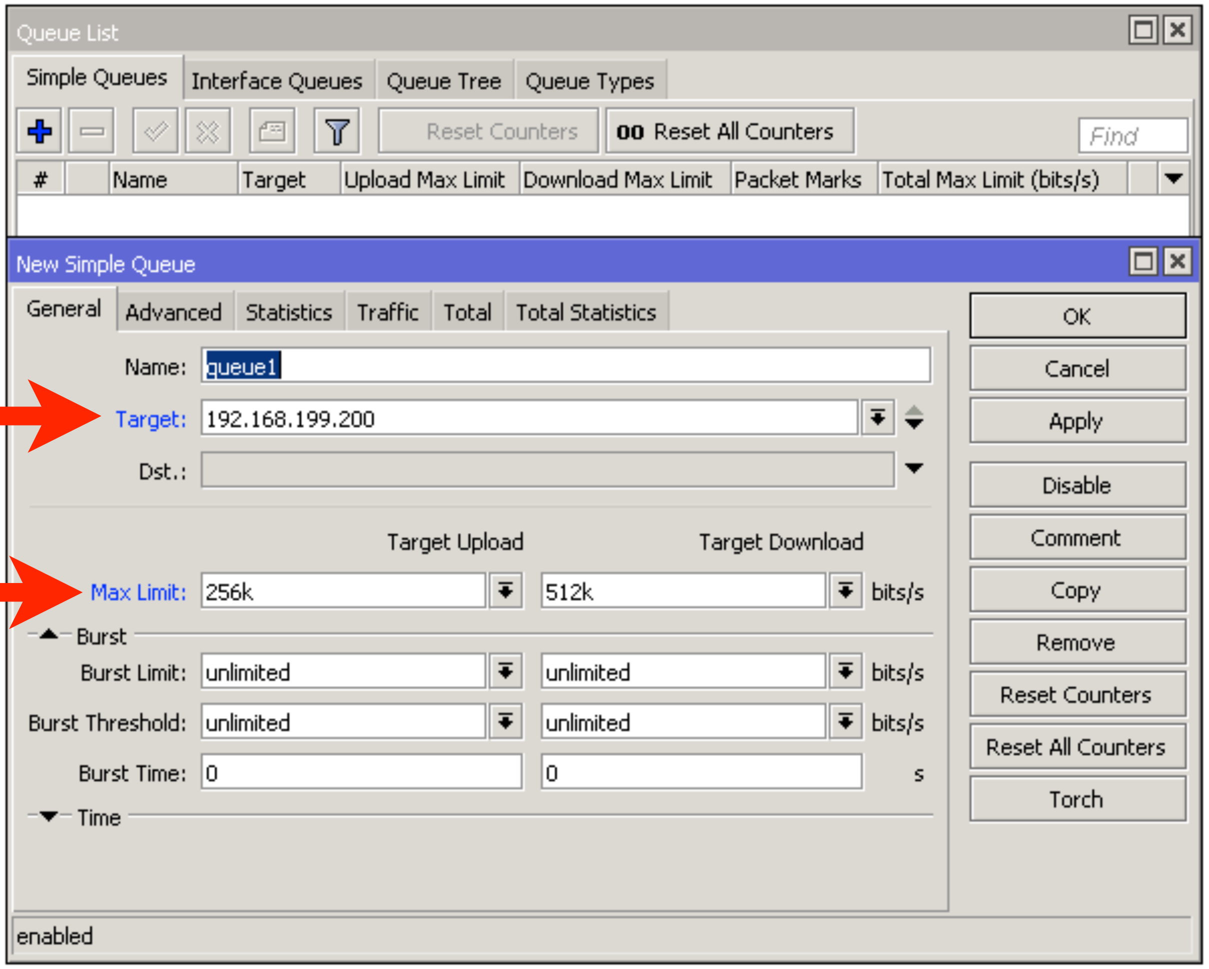
Speed Limiting

- Direct control over inbound traffic is not possible
- But it is possible to do it indirectly by dropping incoming packets
- TCP will adapt to the effective connection speed

Simple Queue

- Can be used to easy limit the data rate of:
  - Client’s download (↓) speed
  - Client’s upload (↑)speed
  - Client’s total speed (↓ + ↑)

Simple Queue



Specify client

Specify Max Limit for the client

Name: queue1

Target: 192.168.199.200

Dst.:

Max Limit: 256k | 512k bits/s

Burst Limit: unlimited | unlimited bits/s

Burst Threshold: unlimited | unlimited bits/s

Burst Time: 0 | 0 s

enabled

Queues → New Simple Queue(+)

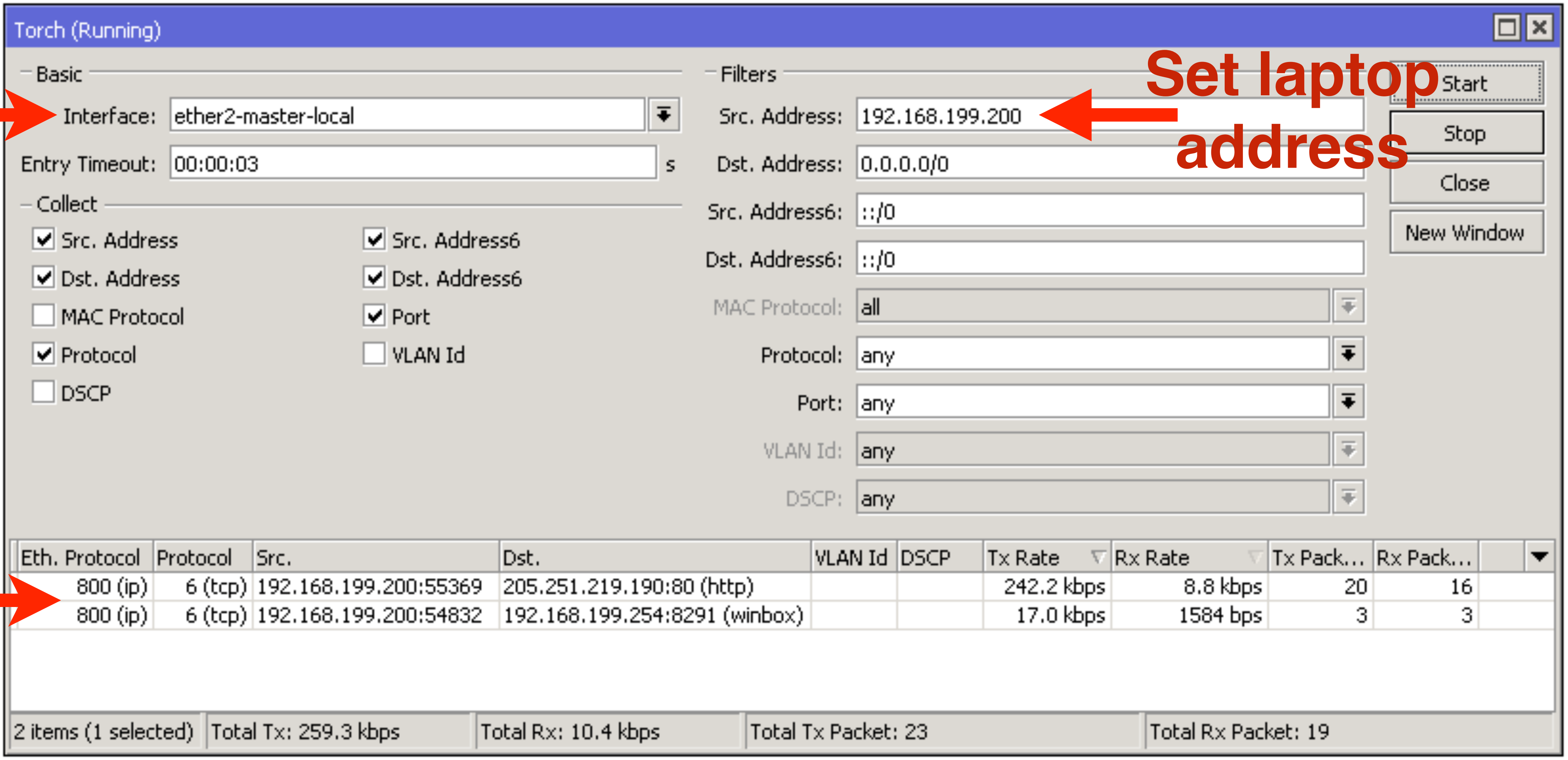
- Disable Firewall FastTrack rule for Simple Queue to work

MikroTik MTCNA

Torch

- Real-time traffic monitoring tool

Set interface



Torch (Running)

Basic

Interface: ether2-master-local

Entry Timeout: 00:00:03 s

Collect

☑ Src. Address
☑ Dst. Address
□ MAC Protocol
☑ Protocol
□ DSCP
☑ Src. Address6
☑ Dst. Address6
☑ Port
□ VLAN Id

Filters

Src. Address: 192.168.199.200
Dst. Address: 0.0.0.0/0
Src. Address6: ::/0
Dst. Address6: ::/0
MAC Protocol: all
Protocol: any
Port: any
VLAN Id: any
DSCP: any

Set laptop address

Eth. Protocol	Protocol	Src.	Dst.	VLAN Id	DSCP	Tx Rate	Rx Rate	Tx Pack...	Rx Pack...
800 (ip)	6 (tcp)	192.168.199.200:55369	205.251.219.190:80 (http)			242.2 kbps	8.8 kbps	20	16
800 (ip)	6 (tcp)	192.168.199.200:54832	192.168.199.254:8291 (winbox)			17.0 kbps	1584 bps	3	3

2 items (1 selected) | Total Tx: 259.3 kbps | Total Rx: 10.4 kbps | Total Tx Packet: 23 | Total Rx Packet: 19

Observe the traffic

Tools → Torch

LAB

Simple Queue

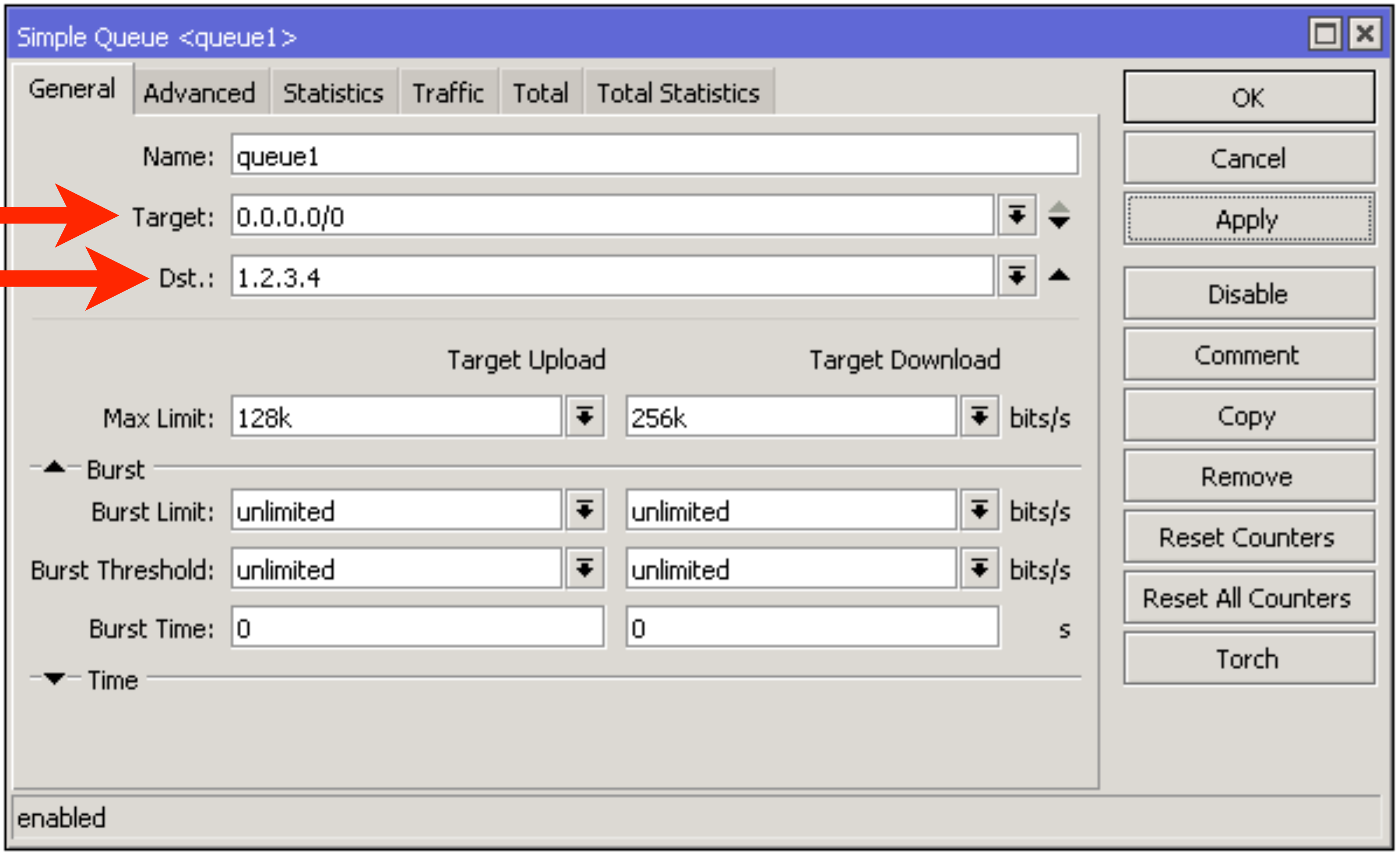
- Create speed limit for your laptop (192.168.XY.200)
- Set upload speed 128k, download speed 256k
- Open www.mikrotik.com/download and download current RouterOS version
- Observe the download speed

Simple Queue

- Instead of setting limits to the client, traffic to the server can also be throttled

Set Target to any

Set Dst. to server address



Simple Queue <queue1>

General | Advanced | Statistics | Traffic | Total | Total Statistics

Name: queue1

Target: 0.0.0.0/0

Dst.: 1.2.3.4

	Target Upload	Target Download	
Max Limit:	128k	256k	bits/s
Burst Limit:	unlimited	unlimited	bits/s
Burst Threshold:	unlimited	unlimited	bits/s
Burst Time:	0	0	s

enabled

LAB

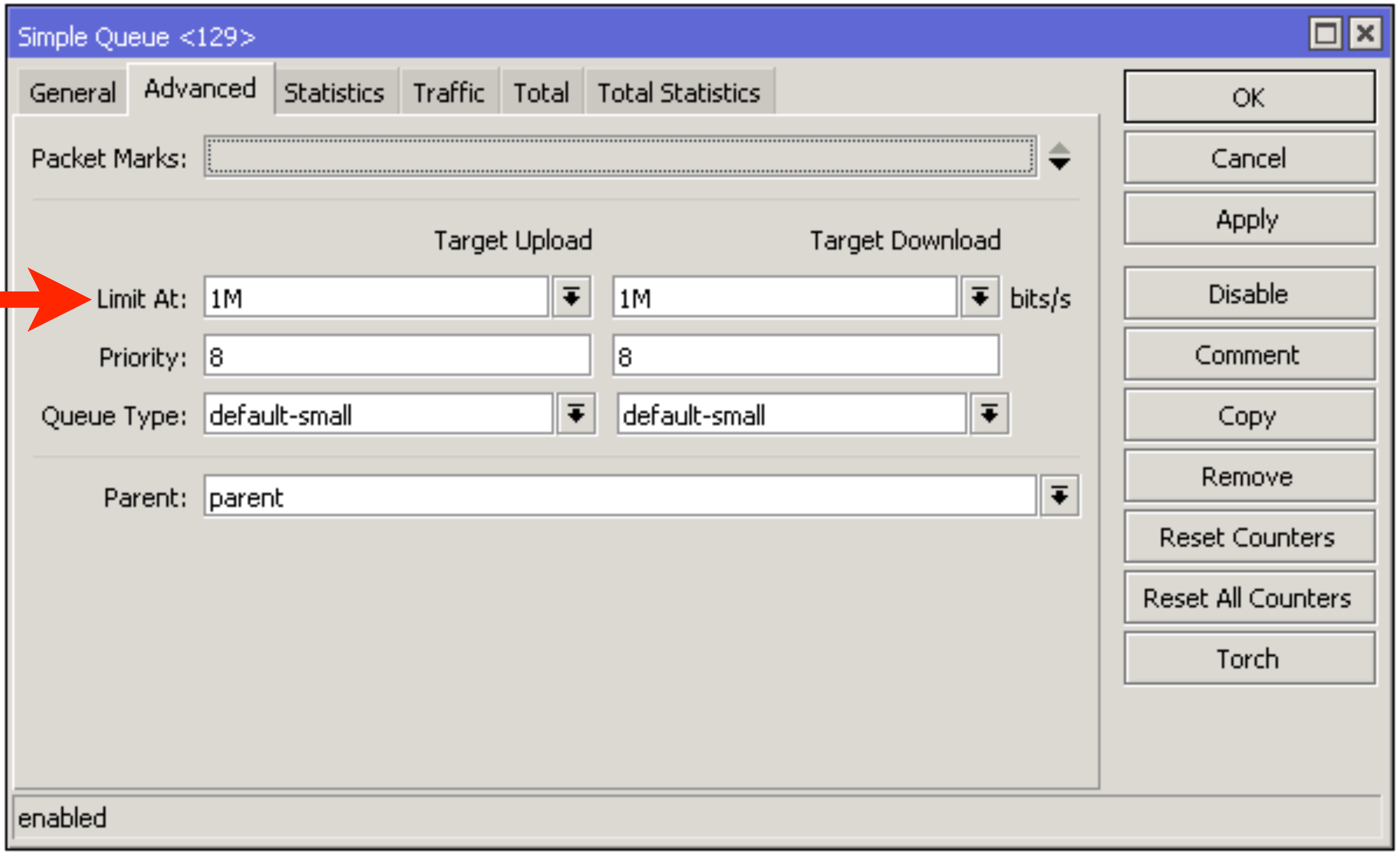
Simple Queue

- Using ping tool find out the address of www.mikrotik.com
- Modify existing simple queue to throttle connection to the mikrotik.com server
- Download MTCNA outline
- Observe the download speed

Guaranteed Bandwidth

- Used to make sure that the client will always get minimum bandwidth
- Remaining traffic will be split between clients on first come first served basis
- Controlled using **Limit-at** parameter

Guaranteed Bandwidth



Set limit at

Simple Queue <129>

Packet Marks:

	Target Upload	Target Download	
Limit At:	1M	1M	bits/s
Priority:	8	8	
Queue Type:	default-small	default-small	

Parent: parent

enabled

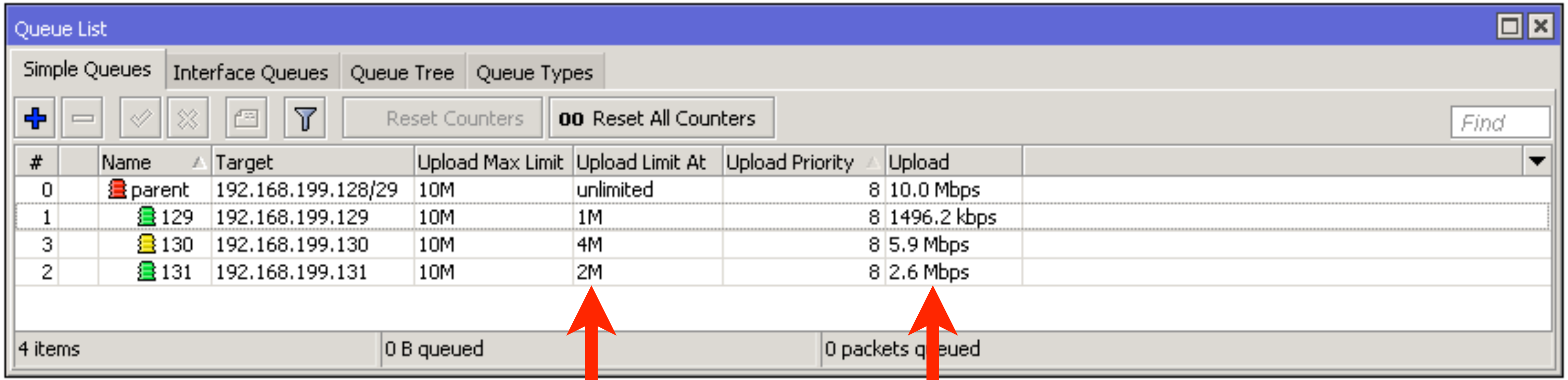
Queues → Simple Queue → Edit → Advanced

- The client will have guaranteed bandwidth 1Mbit download and upload

Guaranteed Bandwidth

- Example:
  - Total bandwith: 10Mbits
  - 3 clients, each have guaranteed bandwidth
  - Remaining bandwidth split between clients

Guaranteed Bandwidth



#		Name	Target	Upload Max Limit	Upload Limit At	Upload Priority	Upload
0		🟥 parent	192.168.199.128/29	10M	unlimited	8	10.0 Mbps
1		🟩 129	192.168.199.129	10M	1M	8	1496.2 kbps
3		🟨 130	192.168.199.130	10M	4M	8	5.9 Mbps
2		🟩 131	192.168.199.131	10M	2M	8	2.6 Mbps

4 items | 0 B queued | 0 packets queued

Guranteed bandwidth

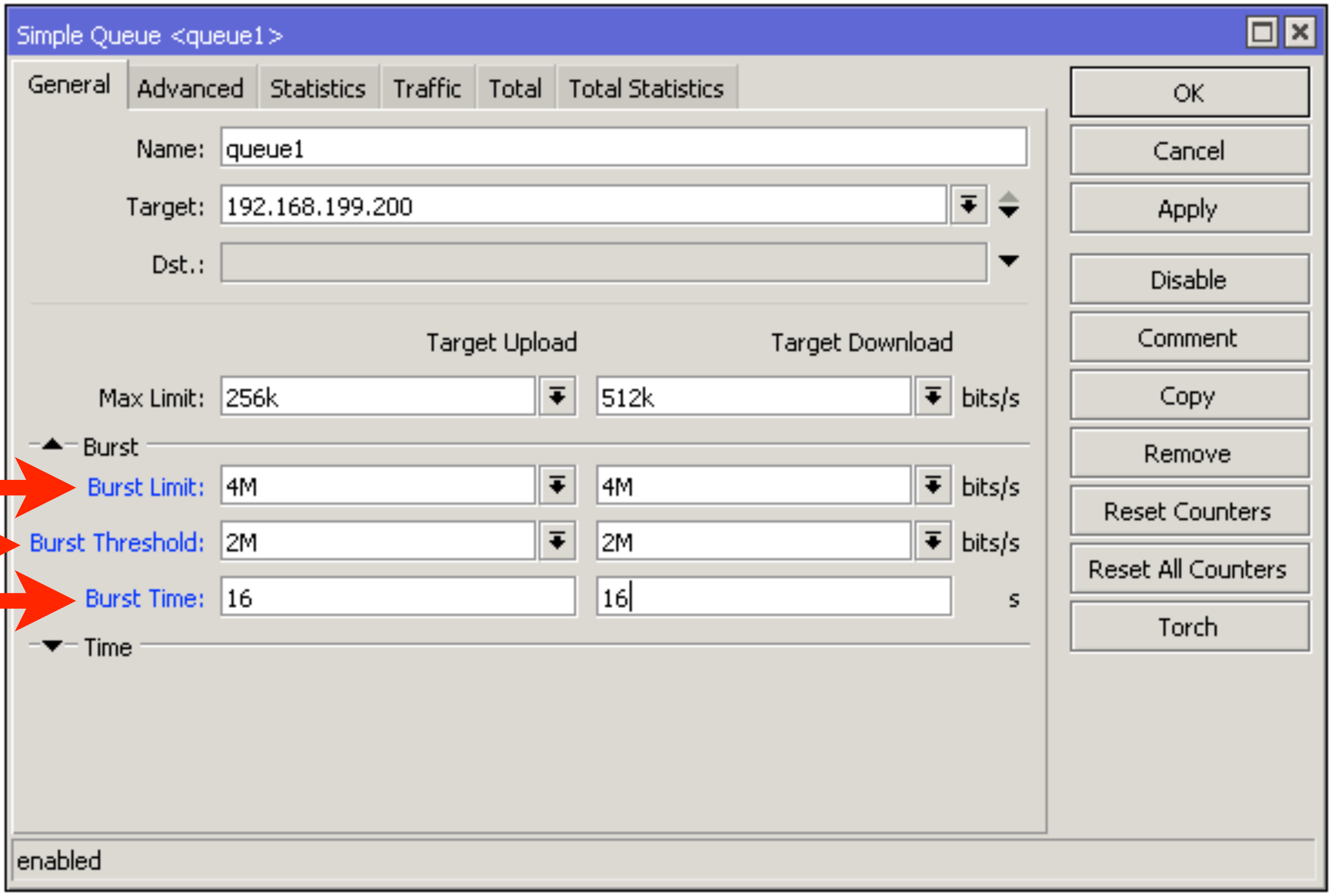
Actual bandwidth

Burst

- Used to allow higher data rates for a short period of time
- Useful for HTTP traffic - web pages load faster
- For file downloads Max Limit restrictions still apply

Burst

Set burst limit, threshold and time



Simple Queue <queue1>

Name: queue1

Target: 192.168.199.200

Dst.:

	Target Upload	Target Download	
Max Limit:	256k	512k	bits/s
Burst Limit:	4M	4M	bits/s
Burst Threshold:	2M	2M	bits/s
Burst Time:	16	16	s

enabled

Queues → Simple Queue → Edit

Burst

- **Burst limit** - max upload/download data rate that can be reached during the burst
- **Burst time** - time (sec), over which the average data rate is calculated (this is NOT the time of actual burst).
- **Burst threshold** - when average data rate exceeds or drops below the threshold the burst is switched off or on

LAB

Burst

- Modify the queue that was created in previous LAB
- Set burst limit to 4M for upload and download
- Set burst threshold 2M for upload and download
- Set burst time 16s for upload and download

LAB

Burst

- Open www.mikrotik.com, observe how fast the page loads
- Download the newest RouterOS version from MikroTik download page
- Observe the download speed with torch tool

Per Connection Queuing

- Queue type for optimising large QoS deployments by limiting per 'sub-stream'
- Substitute multiple queues with one
- Several classifiers can be used:
  - source/destination IP address
  - source/destination port

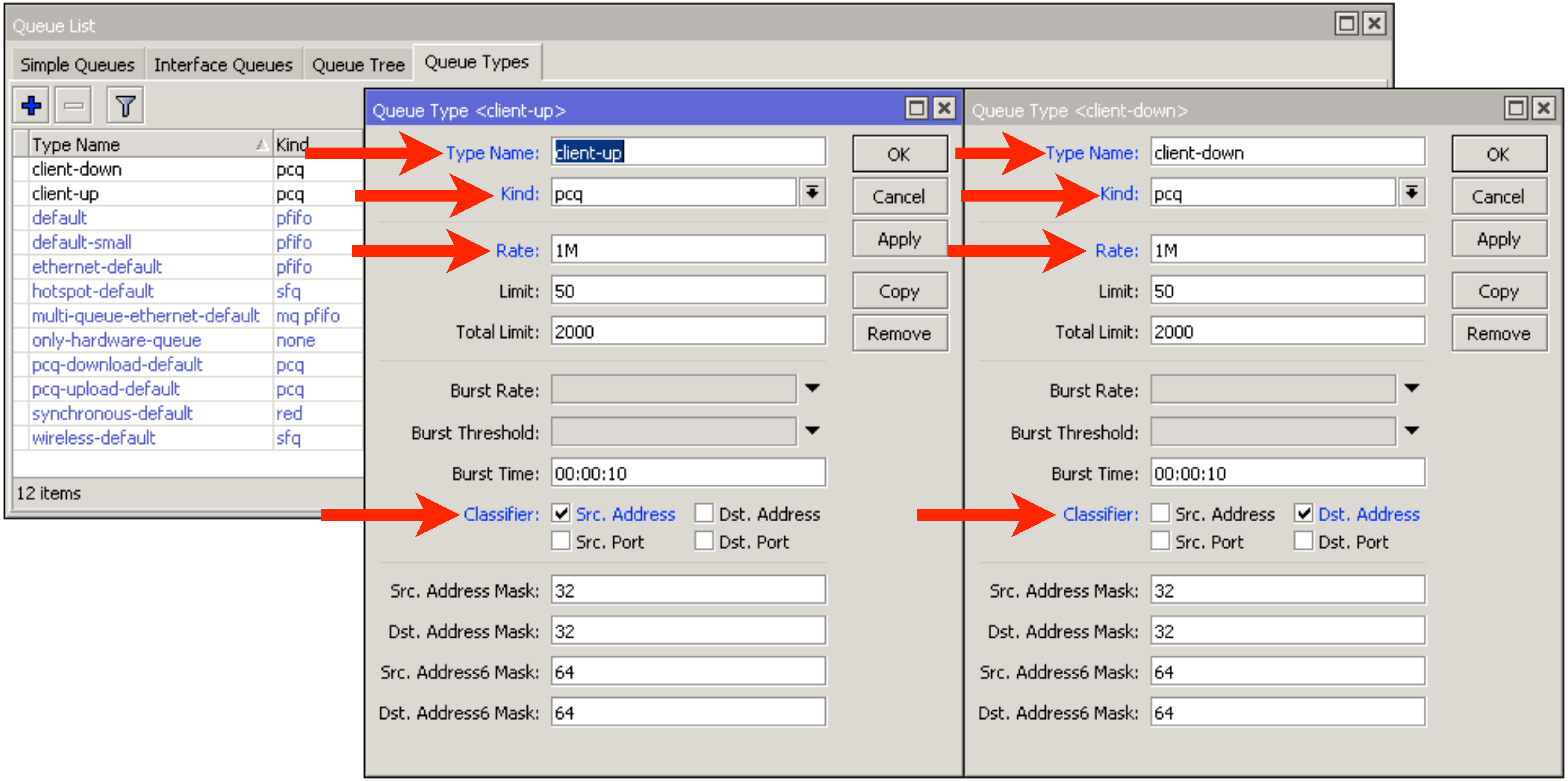
Per Connection Queuing

- Rate - max available data rate of each sub-stream
- Limit - queue size of single sub-stream (KiB)
- Total Limit - max amount of queued data in all sub-streams (KiB)

PCQ Example

- Goal: limit all clients to 1Mbps download and 1Mbps upload bandwidth
- Create 2 new queue types
  - 1 for Dst Address (download limit)
  - 1 for Scr Address (upload limit)
- Set queues for LAN and WAN interfaces

PCQ Example



Type Name	Kind
client-down	pcq
client-up	pcq
default	pfifo
default-small	pfifo
ethernet-default	pfifo
hotspot-default	sfq
multi-queue-ethernet-default	mq pfifo
only-hardware-queue	none
pcq-download-default	pcq
pcq-upload-default	pcq
synchronous-default	red
wireless-default	sfq

12 items

Queue Type <client-up>

Type Name: client-up
Kind: pcq
Rate: 1M
Limit: 50
Total Limit: 2000
Burst Rate:
Burst Threshold:
Burst Time: 00:00:10
Classifier: ☑ Src. Address □ Dst. Address □ Src. Port □ Dst. Port
Src. Address Mask: 32
Dst. Address Mask: 32
Src. Address6 Mask: 64
Dst. Address6 Mask: 64

Queue Type <client-down>

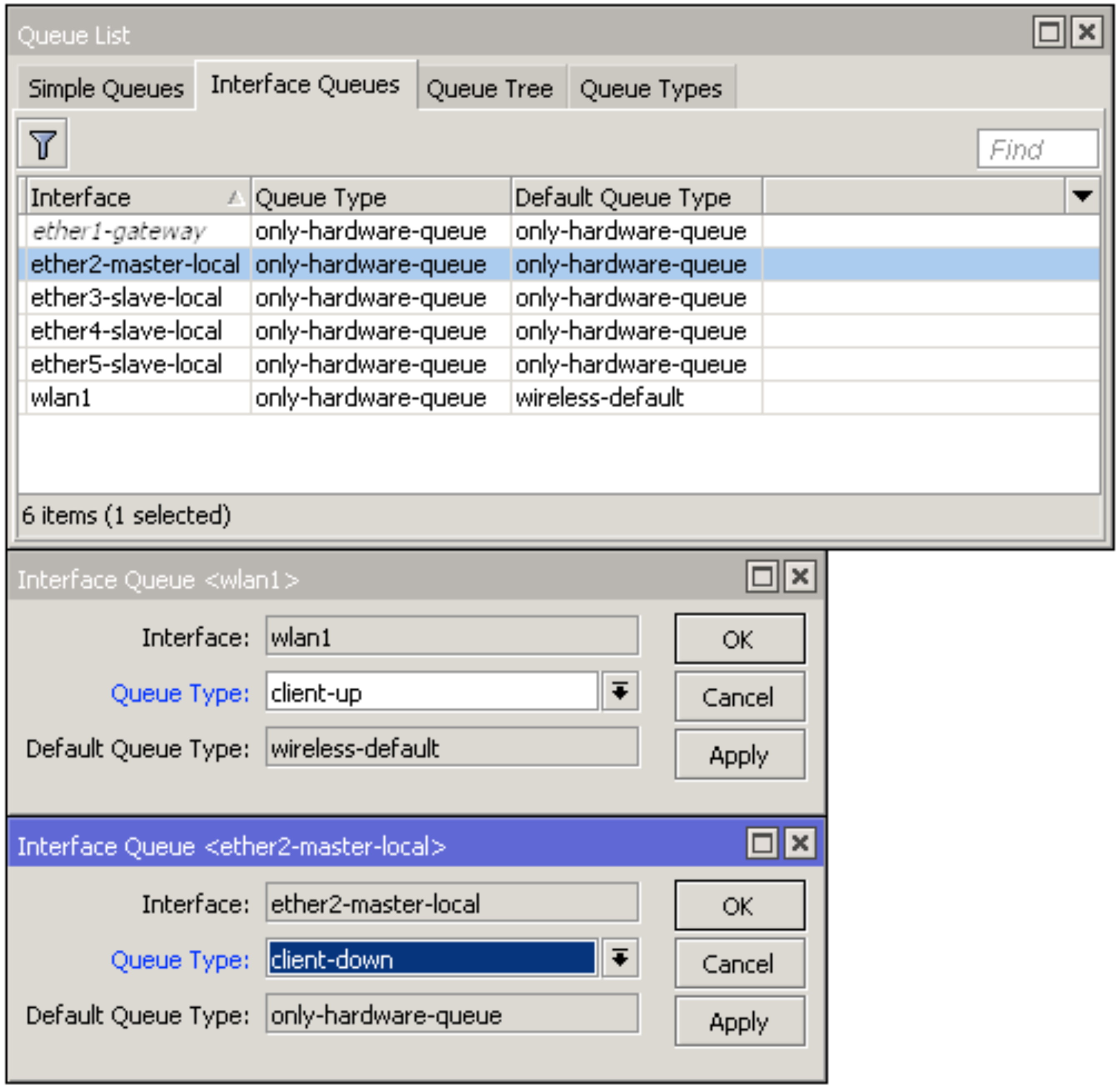
Type Name: client-down
Kind: pcq
Rate: 1M
Limit: 50
Total Limit: 2000
Burst Rate:
Burst Threshold:
Burst Time: 00:00:10
Classifier: □ Src. Address ☑ Dst. Address □ Src. Port □ Dst. Port
Src. Address Mask: 32
Dst. Address Mask: 32
Src. Address6 Mask: 64
Dst. Address6 Mask: 64

Queues → Queue Type → New Queue Type(+)

PCQ Example

WAN interface

LAN interface



Interface	Queue Type	Default Queue Type
ether1-gateway	only-hardware-queue	only-hardware-queue
ether2-master-local	only-hardware-queue	only-hardware-queue
ether3-slave-local	only-hardware-queue	only-hardware-queue
ether4-slave-local	only-hardware-queue	only-hardware-queue
ether5-slave-local	only-hardware-queue	only-hardware-queue
wlan1	only-hardware-queue	wireless-default

6 items (1 selected)

Interface Queue <wlan1>

Interface: wlan1

Queue Type: client-up

Default Queue Type: wireless-default

Interface Queue <ether2-master-local>

Interface: ether2-master-local

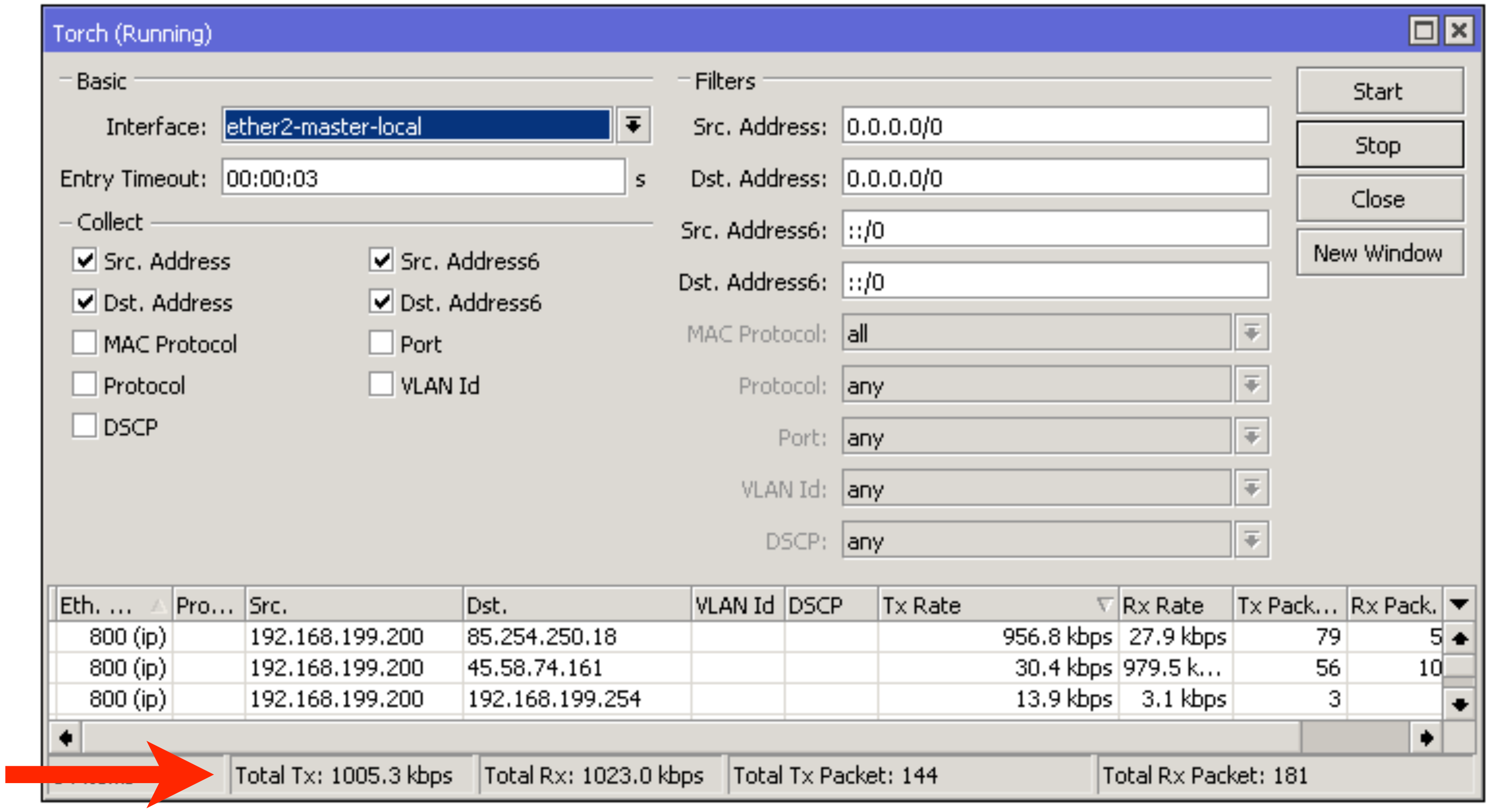
Queue Type: client-down

Default Queue Type: only-hardware-queue

Queues → Interface Queues

PCQ Example

- All clients connected to the LAN interface will have 1Mbps upload and download limit



Torch (Running)

Basic

Interface: ether2-master-local

Entry Timeout: 00:00:03 s

Collect

☑ Src. Address ☑ Src. Address6

☑ Dst. Address ☑ Dst. Address6

□ MAC Protocol □ Port

□ Protocol □ VLAN Id

□ DSCP

Filters

Src. Address: 0.0.0.0/0

Dst. Address: 0.0.0.0/0

Src. Address6: ::/0

Dst. Address6: ::/0

MAC Protocol: all

Protocol: any

Port: any

VLAN Id: any

DSCP: any

Eth. ...	Pro...	Src.	Dst.	VLAN Id	DSCP	Tx Rate	Rx Rate	Tx Pack...	Rx Pack.
800 (ip)		192.168.199.200	85.254.250.18			956.8 kbps	27.9 kbps	79	5
800 (ip)		192.168.199.200	45.58.74.161			30.4 kbps	979.5 k...	56	10
800 (ip)		192.168.199.200	192.168.199.254			13.9 kbps	3.1 kbps	3	

Total Tx: 1005.3 kbps | Total Rx: 1023.0 kbps | Total Tx Packet: 144 | Total Rx Packet: 181

Tools → Torch

MikroTik MTCNA

LAB

PCQ Example

- The trainer will create two pcq queues and limit all clients (student routers) to 512Kbps upload and download bandwidth
- Try download newest RouterOS version from www.mikrotik.com and observe the download speed with torch tool

Module 7
Summary

Certified Network Associate (MTCNA)

Module 8

Tunnels

Point-to-Point Protocol

- Point-to-Point Protocol (PPP) is used to establish a tunnel (direct connection) between two nodes
- PPP can provide connection authentication, encryption and compression
- RouterOS supports various PPP tunnels such as PPPoE, SSTP, PPTP and others

PPPoE

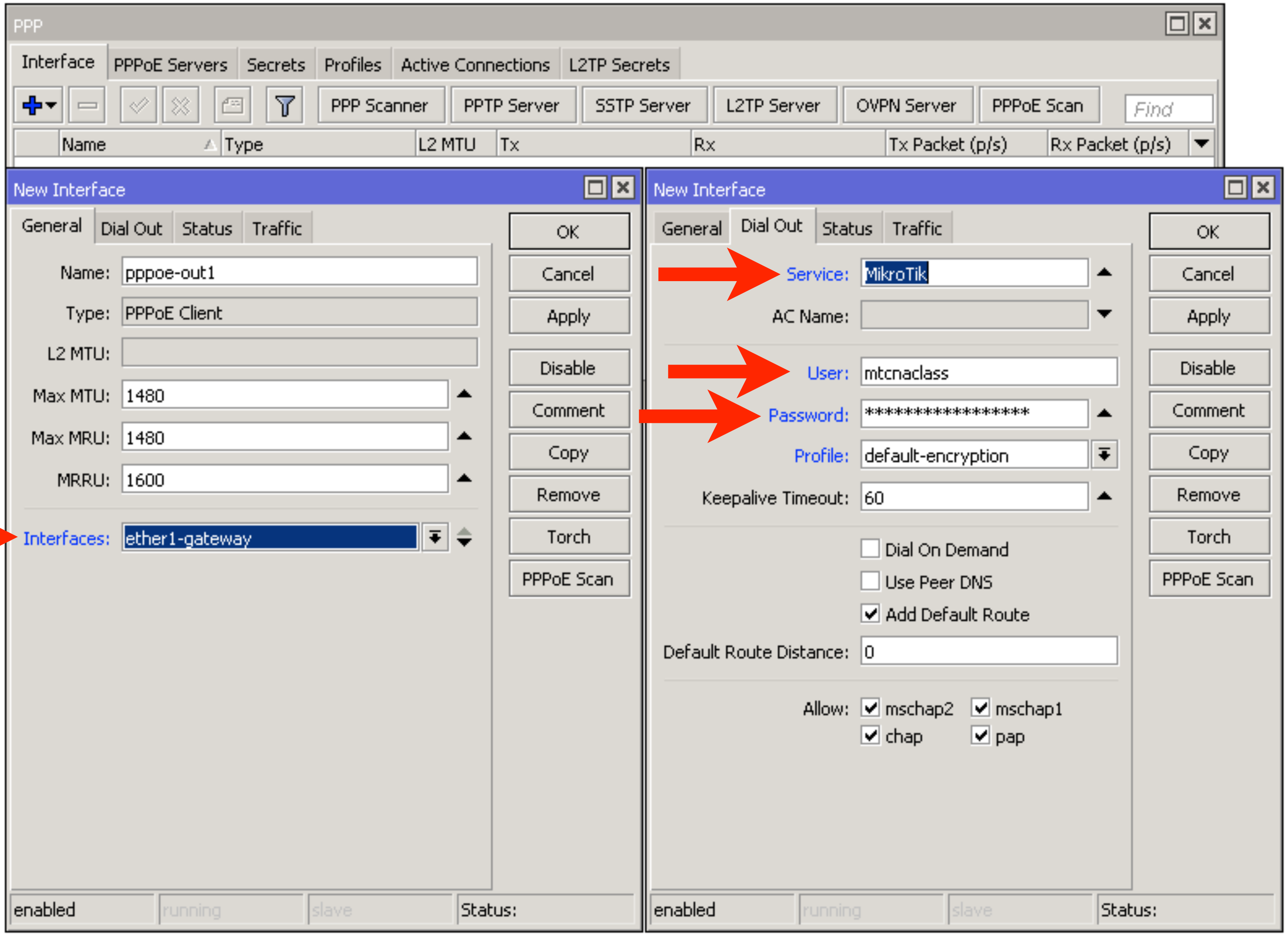
- Point-to-Point Protocol over Ethernet is a layer 2 protocol which is used to control access to the network
- Provides authentication, encryption and compression
- PPPoE can be used to hand out IP addresses to the clients

PPPoE

- Most desktop operating systems have PPPoE client installed by default
- RouterOS supports both PPPoE client and PPPoE server (access concentrator)

PPPoE Client

Set interface, service, username, password



New Interface (General):

Name: pppoe-out1
Type: PPPoE Client
L2 MTU:
Max MTU: 1480
Max MRU: 1480
MRRU: 1600
Interfaces: ether1-gateway

enabled | running | slave | Status:

New Interface (Dial Out):

Service: MikroTik
AC Name:
User: mtcnaclass
Password: *****************
Profile: default-encryption
Keepalive Timeout: 60

☐ Dial On Demand
☐ Use Peer DNS
☑ Add Default Route

Default Route Distance: 0

Allow: ☑ mschap2 ☑ mschap1
☑ chap ☑ pap

enabled | running | slave | Status:

PPP → New PPPoE Client(+)

PPPoE Client

- If there are more than one PPPoE servers in a broadcast domain **service name** should also be specified
- Otherwise the client will try to connect to the one which responds first

LAB

PPPoE Client

- The trainer will create a PPPoE server on his/her router
- Disable the DHCP client on your router
- Set up PPPoE client on your router’s outgoing interface
- Set username **mtcnaclass** password **mtcnaclass**

LAB

PPPoE Client

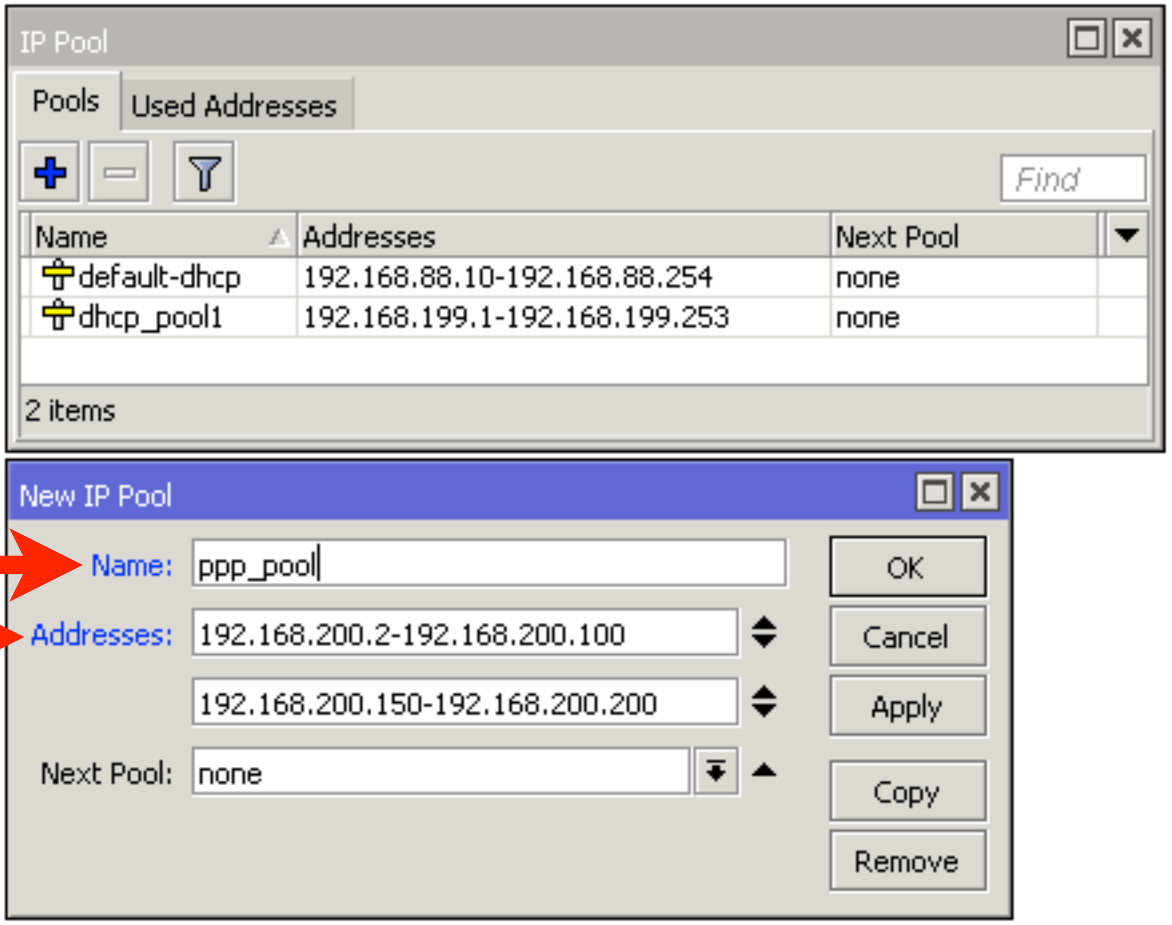
- Check PPPoE client status
- Check that the connection to the Internet is available
- When done, disable PPPoE client
- Enable DHCP client to restore previous configuration

IP Pool

- Defines the range of IP addresses for handing out by RouterOS services
- Used by DHCP, PPP and HotSpot clients
- Addresses are taken from the pool automatically

IP Pool

Set the pool name and address range(s)



Name	Addresses	Next Pool
default-dhcp	192.168.88.10-192.168.88.254	none
dhcp_pool1	192.168.199.1-192.168.199.253	none

2 items

New IP Pool

Name: ppp_pool

Addresses: 192.168.200.2-192.168.200.100

192.168.200.150-192.168.200.200

Next Pool: none

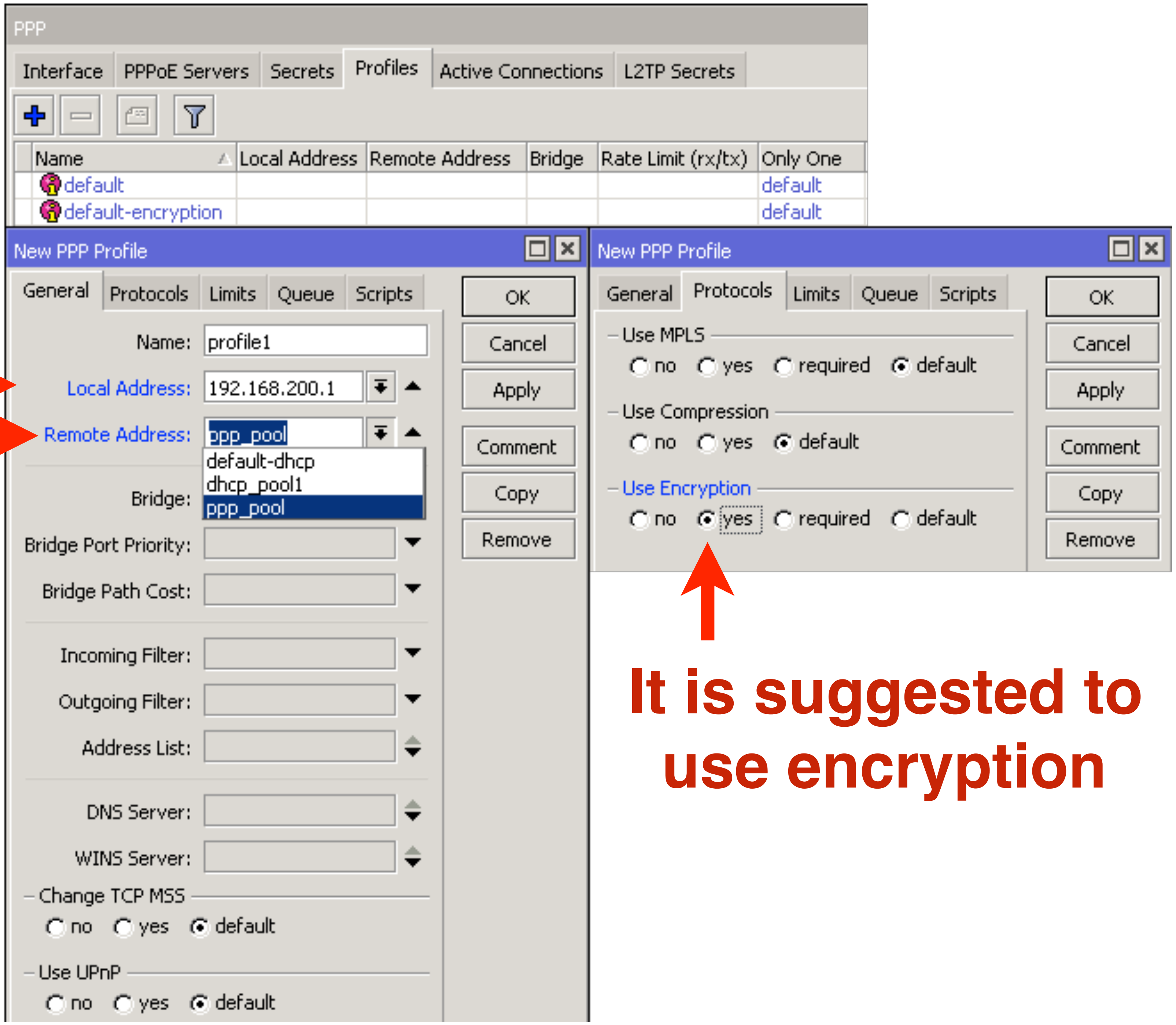
IP → Pool → New IP Pool(+)

PPP Profile

- Profile defines rules used by PPP server for it's clients
- Method to set the same settings for multiple clients

PPP Profile

Set the local and remote address of the tunnel



Name	Local Address	Remote Address	Bridge	Rate Limit (rx/tx)	Only One
default					default
default-encryption					default

Name: profile1

Local Address: 192.168.200.1

Remote Address: ppp_pool

- default-dhcp
- dhcp_pool1
- ppp_pool

Bridge:

Bridge Port Priority:

Bridge Path Cost:

Incoming Filter:

Outgoing Filter:

Address List:

DNS Server:

WINS Server:

Change TCP MSS: ○ no ○ yes ● default

Use UPnP: ○ no ○ yes ● default

Use MPLS: ○ no ○ yes ○ required ● default

Use Compression: ○ no ○ yes ● default

Use Encryption: ○ no ● yes ○ required ○ default

It is suggested to use encryption

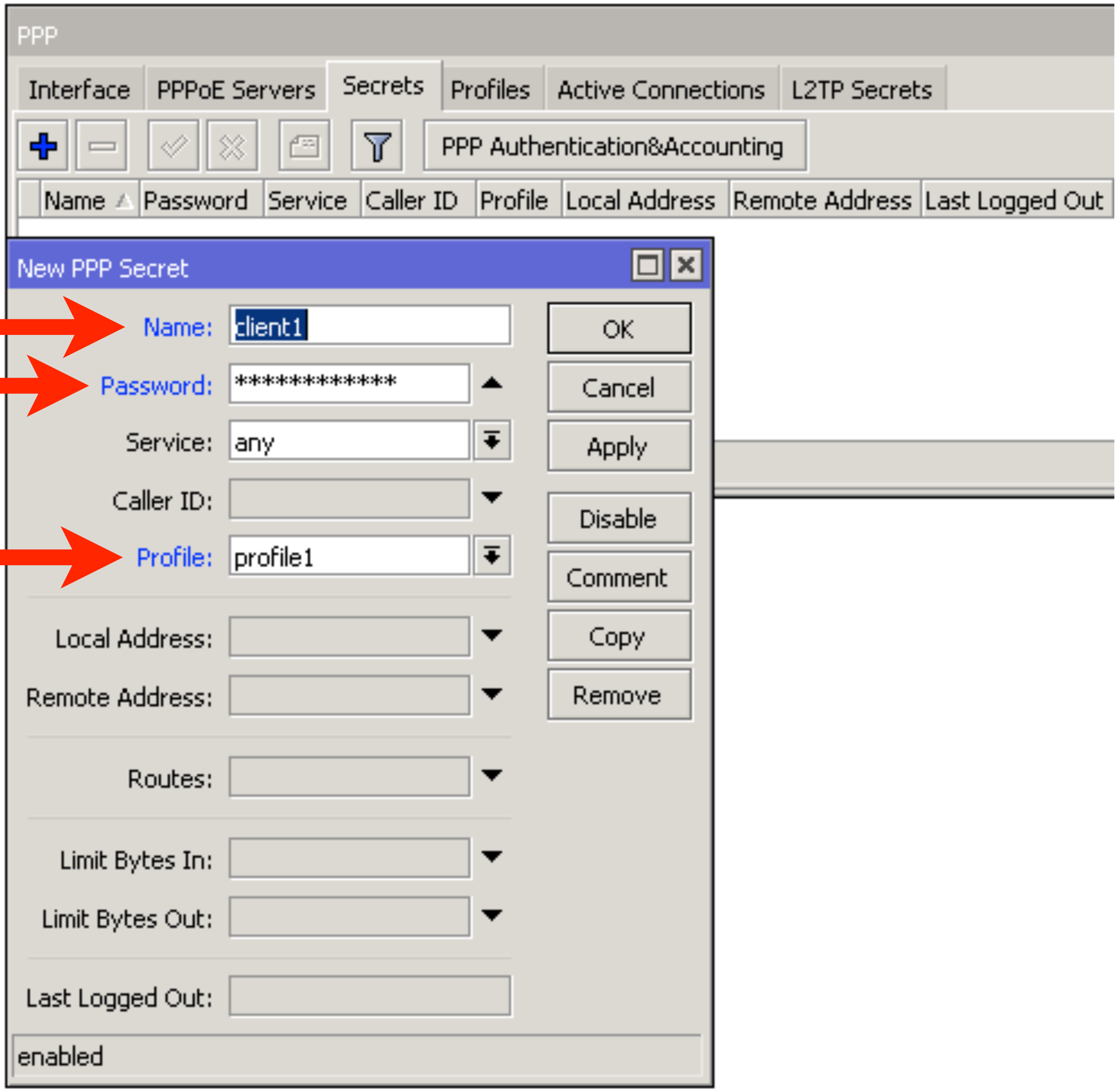
PPP → Profiles → New PPP Profile(+)

PPP Secret

- Local PPP user database
- Username, password and other user specific settings can be configured
- Rest of the settings are applied from the selected PPP profile
- PPP secret settings override corresponding PPP profile settings

PPP Secret

Set the username, password and profile. Specify service if necessary



Name: client1

Password: ************

Service: any

Caller ID:

Profile: profile1

Local Address:

Remote Address:

Routes:

Limit Bytes In:

Limit Bytes Out:

Last Logged Out:

enabled

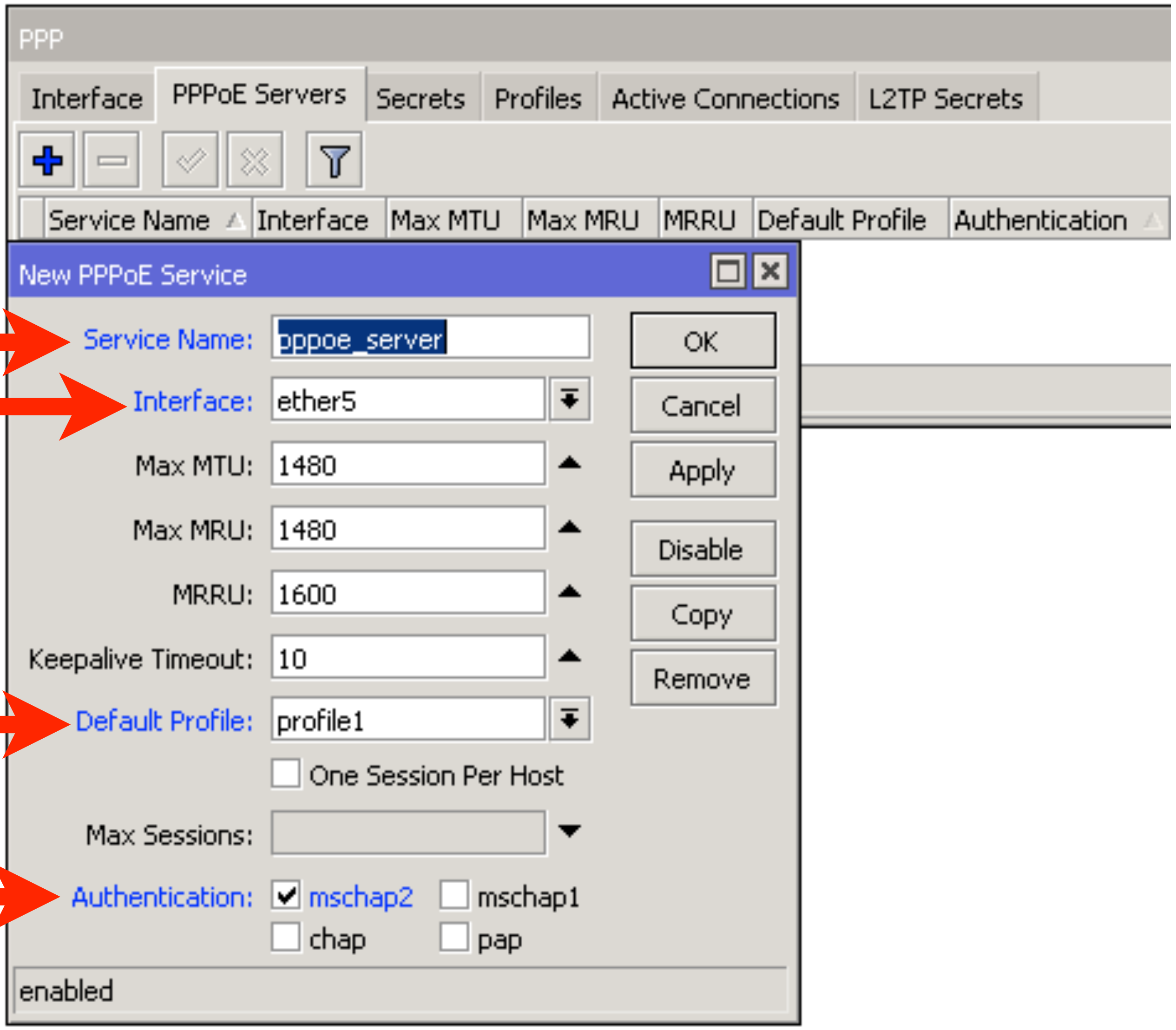
PPP → Secrets → New PPP Secret(+)

PPPoE Server

- PPPoE server runs on an interface
- Can not be configured on an interface which is part of a bridge
- Either remove from the bridge or set up PPPoE server on the bridge
- For security reasons IP address should not be used on the interface on which PPPoE server is configured

PPPoE Server

Set the service name, interface, profile and authentication protocols



Service Name: pppoe_server

Interface: ether5

Max MTU: 1480

Max MRU: 1480

MRRU: 1600

Keepalive Timeout: 10

Default Profile: profile1

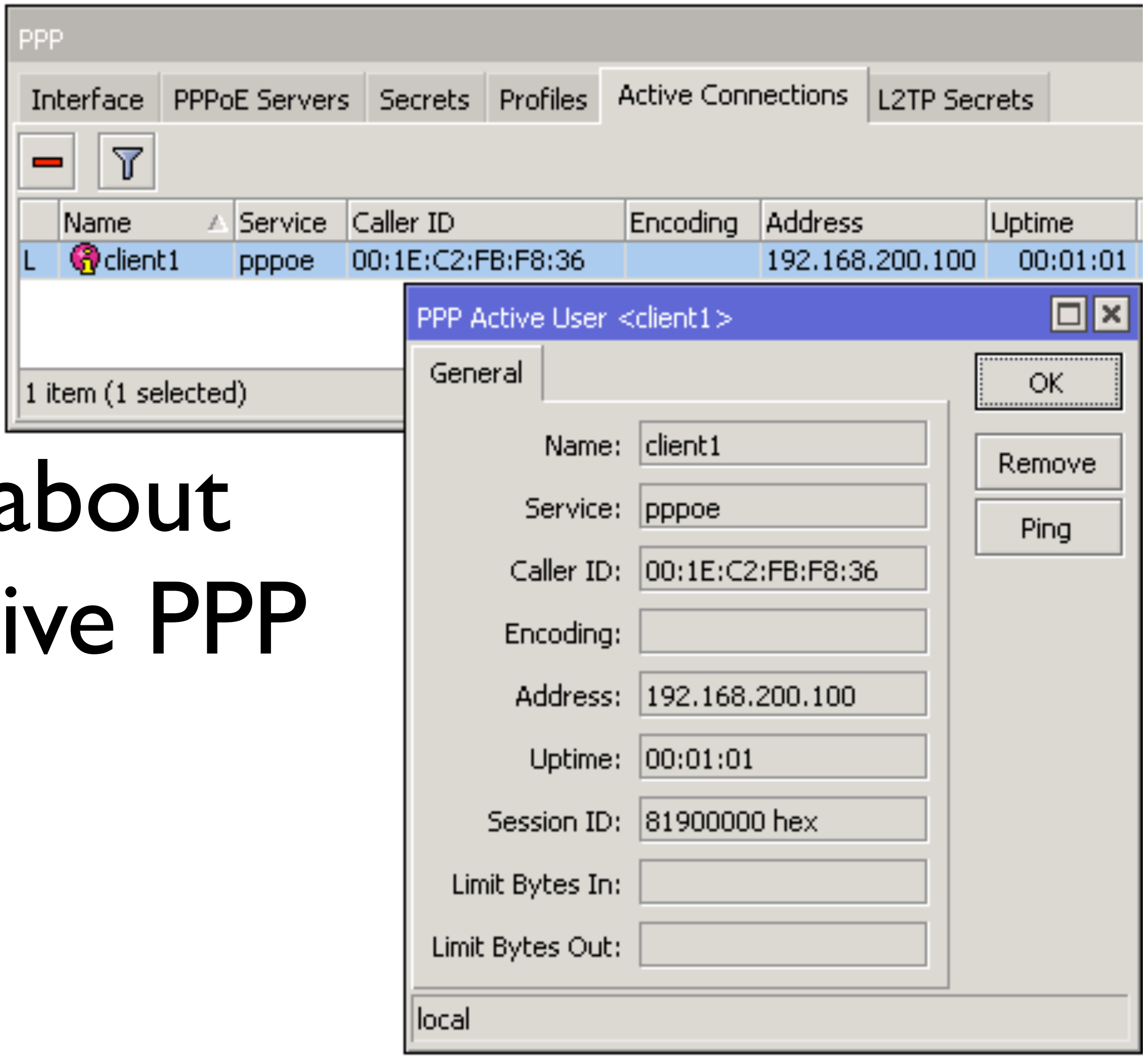
□ One Session Per Host

Max Sessions:

Authentication: ☑ mschap2 □ mschap1 □ chap □ pap

enabled

PPP Status



	Name	Service	Caller ID	Encoding	Address	Uptime
L	client1	pppoe	00:1E:C2:FB:F8:36		192.168.200.100	00:01:01

1 item (1 selected)

Name:	client1
Service:	pppoe
Caller ID:	00:1E:C2:FB:F8:36
Encoding:	
Address:	192.168.200.100
Uptime:	00:01:01
Session ID:	81900000 hex
Limit Bytes In:	
Limit Bytes Out:	

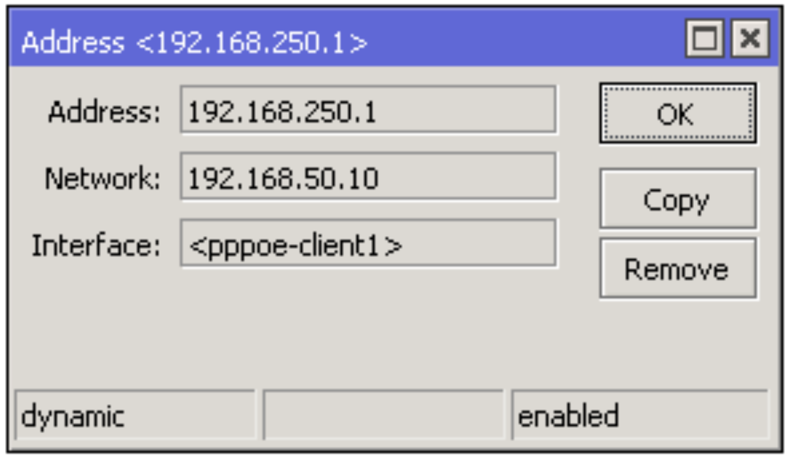
local

- Information about currently active PPP users

PPP → Active Connections

Point-to-Point Addresses

- When a connection is made between the PPP client and server, /32 addresses are assigned
- For the client network address (or gateway) is the other end of the tunnel (router)



Address <192.168.250.1>

Address: 192.168.250.1

Network: 192.168.50.10

Interface: <pppoe-client1>

dynamic

enabled

Point-to-Point Addresses

- Subnet mask is not relevant when using PPP addressing
- PPP addressing saves 2 IP addresses
- If PPP addressing is not supported by the other device, /30 network addressing should be used

LAB

PPPoE Server

- Set up PPPoE server on an unused LAN interface (e.g. eth5) of the router
- Remove eth5 from the switch (set master port: none)
- Check that the interface is not a port of the bridge
- Check that the interface has no IP address

LAB

PPPoE Server

- Create an **IP pool, PPP profile** and **secret** for the PPPoE server
- Create the PPPoE server
- Configure PPPoE client on your laptop
- Connect your laptop to the router port on which the PPPoE server is configured

MikroTik
MTCNA

PPPoE Server

LAB

- Connect to PPPoE server
- Check that the connection to the Internet is available
- Connect to the router using MAC WinBox and observe PPP status
- Disconnect from the PPPoE server and connect the laptop back to previously used port

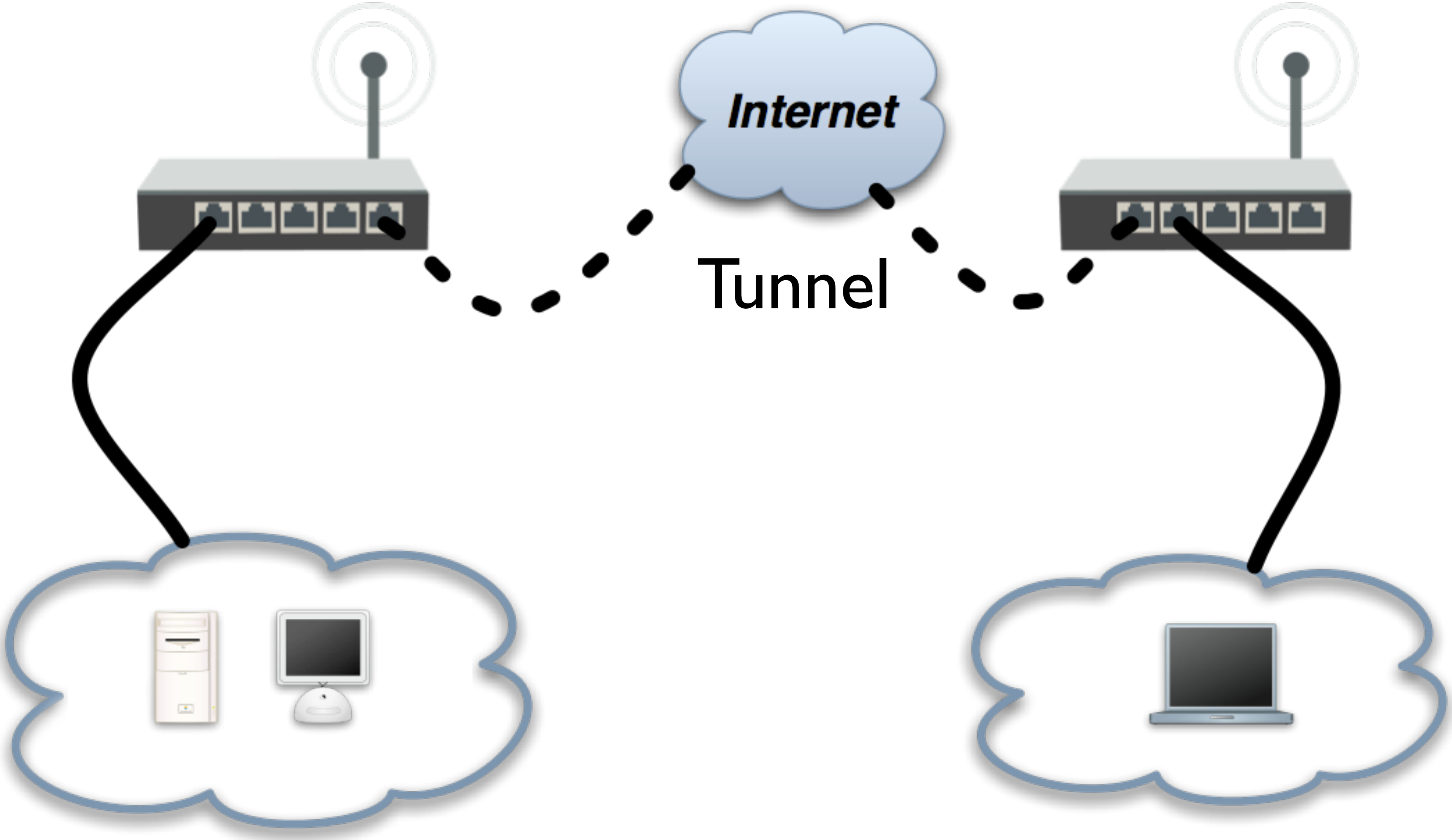
PPTP

- Point-to-point tunnelling protocol (PPTP) provides encrypted tunnels over IP
- Can be used to create secure connections between local networks over the Internet
- RouterOS supports both PPTP client and PPTP server

PPTP

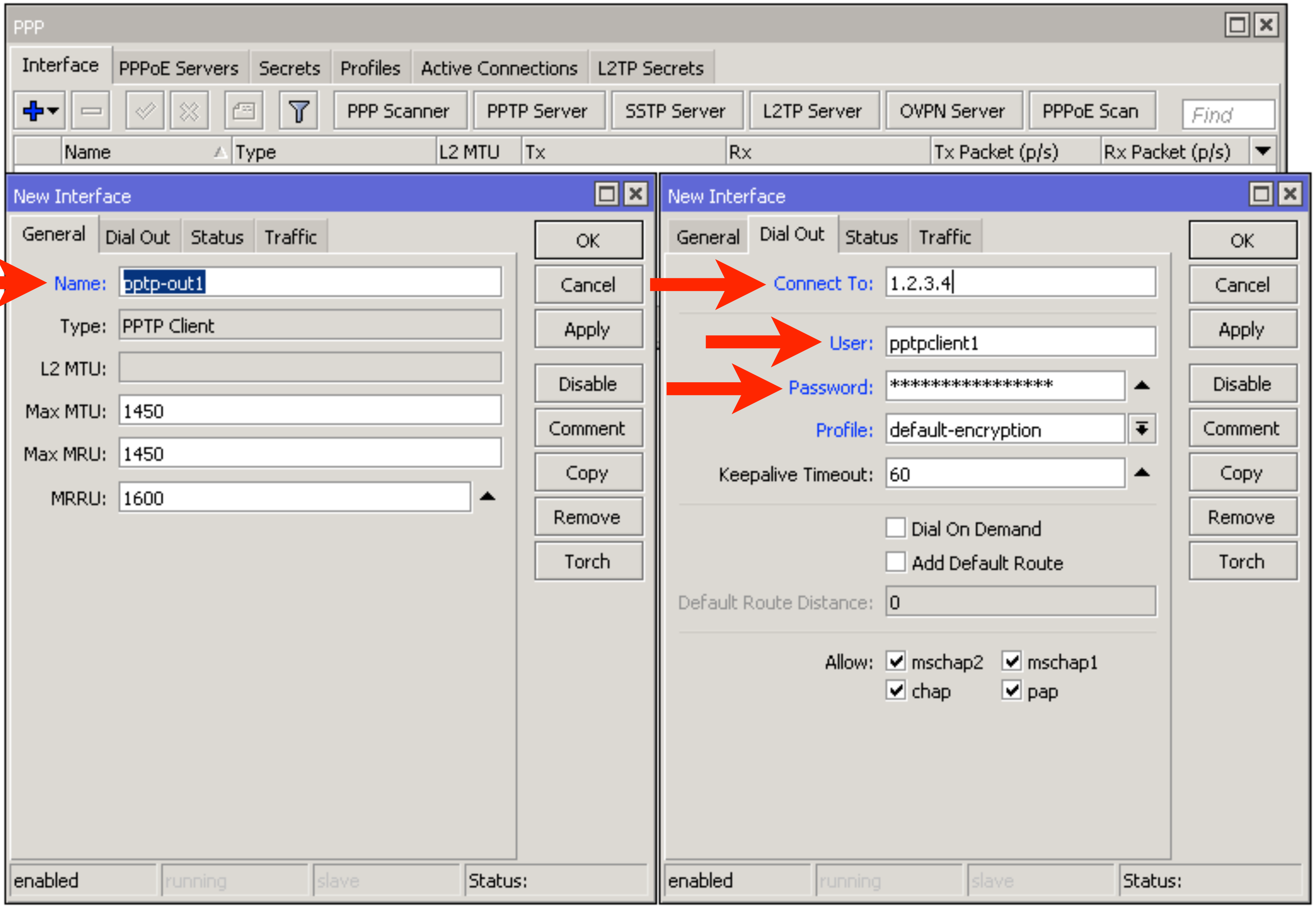
- Uses port tcp/1723 and IP protocol number 47 - GRE (Generic Routing Encapsulation)
- NAT helpers are used to support PPTP in a NAT'd network

PPP Tunnel



PPTP Client

Set name, PPTP server IP address, username, password



PPP

New Interface — General

Name: pptp-out1

Type: PPTP Client

L2 MTU:

Max MTU: 1450

Max MRU: 1450

MRRU: 1600

enabled | running | slave | Status:

New Interface — Dial Out

Connect To: 1.2.3.4

User: pptpclient1

Password: ****************

Profile: default-encryption

Keepalive Timeout: 60

☐ Dial On Demand

☐ Add Default Route

Default Route Distance: 0

Allow: ☑ mschap2 ☑ mschap1 ☑ chap ☑ pap

enabled | running | slave | Status:

PPP → New PPTP Client(+)

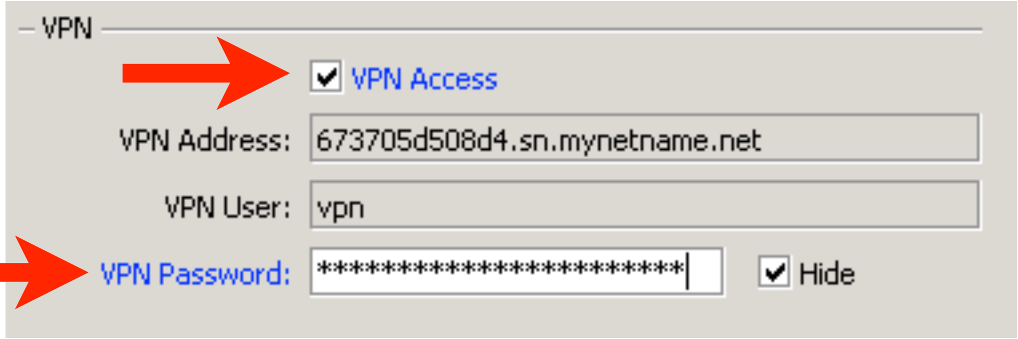
PPTP Client

- Use Add Default Route to send all traffic through the PPTP tunnel
- Use static routes to send specific traffic through the PPTP tunnel
- Note! PPTP is not considered secure anymore - use with caution!
- Instead use SSTP, OpenVPN or other

PPTP Server

- RouterOS provides simple PPTP server setup for administrative purposes
- Use QuickSet to enable VPN Access

Enable VPN access and set VPN password



VPN

☑ VPN Access

VPN Address: 673705d508d4.sn.mynetname.net

VPN User: vpn

VPN Password: ********************** ☑ Hide

SSTP

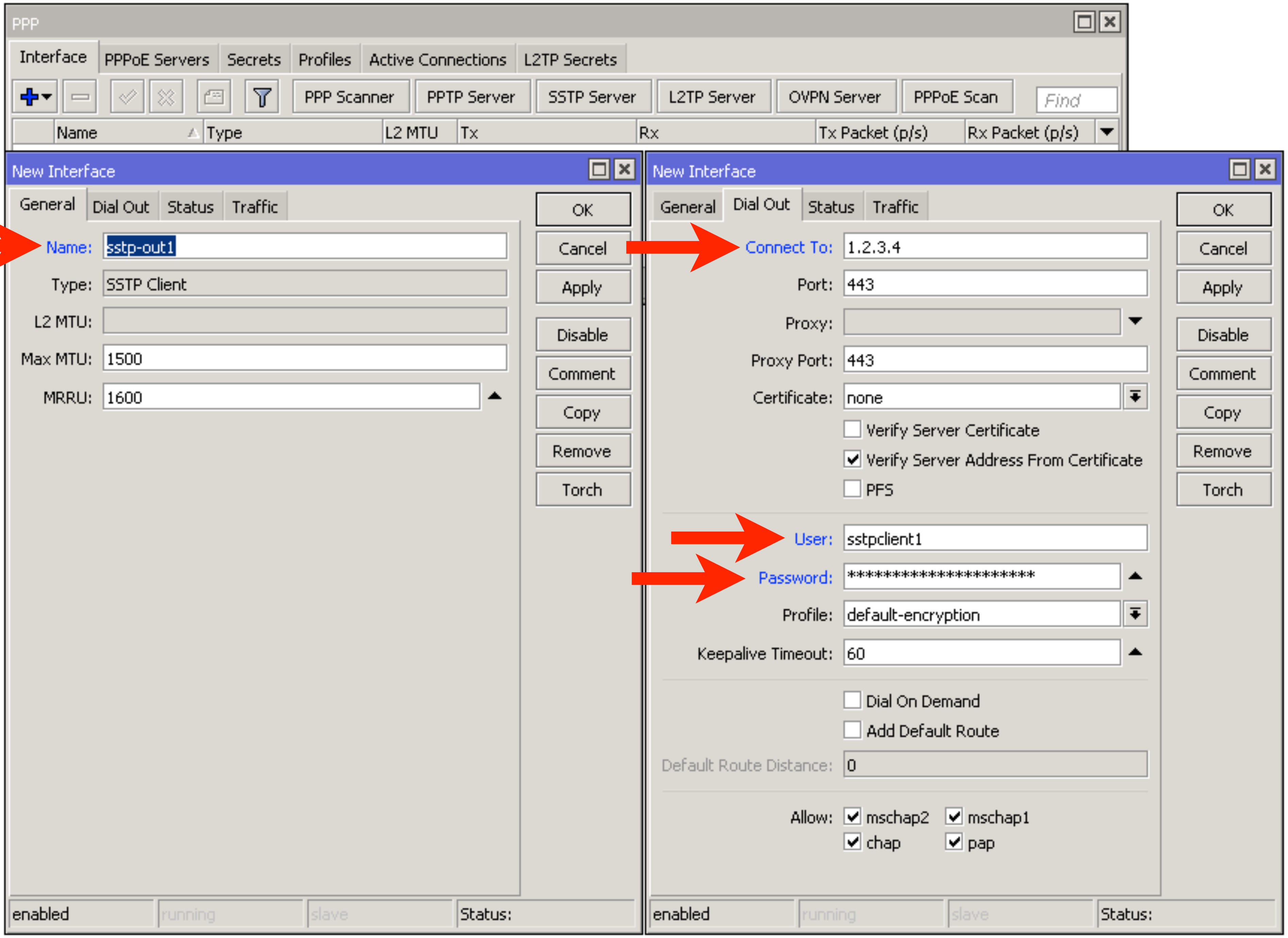
- Secure Socket Tunnelling Protocol (SSTP) provides encrypted tunnels over IP
- Uses port tcp/443 (the same as HTTPS)
- RouterOS supports both SSTP client and SSTP server
- SSTP client available on Windows Vista SP1 and later versions

SSTP

- Open Source client and server implementation available on Linux
- As it is identical to HTTPS traffic, usually SSTP can pass through firewalls without specific configuration

SSTP Client

Set name, SSTP server IP address, username, password



Name: sstp-out1
Type: SSTP Client
L2 MTU:
Max MTU: 1500
MRRU: 1600

enabled | running | slave | Status:

Connect To: 1.2.3.4
Port: 443
Proxy:
Proxy Port: 443
Certificate: none
□ Verify Server Certificate
☑ Verify Server Address From Certificate
□ PFS

User: sstpclient1
Password: ********************
Profile: default-encryption
Keepalive Timeout: 60

□ Dial On Demand
□ Add Default Route
Default Route Distance: 0

Allow: ☑ mschap2 ☑ mschap1
☑ chap ☑ pap

enabled | running | slave | Status:

SSTP Client

- Use Add Default Route to send all traffic through the SSTP tunnel
- Use static routes to send specific traffic through the SSTP tunnel

SSTP Client

- No SSL certificates needed to connect between two RouterOS devices
- To connect from Windows, a valid certificate is necessary
- Can be issued by internal certificate authority (CA)

MikroTik MTCNA

LAB

PPTP/SSTP

- Pair up with your neighbor
- One of you will create PPTP server and SSTP client, the other - SSTP server and PPTP client
- Reuse previously created **IP pool**, **PPP profile** and **secret** for the servers
- Create client connection to your neighbor’s router

LAB

PPTP/SSTP

- Check firewall rules. Remember PPTP server uses port tcp/1723 and GRE protocol, SSTP port tcp/443
- Ping your neighbor's laptop from your laptop (not pinging)
- WHY? (answer on the next slide)

PPTP/SSTP

LAB

- There are no routes to your neighbors internal network
- Both create static routes to the other's network, set PPP client interface as a gateway
- Ping your neighbor's laptop from your laptop (should ping)

PPP

- In more detail PPPoE, PPTP, SSTP and other tunnel protocol server and client implementations are covered in MTCRE and MTCINE MikroTik certified courses
- For more info see: http://training.mikrotik.com

Module 8
Summary

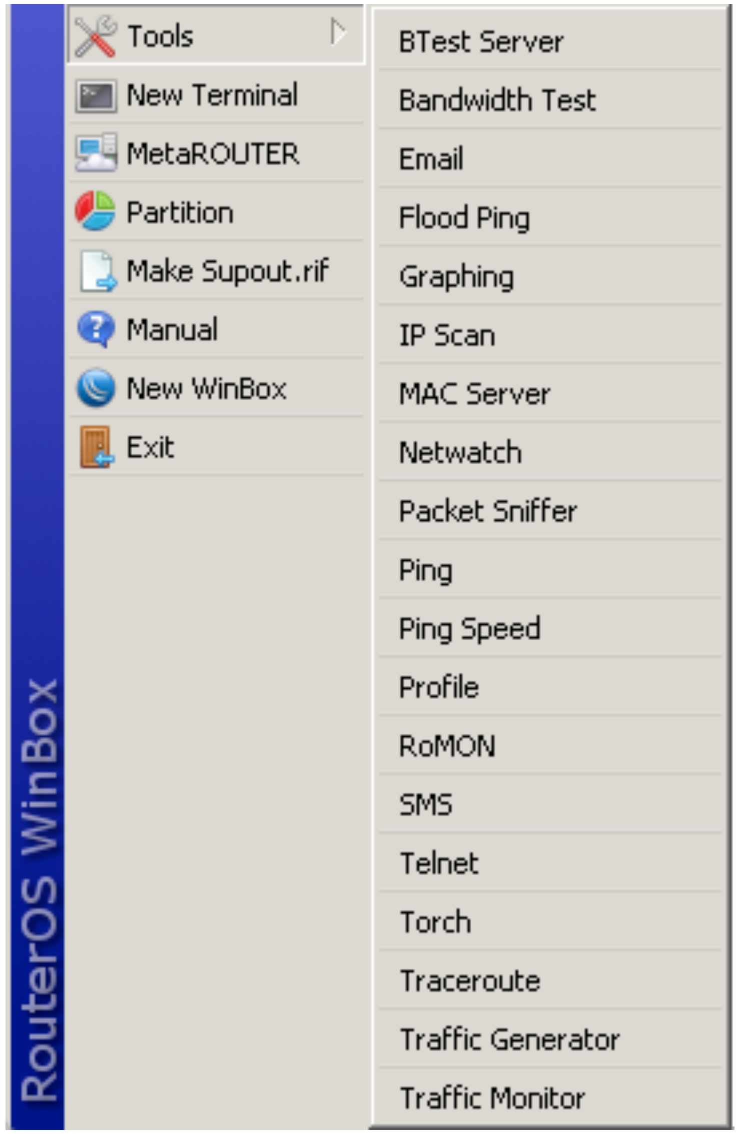
Certified Network Associate (MTCNA)

Module 9

Misc

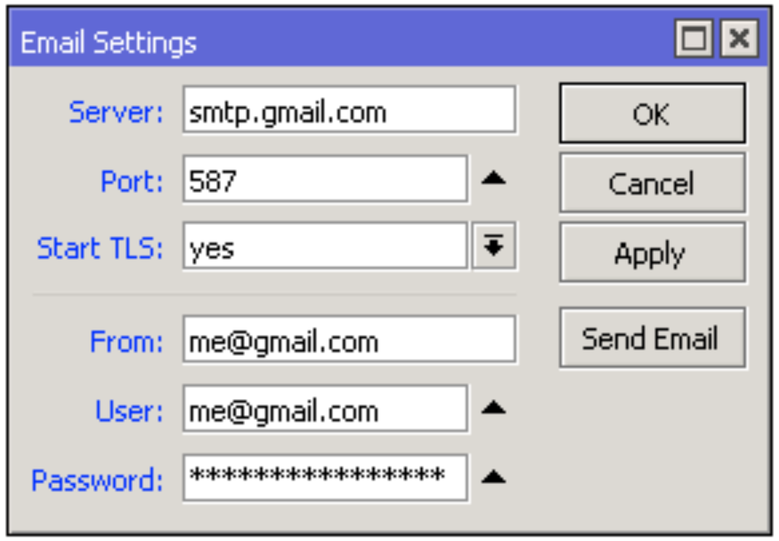
RouterOS Tools

- RouterOS provides various utilities that help to administrate and monitor the router more efficiently



E-mail

- Allows to send e-mails from the router
- For example to send router backup



Email Settings

Server: smtp.gmail.com

Port: 587

Start TLS: yes

From: me@gmail.com

User: me@gmail.com

Password: ***************

Tools → Email

```
/export file=export
/tool e-mail send to=you@gmail.com\
  subject="$[/system identity get name] export"\
  body="$[/system clock get date]\
  configuration file" file=export.rsc
```

A script to make an export file and send it via e-mail

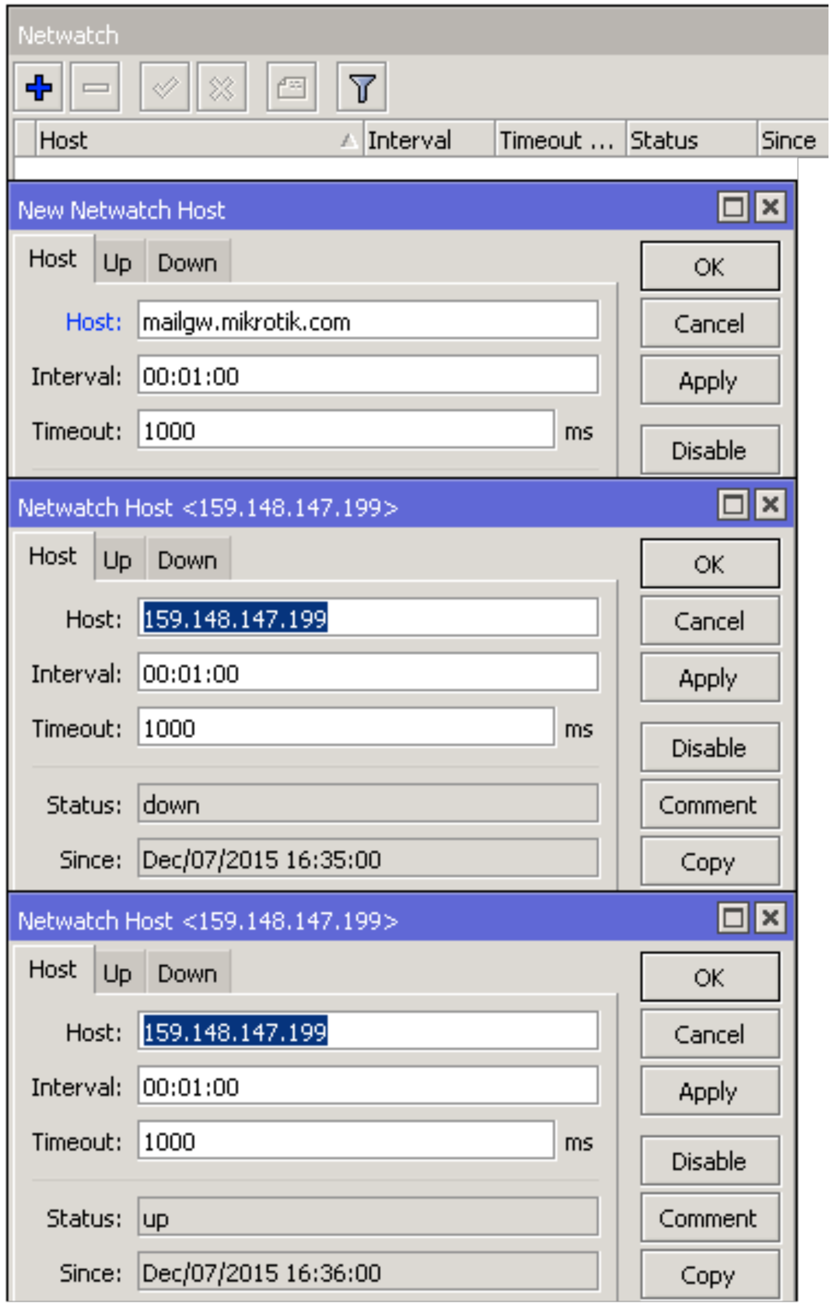
Optional LAB

E-mail

- Configure your SMTP server settings on the router
- Export the configuration of your router
- Send it to your e-mail from the RouterOS

Netwatch

- Monitors state of hosts on the network
- Sends ICMP echo request (ping)
- Can execute a script when a host becomes unreachable or reachable



New Netwatch Host

Host: mailgw.mikrotik.com
Interval: 00:01:00
Timeout: 1000 ms

Netwatch Host <159.148.147.199>

Host: 159.148.147.199
Interval: 00:01:00
Timeout: 1000 ms
Status: down
Since: Dec/07/2015 16:35:00

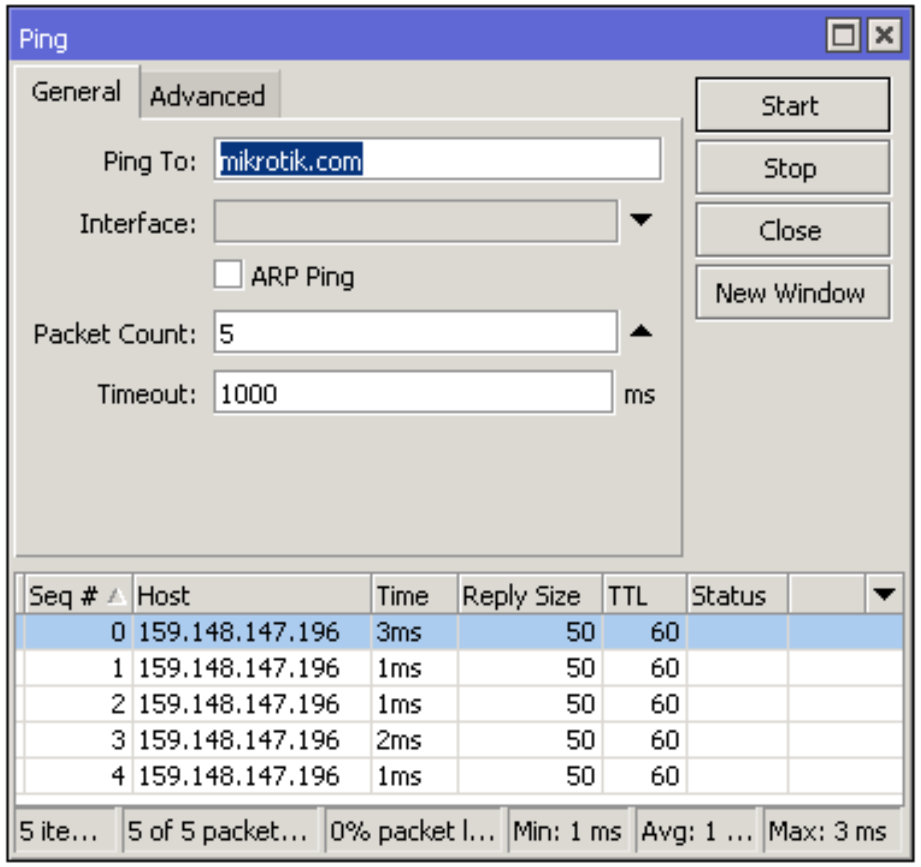
Netwatch Host <159.148.147.199>

Host: 159.148.147.199
Interval: 00:01:00
Timeout: 1000 ms
Status: up
Since: Dec/07/2015 16:36:00

Tools → Netwatch

Ping

- Used to test the reachability of a host on an IP network
- To measure the round trip time for messages between source and destination hosts
- Sends ICMP echo request packets



Ping To: mikrotik.com

Interface:

□ ARP Ping

Packet Count: 5

Timeout: 1000 ms

Seq #	Host	Time	Reply Size	TTL	Status
0	159.148.147.196	3ms	50	60	
1	159.148.147.196	1ms	50	60	
2	159.148.147.196	1ms	50	60	
3	159.148.147.196	2ms	50	60	
4	159.148.147.196	1ms	50	60	

5 ite... | 5 of 5 packet... | 0% packet l... | Min: 1 ms | Avg: 1 ... | Max: 3 ms

Tools → Ping

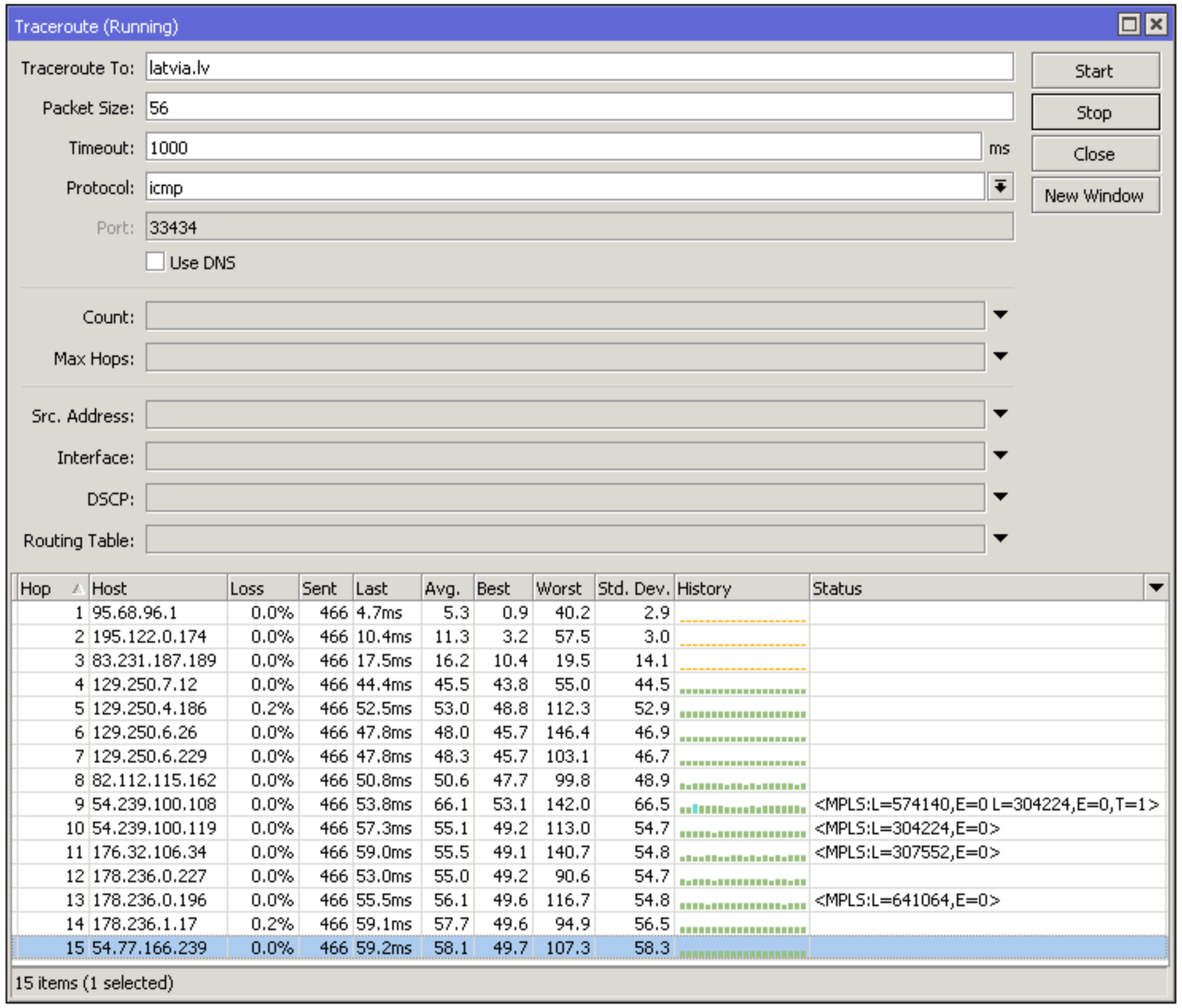
LAB

Ping

- Ping your laptop's IP address from the router
- Click 'New Window' and ping www.mikrotik.com from the router
- Observe the round trip time difference

Traceroute

- Network diagnostic tool for displaying route (path) of packets across an IP network
- Can use **icmp** or **udp** protocol



Traceroute To: latvia.lv

Packet Size: 56

Timeout: 1000 ms

Protocol: icmp

Port: 33434

☐ Use DNS

Count:

Max Hops:

Src. Address:

Interface:

DSCP:

Routing Table:

Hop	Host	Loss	Sent	Last	Avg.	Best	Worst	Std. Dev.	History	Status
1	95.68.96.1	0.0%	466	4.7ms	5.3	0.9	40.2	2.9		
2	195.122.0.174	0.0%	466	10.4ms	11.3	3.2	57.5	3.0		
3	83.231.187.189	0.0%	466	17.5ms	16.2	10.4	19.5	14.1		
4	129.250.7.12	0.0%	466	44.4ms	45.5	43.8	55.0	44.5		
5	129.250.4.186	0.2%	466	52.5ms	53.0	48.8	112.3	52.9		
6	129.250.6.26	0.0%	466	47.8ms	48.0	45.7	146.4	46.9		
7	129.250.6.229	0.0%	466	47.8ms	48.3	45.7	103.1	46.7		
8	82.112.115.162	0.0%	466	50.8ms	50.6	47.7	99.8	48.9		
9	54.239.100.108	0.0%	466	53.8ms	66.1	53.1	142.0	66.5		<MPLS:L=574140,E=0 L=304224,E=0,T=1>
10	54.239.100.119	0.0%	466	57.3ms	55.1	49.2	113.0	54.7		<MPLS:L=304224,E=0>
11	176.32.106.34	0.0%	466	59.0ms	55.5	49.1	140.7	54.8		<MPLS:L=307552,E=0>
12	178.236.0.227	0.0%	466	53.0ms	55.0	49.2	90.6	54.7		
13	178.236.0.196	0.0%	466	55.5ms	56.1	49.6	116.7	54.8		<MPLS:L=641064,E=0>
14	178.236.1.17	0.2%	466	59.1ms	57.7	49.6	94.9	56.5		
15	54.77.166.239	0.0%	466	59.2ms	58.1	49.7	107.3	58.3		

15 items (1 selected)

Tools → Traceroute

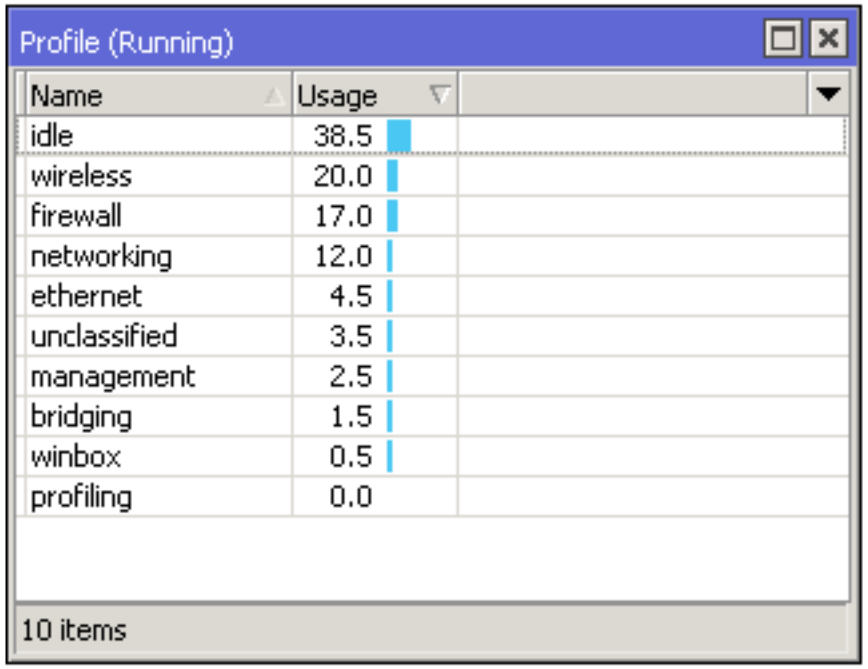
LAB

Traceroute

- Choose a web site in your country and do a traceroute to it
- Click ‘New Window’ and do a traceroute to www.mikrotik.com
- Observe the difference between the routes

Profile

- Shows CPU usage for each RouterOS running process in real time
- idle - unused CPU resources
- For more info see Profile wiki page



Profile (Running)

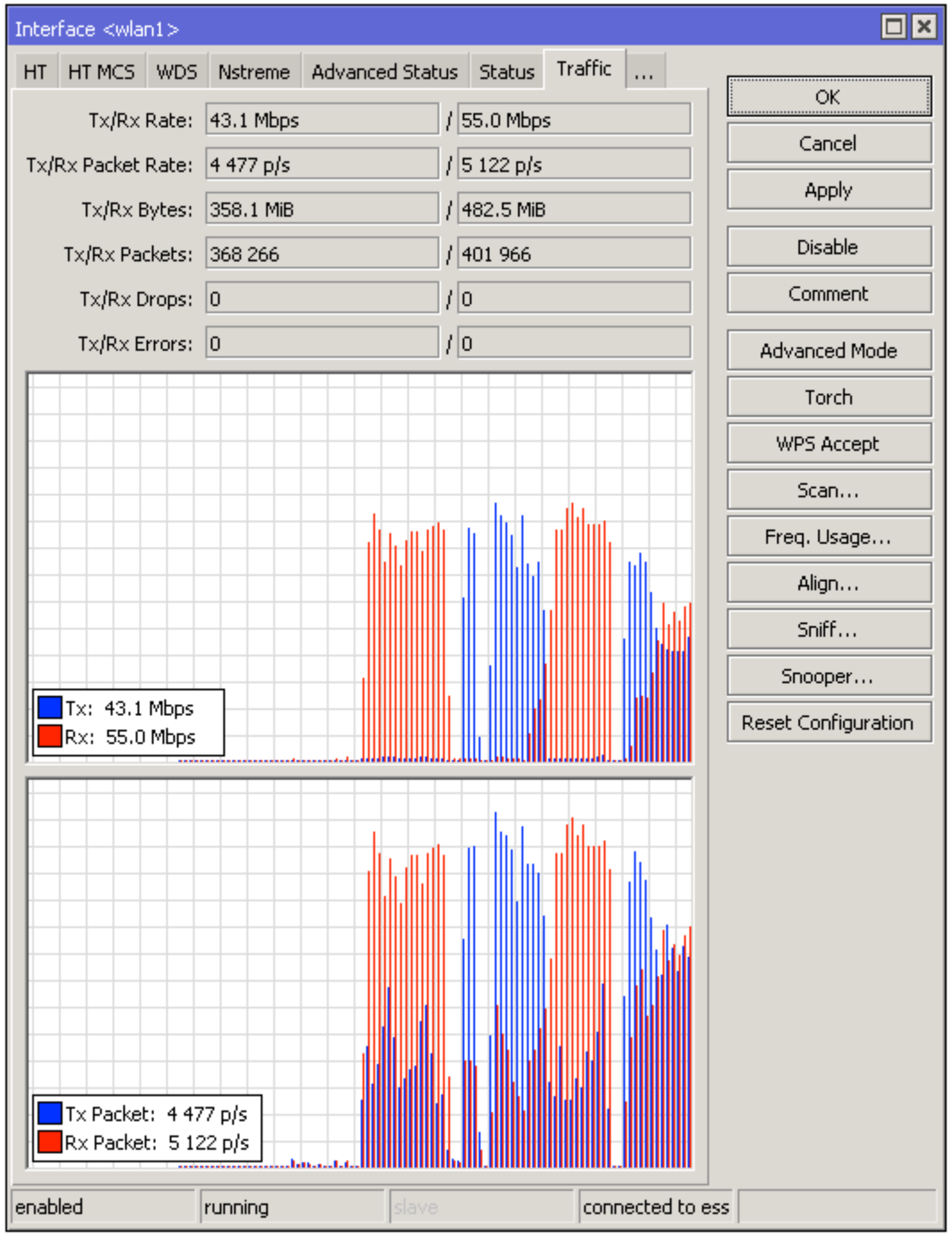
Name	Usage
idle	38.5
wireless	20.0
firewall	17.0
networking	12.0
ethernet	4.5
unclassified	3.5
management	2.5
bridging	1.5
winbox	0.5
profiling	0.0

10 items

Tools → Profile

Interface Traffic Monitor

- Real time traffic status
- Available for each interface in traffic tab
- Can also be accessed from both WebFig and command line interface



Tx/Rx Rate: 43.1 Mbps / 55.0 Mbps
Tx/Rx Packet Rate: 4 477 p/s / 5 122 p/s
Tx/Rx Bytes: 358.1 MiB / 482.5 MiB
Tx/Rx Packets: 368 266 / 401 966
Tx/Rx Drops: 0 / 0
Tx/Rx Errors: 0 / 0

🟦 Tx: 43.1 Mbps
🟥 Rx: 55.0 Mbps

🟦 Tx Packet: 4 477 p/s
🟥 Rx Packet: 5 122 p/s

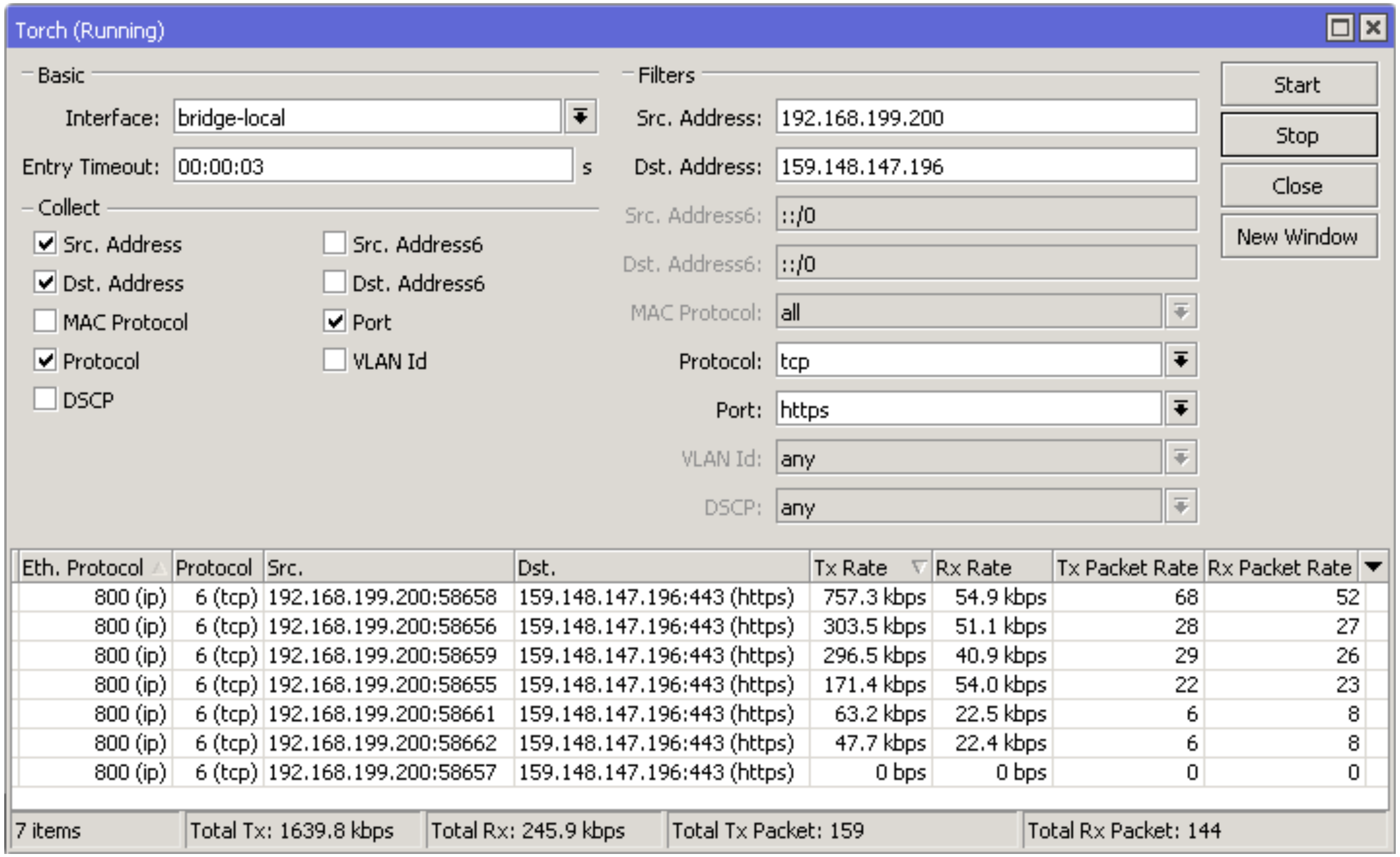
enabled | running | slave | connected to ess

Interfaces → wlan1 → Traffic

Torch

- Real-time monitoring tool
- Can be used to monitor the traffic flow through the interface
- Can monitor traffic classified by IP protocol name, source/destination address (IPv4/IPv6), port number

Torch



Torch (Running)

Basic

Interface: bridge-local

Entry Timeout: 00:00:03 s

Collect

☑ Src. Address ☐ Src. Address6

☑ Dst. Address ☐ Dst. Address6

☐ MAC Protocol ☑ Port

☑ Protocol ☐ VLAN Id

☐ DSCP

Filters

Src. Address: 192.168.199.200

Dst. Address: 159.148.147.196

Src. Address6: ::/0

Dst. Address6: ::/0

MAC Protocol: all

Protocol: tcp

Port: https

VLAN Id: any

DSCP: any

Eth. Protocol	Protocol	Src.	Dst.	Tx Rate	Rx Rate	Tx Packet Rate	Rx Packet Rate
800 (ip)	6 (tcp)	192.168.199.200:58658	159.148.147.196:443 (https)	757.3 kbps	54.9 kbps	68	52
800 (ip)	6 (tcp)	192.168.199.200:58656	159.148.147.196:443 (https)	303.5 kbps	51.1 kbps	28	27
800 (ip)	6 (tcp)	192.168.199.200:58659	159.148.147.196:443 (https)	296.5 kbps	40.9 kbps	29	26
800 (ip)	6 (tcp)	192.168.199.200:58655	159.148.147.196:443 (https)	171.4 kbps	54.0 kbps	22	23
800 (ip)	6 (tcp)	192.168.199.200:58661	159.148.147.196:443 (https)	63.2 kbps	22.5 kbps	6	8
800 (ip)	6 (tcp)	192.168.199.200:58662	159.148.147.196:443 (https)	47.7 kbps	22.4 kbps	6	8
800 (ip)	6 (tcp)	192.168.199.200:58657	159.148.147.196:443 (https)	0 bps	0 bps	0	0

7 items | Total Tx: 1639.8 kbps | Total Rx: 245.9 kbps | Total Tx Packet: 159 | Total Rx Packet: 144

Tools → Torch

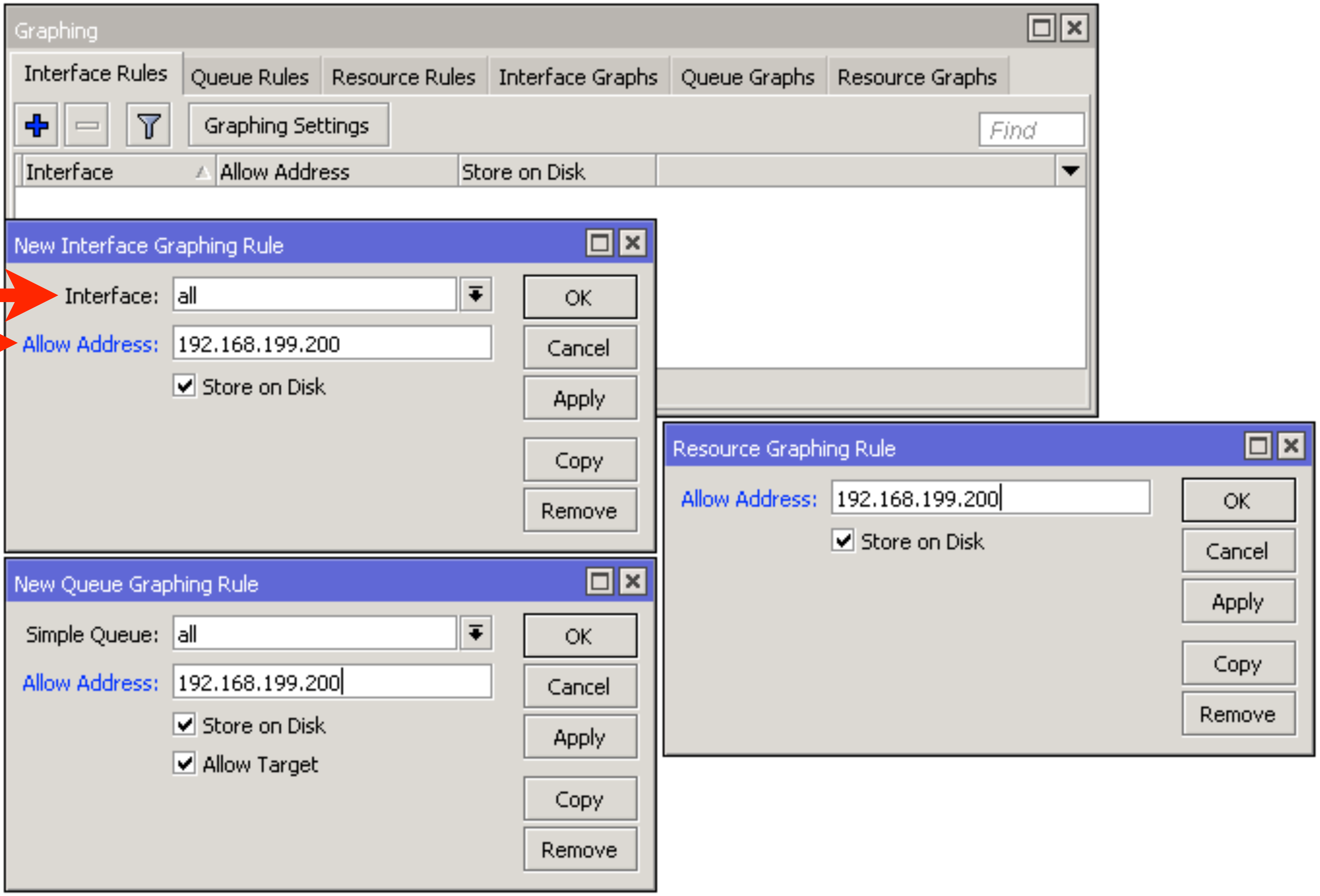
- Traffic flow from the laptop to the mikrotik.com web server HTTPS port

Graphs

- RouterOS can generate graphs showing how much traffic has passed through an interface or a queue
- Can show CPU, memory and disk usage
- For each metric there are 4 graphs - daily, weekly, monthly and yearly

Graphs

Set specific interface to monitor or leave all, set IP address/ subnet which will be able to access the graphs



New Interface Graphing Rule

Interface: all

Allow Address: 192.168.199.200

☑ Store on Disk

New Queue Graphing Rule

Simple Queue: all

Allow Address: 192.168.199.200

☑ Store on Disk

☑ Allow Target

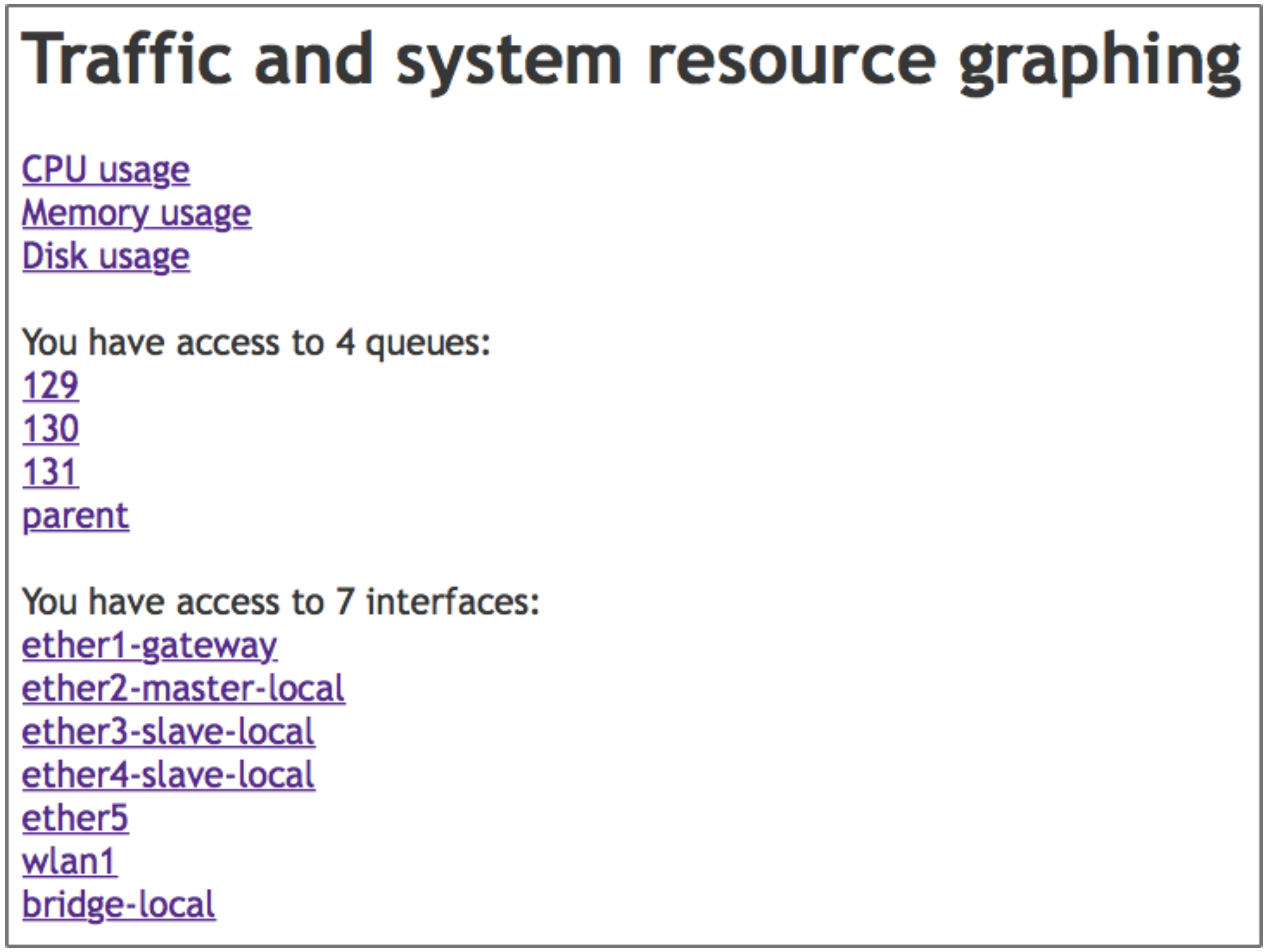
Resource Graphing Rule

Allow Address: 192.168.199.200

☑ Store on Disk

Tools → Graphing

Graphs



Traffic and system resource graphing

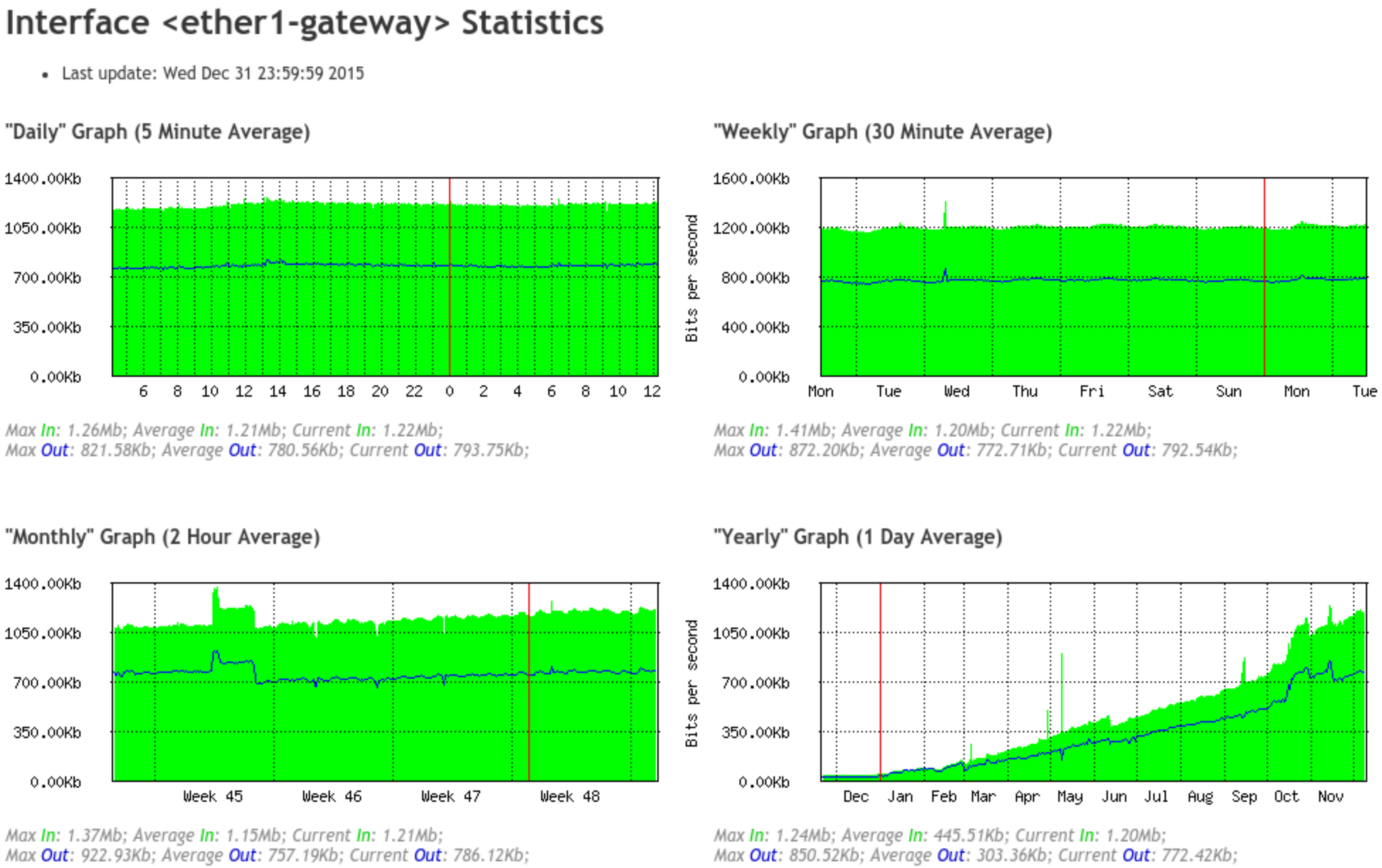
CPU usage
Memory usage
Disk usage

You have access to 4 queues:
129
130
131
parent

You have access to 7 interfaces:
ether1-gateway
ether2-master-local
ether3-slave-local
ether4-slave-local
ether5
wlan1
bridge-local

- Available on the router: **http://router_ip/graphs**

Graphs



Interface <ether1-gateway> Statistics

- Last update: Wed Dec 31 23:59:59 2015

"Daily" Graph (5 Minute Average)

Max In: 1.26Mb; Average In: 1.21Mb; Current In: 1.22Mb;
Max Out: 821.58Kb; Average Out: 780.56Kb; Current Out: 793.75Kb;

"Weekly" Graph (30 Minute Average)

Max In: 1.41Mb; Average In: 1.20Mb; Current In: 1.22Mb;
Max Out: 872.20Kb; Average Out: 772.71Kb; Current Out: 792.54Kb;

"Monthly" Graph (2 Hour Average)

Max In: 1.37Mb; Average In: 1.15Mb; Current In: 1.21Mb;
Max Out: 922.93Kb; Average Out: 757.19Kb; Current Out: 786.12Kb;

"Yearly" Graph (1 Day Average)

Max In: 1.24Mb; Average In: 445.51Kb; Current In: 1.20Mb;
Max Out: 850.52Kb; Average Out: 303.36Kb; Current Out: 772.42Kb;

Optional LAB

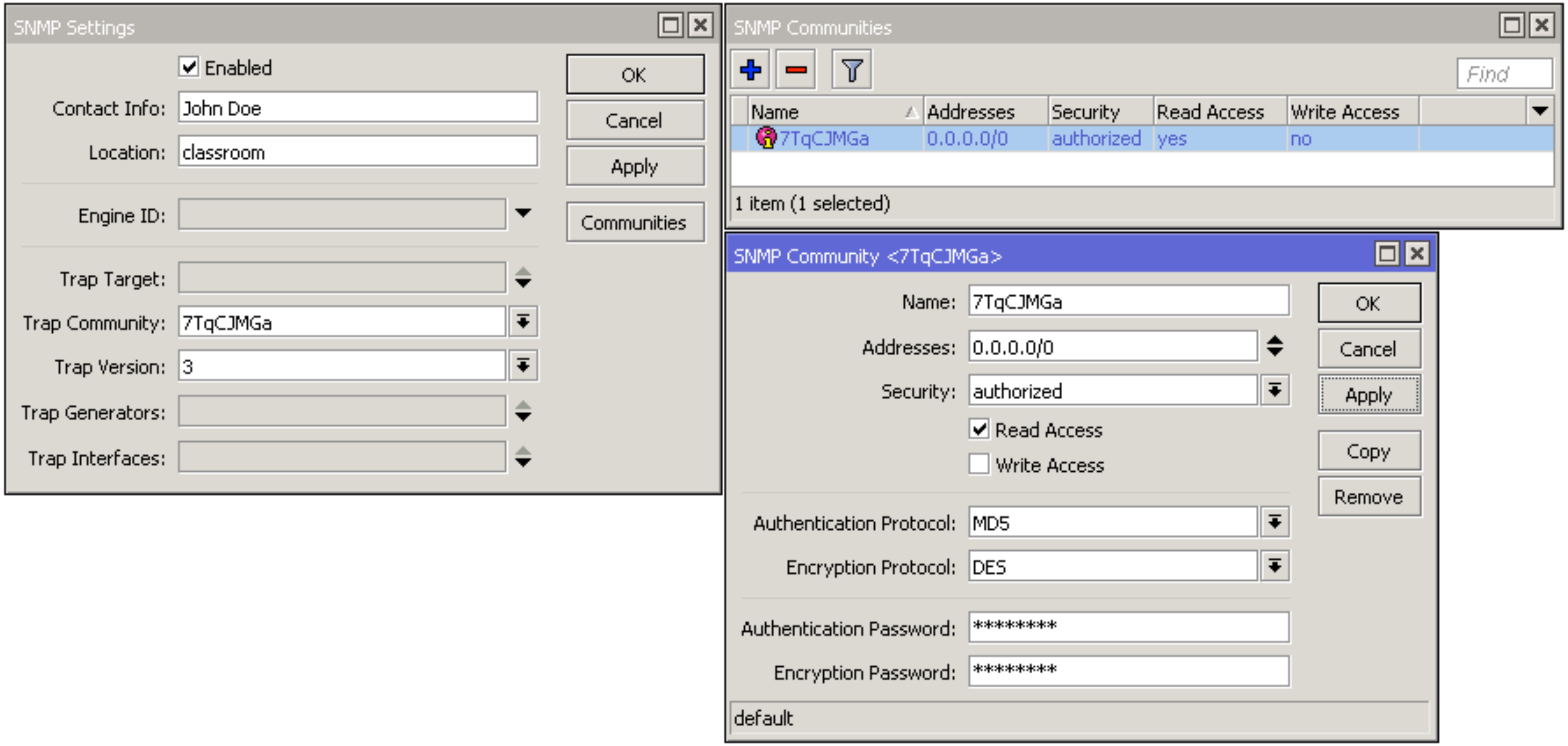
Graphs

- Enable interface, queue and resource graphs on your router
- Observe the graphs
- Download a large file from the Internet
- Observe the graphs

SNMP

- Simple Network Management Protocol (SNMP)
- Used for monitoring and managing devices
- RouterOS supports SNMP v1, v2 and v3
- SNMP write support is available only for some settings

SNMP



☑ Enabled

Contact Info: John Doe

Location: classroom

Engine ID:

Trap Target:

Trap Community: 7TqCJMGa

Trap Version: 3

Trap Generators:

Trap Interfaces:

Name	Addresses	Security	Read Access	Write Access
7TqCJMGa	0.0.0.0/0	authorized	yes	no

1 item (1 selected)

Name: 7TqCJMGa

Addresses: 0.0.0.0/0

Security: authorized

☑ Read Access

□ Write Access

Authentication Protocol: MD5

Encryption Protocol: DES

Authentication Password: ********

Encryption Password: ********

default

Tools → SNMP

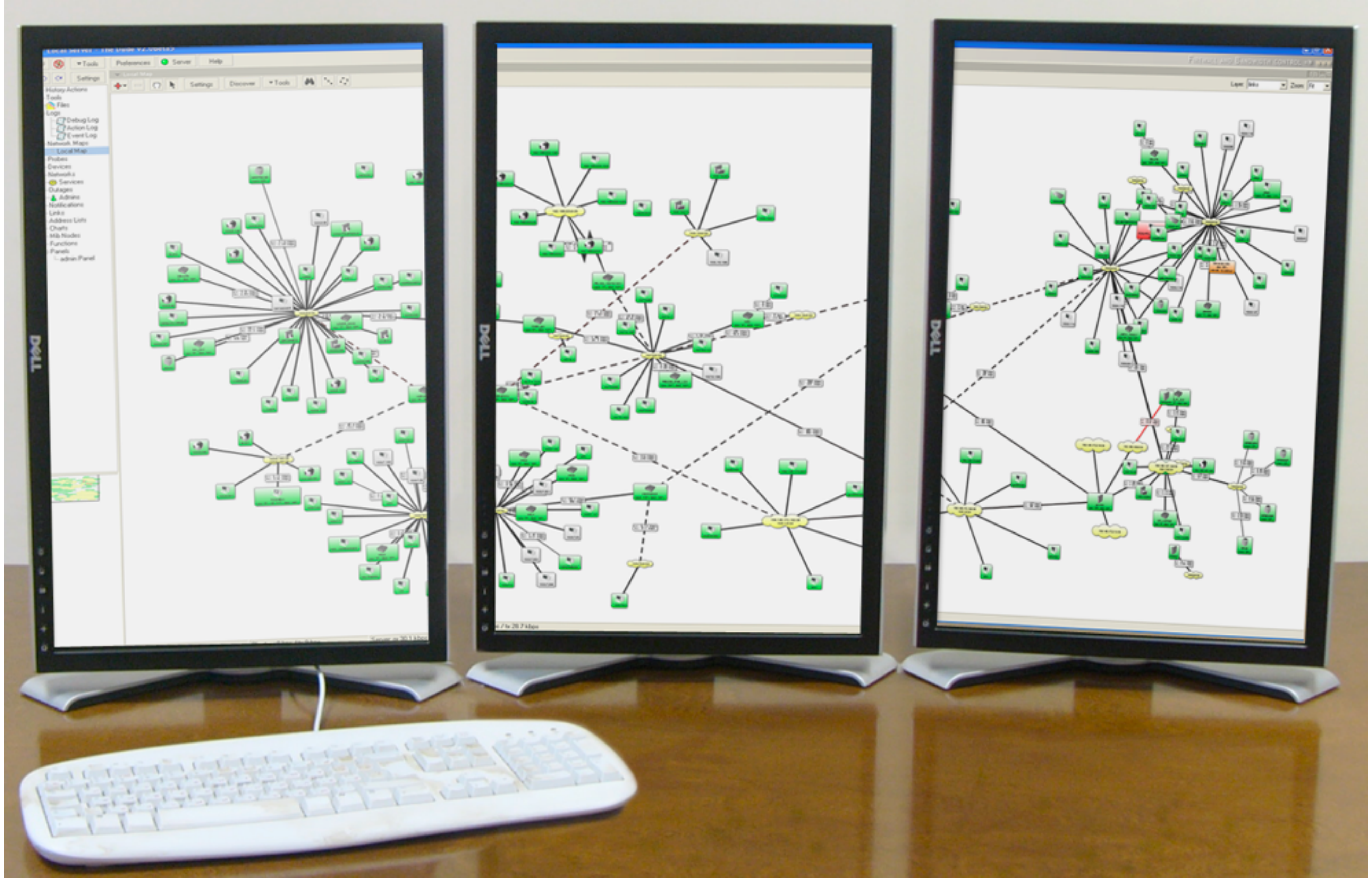
The Dude

- Application by MikroTik which can dramatically improve the way you manage your network environment
- Automatic discovery and layout map of devices
- Monitoring of services and alerting
- Free of charge

The Dude

- Supports SNMP, ICMP, DNS and TCP monitoring
- Server part runs on RouterOS (CCR, CHR or x86)
- Client on Windows (works on Linux and OS X using Wine)
- For more info see The Dude wiki page

The Dude



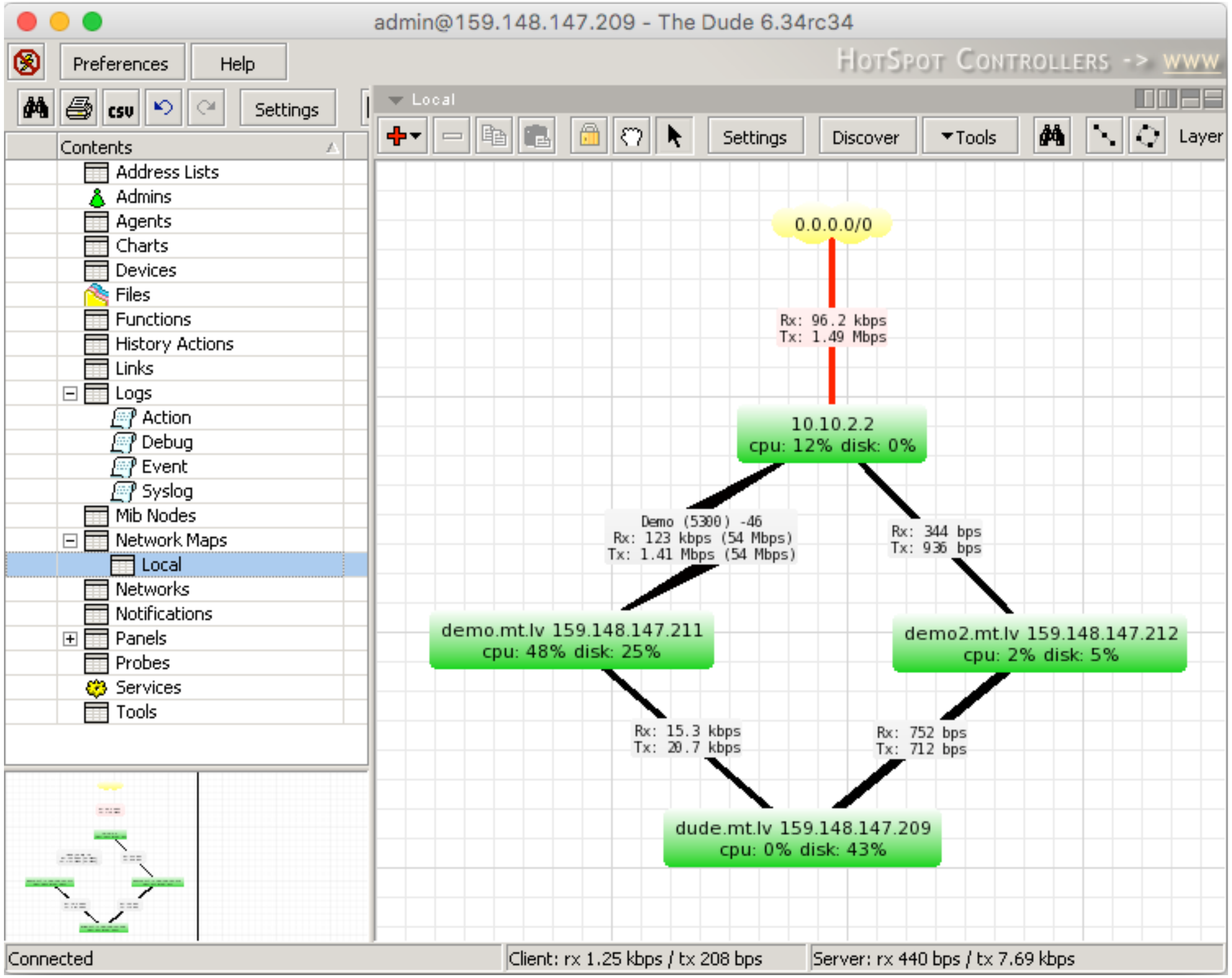
Optional LAB

The Dude

- Download the Dude client for Windows from mikrotik.com/download page
- Install and connect to MikroTik Dude demo server: **dude.mt.lv**
- Observe the Dude

Optional LAB

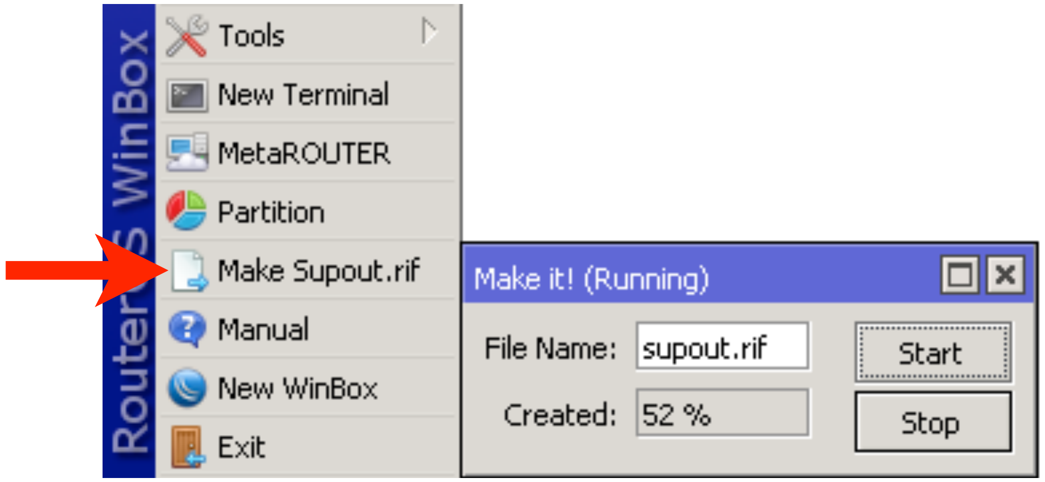
The Dude



Connected | Client: rx 1.25 kbps / tx 208 bps | Server: rx 440 bps / tx 7.69 kbps

Contacting Support

- In order for MikroTik support to be able to help better, few steps should be taken beforehand
- Create support output file (supout.rif)



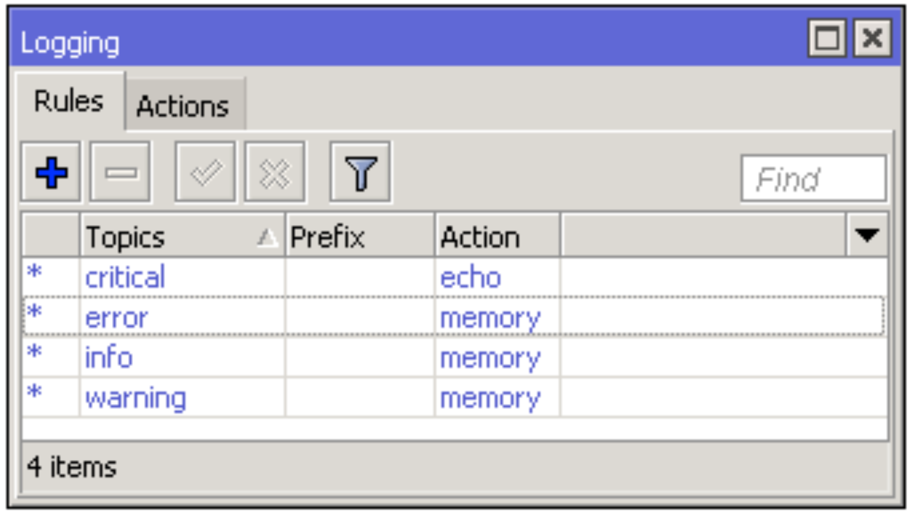
File Name: supout.rif
Created: 52 %

Contacting Support

- autosupout.rif can be created automatically in case of hardware malfunction
- Managed by watchdog process
- Before sending to MikroTik, support output file contents can be viewed in your mikrotik.com account
- For more info see Support Output File and Watchdog wiki pages

System Logs

- By default RouterOS already logs information about the router
- Stored in memory
- Can be stored on disk
- Or sent to a remote syslog server



	Topics	Prefix	Action
*	critical		echo
*	error		memory
*	info		memory
*	warning		memory

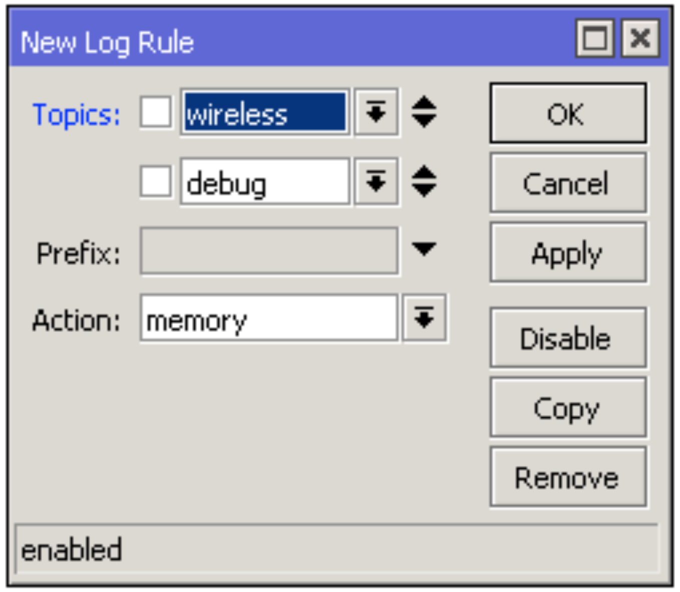
4 items

System → Logging

MikroTik MTCNA

System Logs

- To enable detailed logs (debug), create a new rule
- Add **debug** topic



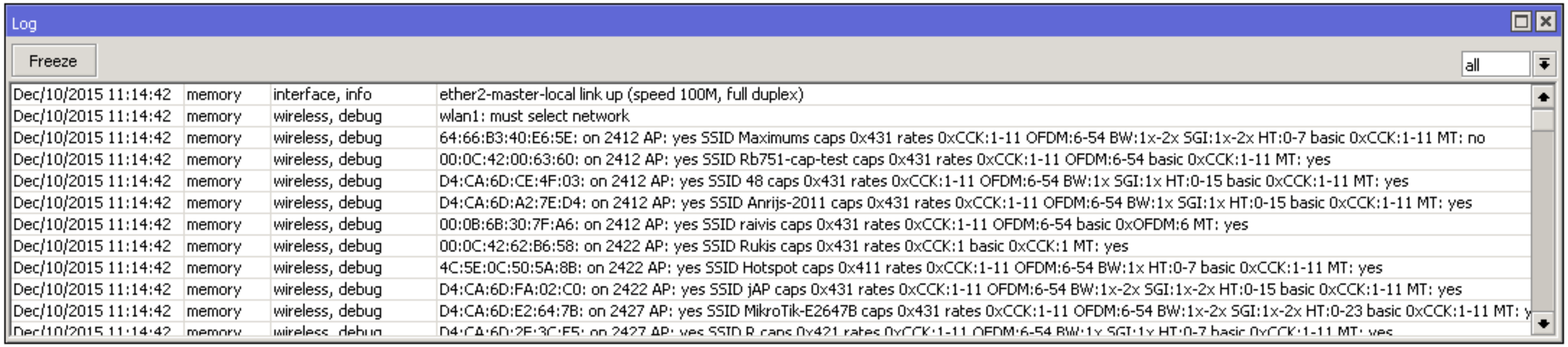
Topics: □ wireless
□ debug

Prefix:

Action: memory

enabled

System → Logging → New Log Rule



```
Dec/10/2015 11:14:42  memory  interface, info  ether2-master-local link up (speed 100M, full duplex)
Dec/10/2015 11:14:42  memory  wireless, debug  wlan1: must select network
Dec/10/2015 11:14:42  memory  wireless, debug  64:66:B3:40:E6:5E: on 2412 AP: yes SSID Maximums caps 0x431 rates 0xCCK:1-11 OFDM:6-54 BW:1x-2x SGI:1x-2x HT:0-7 basic 0xCCK:1-11 MT: no
Dec/10/2015 11:14:42  memory  wireless, debug  00:0C:42:00:63:60: on 2412 AP: yes SSID Rb751-cap-test caps 0x431 rates 0xCCK:1-11 OFDM:6-54 basic 0xCCK:1-11 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  D4:CA:6D:CE:4F:03: on 2412 AP: yes SSID 48 caps 0x431 rates 0xCCK:1-11 OFDM:6-54 BW:1x SGI:1x HT:0-15 basic 0xCCK:1-11 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  D4:CA:6D:A2:7E:D4: on 2412 AP: yes SSID Anrijs-2011 caps 0x431 rates 0xCCK:1-11 OFDM:6-54 BW:1x SGI:1x HT:0-15 basic 0xCCK:1-11 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  00:0B:6B:30:7F:A6: on 2412 AP: yes SSID raivis caps 0x431 rates 0xCCK:1-11 OFDM:6-54 basic 0xOFDM:6 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  00:0C:42:62:B6:58: on 2422 AP: yes SSID Rukis caps 0x431 rates 0xCCK:1 basic 0xCCK:1 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  4C:5E:0C:50:5A:8B: on 2422 AP: yes SSID Hotspot caps 0x411 rates 0xCCK:1-11 OFDM:6-54 BW:1x HT:0-7 basic 0xCCK:1-11 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  D4:CA:6D:FA:02:C0: on 2422 AP: yes SSID jAP caps 0x431 rates 0xCCK:1-11 OFDM:6-54 BW:1x-2x SGI:1x-2x HT:0-15 basic 0xCCK:1-11 MT: yes
Dec/10/2015 11:14:42  memory  wireless, debug  D4:CA:6D:E2:64:7B: on 2427 AP: yes SSID MikroTik-E2647B caps 0x431 rates 0xCCK:1-11 OFDM:6-54 BW:1x-2x SGI:1x-2x HT:0-23 basic 0xCCK:1-11 MT: y
Dec/10/2015 11:14:42  memory  wireless, debug  D4:CA:6D:2E:3C:E5: on 2427 AP: yes SSID R caps 0x421 rates 0xCCK:1-11 OFDM:6-54 BW:1x SGI:1x HT:0-7 basic 0xCCK:1-11 MT: yes
```

Contacting Support

- Before contacting support@mikrotik.com check these resources
- wiki.mikrotik.com - RouterOS documentation and examples
- forum.mikrotik.com - communicate with other RouterOS users
- mum.mikrotik.com - MikroTik User Meeting page - presentations videos

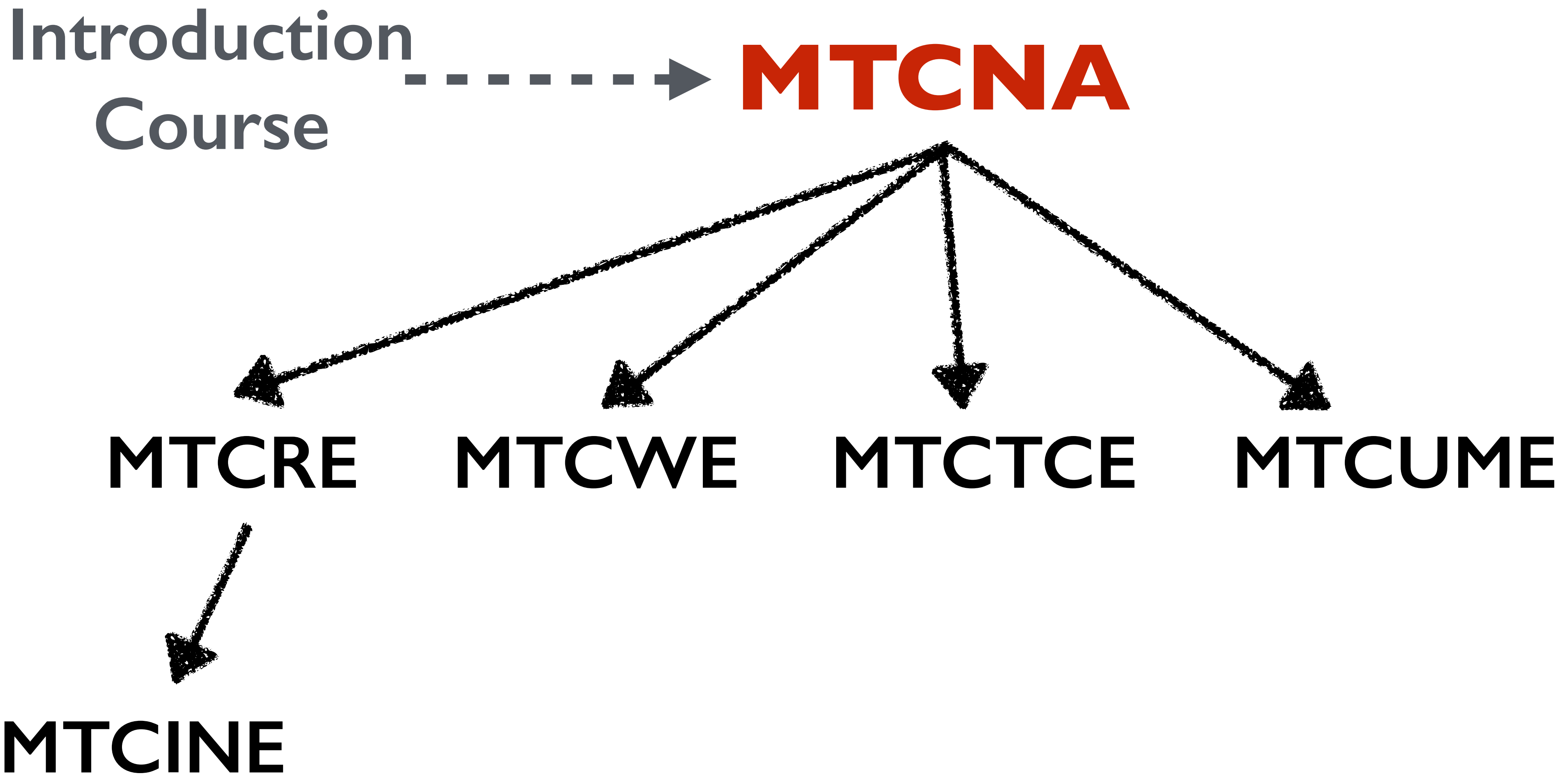
Contacting Support

- It is suggested to add meaningful comments to your rules, items
- Describe as detailed as possible so that MikroTik support team can help you better
- Include your network diagram
- For more info see support page

Module 9
Summary

MTCNA Summary

MikroTik Certified Courses



Introduction Course

MTCNA

MTCRE

MTCWE

MTCTCE

MTCUME

MTCINE

For more info see: http://training.mikrotik.com

Certification Test

- If needed reset router configuration and restore from a backup
- Make sure that you have an access to the www.mikrotik.com training portal
- Login with your account
- Choose **my training sessions**
- Good luck!