MikroTik RouterOS Training Class MTCNA

- **Kabul , Afghanistan**
- **15-18 November 2018**
- **Hamed Ghaseri**
- **www.MikroTikTrain.com**

Instructors

- **Hamed Ghaseri**
- **MikroTik Trainer (TR0149)**
- Working with MikroTik OS for More than 13 years
- Expert in DSL & Wimax Networks
- Implementation and experience in VOIP
- Work as Network Engineer in Laser (Nation Wide Company) for 4 years
- TNS Network Administrator (WISP)
- Technical Manager and Consultant of lots of other company
- Parsis Net (CEO) MikroTik Master distrubuter

Schedule

- Training day: 9 AM – 5 PM (5.30 PM if needed)
- 30 minute Breaks: 10:30 AM and 3 PM
- 1 hour Lunch: 12:45 PM

Course Objective

- Overview of RouterOS software and RouterBoard capabilities
- Hands-on training for MikroTik router configuration, maintenance and basic troubleshooting

About MikroTik

- Router software and hardware manufacturer
- Provide routing and wireless equipment for all possible uses
- Make Internet technologies faster, powerful and affordable to wider range of users

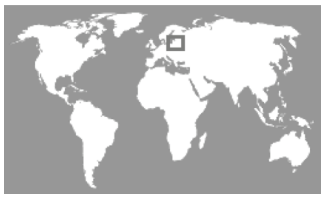
MikroTik's History

- 1996: Established
- 1997: RouterOS software for x86 (PC)
- 2002: RouterBOARD is born
- 2006: First MUM

Where is MikroTik?

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

Where is MikroTik ?



Introduce Yourself

- Please, introduce yourself to the class
  - Your name
  - Your Company
  - Your previous knowledge about RouterOS (?)
  - Your previous knowledge about networking (?)
  - What do you expect from this course? (?)
- Please, remember your class XY number. _____

MikroTik RouterOS

What is RouterOS ?

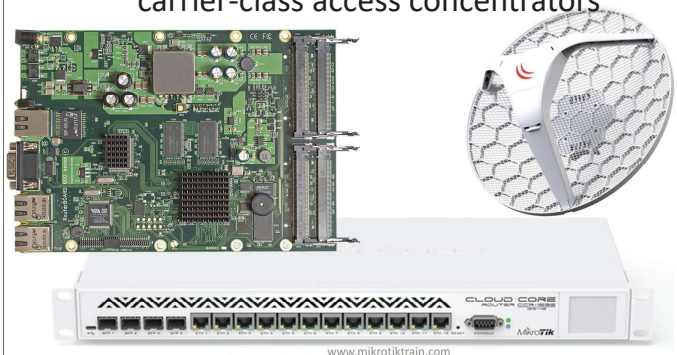
- RouterOS is an operating system that will make your device:
  - A dedicated router
  - A bandwidth management
  - Advanced Quality of Service
  - A (transparent) packet filter
  - Any 802.11a,b/g/n wireless device
  - A VPN and Tunnel Server & Client
  - 3G/LTE support
  - HotSpot for Plug-and-Play access
  - RIP, OSPF, BGP, MPLS routing
  - A Backhaul Link
  - More …

What is RouterOS ?

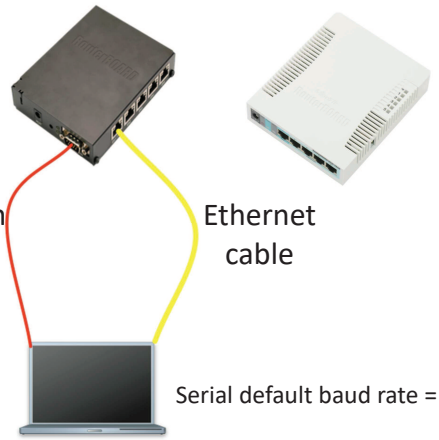
- The operating system of RouterBOARD
- Can be also installed on a X86

What is RouterBOARD ?

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



First Time Access

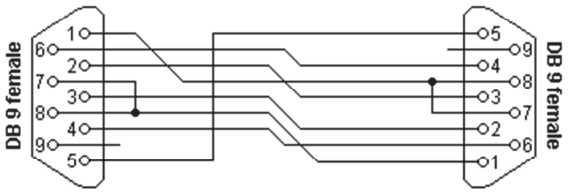


Null Modem Cable

Ethernet cable

Serial default baud rate = 115200

Null modem with partial handshaking



Connector 1	Connector 2	Function
1	7 + 8	RTS_2 → CTS_2 + CD_1
2	3	Rx ← Tx
3	2	Tx → Rx
4	6	DTR → DSR
5	5	Signal ground
6	4	DSR ← DTR
7 + 8	1	RTS_1 → CTS_1 + CD_2

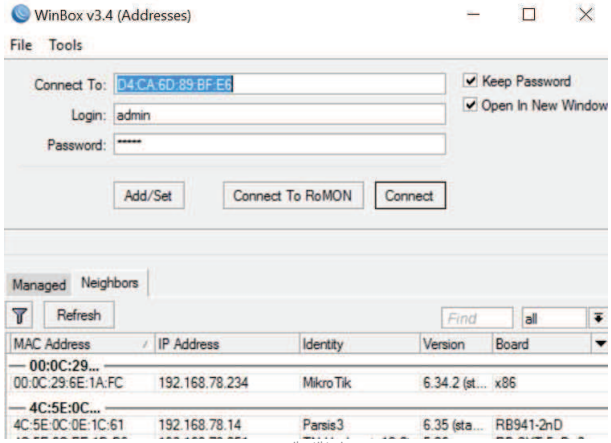
Winbox

- The application for configuring RouterOS
- It can be downloaded from ***router web page*** or www.mikrotik.com or www.mikrotiktrain.com

Download Winbox

Connecting

- Click on the [Neighbors] button to see your router



Configuration Access

Winbox ✓

Web ✓

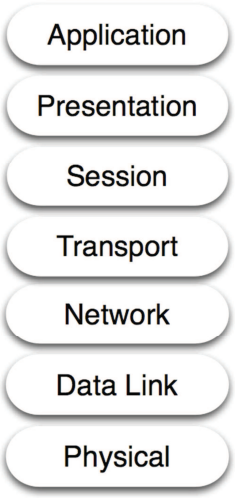
Telnet , SSH ✓

Consol Port ✓

Parsis

Communication

- Process of communication is divided into seven layers
- Lowest is physical layer, highest is application layer



MAC address

- It is the unique physical address of a network device
- It's used for communication within LAN
- Example: 00:0C:42:20:97:68

IP

- It is logical address of network device
- It is used for communication over networks
- Example: 159.148.60.20

Subnets

- Range of logical IP addresses that divides network into segments
- Example: 255.255.255.0 or /24

Subnets

- Network address is the first IP address of the subnet
- Broadcast address is the last IP address of the subnet
- They are reserved and cannot be used

CIDR	Subnet Mask	Available Hosts
/32	255.255.255.255	
/30	255.255.255.252	4-2
/29	255.255.255.248	8-2
/28	255.255.255.240	16-2
/27	255.255.255.224	32-2
/26	255.255.255.192	64-2
/25	255.255.255.128	128-2
/24	255.255.255.0	256-2

IP Addresses	Bits	Prefix	Subnet Mask
1	0	/32	255.255.255.255
2	1	/31	255.255.255.254
4	2	/30	255.255.255.252
8	3	/29	255.255.255.248
16	4	/28	255.255.255.240
32	5	/27	255.255.255.224
64	6	/26	255.255.255.192
128	7	/25	255.255.255.128
256	8	/24	255.255.255.0
512	9	/23	255.255.254.0
1 K	10	/22	255.255.252.0
2 K	11	/21	255.255.248.0
4 K	12	/20	255.255.240.0
8 K	13	/19	255.255.224.0
16 K	14	/18	255.255.192.0
32 K	15	/17	255.255.128.0
64 K	16	/16	255.255.0.0
128 K	17	/15	255.254.0.0
256 K	18	/14	255.252.0.0
512 K	19	/13	255.248.0.0
1 M	20	/12	255.240.0.0
2 M	21	/11	255.224.0.0
4 M	22	/10	255.192.0.0
8 M	23	/9	255.128.0.0
16 M	24	/8	255.0.0.0
32 M	25	/7	254.0.0.0
64 M	26	/6	252.0.0.0
128 M	27	/5	248.0.0.0
256 M	28	/4	240.0.0.0
512 M	29	/3	224.0.0.0
1024 M	30	/2	192.0.0.0
2048 M	31	/1	128.0.0.0
4096 M	32	/0	0.0.0.0

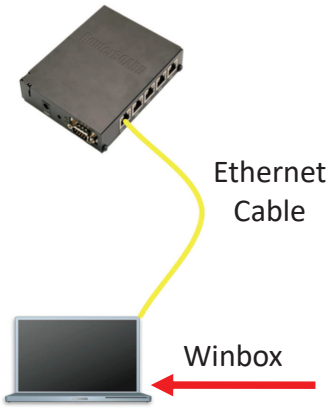
Selecting IP address

- Select IP address from the same subnet on local networks
- Especially for big network with multiple subnets

Selecting IP address Example

- Clients use different subnet masks /25 and /26
- **A** has 192.168.0.200/**26** IP address
- **B** use subnet mask /**25**, available addresses 192.168.0.129-192.168.0.254
- **B** should **not** use 192.168.0.129-192.168.0.192
- **B** should use IP address from 192.168.0.193 - 192.168.0.254/25

Connecting

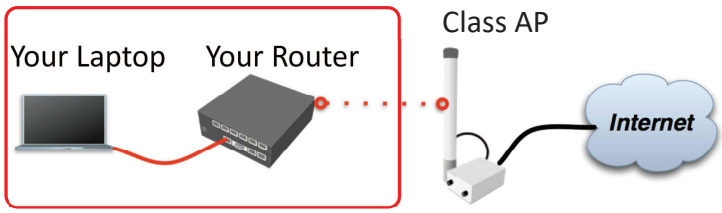


Connecting Lab

LAB

- Click on the Mac-Address in Winbox
- Default username “admin” and no password

Diagram

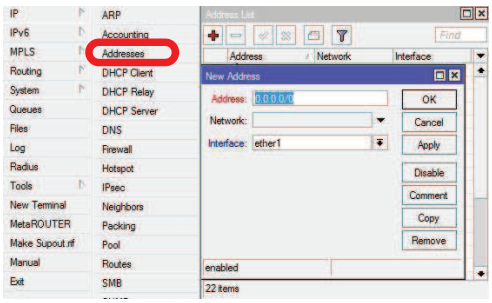


Laptop - Router

- Disable any other interfaces (wireless) in your laptop
- Set 192.168.X.1 as IP address
- Set 255.255.255.0 as Subnet Mask
- Set 192.168.X.254 as Default Gateway

Laptop - **Router**

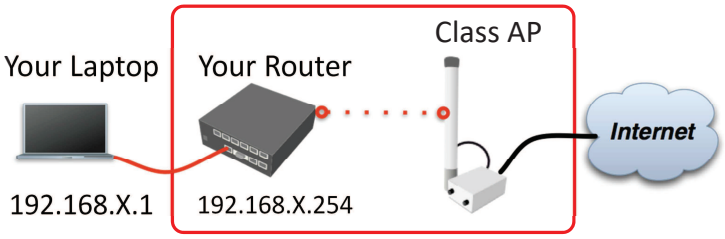
- Connect to router with MAC-Winbox
- Add 192.168.X.254/24 to Ether1



Laptop - **Router**

- Close Winbox and connect again using IP address
- MAC-address should only be used when there is no IP access

Router Internet

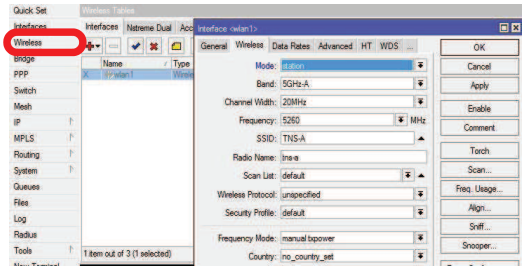


Router - **Internet**

- The Internet gateway of your class is accessible over wireless - it is an **AP** (access point)
- To connect you have to configure the wireless interface of your router as a **station**

Router - Internet

- To configure wireless interface, double-click on it's name



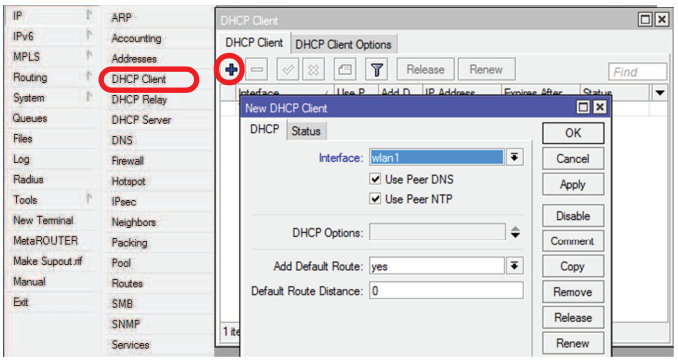
Router - Internet

- To see available AP use **scan** button
- Select **MikroTikTrain** and click on **connect**
- Close the scan window
- You are now connected to AP!
- Remember class SSID **MikroTikTrain**

Router - Internet

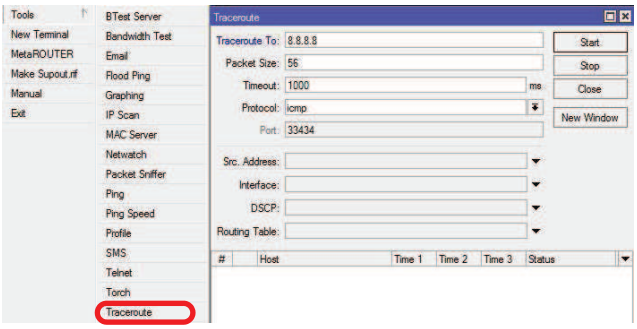
- The wireless interface also needs an IP address
- The AP provides automatic IP addresses over DHCP
- You need to enable DHCP client on your router to get an IP address

Router - Internet

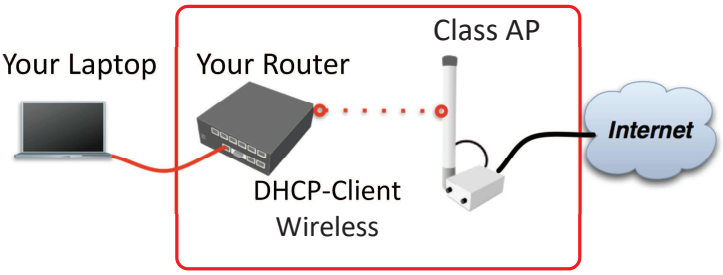


Router - Internet

- Check Internet connectivity by Traceroute tool



Router Internet



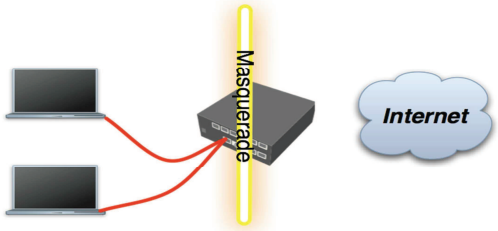
Private networks

- 10.0.0.0/8 - 255.0.0.0
- 10.0.0.0-10.255.255.255

- 172.16.0.0/12 - 255.240.0.0
- 172.16.0.0-172.31.255.255

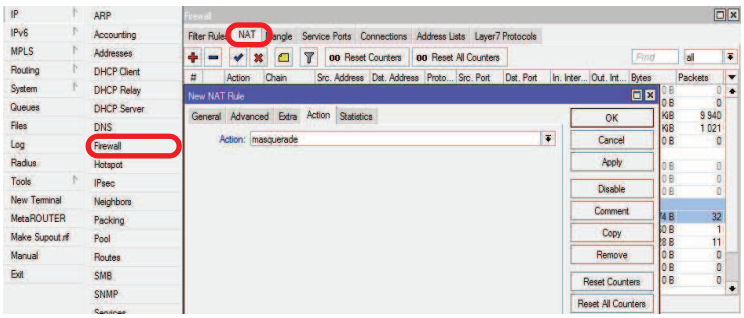
- 192.168.0.0/16 - 255.255.0.0
- 192.168.0.0-192.168.255.255

Private and Public space

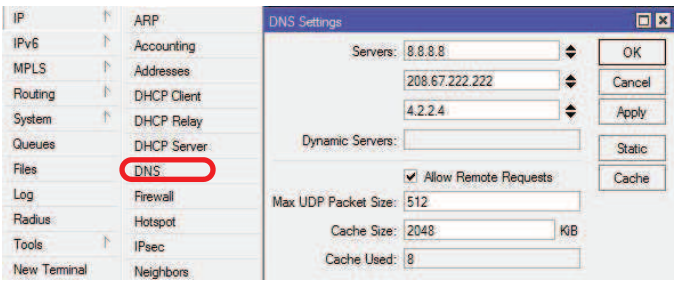


- **Masquerade** is used for Public network access, where private addresses are present

Laptop - Internet



Laptop - Internet



- Your router too can be a DNS server for your local network (laptop)

Laptop - Internet

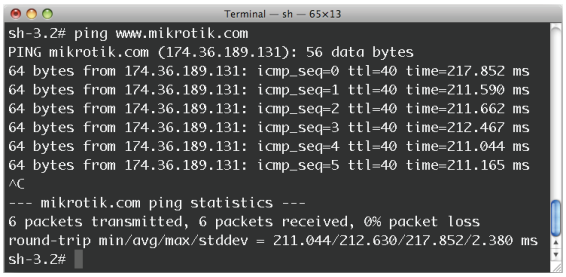
- Tell **your Laptop** to use **your router** as the **DNS** server
- Enter your router IP (192.168.x.254) as the DNS server in laptop network settings

Laptop - Internet

- Laptop can access the router and the router can access the internet, one more step is required
- Make a Masquerade rule to hide your private network behind the router, make Internet work in your laptop

Check Connectivity

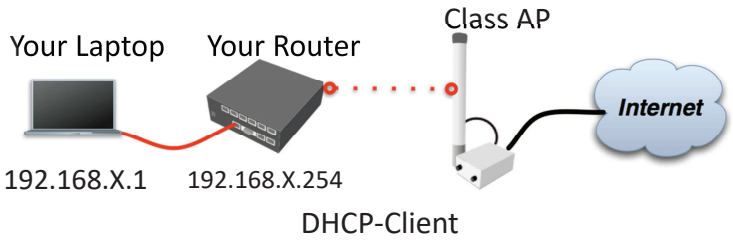
- Ping www.mikrotik.com from your laptop



What Can Be Wrong

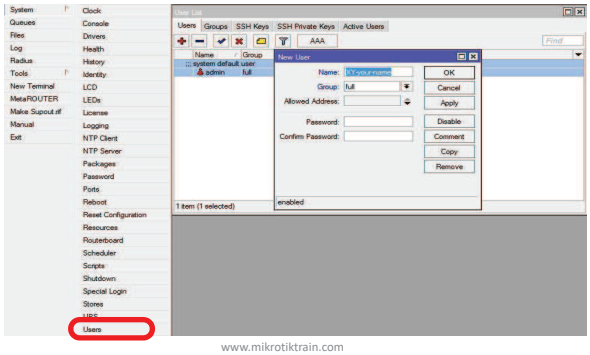
- Router cannot ping further than AP
- Router cannot resolve names
- Computer cannot ping further than router
- Computer cannot resolve names
- Is masquerade rule working
- Does the laptop use the router as default gateway and DNS

Network Diagram



User Management

- Access to the router can be controlled
- You can create different types of users



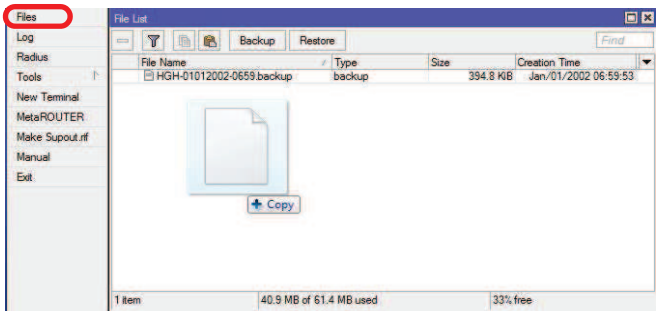
LAB

User Management Lab

- Add new router user with full access
- Make sure you remember user name
- Make admin user as read-only
- Login with your new user

Upgrading Router

- Use combined RouterOS package
- Drag it to the Files window



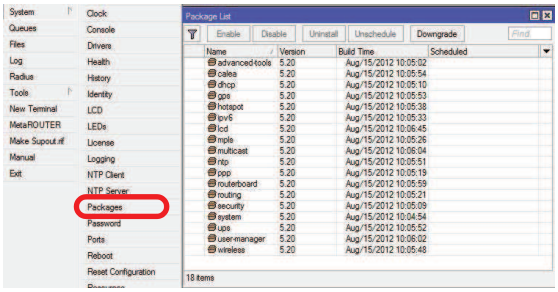
LAB

Upgrading Router Lab

- Download packages from ftp://192.168.200.254
- Upload them to router with Winbox
- Reboot the router
- Newest packages are always available on www.mikrotik.com

Package Management

- RouterOS functions are enabled by packages



Package Information

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

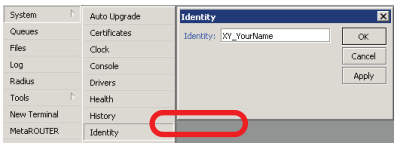
LAB

Package Lab

- Disable wireless
- Reboot
- Check interface list
- Enable wireless

Router Identity

- Option to set name for each router



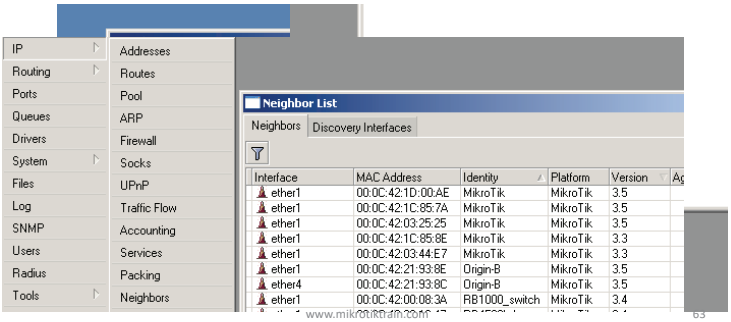
Router Identity Lab

LAB

- Set **your number + your name** as router identity

Router Identity

- Identity information is shown in different places



NTP

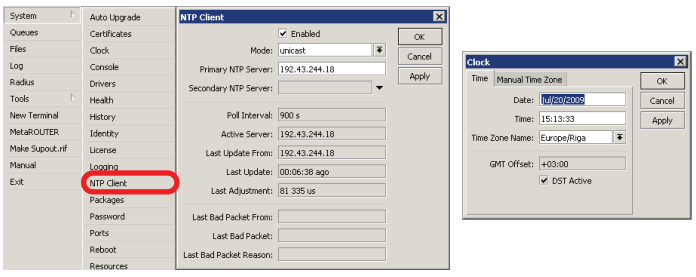
- Network Time Protocol, to synchronize time
- NTP Client and NTP Server support in RouterOS

Why NTP

- To get correct clock on router
- For routers without internal memory to save clock information
- For all RouterBOARDs

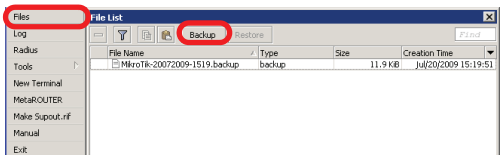
NTP Client

- NTP package is not required



Configuration Backup

- You can backup and restore configuration in the Files menu of Winbox
- Backup file is not editable



Configuration Backup

- Additionally use export and import commands in CLI
- Export files are editable
- Passwords are not saved with export

```
/export file=conf-august-2009
/ ip firewall filter export file=firewall-aug-2009
/ file print
/ import [Tab]
```


Backup Lab

LAB

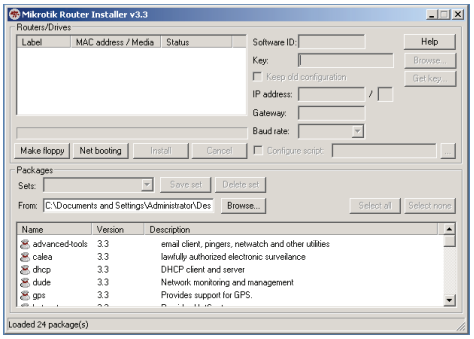
- Create Backup and Export files
- Download them to your laptop
- Open export file with text editor

Netinstall

- Used for installing and reinstalling RouterOS
- Runs on Windows computers
- Direct network connection to router is required or over switched LAN
- Install only on primary interface
- Available at www.mikrotik.com
- User Bootp Protocol

Netinstall

1. List of routers
2. Net Booting
3. Keep old configuration
4. Packages
5. Install



Optional Lab

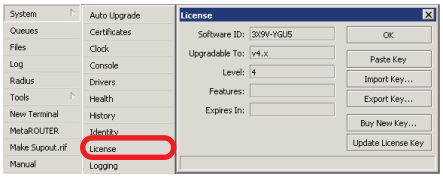
LAB

- Download Netinstall from ftp://192.168.100.254
- Run Netinstall
- Enable Net booting, set address 192.168.x.13
- Use null modem cable and Putty to connect
- Set router to boot from Ethernet

RouterOS License

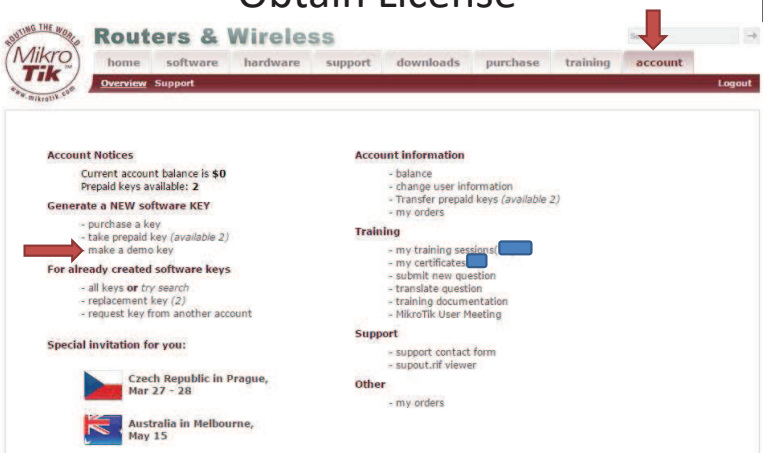
- All RouterBOARDs shipped with license
- Several levels available, no upgrades
- Can be viewed in system license menu
- License for PC can be purchased from mikrotik.com or from distributors

License

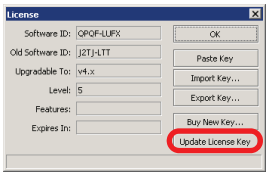


http://www.mikrotiktrain.com/index.php/routeros-license/

Obtain License



Update License



- 8-symbol software-ID system is introduced
- **Update key** on existing routers to get full features support (**802.11N**, etc.)

Summary

Useful Links

- www.mikrotik.com - manage licenses, documentation
- forum.mikrotik.com - share experience with other users
- wiki.mikrotik.com - tons of examples
- mum.mikrotik.com - conference on MikroTik

Firewall

Firewall

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

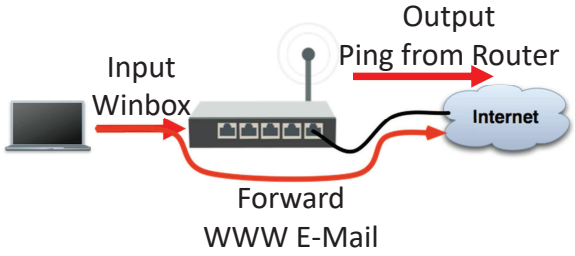
Firewall Filter

- Consists of user defined rules that work on the **IF-Then** principle
- These rules are ordered in Chains
- There are predefined Chains, and User created Chains

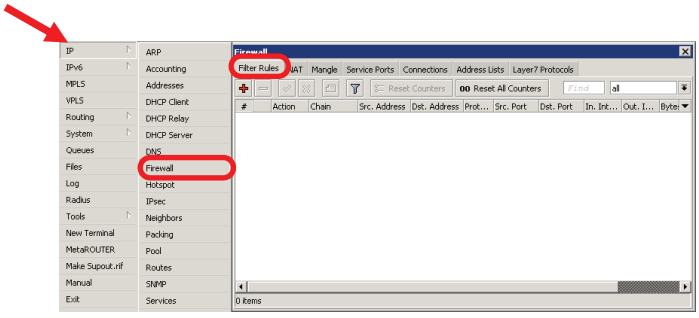
Filter Chains

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

Firewall Chains



Firewall Chains

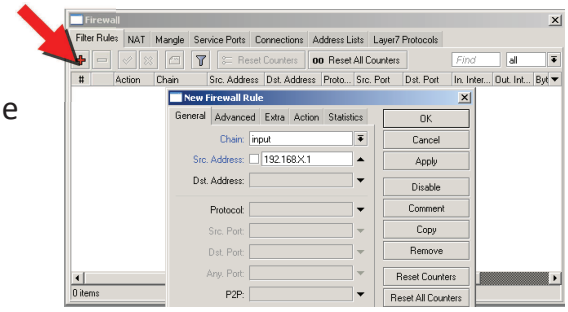


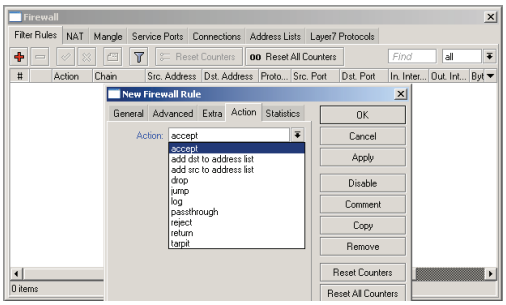
Input

- Chain contains filter rules that protect the **router itself**
- Let's block everyone except your laptop

Input

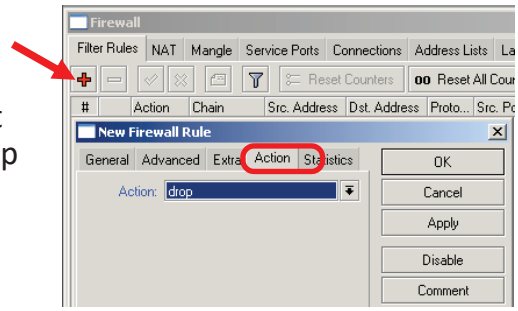
- Add an **accept** rule for your Laptop IP address





Input

- Add a **drop** rule in input chain to drop everyone else



Input Lab

LAB

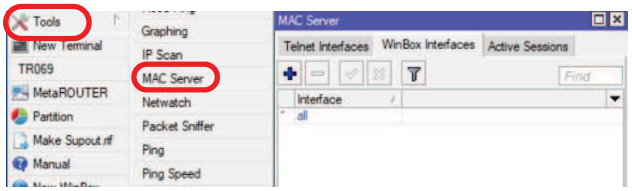
- Change your laptop IP address, 192.168.x.y
- Try to connect. The firewall is working
- You can still connect with MAC-address, Firewall Filter is only for IP

Input

- Access to your router is blocked
- Internet is not working
- Because we are blocking DNS requests as well
- Change configuration to make Internet working

Input

- You can disable MAC access in the **MAC Server** menu
- Change the Laptop IP address back to 192.168.X.1, and connect with IP

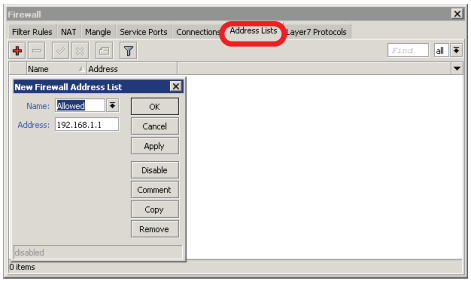


Address-List

- Address-list allows you to filter group of the addresses with one rule
- Automatically add addresses by address-list and then block

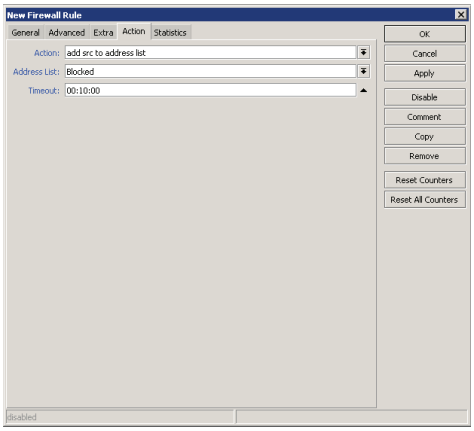
Address-List

- Create different lists
- Subnets, separates ranges, one host addresses are supported



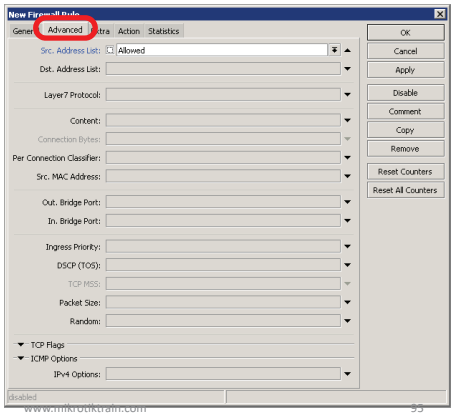
Address-List

- Add specific host to address-list
- Specify timeout for temporary service



Address-List in Firewall

- Ability to block by source and destination addresses



Address-List Lab

LAB

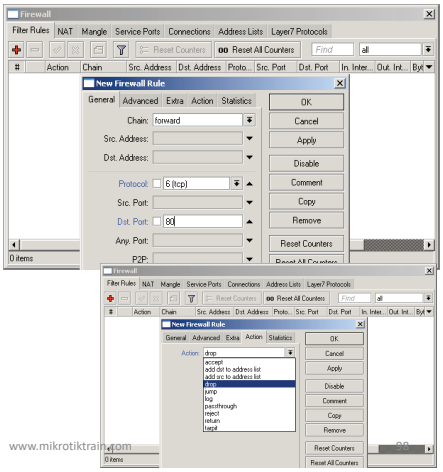
- Create address-list with allowed IP addresses
- Add accept rule for the allowed addresses

Forward

- Chain contains rules that control packets going **trough** the router
- Control traffic **to and from the clients**

Forward

- Create a rule that will block TCP port 80 (web browsing)
- Must select protocol to block ports



LAB

Forward

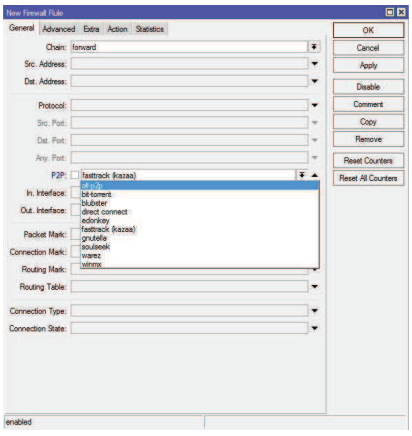
- Try to open www.mikrotik.com
- Try to open http://192.168.X.254
- Router web page works because drop rule is for **chain=forward** traffic

List of well-known ports

Port	Protocol	Service
80	TCP	WWW, HTTP
22	TCP	SSH
23	TCP	Telnet
53	TCP/UDP	DNS
21,20	TCP	FTP
8291	TCP	Winbox
123	UDP	NTP
443	TCP	HTTPS, SSL
5678	UDP	MNDP
8080	TCP	MikroTik Proxy
20561	UDP	MAC-Winbox
/1	ICMP	Pings

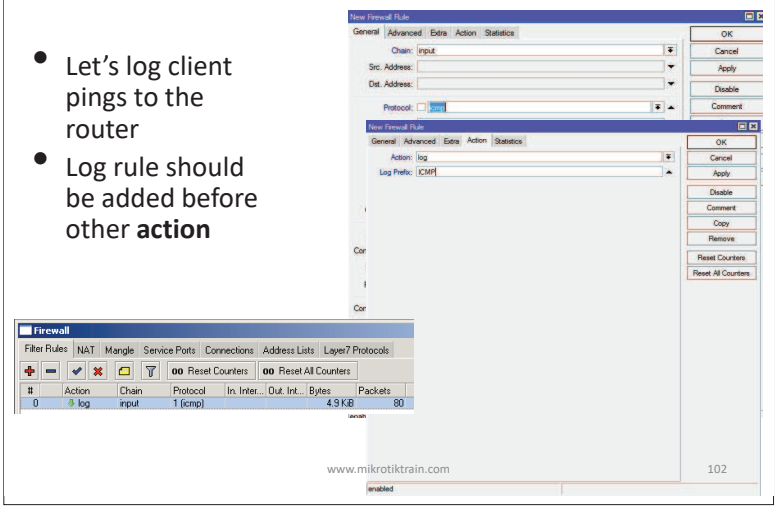
Forward

- Create a rule that will block client's p2p traffic

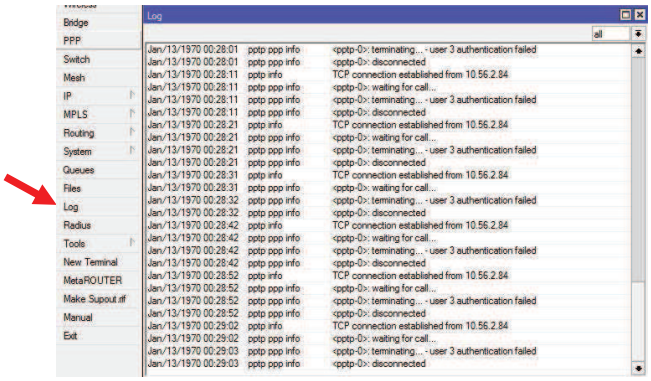


Firewall Log

- Let's log client pings to the router
- Log rule should be added before other **action**



Firewall Log

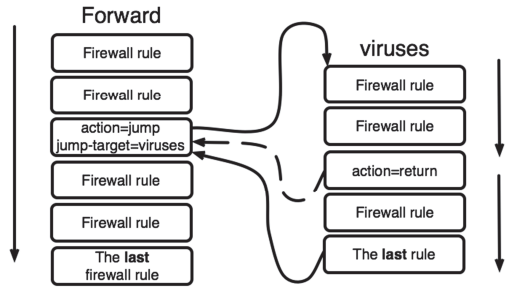


Firewall chains

- Except of the built-in chains (input, forward, output), custom chains can be created
- Make firewall structure more simple
- Decrease load of the router

Firewall chains in Action

- Sequence of the firewall custom chains
- Custom chains can be for viruses, TCP, UDP protocols, etc.

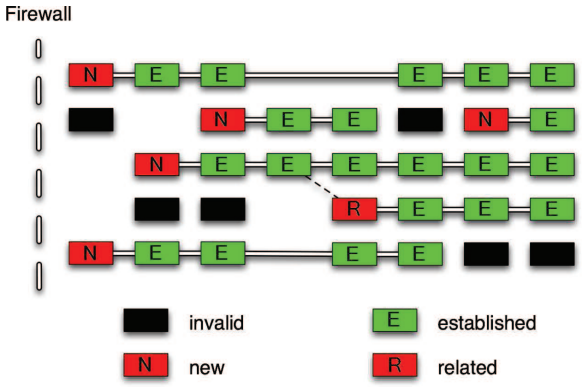


LAB

Firewall chain Lab

- Download viruses.rsc from router (access by FTP)
- Export the configuration by import command
- Check the firewall

Connections



Connection State

- Advise, drop invalid connections
- Firewall should proceed only new packets, it is recommended to exclude other types of states
- Filter rules have the “connection state” matcher for this purpose
- Connection state isn’t tcp state

LAB

Connection State

- Add rule to drop invalid packets
- Add rule to accept established packets
- Add rule to accept related packets
- Let Firewall to work with **new** packets **only**

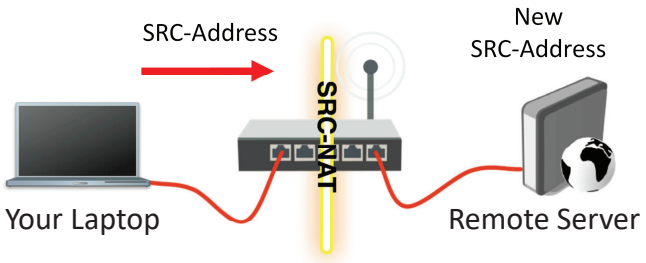
Summary

Network Address Translation

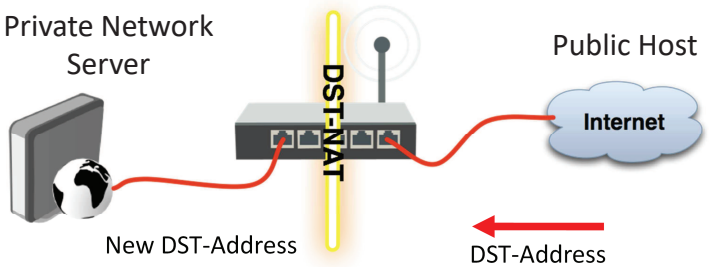
NAT

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

SRC-NAT



DST-NAT



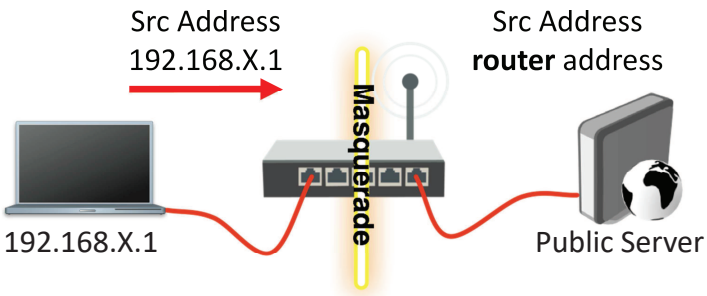
NAT Chains

- To achieve these scenarios you have to order your NAT rules in appropriate chains: **dstnat** or **srcnat**
- NAT rules work on **IF-THEN** principle

SRC-NAT

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

Masquerade



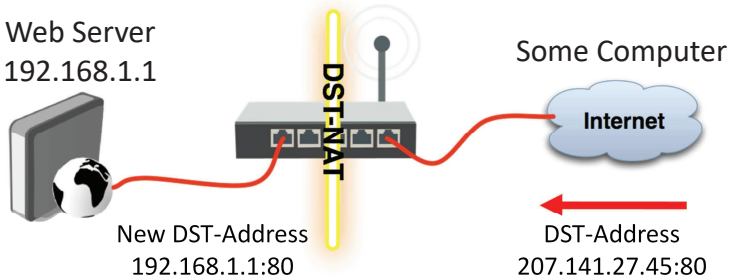
SRC-NAT Limitations

- Connecting to internal servers from outside is not possible (DST-NAT needed)
- Some protocols require NAT helpers to work correctly

DST-NAT

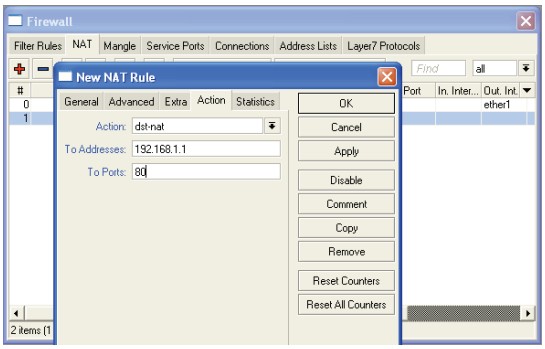
- DST-NAT changes packet's destination address and port
- It can be used to direct internet users to a server in your private network

DST-NAT Example



DST-NAT Example

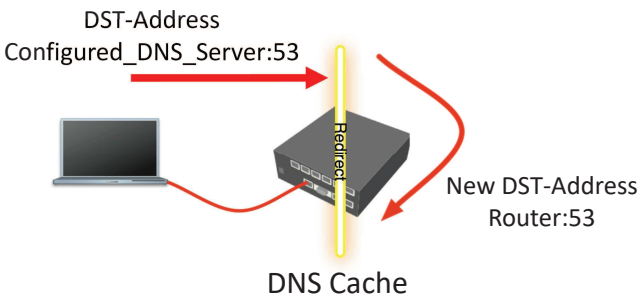
- Create a rule to forward traffic to WEB server in private network



Redirect

- Special type of DST-NAT
- This action redirects packets to the router itself
- It can be used for proxying services (DNS, HTTP)

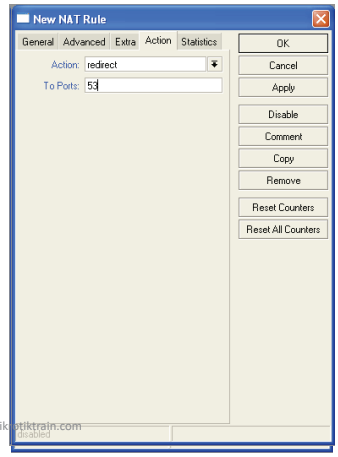
Redirect example



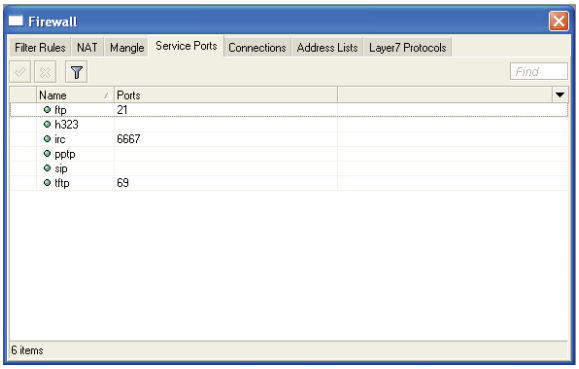
Redirect Example

LAB

- Let's make local users to use Router DNS cache
- Also make rule for **udp** protocol



NAT Helpers



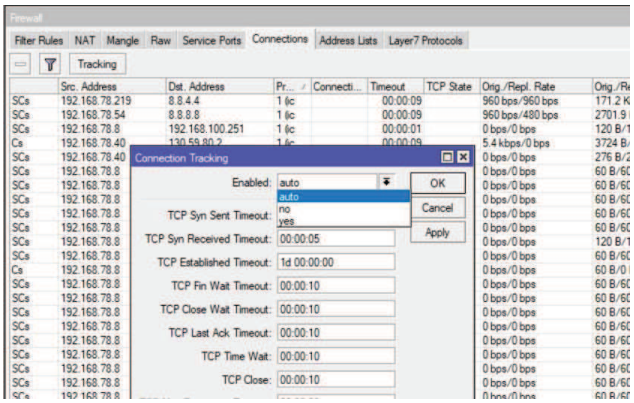
Firewall Tips

- Add comments to your rules
- Use Connection Tracking or Torch

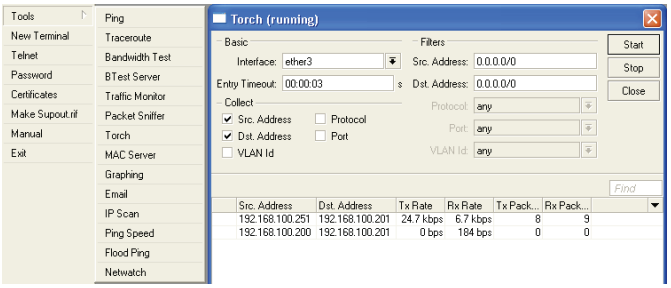
Connection Tracking

- Connection tracking manages information about all active connections.
- It should be enabled for Filter and NAT

Connection Tracking



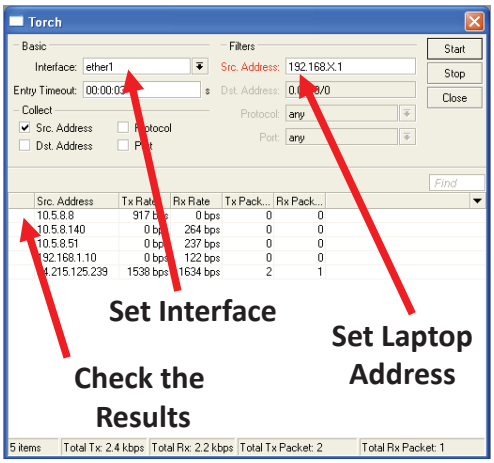
Torch



- Detailed actual traffic report for interface

Using Torch

- Select local network interface
- See actual bandwidth



Firewall Actions

- Accept
- Drop
- Reject
- Tarpit
- log
- add-src-to-address-list(dst)
- Jump, Return
- Passthrough

NAT Actions

- Accept
- DST-NAT/SRC-NAT
- Redirect
- Masquerade
- Netmap

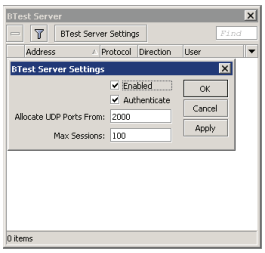
Summary

Bandwidth Test Utility

- Bandwidth test can be used to monitor throughput to remote device
- Bandwidth test works between two MikroTik routers
- Bandwidth test utility available for Windows
- Bandwidth test is available on **MikroTiktrain.com**

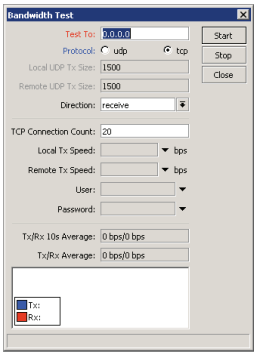
Bandwidth Server

- Server should be enabled
- It is advised to use enabled **Authenticate**



Bandwidth Test

- Set **Test To** as testing address
- Select protocol
- TCP supports multiple connections
- Authentication might be required



LAB

Bandwidth Test

- Set **Test To** as testing address
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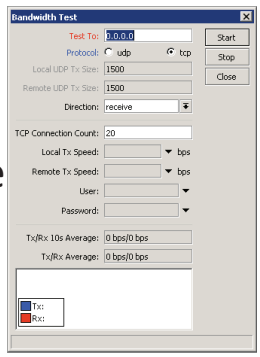


Bandwidth Limit

Simple Queue

- The easiest way to limit bandwidth:
  - client download
  - client upload
  - client aggregate, download+upload

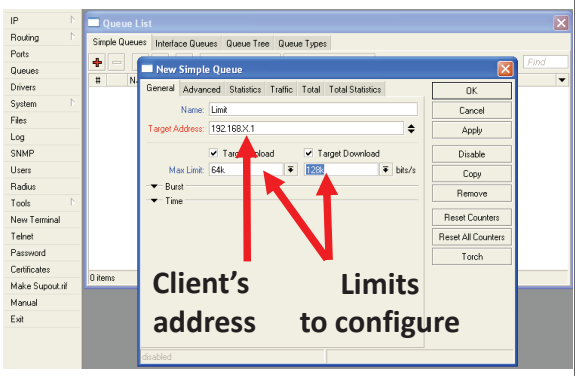
Simple Queue

- You must use **Target-Address** for Simple Queue
- Rule order is important for queue rules

Simple Queue

LAB

- Let's create limitation for your laptop
- 64k Upload, 128k Download



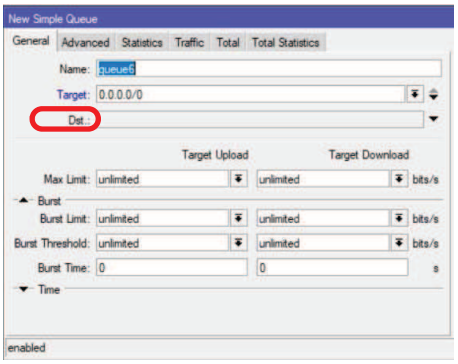
Simple Queue

- Check your limits
- Torch is showing bandwidth rate

Specific Server Limit

LAB

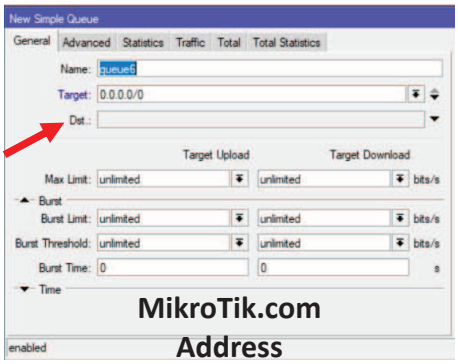
- Let's create bandwidth limit to MikroTik.com
- DST-address is used for this
- Rules order is important



Specific Server Limit

LAB

- Ping www.mikrotik.com
- Put MikroTik address to DST-address
- MikroTik address can be used as Target-address too



LAB

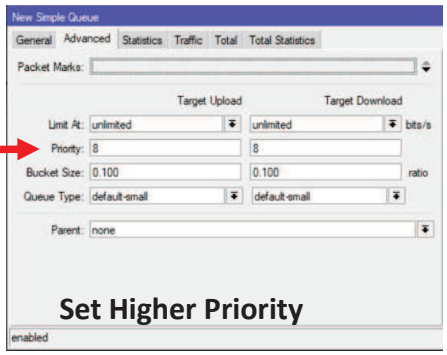
Specific Server Limit

- DST-address is useful to set unlimited access to the local network resources
- Target-address and DST-addresses can be vice versa

LAB

Traffic Priority

- Let's configure higher priority for queues
- Priority 1 is higher than 8
- There should be at least two priority

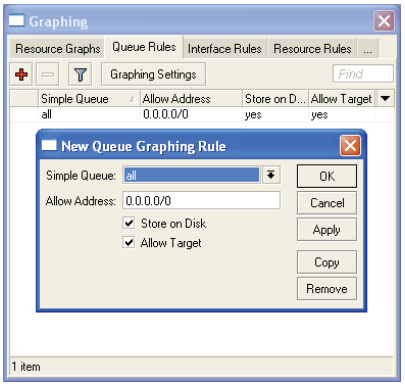


Simple Queue Monitor

- It is possible to get **graph** for each queue simple rule
- Graphs show how much traffic is passed trough queue

Simple Queue Monitor

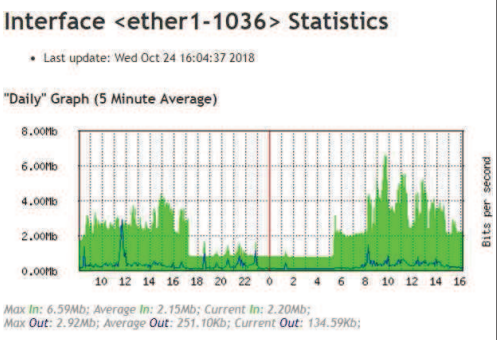
- Let's enable graphing for Queues



LAB

Simple Queue Monitor

- Graphs are available on WWW
- To view graphs http://router_IP
- You can give it to your customer

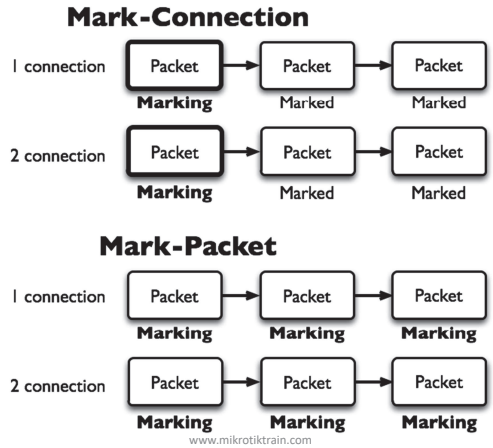


Advanced Queing

Mangle

- Mangle is used to mark packets
- Separate different type of traffic
- Marks are active within the router
- Used for queue to set different limitation
- Mangle do not change packet structure (except DSCP, TTL specific actions)

Mangle Actions

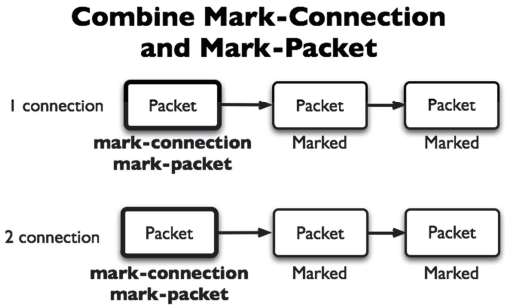


Mangle Actions

- **Mark-connection** uses connection tracking
- Information about new connection added to connection tracking table
- Mark-packet works with packet directly
- Router follows each packet to apply **mark-packet**

Optimal Mangle

- Queues have packet-mark option only



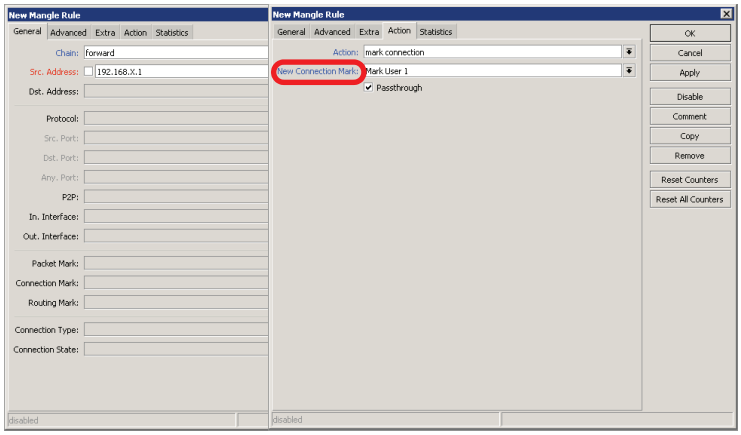
Optimal Mangle

- Mark new connection with **mark-connection**
- Add **mark-packet** for every **mark-connection**

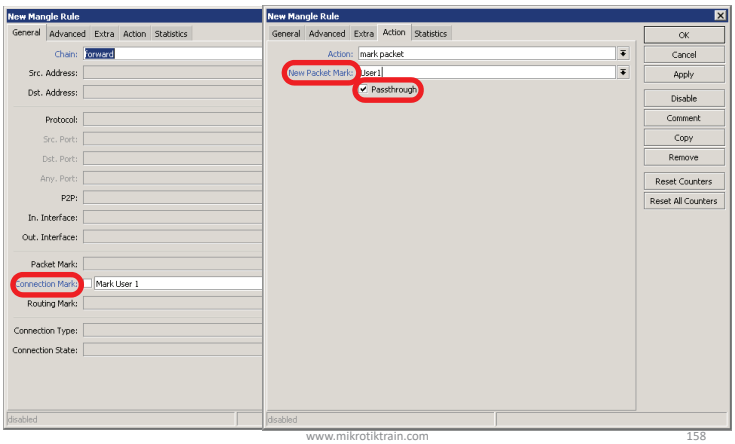
Mangle Example

- Imagine you have second client on the router network with 192.168.X.55 IP address
- Let's create two different marks (**Gold**, **Silver**), one for your computer and second for 192.168.X.55

Mark Connection



Mark Packet



LAB

Mangle Example

- Add Marks for second user too
- There should be 4 mangle rules for two groups

Advanced Queuing

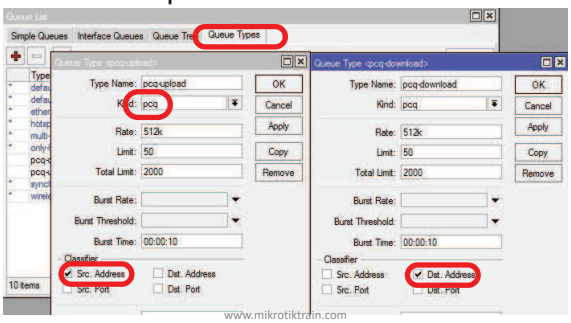
- Replace hundreds of queues with just few
- Set the same limit to any user
- Equalize available bandwidth between users

PCQ

- PCQ is advanced Queue type
- PCQ uses classifier to divide traffic (from client point of view; src-address is upload, dst-address is download)

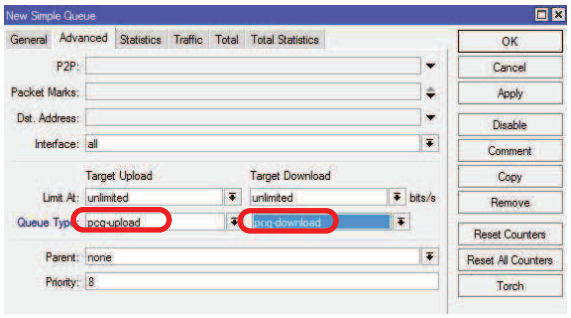
PCQ, one limit to all

- PCQ allows to set one limit to all users with one queue



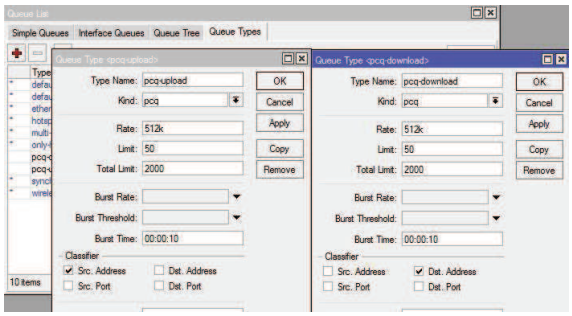
One limit to all

- Multiple queue rules are changed by one



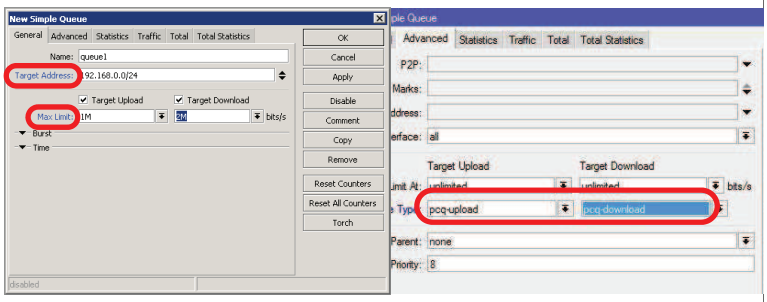
PCQ, equalize bandwidth

- Equally share bandwidth between customers



Equalize bandwidth

- 1M upload/2M download is shared between users



PCQ Lab

LAB

- Teacher is going to make PCQ lab on the router
- Two PCQ scenarios are going to be used with mangle

Summary

Wireless

What is Wireless

- RouterOS supports various radio modules that allow communication over the air (2.4GHz and 5GHz)
- MikroTik RouterOS provides a complete support for IEEE 802.11a, 802.11b, 802.11g and 802.11n wireless networking standards

Wireless Standards

- IEEE 802.11b - 2.4GHz frequencies, 11Mbps
- IEEE 802.11g - 2.4GHz frequencies, 54Mbps
- IEEE 802.11a - 5GHz frequencies, 54Mbps
- IEEE 802.11n - 2.4GHz - 5GHz (From version 4 RouterOS)
- IEEE 802.11ac - 5GHz (From version 6.16 RouterOS)

Supported Bands

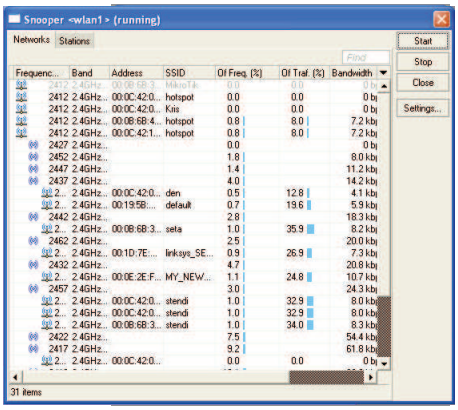
- All 5GHz (802.11a) and 2.4GHz (802.11b/g), including small channels

Supported Frequencies

- Depending on your country regulations wireless card might support
  - 2.4GHz: 2312 - 2499 MHz New :2192-2734
  - 5GHz: 4920 - 6100 MHz

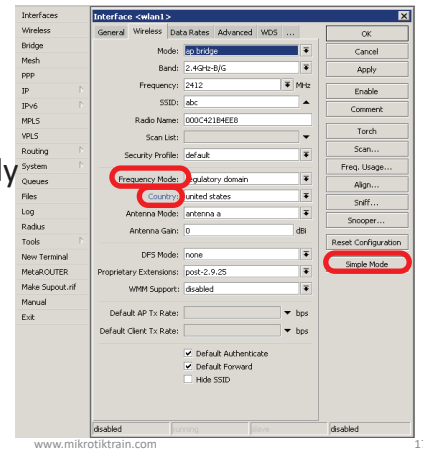
Snooper wireless monitor

- Use **Snooper** to get total view of the wireless networks on used band
- Wireless **interface is disconnected** at this moment



Apply Country Regulations

- Set wireless interface to apply your country regulations



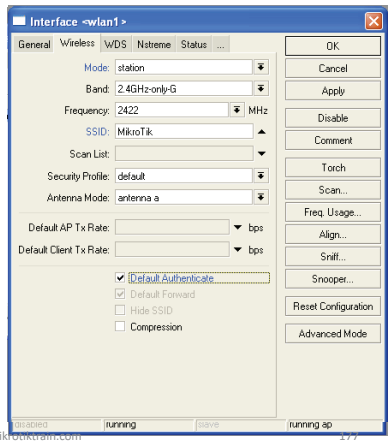
RADIO Name

- We will use RADIO Name for the same purposes as router identity
- Set RADIO Name as **Number+Your Name**

Wireless Network

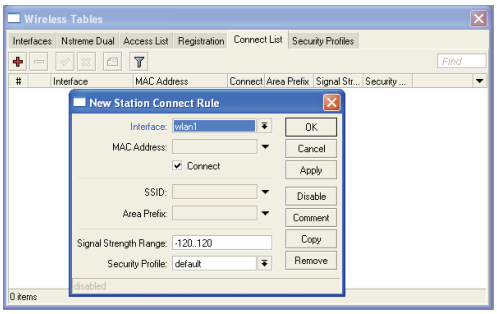
Station Configuration

- Set Interface **mode=station**
- Select **band**
- Set **SSID**, Wireless Network Identity
- Frequency is **not important** for client, use scan-list



Connect List

- Set of rules used by station to select access-point



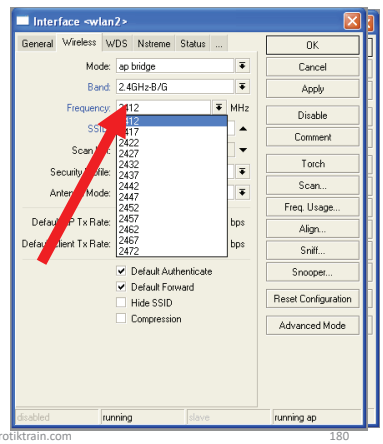
LAB

Connect List Lab

- Currently your router is connected to class access-point
- Let's make rule to disallow connection to class access-point
- Use connect-list matchers

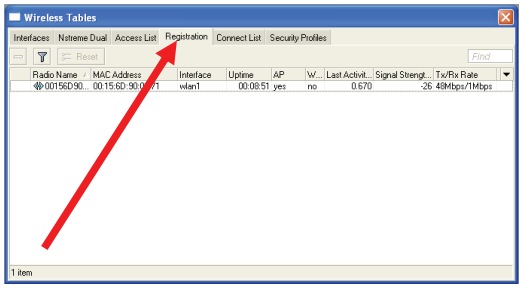
Access Point Configuration

- Set Interface **mode=ap-bridge**
- Select **band**
- Set **SSID**, Wireless Network Identity
- Set **Frequency**



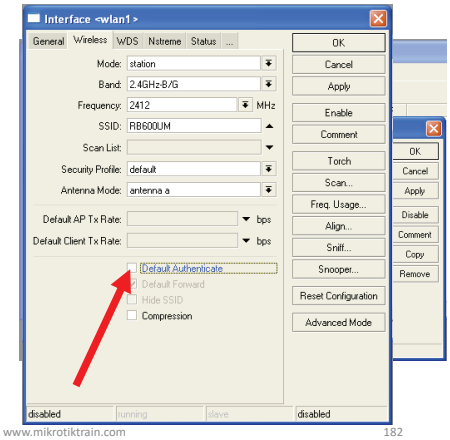
Registration Table

- View all connected wireless interfaces



Security on Access Point

- **Access-list** is used to set **MAC-address** security
- Disable **Default-Authentication** to use only Access-list



Default Authentication

- **Yes,** Access-List rules are checked, client is able to connect, if there is no deny rule
- **No,** only Access-List rule are checked

LAB

Access-List Lab

- Since you have mode=station configured we are going to make lab on teacher's router
- Disable connection for specific client
- Allow connection only for specific clients

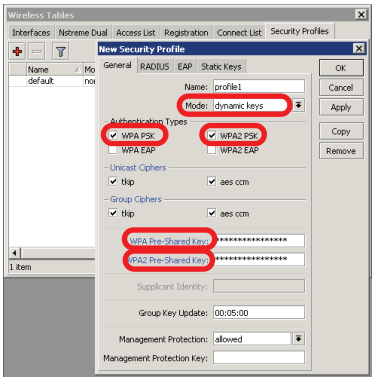
Security

- Let's enable encryption on wireless network
- You must use WPA or WPA2 encryption protocols
- All devices on the network should have the same security options

LAB

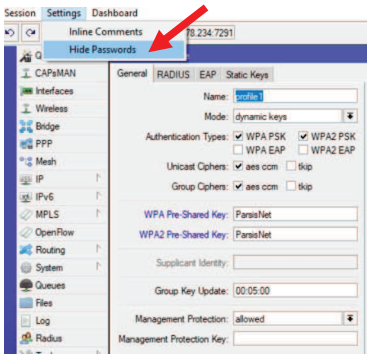
Security

- Let's create WPA **encryption** for our wireless network
- WPA Pre-Shared Key is **mikrotiktraining**



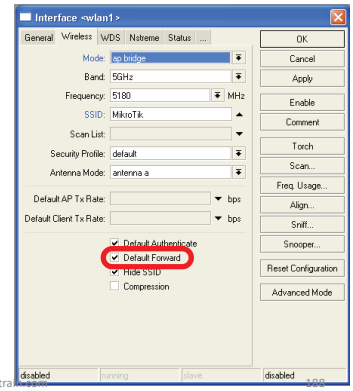
Configuration Tip

- To view hidden Pre-Shared Key, click on Hide Passwords
- It is possible to view other hidden information, except router password



Drop Connections between clients

- **Default-Forwarding** used to disable communications between clients connected to the same access-point



Default Forwarding

- Access-List rules have higher priority
- Check your access-list if connection between client is working

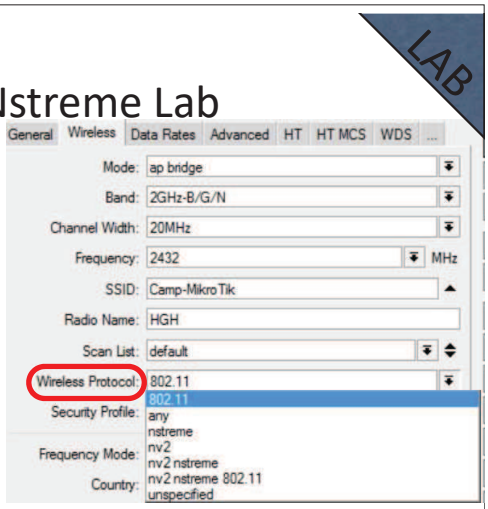
Nstreme

- MikroTik proprietary wireless protocol
- Improves wireless links, especially long-range links
- To use it on your network, enable protocol **on all** wireless devices of this network
- NV2 = Nstreme version 2

Nstreme Lab

LAB

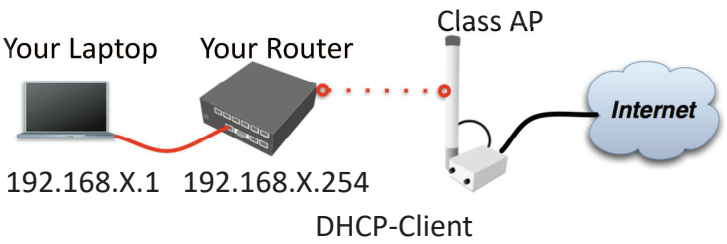
- Enable Nstreme on your router
- Check the connection status
- **Nstreme** should be enabled on **both** routers



Summary

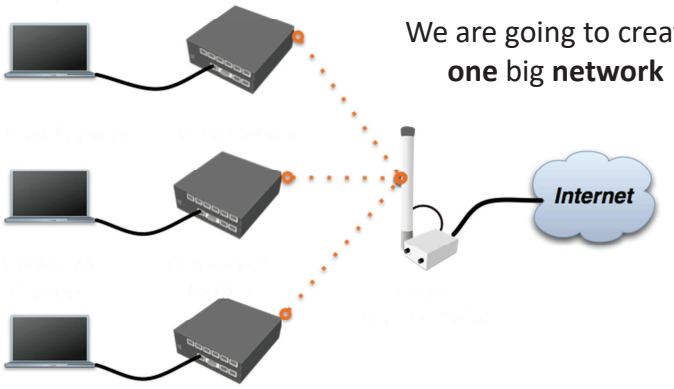
Bridging

Bridge Wireless Network



- Let's get back to our configuration

Bridge Wireless Network



Bridge

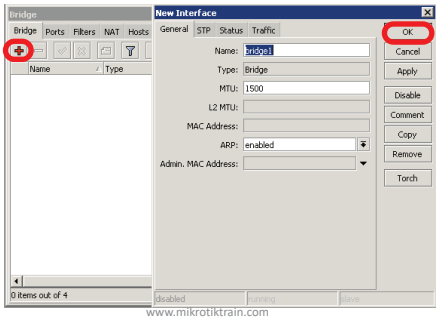
- We are going to bridge local Ethernet interface with Internet wireless interface
- Bridge unites different physical interfaces into one logical interface
- All your laptops will be in the same network

Bridge

- To bridge you need to create bridge interface
- Add interfaces to bridge ports

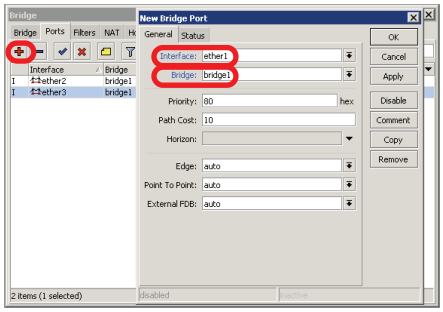
Create Bridge

- Bridge is configured from **/interface bridge** menu



Add Bridge Port

- Interfaces are added to bridge via ports



Bridge

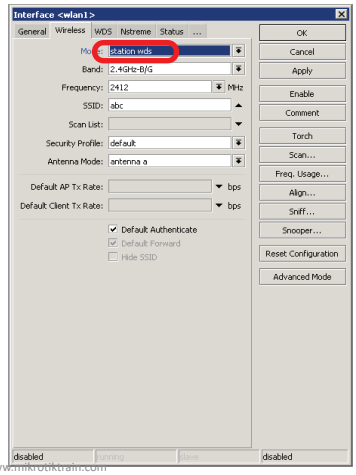
- There are no problems to bridge Ethernet interface
- Wireless Clients (**mode=station**) do not support **bridging** due the limitation of 802.11

Bridge Wireless

- **WDS** allows to add wireless client to **bridge**
- WDS (Wireless Distribution System) enables connection between Access Point and Access Point

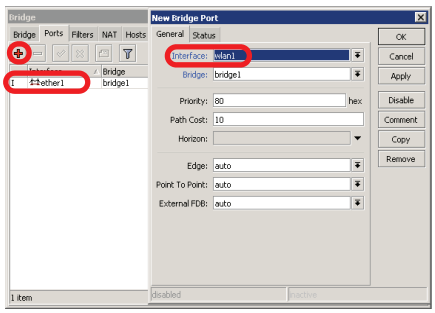
Set WDS Mode

- Station-wds is special station mode with WDS support



Add Bridge Ports

- Add public and local interface to bridge
- Ether1 (local), wlan1 (public)

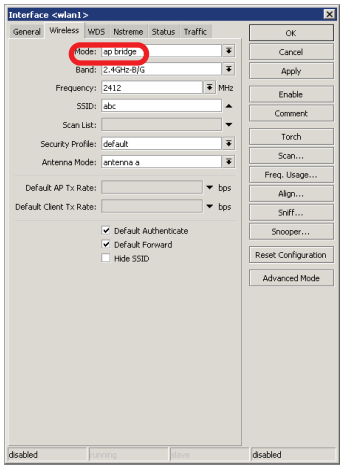


Access Point WDS

- Enable WDS on AP-bridge, use mode=dynamic(…)
- WDS interfaces are created on the fly
- Use default bridge for WDS interfaces
- Add Wireless Interface to Bridge

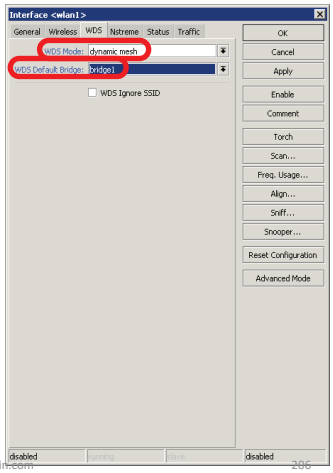
AP-bridge

- Set AP-bridge settings
- Add Wireless interface to **bridge**



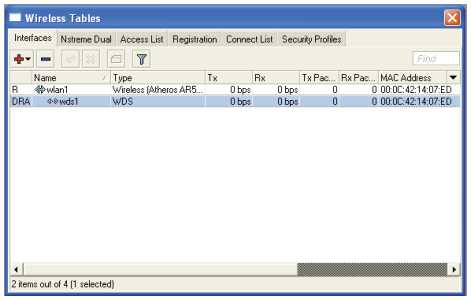
WDS configuration

- Use **dynamic (mesh)** WDS mode
- WDS interfaces are created on the fly
- Others AP should use **dynamic (mesh)** too



WDS

- WDS link is established
- Dynamic interface is present



LAB

WDS Lab

- Delete **masquerade** rule
- Delete **DHCP-client** on router wireless interface
- Use mode=station-wds on router
- Enable DHCP on your laptop
- Can you ping neighbor's laptop

WDS Lab

- Your **Router** is **Transparent Bridge** now
- You should be able to ping neighbor router and computer now
- Just use correct IP address

Station Bridge

- There is an easy way for bridging wireless in MikroTik
- You can Bridge wireless link with **ap-bridge** with **station-bridge** if both side use RouterOS

LAB

Restore Configuration

- To restore configuration manually
  - change back to Station mode
  - Add DHCP-Client on correct interface
  - Add masquerade rule
  - Set correct network configuration to laptop

Summary

Routing

Route Networks

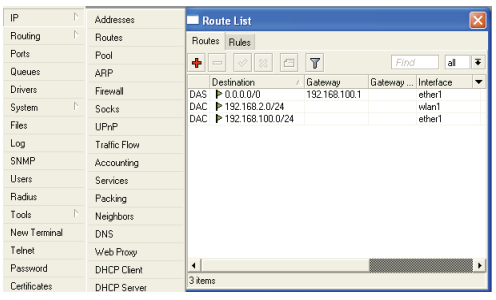
- Configuration is back
- Try to ping neighbor's laptop
- Neighbor's address 192.168.X.1
- We are going to learn how to use route rules to ping neighbor laptop

Route

- **ip route** define where packets should be sent
- Let's look at /ip route

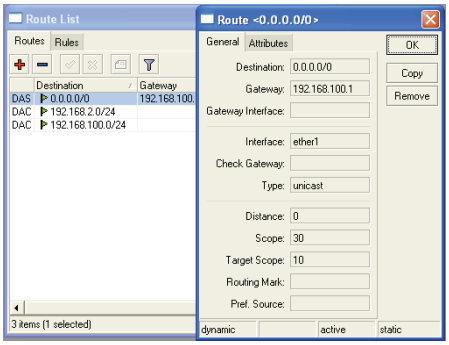
Routes

- **Destination: networks** which can be reached
- **Gateway:** IP of the next router to reach the **destination**



Default Gateway

- Default gateway: next hop router where all (**0.0.0.0/0**) traffic is sent

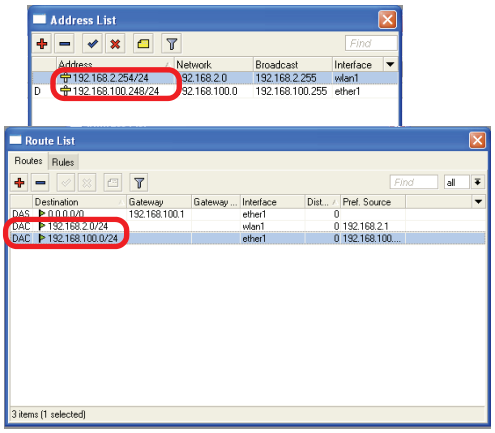


Set Default Gateway Lab

- Currently you have default gateway received from DHCP-Client
- Disable automatic receiving of default gateway in DHCP-client settings
- Add default gateway manually

Routes Status

- Look at the other routes
- Routes with **DAC** are added automatically
- **DAC** route comes from IP address configuration



Routes

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

Static Routes

- Our goal is to ping neighbor laptop
- Static route will help us to achieve this

Static Route

- Static route specifies how to reach specific destination network
- **Default gateway** is also static route, it sends all traffic (destination 0.0.0.0/0) to host - the gateway

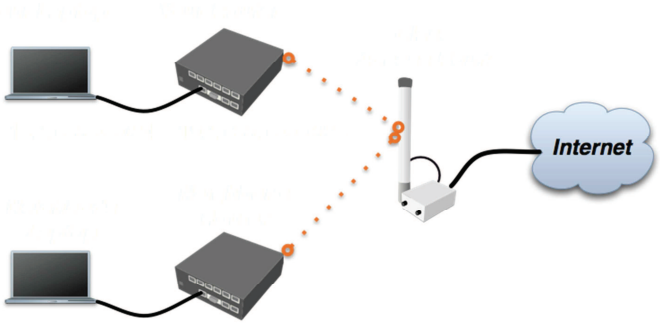
Static Route

- Additional static route is required to reach your neighbor laptop
- Because **gateway** (teacher's router) does not have information about **student's** private **network**

Route to Your Neighbor

- Remember the network structure
- Neighbor's local network is 192.168.x.0/24
- Ask your neighbor the IP address of their wireless interface

Network Structure



LAB

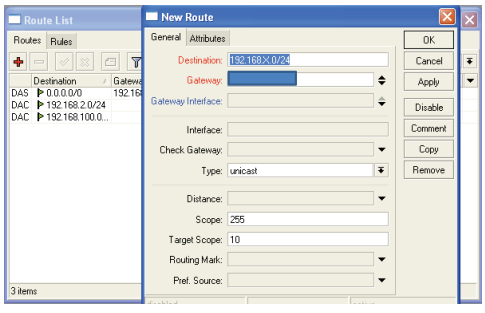
Route To Your Neighbor

- Add one route rule
- Set Destination, **destination** is **neighbor's local network**
- Set Gateway, address which is used to reach destination - **gateway** is IP address of neighbor's router wireless interface

LAB

Route Your Neighbor

- Add static route
- Set Destination and Gateway
- Try to ping Neighbor's Laptop



Router To Your Neighbor

- You should be able to ping neighbor's laptop now

Dynamic Routes

- The same configuration is possible with dynamic routes
- Imagine you have to add static routes to all neighbors networks
- Instead of adding tons of rules, dynamic routing protocols can be used

Summary

Local Network Management

Access to Local Network

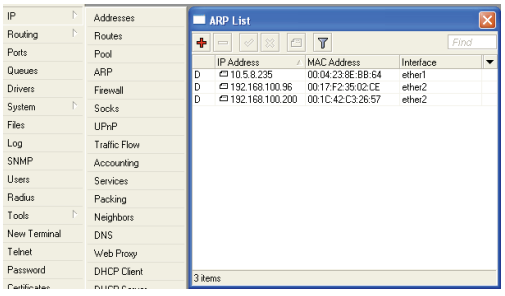
- Plan network design carefully
- Take care of user's local access to the network
- Use RouterOS features to secure local network resources

ARP

- Address Resolution Protocol
- ARP joins together client's IP address with MAC-address
- ARP operates dynamically, but can also be manually configured

ARP Table

- ARP table provides: IP address, MAC-address and Interface

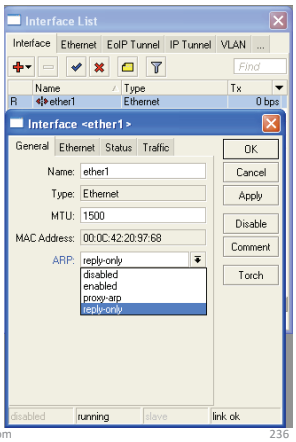


Static ARP table

- To increase network security ARP entries can be crated manually
- Router's client will not be able to access Internet with changed IP address

Static ARP configuration

- Add Static Entry to ARP table
- Set for interface arp=reply-only to disable dynamic ARP creation
- Disable/enable interface or reboot router



LAB

Static ARP Lab

- Make your laptop ARP entry as static
- Set arp=reply-only to Local Network interface
- Try to change computer IP address
- Test Internet connectivity

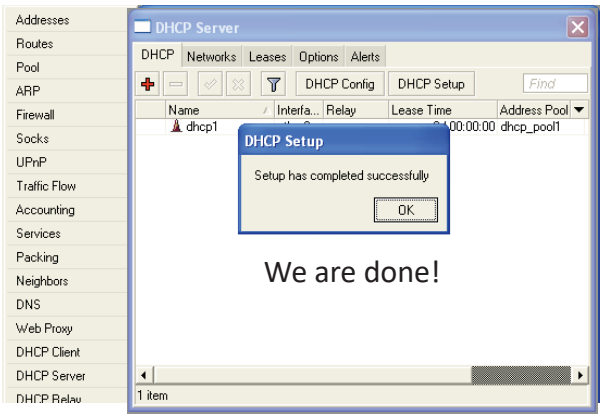
DHCP Server

- Dynamic Host Configuration Protocol
- Used for automatic IP address distribution over local network
- Use DHCP only in secure networks

DHCP Server

- To setup DHCP server you should have IP address on the interface
- Use setup command to enable DHCP server
- It will ask you for necessary information

DHCP-Server Setup



We are done!

Important

- To configure **DHCP server** on **bridge**, set server on **bridge interface**
- DHCP server will be **invalid**, when it is configured on **bridge port**

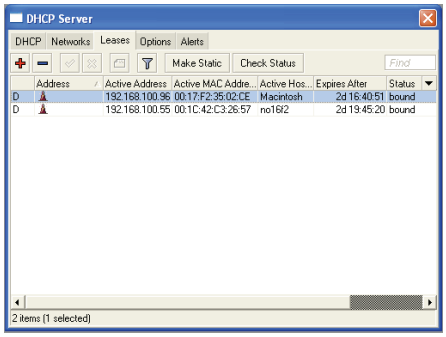
LAB

DHCP Server Lab

- Setup DHCP server on Ethernet Interface where Laptop is connected
- Change computer Network settings and enable DHCP-client (Obtain an IP address Automatically)
- Check the Internet connectivity

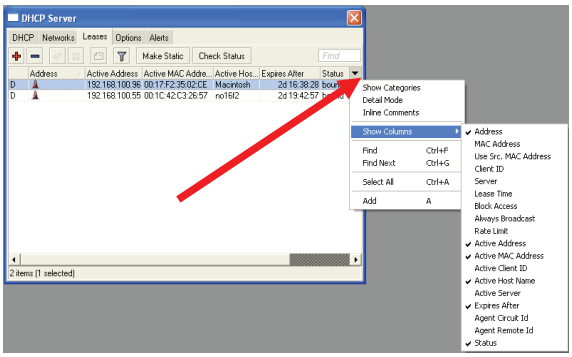
DHCP Server Information

- Leases provide information about DHCP clients



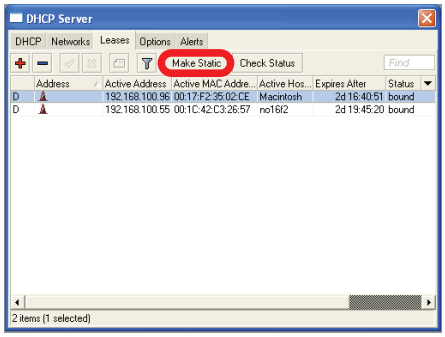
Winbox Configuration Tip

- Show or hide different Winbox columns



Static Lease

- We can make lease to be static
- Client will not get other IP address



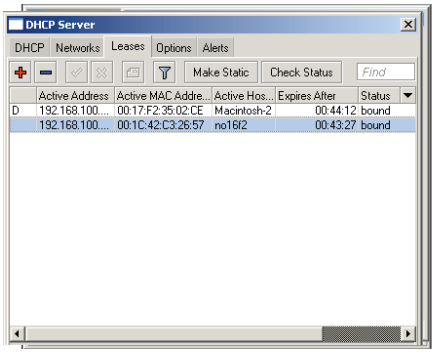
Static Lease

- DHCP-server could run without dynamic leases
- Clients will receive only preconfigured IP address

Static Lease

LAB

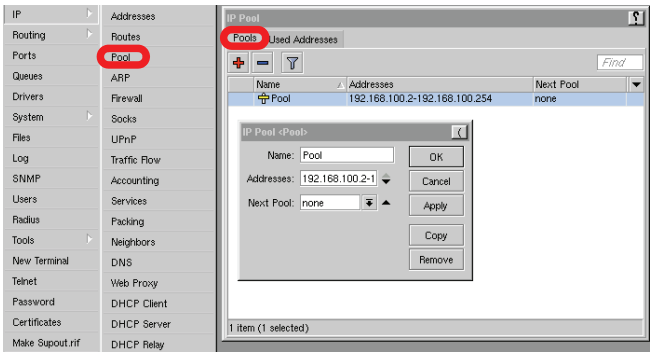
- Set Address-Pool to static-only
- Create Static leases



Pools

- Pool defines the range of IP addresses for PPP, DHCP and HotSpot clients
- We will use a pool, because there will be more than one client
- Addresses are taken from pool automatically

Pool



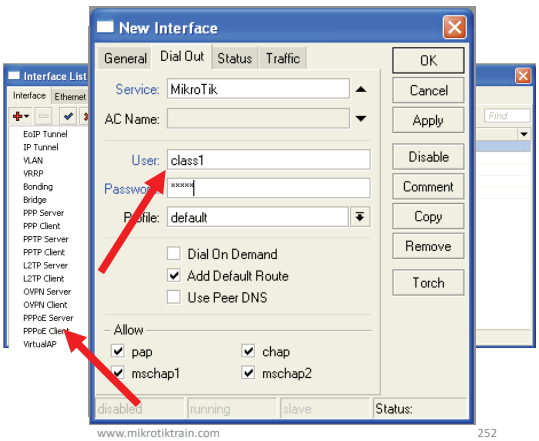
Tunnels

PPPoE

- Point to Point Protocol over Ethernet is often used to control client connections for DSL, cable modems and plain Ethernet networks
- MikroTik RouterOS supports PPPoE client and PPPoE server (ppp package)

PPPoE Client Setup

- Add PPPoE client
- You need to set **Interface**
- Set **Login** and **Password**



PPPoE Client Lab

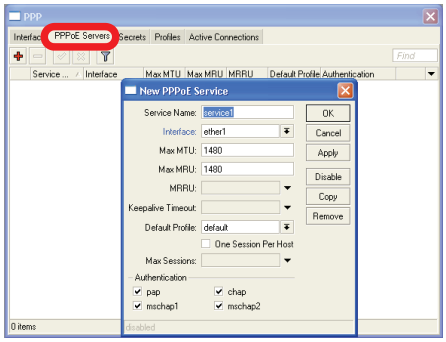
- Teachers are going to create PPPoE server on their router
- Disable DHCP-client on router's outgoing interface
- Set up PPPoE client on outgoing interface
- Set Username **class**, password **class**

PPPoE Client Setup

- Check PPP connection
- Disable PPPoE client
- Enable DHCP client to restore old configuration

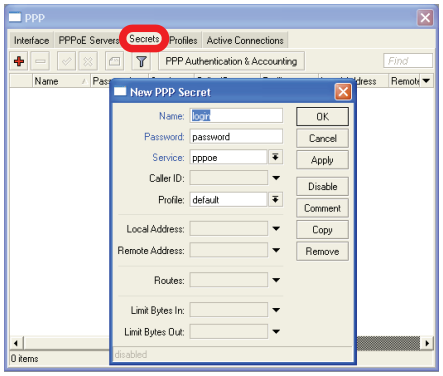
PPPoE Server Setup

- Select Interface
- Select Profile



PPP Secret

- User's database
- Add login and Password
- Select service
- Configuration is takef from profile

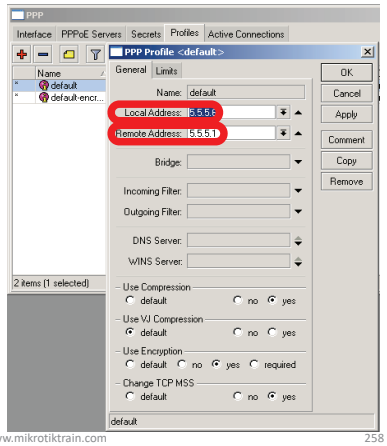


PPP Profiles

- Set of rules used for PPP clients
- The way to set same settings for different clients

PPP Profile

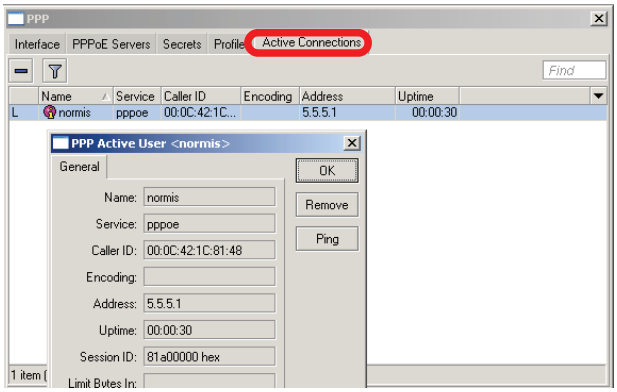
- **Local address** - Server address
- **Remote Address** - Client address



PPPoE

- Important, PPPoE server runs on the interface
- PPPoE interface can be without IP address configured
- For security, leave PPPoE interface without IP address configuration

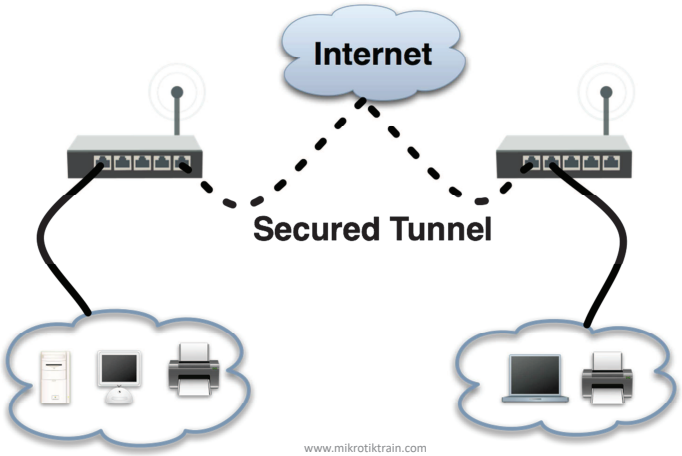
PPP Status



PPTP

- Point to Point Tunnel Protocol provides encrypted tunnels over IP
- MikroTik RouterOS includes support for PPTP client and server
- Used to secure link between Local Networks over Internet
- For mobile or remote clients to access company Local network resources

PPTP

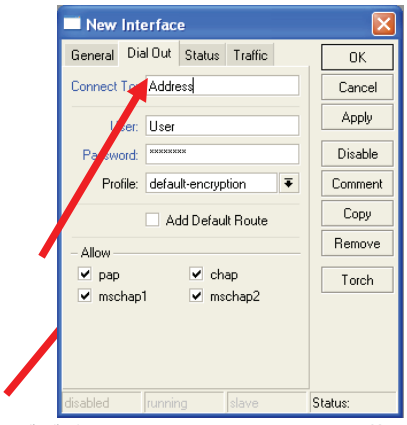


PPTP configuration

- PPTP configuration is very similar to PPPoE
- L2TP configuration is very similar to PPTP and PPPoE

PPTP client

- Add PPTP Interface
- Specify address of PPTP server
- Set login and password

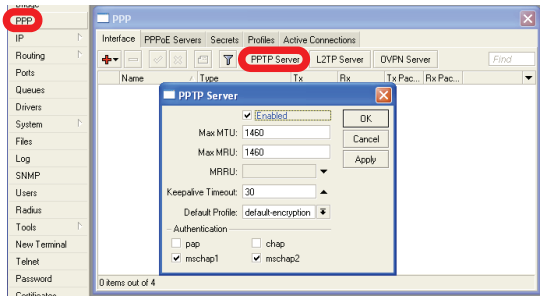


PPTP Client

- That's all for PPTP client configuration
- Use Add Default Gateway to route all router's traffic to PPTP tunnel
- Use static routes to send specific traffic to PPTP tunnel

PPTP Server

- PPTP Server is able to maintain multiple clients
- It is easy to enable PPTP server



PPTP Server Clients

- PPTP client settings are stored in ppp secret
- ppp secret is used for PPTP, L2TP, PPPoE clients
- ppp secret database is configured on server

Important

- The same profile is used for PPTP, PPPoE, L2TP and PPP clients
- PPTP(L2tp ,PPPoE ,….) Server and client can be active within a router at same time

LAB

PPTP Lab

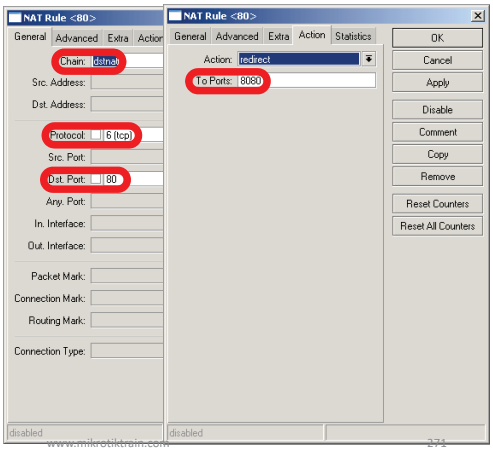
- Teachers are going to create PPTP server on Teacher's router
- Set up PPTP client on outgoing interface
- Use username **class** password **class**
- Disable PPTP interface

Transparent Proxy

- User need to set additional configuration to browser to use Proxy
- Transparent proxy allows to direct all users to proxy automatically

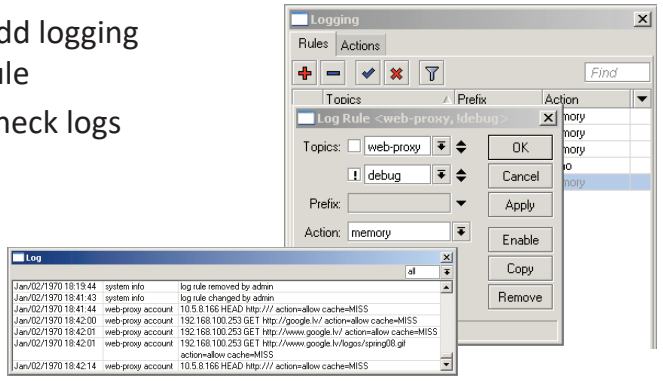
Transparent Proxy

- DST-NAT rules required for transparent proxy
- HTTP traffic should be redirected to router



Logging

- Add logging rule
- Check logs



Summary

Dude

Dude

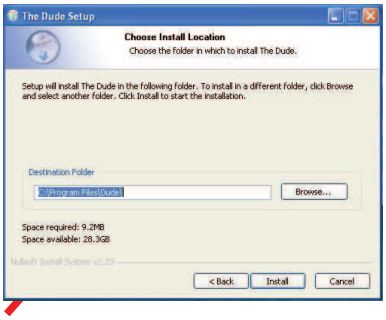
- Network monitor program
- Automatic discovery of devices
- Draw and Layout map of your networks
- Services monitor and alerts
- It is **Free**

Dude

- Dude consists of two parts:
  1. Dude server - the actual monitor program. It does not have a graphical interface. You can run Dude server even on RouterOS
  2. Dude client - connects to Dude server and shows all the information it receives

Dude Install

- Dude is available at www.mikrotik.com
- Install is very easy
- Read and use next button



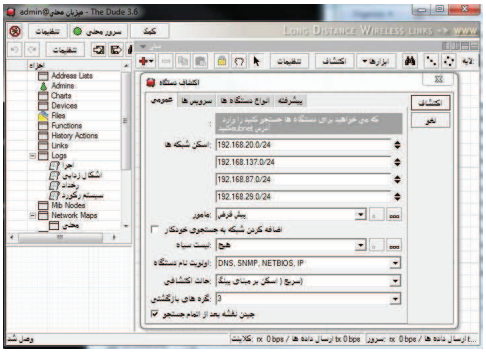
Install **Dude Server** on computer

Dude

- Dude is translated to different languages
- Available on wiki.mikrotik.com

Dude First Launch

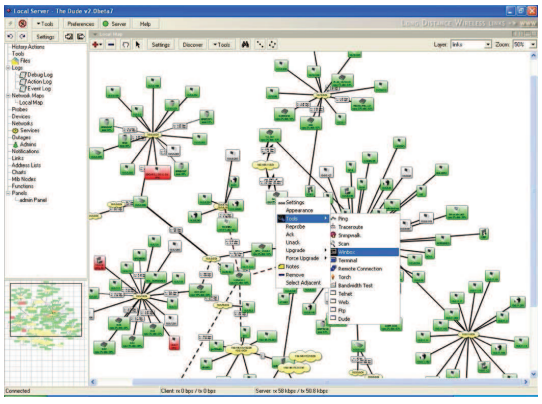
- Discover option is offered for the first launch
- You can discover local network



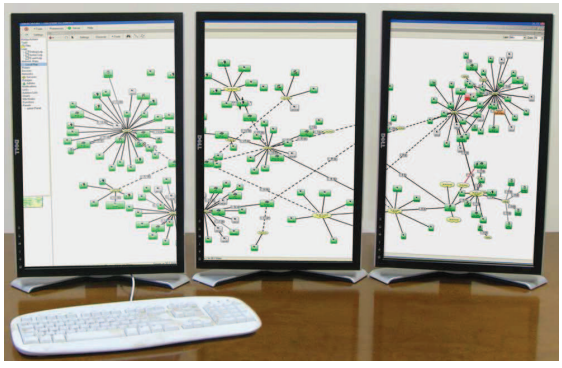
Dude Lab

- Download Dude from ftp://192.168.100.254
- Install Dude
- Discover Network
- Add laptop and router
- Disconnect Laptop from Router

Dude Usage



Dude Usage



Troubleshooting

Lost Password

- The only solution to reset password is to reinstall the routerOS or use reset jumper

RouterBOARD License

- All purchased licenses are stored in the MikroTik account server
- If your router loses the Key for some reason - just log into mikrotik.com to get it from keys list
- If the key is not in the list use Request Key option

Bad Wireless Signal

- check that the antenna connector is connected 'main' antenna connector
- check that there is no water or moisture in the cable
- check that the default settings for the radio are being used
- Use interface wireless reset-configuration

No Connection

- Try different Ethernet port or cable
- Use reset jumper on RouterBOARD
- Use serial console to view any possible messages
- Use netinstall if possible
- Contact support (info@mikrotiktrain.com)

Before Certification Test

- Reset the router
- Restore backup or restore configuration
- Make sure you have access to the Internet and to training.mikrotik.com

Before Certification Test

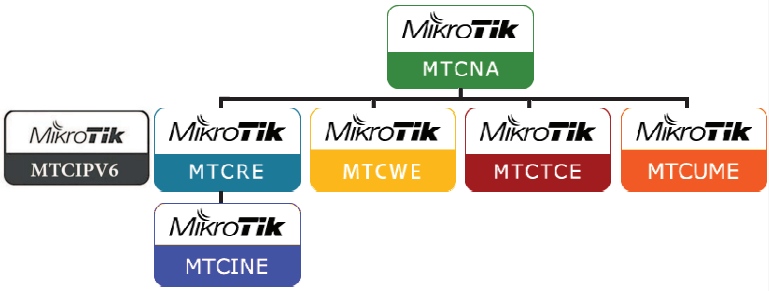
- Turn off your cellphone
- Don’t use proxy
- Don’t use copy, paste and print screen bottom
- Close all messenger, email services and any capture software

Certification Test

Certification test

- Go to http://training.mikrotik.com
- Login with your account
- Look for IRAN/Mashad by H.Ghaseri Training
- Select Essential Training Test

معرفی دوره های بین المللی میکروتیک



Parsis

مرکز رسمی برگزاری دوره های بین المللی میکروتیک

- **MTCNA** - MikroTik Certified Network Associate
- **MTCRE** - MikroTik Certified Routing Engineer
- **MTCWE** - MikroTik Certified Wireless Engineer
- **MTCTCE** - MikroTik Certified Traffic Control Engineer
- **MTCUME** - MikroTik Certified User Management Engineer
- **MTCIPv6E** - MikroTik Certified IPv6 Engineer
- **MTCINE** - MikroTik Certified Inter-networking Engineer

Parsis

Instructions