

# **RouterOS 101**

**John W0VG  
Willem AC0KQ**

**November 13, 2021**

# Preliminaries

- Download this presentation from <https://www.rmham.org/course-syllabus/>
- Download WinBox from <https://mikrotik.com/download>
- Put your laptop in **airplane mode**
  - Prevents you from configuring the wrong device
- Check your worksheet

# What is RouterOS?

- Linux based software for IP routing
  - Runs all Mikrotik hardware
    - Routers
    - Radios
  - Can also be run on x86 hardware
- License level
  - 3 for client only devices
  - 4-6 routers, access points, controllers
  - Included with all Mikrotik hardware
    - Free lifetime updates

# Advantages of RouterOS

- Same software on all hardware
  - Radios and routers
- Any interface can perform any function
  - Hardware acceleration on some ports
- By defaults all ports are routed
  - Radios can be a bridge or a router
- Easy to configure
  - Great GUI and command line tools

# Connecting to the Internet

- **The configuration shown here is for when the router is on a trusted network.**
- Security is a complex topic
  - Use a strong password
    - Disable admin and add a new *full* user
  - Use a good firewall
    - Quickset has an OK firewall
    - NAT does not protect the router itself
    - RMHAM use DevDB to maintain firewalls
  - Disable services you do not need
    - Limit services you must have

# Accessing RouterOS

- WinBox
  - Convenient GUI
  - MAC address access
- WebFig
  - Browser based GUI using HTTP
- Command line
  - ssh access or mactelnet
- API
  - Convenient for programs like DevDB

# WinBox

- Windows executable but runs well under WINE
- Best for initial configuration
  - Convenient GUI
  - Access device via MAC address
- Great for management
  - GUI for advanced configuration
  - Graphing and dynamic tables
  - Remote access via RoMON
- CLI and API (DevDB) convenient for some things

# Setup using WinBox

- Reset device
  - Remove configuration or do hard reset
- Basic configuration with WinBox
  - Assign ports, IP addresses
- Advanced configuration
  - Command line often most convenient
  - RMHAM use DevDB for “standard” configuration
- **Quick Set** is sometimes OK
  - Hard to undo its quirks



# Configuration Overview

- Initial Configuration for all devices
  - Reset device and erase configuration
  - Set system ID and password
  - Label interfaces
  - Create bridge and map ports
  - Set IP addresses
  - Configure routing
  - Configure DNS
  - Update software
- Rest of configuration depends on application

# Mikrotik hAP Mini

- RB931-2nD
  - 650 MHz SMIPS CPU
  - 32MB RAM, 16MB flash
- RouterOS 4
- 3xEthernet
  - 10/100
- 2.4GHz wifi
  - 802.11b/g/n
- MicroUSB for power (5V)



# WinBox via Ethernet

- Connect via ethernet
  - May need static IP address depending on OS
  - Click refresh
  - Click on MAC Address
  - Login=admin
  - Password=blank
- Connect

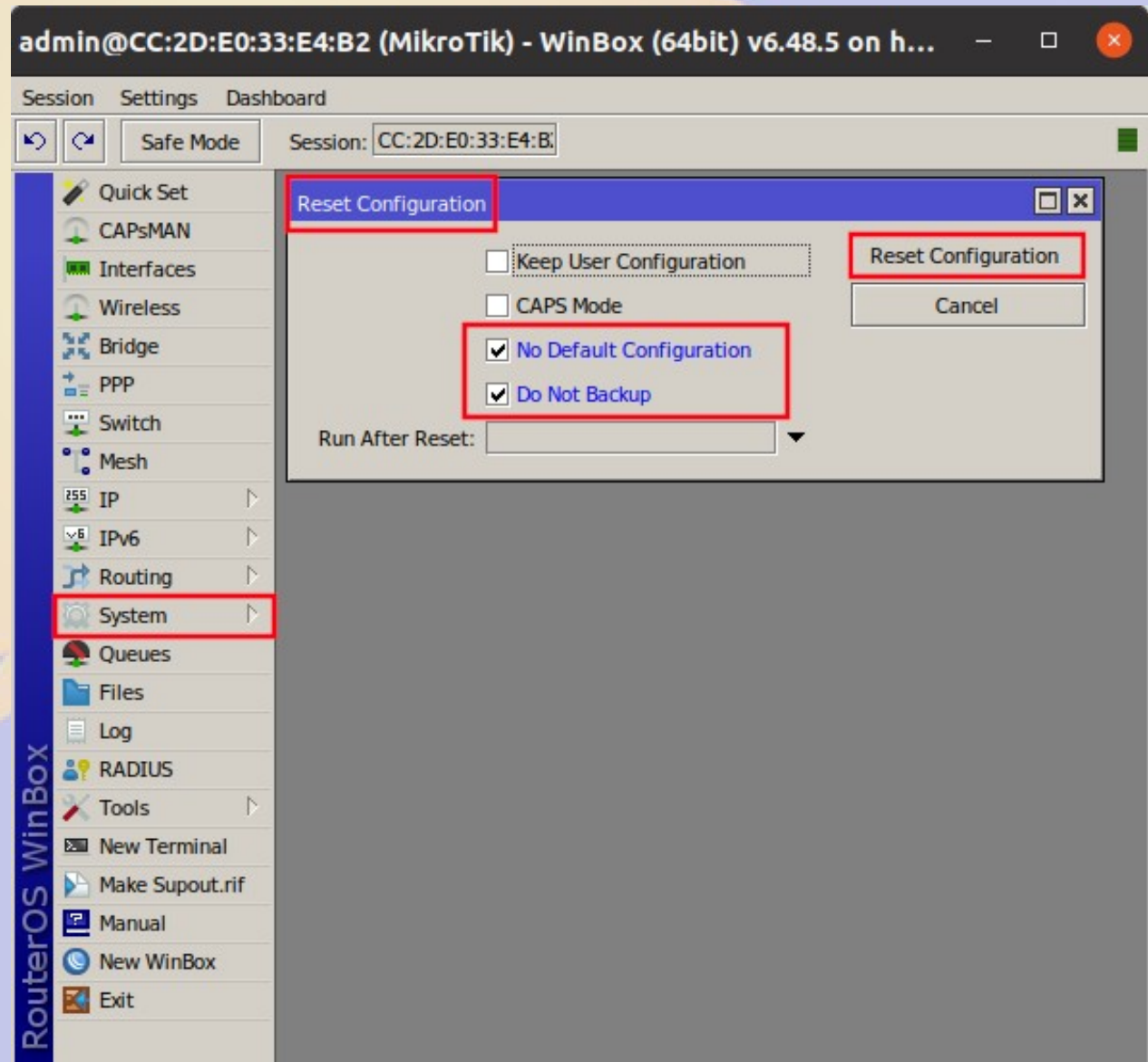
The screenshot shows the WinBox (64bit) v3.31 (Addresses) window. The 'Connect To' field is set to 'CC:2D:E0:4E:13:8B'. The 'Login' field is set to 'admin' and the 'Password' field is empty. The 'Session' dropdown is set to '<own>'. The 'Note' field is set to 'MikroTik'. The 'Group' dropdown is set to '<own>'. The 'RoMON Agent' dropdown is set to '<own>'. The 'Connect' button is highlighted with a red box. Below the connection fields, there is a table with the following data:

| MAC Address       | IP Address   | Identity | Version       | Board     | Uptime   |
|-------------------|--------------|----------|---------------|-----------|----------|
| CC:2D:E0:4E:13:8B | 192.168.88.1 | MikroTik | 6.48.5 (lo... | RB931-2nD | 00:06:19 |

The 'Refresh' button is also visible above the table. The 'Find' field is set to 'all'.

# Reset configuration

- Cleans out all accumulated crud in the configuration
- **ALWAYS** reset the configuration on a new or repurposed router pr radio



# Hard Resetting the Device

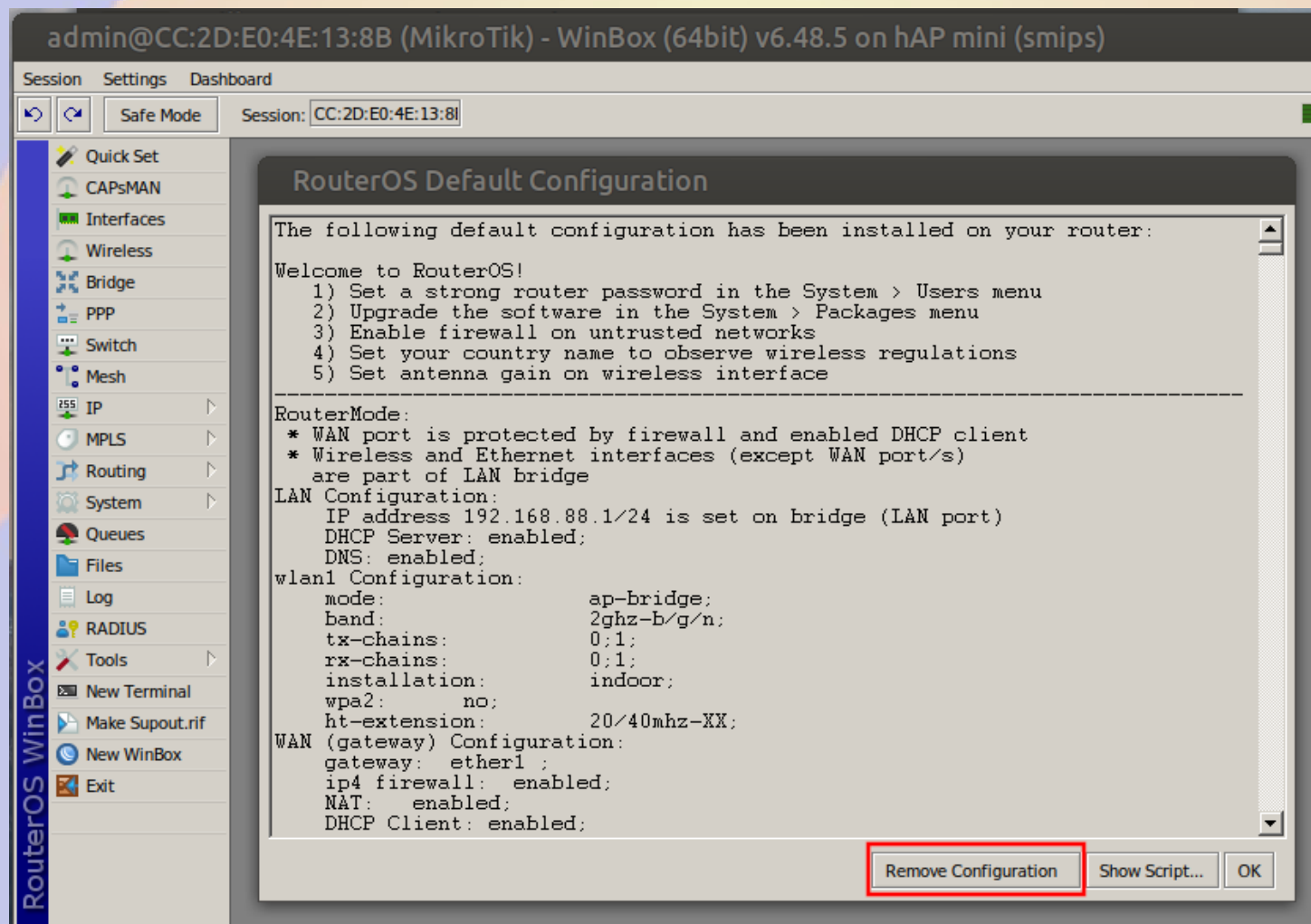
- Hold RESET button while applying power
  - Not the MODE button
- Release RESET when green USR LED starts flashing
  - About 5 seconds
- This procedure resets the device to factory defaults
  - Clears configuration
  - Resets passwords





# Remove configuration

Start with a clean slate, not a canned configuration



# Quick Set

- Set working configuration
  - CPE – WiFi for WAN
  - AP – Ether1 for WAN
  - PTP Bridge – AP and CPE
- Could make a mess when used multiple times
- Make sure you change the default password
- We will not use Quick Set today so you can get exposed to RouterOS

# Quick Set - CPE

admin@CC:2D:E0:4E:13:8B (MikroTik) - WinBox (64bit) v6.48.5 on hAP mini (smips)

Session Settings Dashboard

Safe Mode Session: CC:2D:E0:4E:13:8B

Quick Set CAPsMAN Interfaces Wireless Bridge PPP Switch Mesh IP MPLS Routing System Queues Files Log RADIUS Tools New Terminal Make Supout.rif New WinBox Exit Windows

RouterOS WinBox

## Quick Set CPE

Info

WLAN MAC Address: CC:2D:E0:4E:13:8E

LAN MAC Address: CC:2D:E0:4E:13:8A

Wireless

Band: 2GHz-B/G

Channel Width: 20MHz

Country: etsi

|     | Address           | Network ...  | Channel           | Proto |
|-----|-------------------|--------------|-------------------|-------|
| P   | 00:26:F2:8E:6D:2F | T3153DXC     | 2462/20/gn(18d... | 802.1 |
| P   | 00:31:92:43:9E:C4 | Star of I... | 2447/20/gn(18d... | 802.1 |
| P   | 02:31:92:23:9E:C4 |              | 2447/20/gn(18d... | 802.1 |
| P   | 04:BF:6D:A8:EF:D3 | Cooper       | 2462/20/gn(18d... | 802.1 |
| P   | 08:26:97:76:7C:EF | CenturyL...  | 2412/20/gn(18d... | 802.1 |
| P   | 3C:37:86:DB:02:69 | NETGEA...    | 2452/20-eC/g(1... | 802.1 |
| P   | 40:8B:07:AD:F9:E5 | Houston      | 2437/20/gn(18d... | 802.1 |
| P   | 44:A5:6E:1A:A5:40 | NETGEA...    | 2462/20/gn(18d... | 802.1 |
| P   | 58:EF:68:FE:E4:C1 | etf_action   | 2417/20/gn(18d... | 802.1 |
| P   | 5A:EF:68:FE:E4:C1 | etf_actio... | 2417/20/gn(18d... | 802.1 |
| ... | 6C:3B:6B:6A:A7:7E | KD0NFS       | 2412/20/g(18dBm)  | 802.1 |

Signal Strength: -60 dB

Network Name: Houston

WiFi Password:  ☐ Hide

active

Configuration

Mode: ☒ Router ☐ Bridge

Wireless Network

Address Acquisition: ☐ Static ☒ Automatic ☐ PPPoE

IP Address:

Netmask:

Gateway:

Upload:  bits/s

Download:  bits/s

Local Network

IP Address: 192.168.3.1

Netmask: 255.255.255.0 (/24)

☒ DHCP Server

DHCP Server Range:

☒ NAT

☒ Bridge All LAN Ports

System

Router Identity: MikroTik

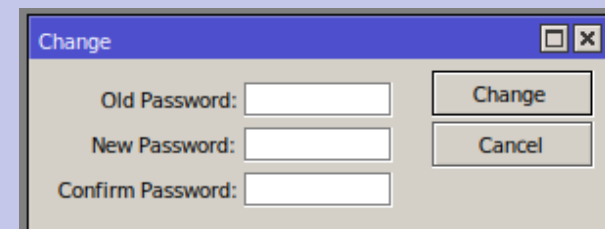
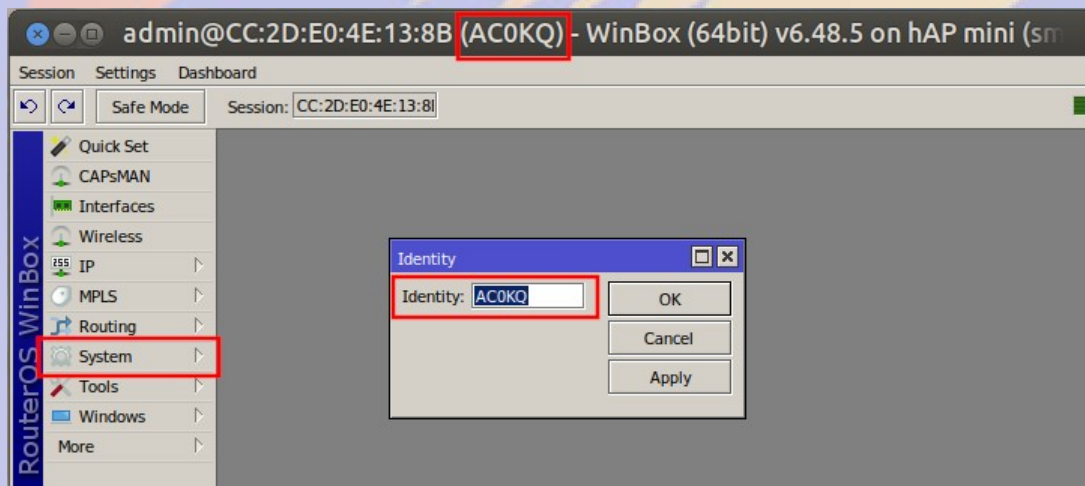
Password:

Confirm Password:



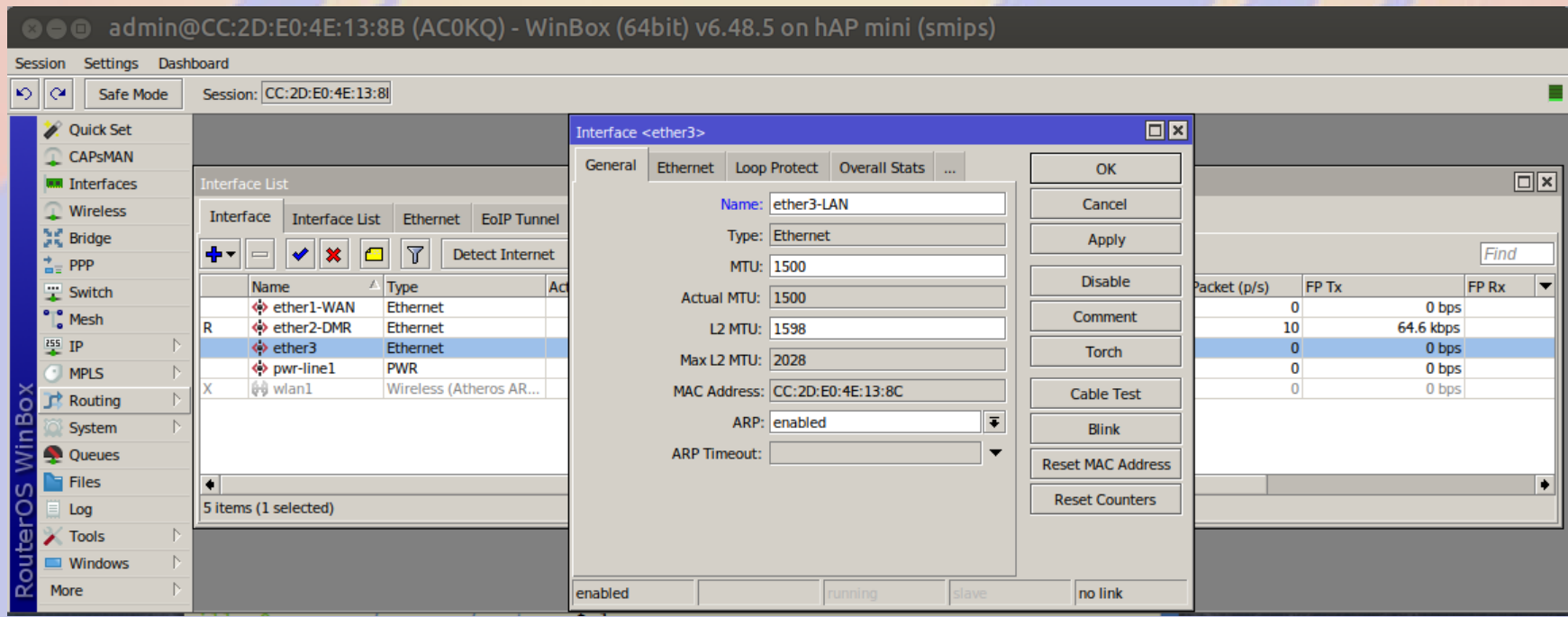
# Set System Identity

- System > Identity
  - Set it to your callsign or something unique
  - **Always double check that you are in the correct device before making changes**
- System > Password
  - Set something you can remember but type



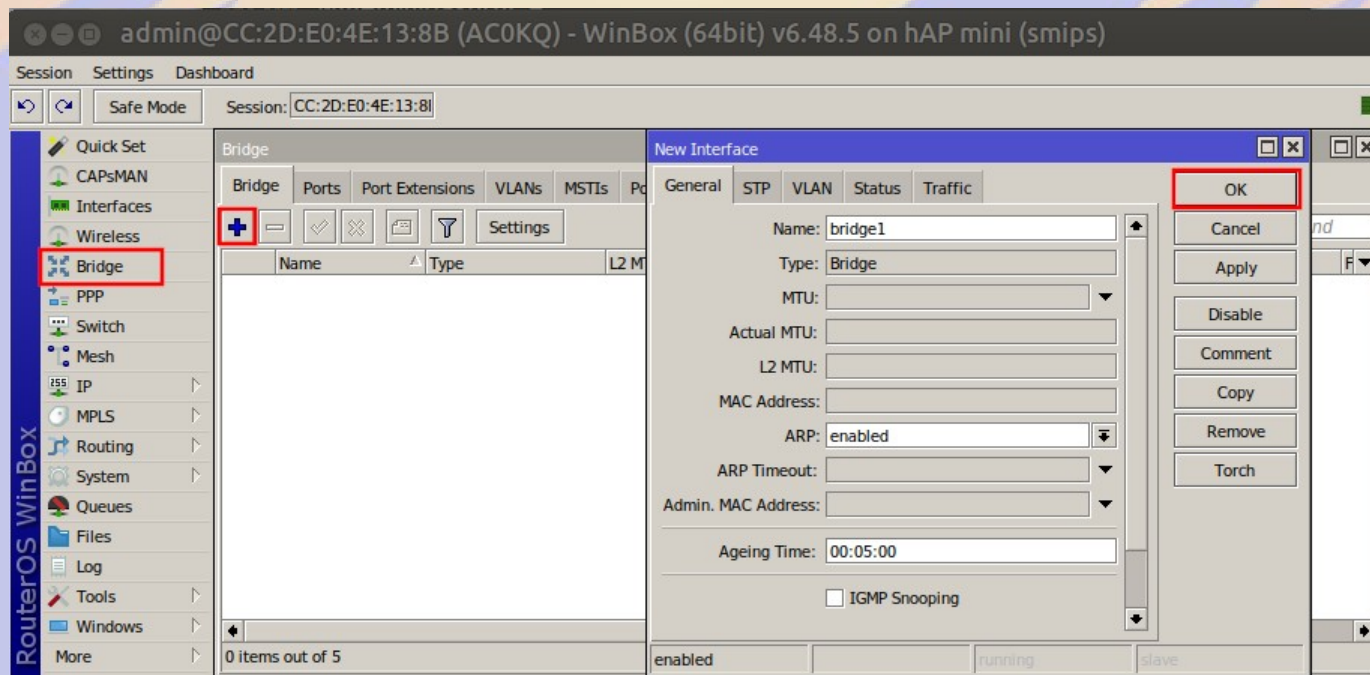
# Rename interfaces

- Name interfaces based on what is connected
  - WAN is used by DevDB for firewall
  - Name changes propagate (can be done any time)
  - Note wlan1 is disabled; ether2-DMR is running
  - Disable **pwr-line1** with **X**



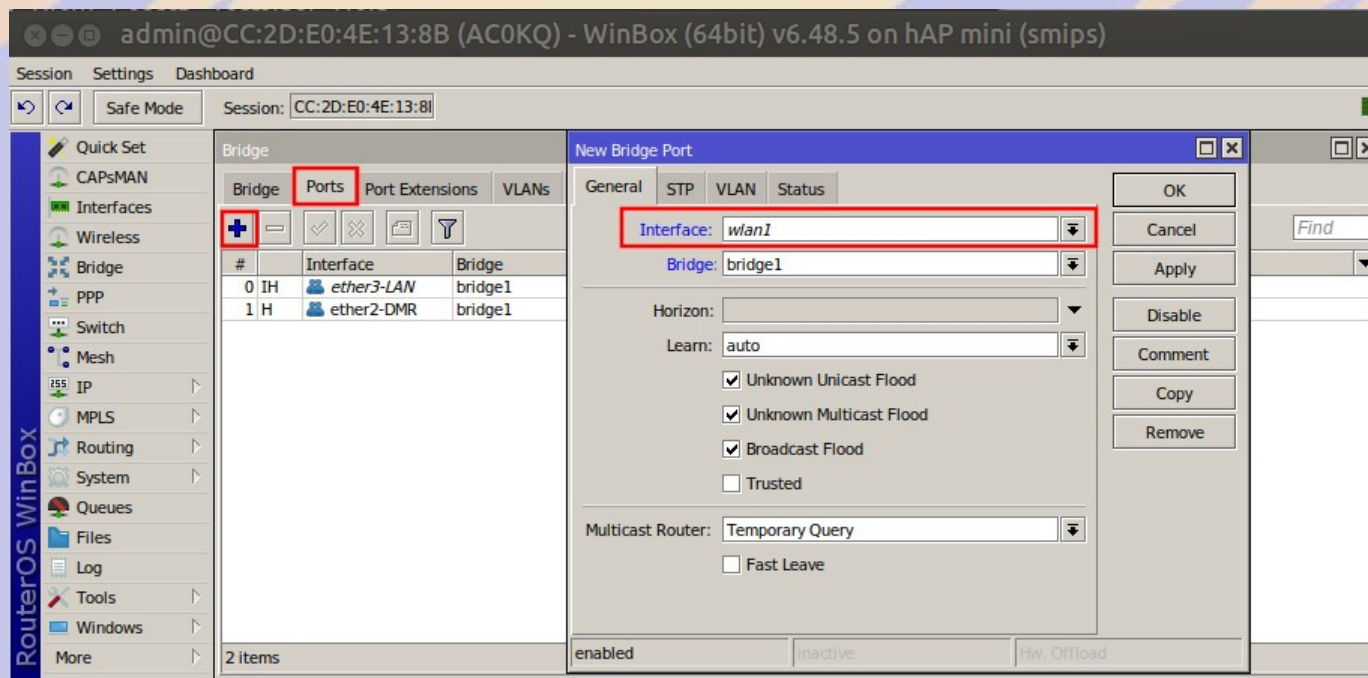
# Add a bridge

- The bridge is a new interface
  - We use it for interfaces that must always be up
- Used to group directly connected ports
  - Typically the local network (LAN)



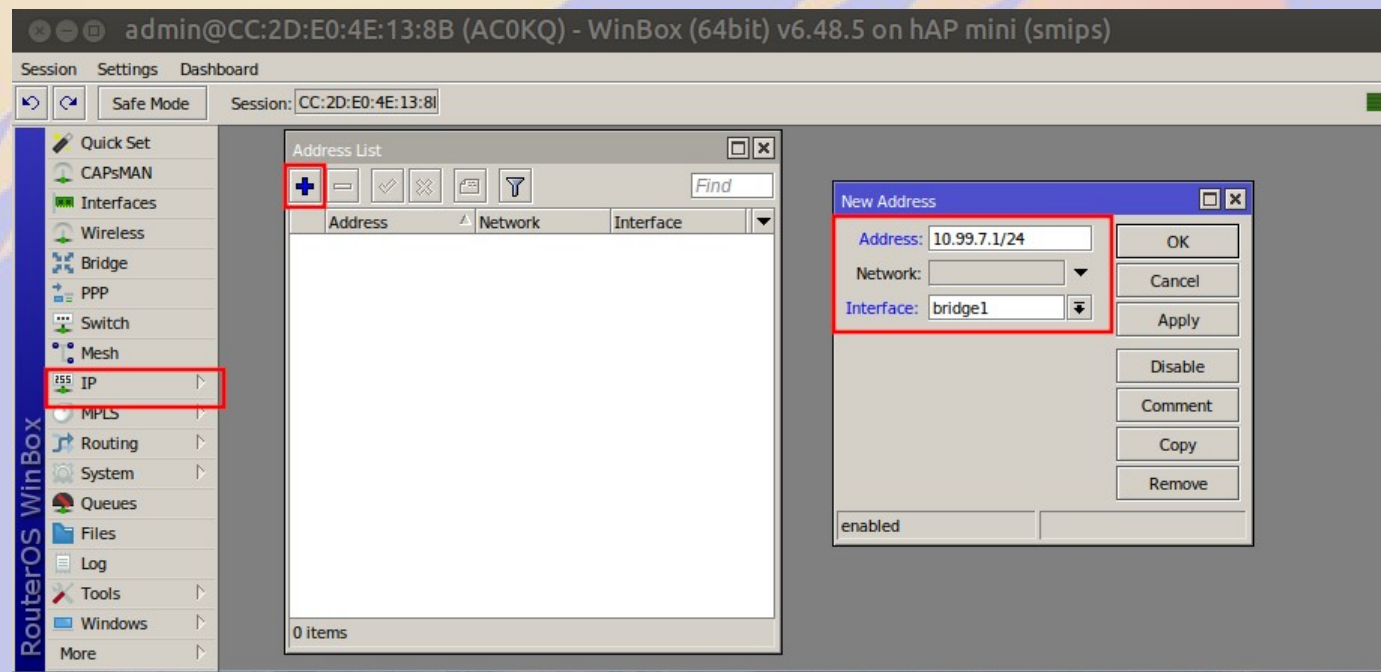
# Add ports to bridge

- Bridged ports are on the LAN
  - **Never add WAN port** (it is routed)
  - **Do NOT add wlan port for today's class**
    - wifi often on LAN, but today we use it for PtP link
  - Bridge can be hardware accelerated



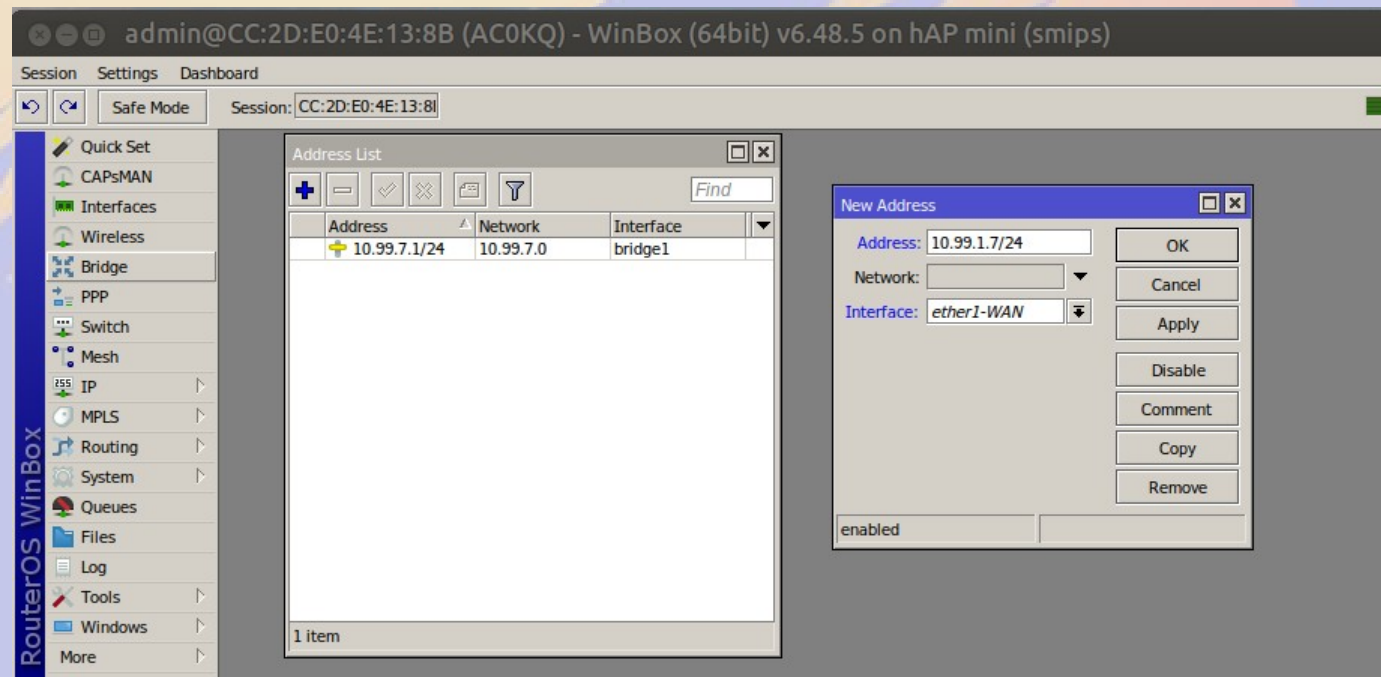
# Set IP address of bridge

- IP > Address +
  - This is what we use to talk to the router
    - .1 is the router octet
    - /24 implies the network
    - Interface is **bridge1**
  - Ratable
- Needed for remote access
- Use IP from worksheet



# Set IP address for WAN

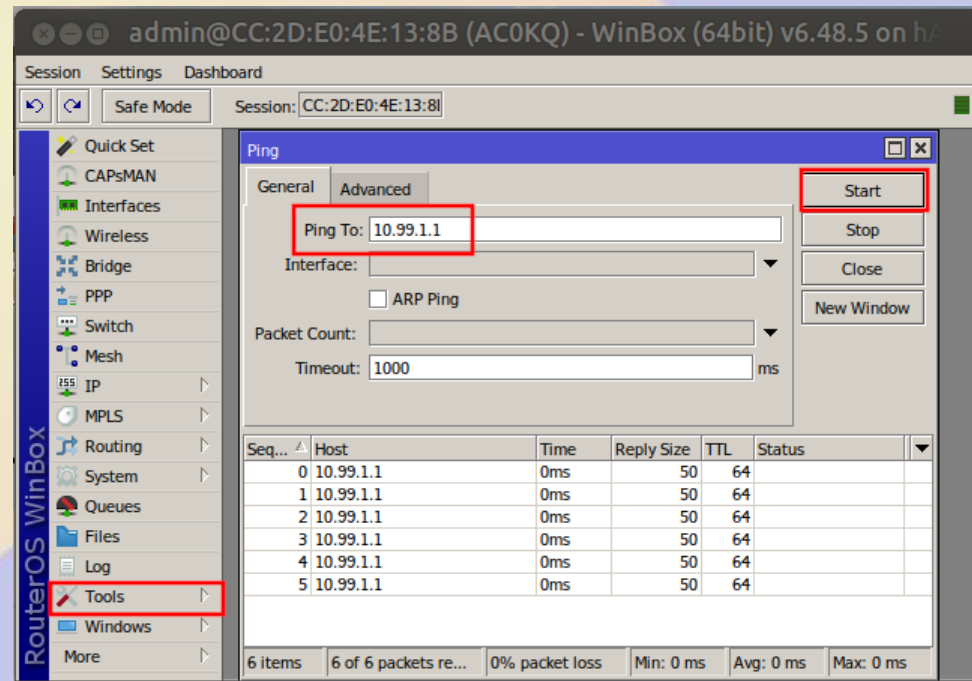
- How the router is know to the rest of the net
  - Associated with WAN interface
- Set value from worksheet
  - Connect to network via ethernet





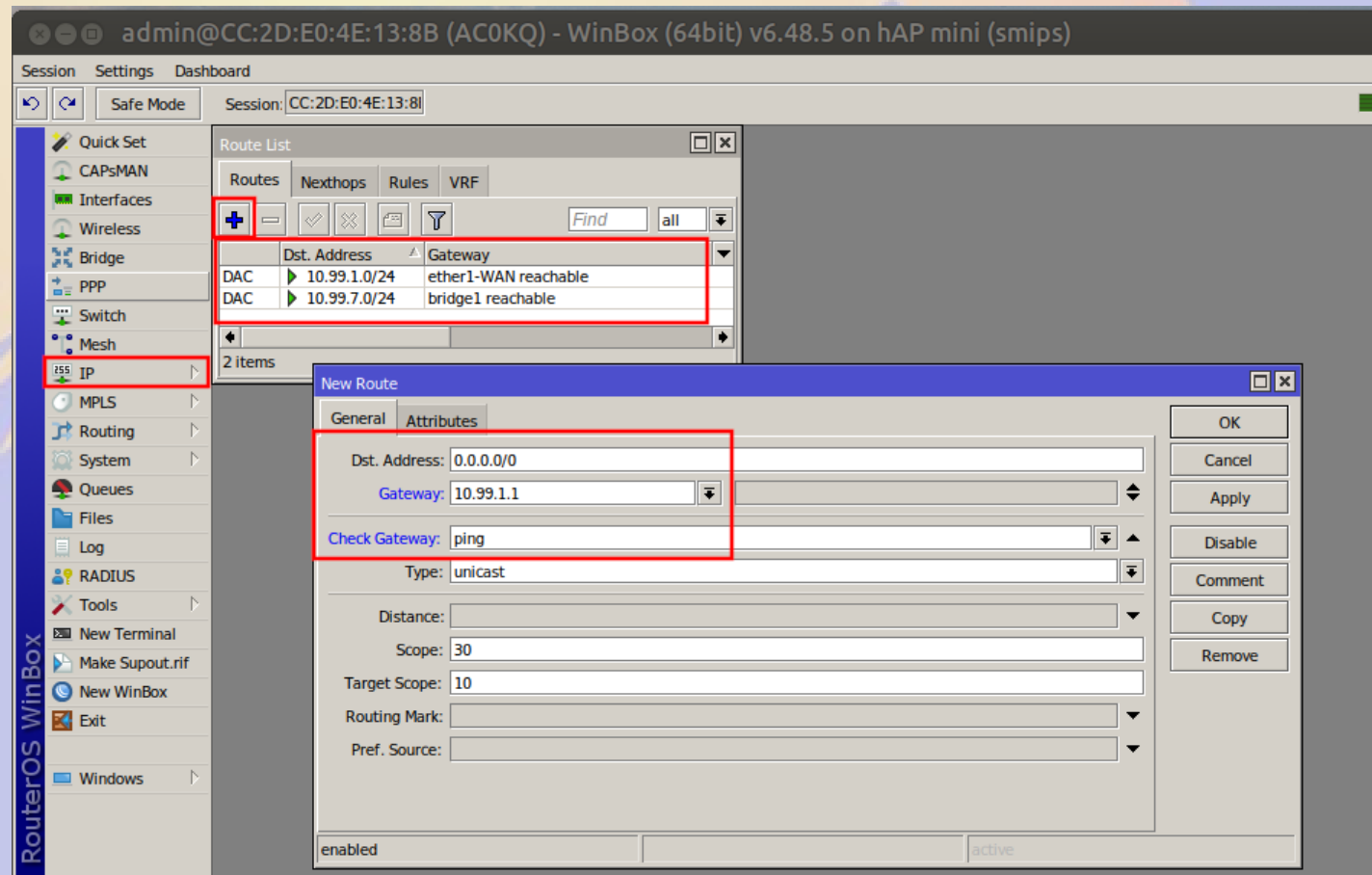
# Check connectivity

- Ping 10.99.1.1
  - Class router IP
  - On 19.99.1.0/24 subnet
- Verifies that WAN is connected and works
- Ping 8.8.8.8
  - timeout
- Traceroute 8.8.8.8
  - goes nowhere



# Default Route

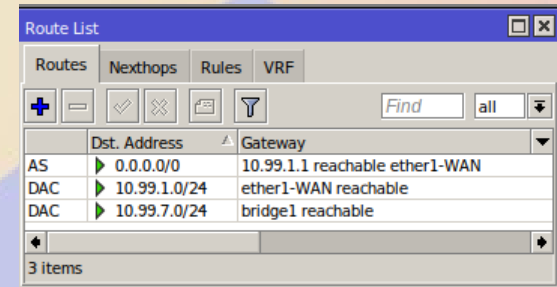
- There is no route to 8.8.8.8
  - Add default route 0.0.0.0/0
  - Note that 10.99.1.1 is reachable via the WAN subnet
  - Try 8.8.8.8
- Send all packets not on known subnet to this address





# Route Flags

- A = Active
  - Turns blue if not active
- S = Static
  - You added it
- C = Connected
  - Interface on this device
- D = Dynamic
  - Added by RouterOS

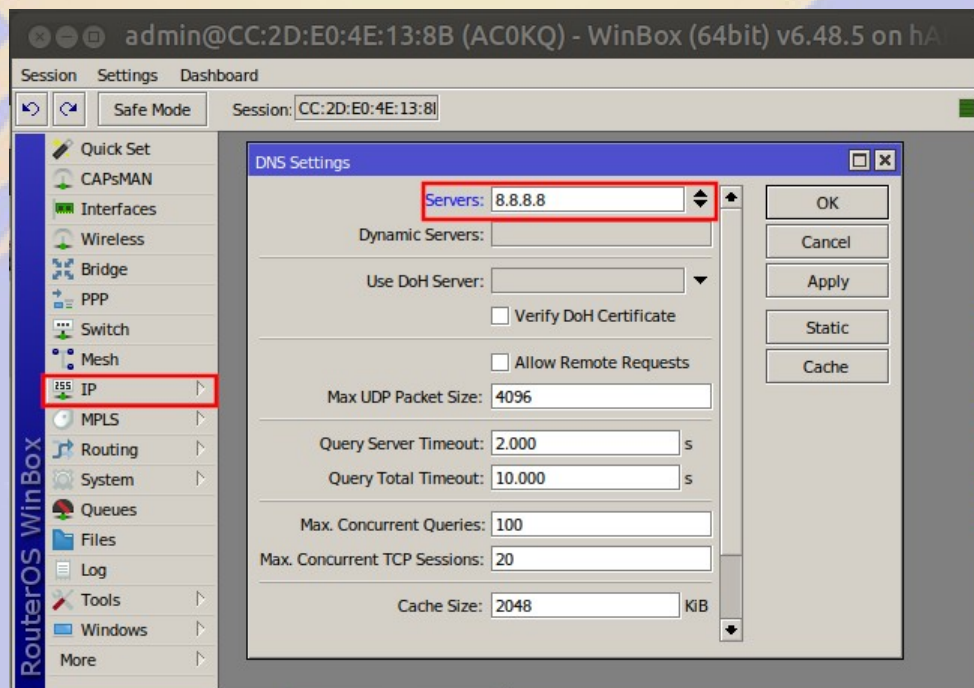


| Routes | Dst. Address | Gateway                        |
|--------|--------------|--------------------------------|
| AS     | 0.0.0.0/0    | 10.99.1.1 reachable ether1-WAN |
| DAC    | 10.99.1.0/24 | ether1-WAN reachable           |
| DAC    | 10.99.7.0/24 | bridge1 reachable              |

3 items

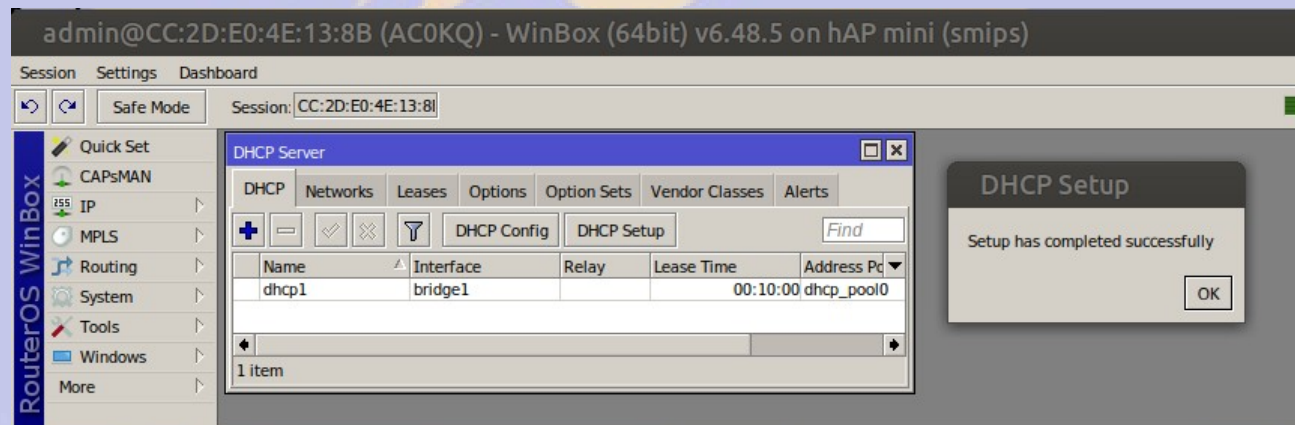
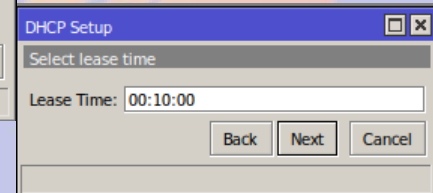
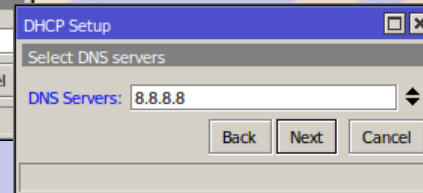
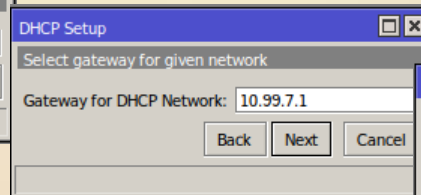
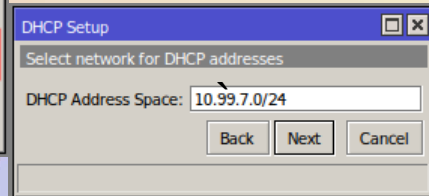
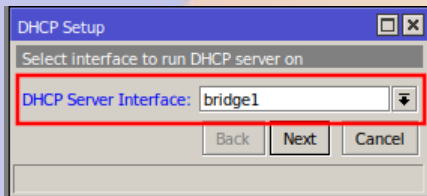
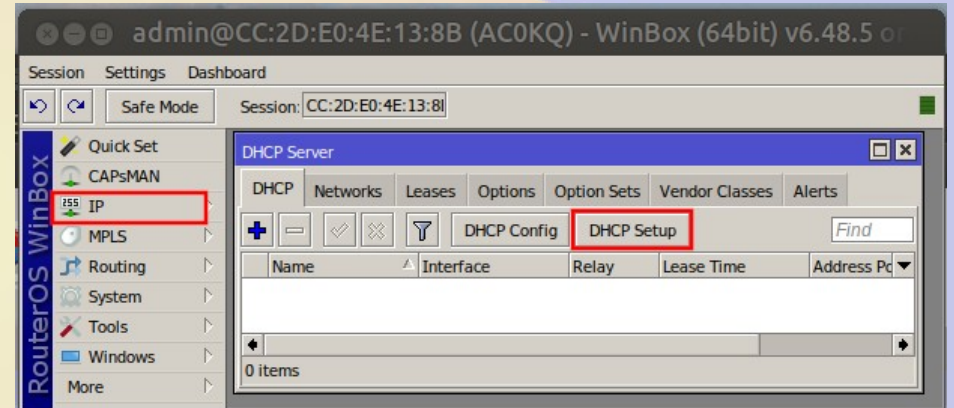
# Add DNS

- IP > DNS
- We will use Google DNS 8.8.8.8
  - Not needed for routing
  - Needed to update software



# DHCP Setup

- Defaults should be OK except for Server Interface

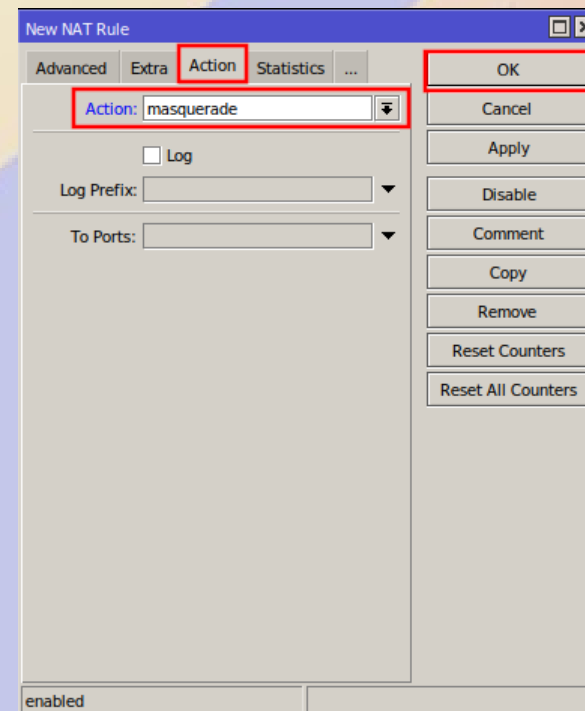
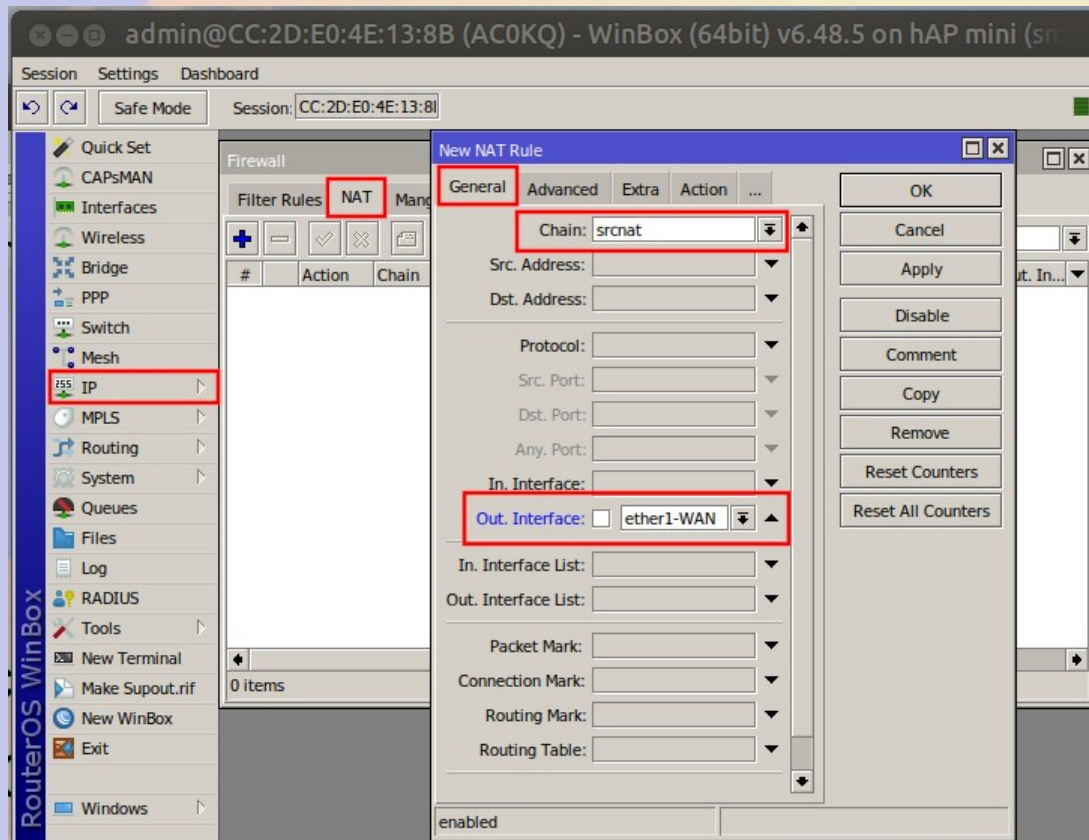


# Test Connectivity

- Switch your computer interface to DHCP
  - Check your IP address
- Ping WAN of your router from your laptop
  - 10.99.X.1 (WAN IP address on Worksheet)
- From WinBox (the router)
  - Ping 10.99.1.1
  - Ping 8.8.8.8
- From your laptop
  - Ping 10.99.1.1
  - Ping 8.8.8.8

# Network Address Translation

- Pretends to be 10.99.X.1 on external requests
  - Commonly used to use only one IP for subnet
  - Not used internal to RMHAM network



# What we did so far

- Set device identity
- Create bridge with named interfaces
- Set bridge and WAN IP address/subnet
- Set DNS
- Set up routing
- Set up DHCP
- Set NAT for external connections
- We can now talk to the world

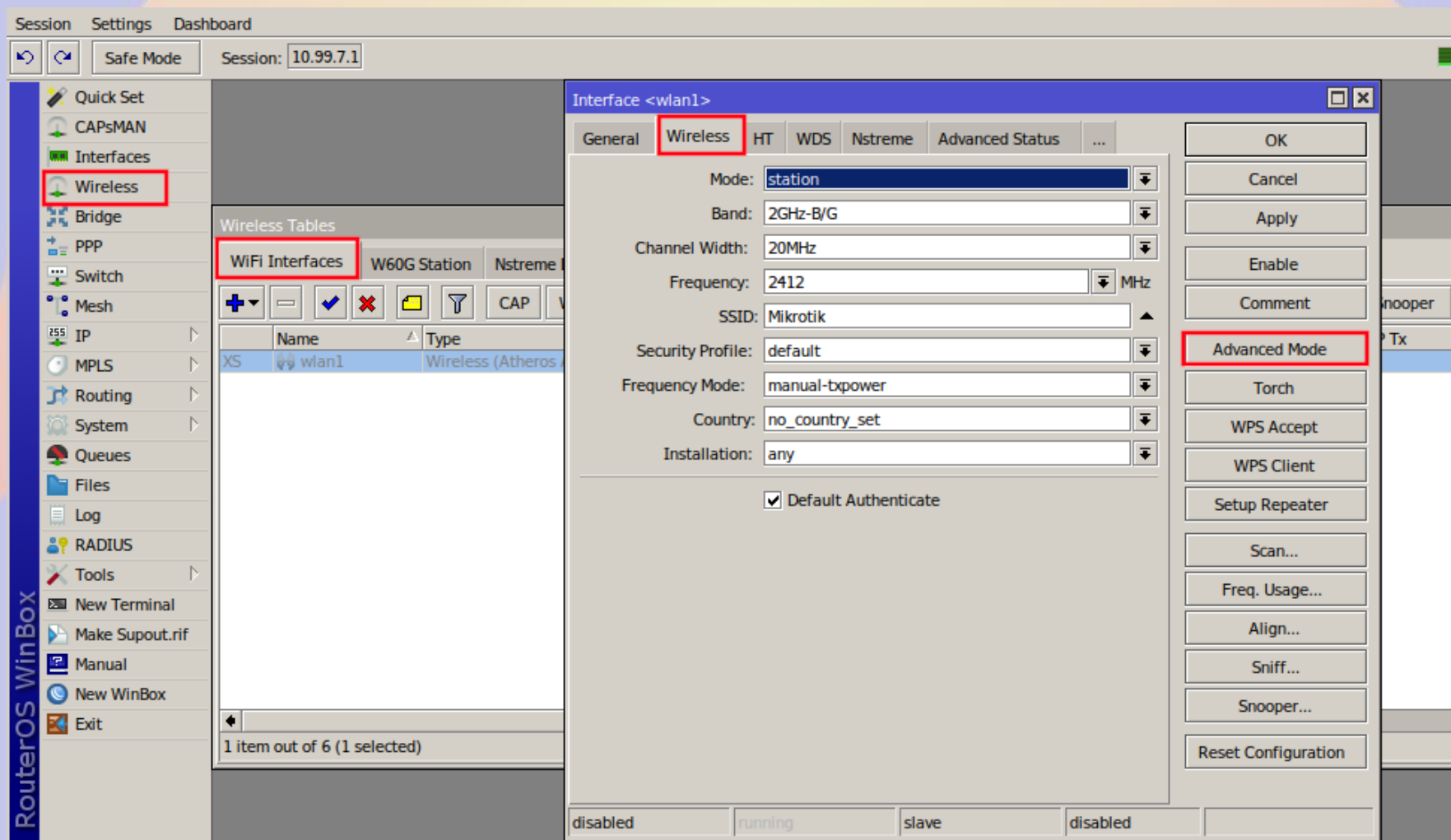
# Setting up a wireless bridge

- Connect to your neighbor using 2.4GHz
  - Bridged RF path instead of ethernet cable
  - Route traffic to limit traffic
  - Clever routing to do fail over
- RMHAM network links up to 80 miles
  - High power (2W) radios
  - High gain antennas (2' and 3' dishes)
  - nstreme to do long time of flight



# Enable Advanced Mode

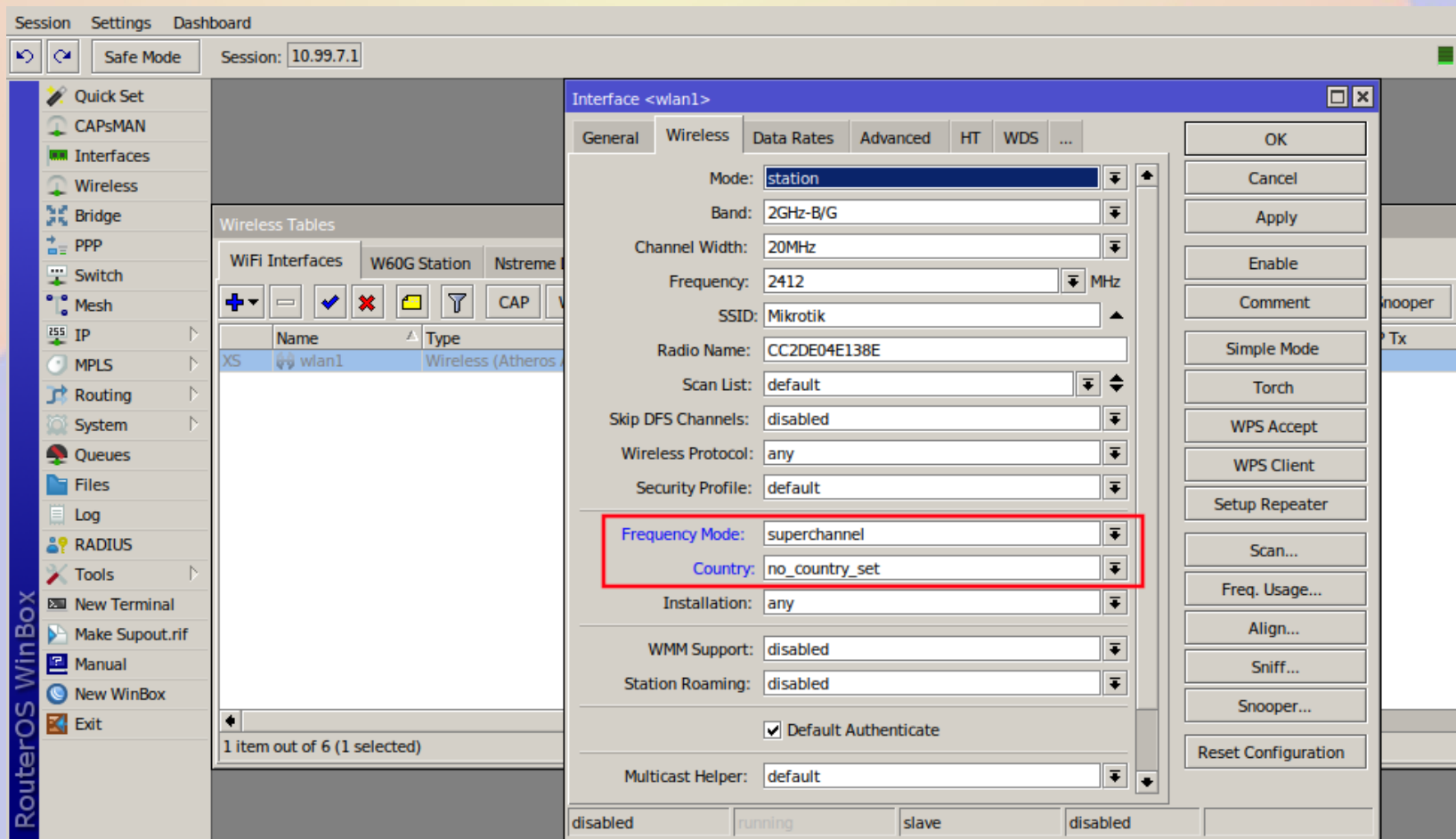
- Amateur bands require advanced mode





# Enable Superchannel

- Superchannel enables all frequencies the hardware is capable of in the **international version** of the hardware
  - The class hardware will show the frequencies, but are limited to only the ISM channels in firmware (not international version)



# Access Point Side

Interface <wlan1>

General Wireless Data Rates Advanced HT WDS ...

Mode: bridge

Band: 2GHz-B/G

Channel Width: 20MHz

Frequency: 2442 MHz

SSID: AC0KQ-7

Radio Name: CC2DE04E138E

Scan List: 2442

Skip DFS Channels: disabled

Wireless Protocol: nstreme

Security Profile: default

Interworking Profile: disabled

WPS Mode: push button

Frequency Mode: superchannel

Country: no\_country\_set

Installation: any

Bridge Mode: enabled

VLAN Mode: no tag

OK Cancel Apply Enable Comment Simple Mode Torch WPS Accept WPS Client Setup Repeater Scan... Freq. Usage... Align... Sniff... Snooper... Reset Configuration

disabled running slave disabled

- bridge is PtP access point
- Select freq for channel
- Set SSID to Callsign
  - IDs every packet
- Type in scan list freq
- Protocol nstreme
  - long distance
- no encryption on ham bands
- Radio name can be useful
  - MAC by default
- Apply and Enable

# Client Side

Interface <wlan1>

General Wireless Data Rates Advanced HT WDS Nstreme ...

Mode: station bridge

Band: 2GHz-B/G

Channel Width: 20MHz

Frequency: 2442 MHz

SSID: AC0KQ-7

Radio Name: CC2DE0367EDB

Scan List: 2442

Skip DFS Channels: disabled

Wireless Protocol: nstreme

Security Profile: default

Frequency Mode: superchannel

Country: no\_country\_set

Installation: any

Station Roaming: enabled

☒ Default Authenticate

Multicast Helper: default

OK Cancel Apply Enable Comment Simple Mode Torch WPS Accept WPS Client Setup Repeater Scan... Freq. Usage... Align... Sniff... Snooper... Reset Configuration

disabled running slave disabled

- station bridge for PtP
- SSID. frequency, scan list and protocol must match
  - IDs as AP callsign
- Radio name can be useful
  - MAC by default
- Apply and Enable

# Radios should now link

- Check registration
  - signal strength in dBm
- If not check
  - Matching SSID, frequencies and protocol
  - Mode **bridge** one side and **station bridge** other side

Wireless Tables

WiFi InterfacesW60G StationNstreme DualAccess ListRegistrationConnect ListSecurity ProfilesChannelsInterworking Profiles

Reset

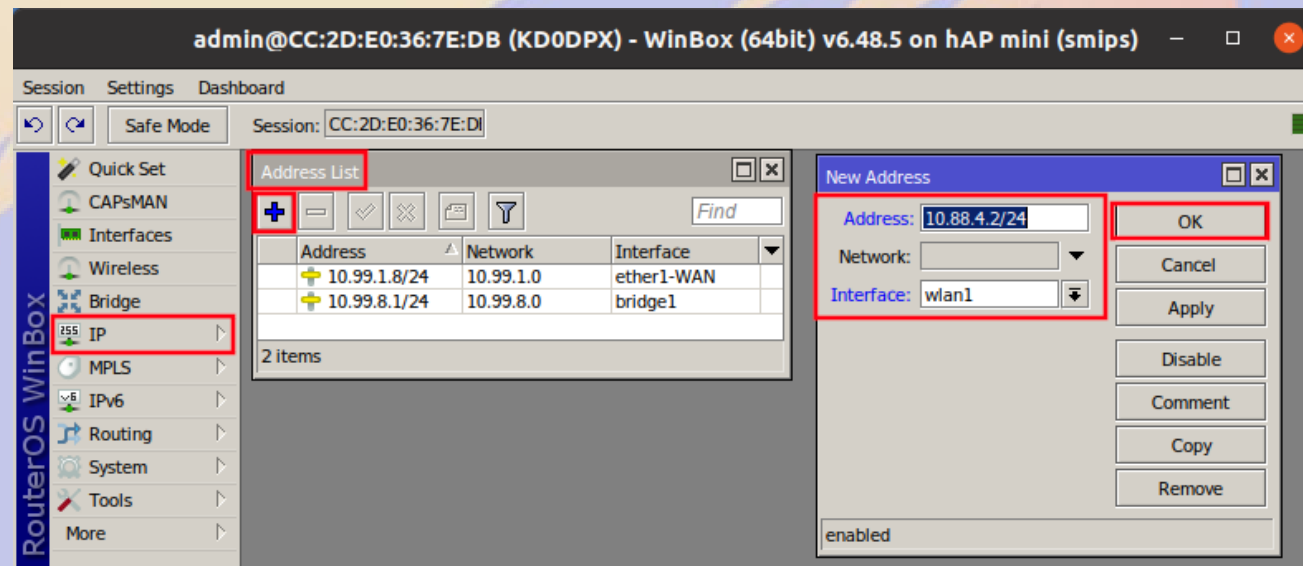
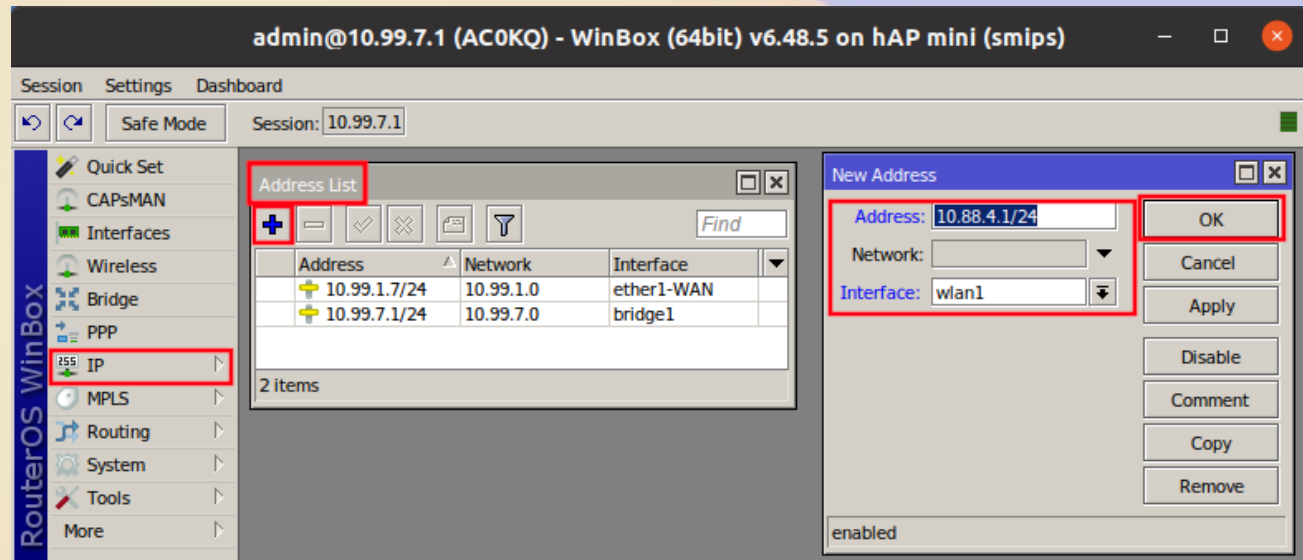
Find

| Radio Name   | MAC Address       | Interface | Uptime   | AP  | W... | Last Activi... | Tx/Rx Signal ... | Tx Rate | Rx Rate |  |
|--------------|-------------------|-----------|----------|-----|------|----------------|------------------|---------|---------|--|
| CC2DE04E138E | CC:2D:E0:4E:13:8E | wlan1     | 00:03:08 | yes | no   | 0.910          | -16/-19          | 11Mbps  | 1Mbps   |  |

1 item

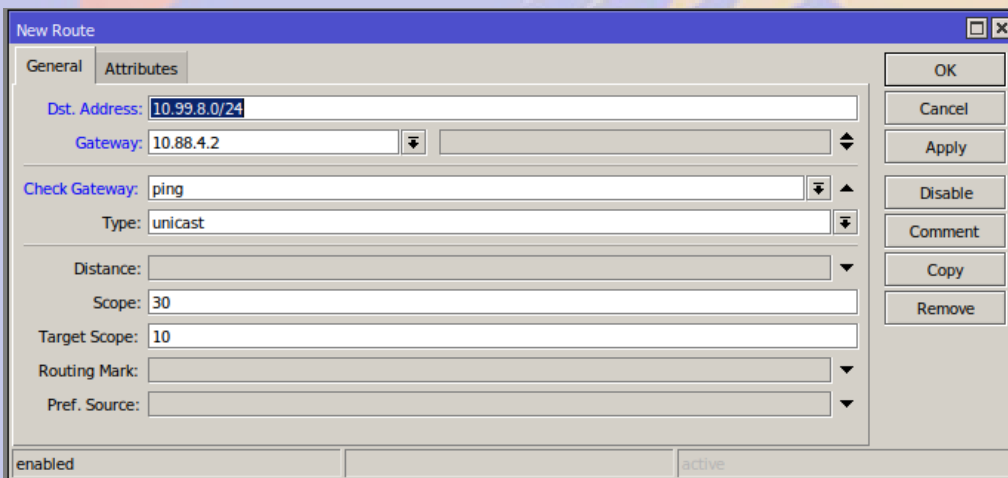
# Assign IP addresses to link

- Use a new subnet
  - 10.88.4.0/24
- Set .1 on bridge
  - 10.88.4.1/24
- Set .2 on station bridge
  - 10.88.4.2/24

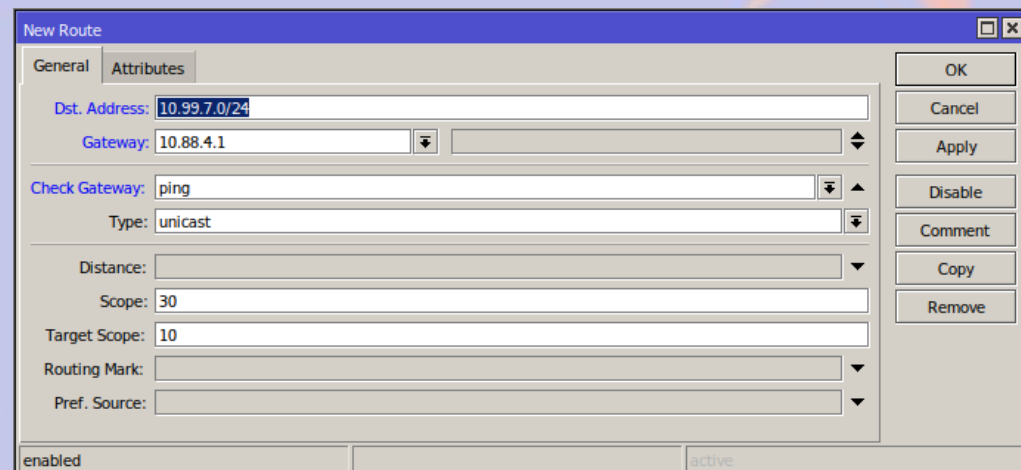


# Check Connectivity

- Ping neighbor
  - wlan IP is reachable (10.88.4.x)
  - bridge IP is not (10.99.x.1)
- Need a route to the neighboring subnet
  - Destination is entire subnet 10.99.x.0/24
  - Gateway is neighboring wlan IP



The 'New Route' dialog box is shown with the 'General' tab selected. The 'Dst. Address' field is set to '10.99.8.0/24'. The 'Gateway' field is set to '10.88.4.2'. The 'Check Gateway' field is set to 'ping'. The 'Type' field is set to 'unicast'. The 'Distance' field is empty. The 'Scope' field is set to '30'. The 'Target Scope' field is set to '10'. The 'Routing Mark' field is empty. The 'Pref. Source' field is empty. The 'enabled' checkbox is checked. The 'active' checkbox is checked. The 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', and 'Remove' buttons are visible on the right side.



The 'New Route' dialog box is shown with the 'General' tab selected. The 'Dst. Address' field is set to '10.99.7.0/24'. The 'Gateway' field is set to '10.88.4.1'. The 'Check Gateway' field is set to 'ping'. The 'Type' field is set to 'unicast'. The 'Distance' field is empty. The 'Scope' field is set to '30'. The 'Target Scope' field is set to '10'. The 'Routing Mark' field is empty. The 'Pref. Source' field is empty. The 'enabled' checkbox is checked. The 'active' checkbox is checked. The 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', and 'Remove' buttons are visible on the right side.

# Add second default route

- Where to send all non-local traffic
  - Gateway is the same (neighbor wlan IP)
- Distance 2 makes it the secondary choice
  - Primary 10.99.1.1 has distance 1

New Route

General Attributes

Dst. Address: 0.0.0.0/0

Gateway: 10.88.4.2

Check Gateway: ping

Type: unicast

Distance: 2

Scope: 30

Target Scope: 10

Routing Mark:

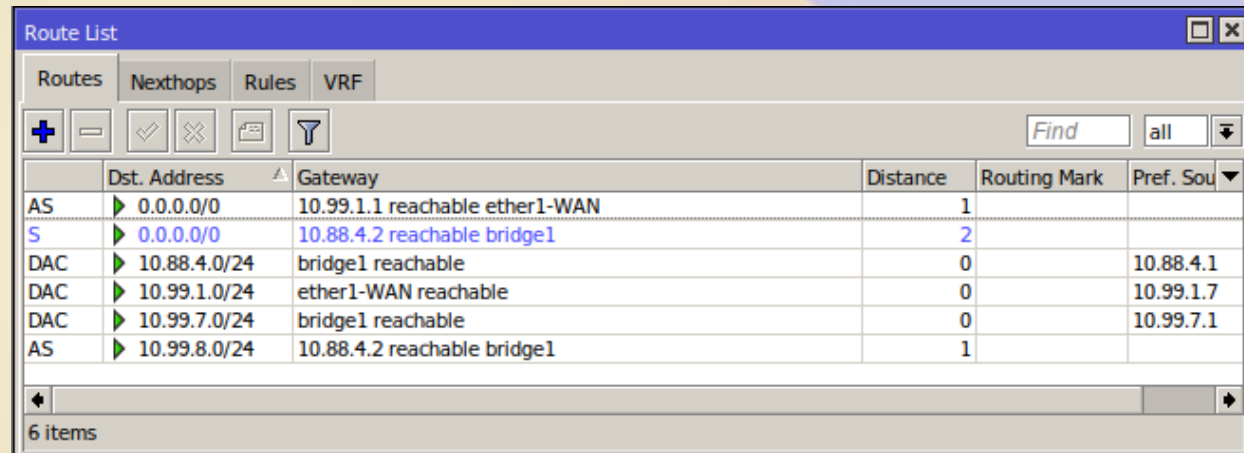
Pref. Source:

enabled active

OK Cancel Apply Disable Comment Copy Remove

# Failover (traceroute to 8.8.8.8)

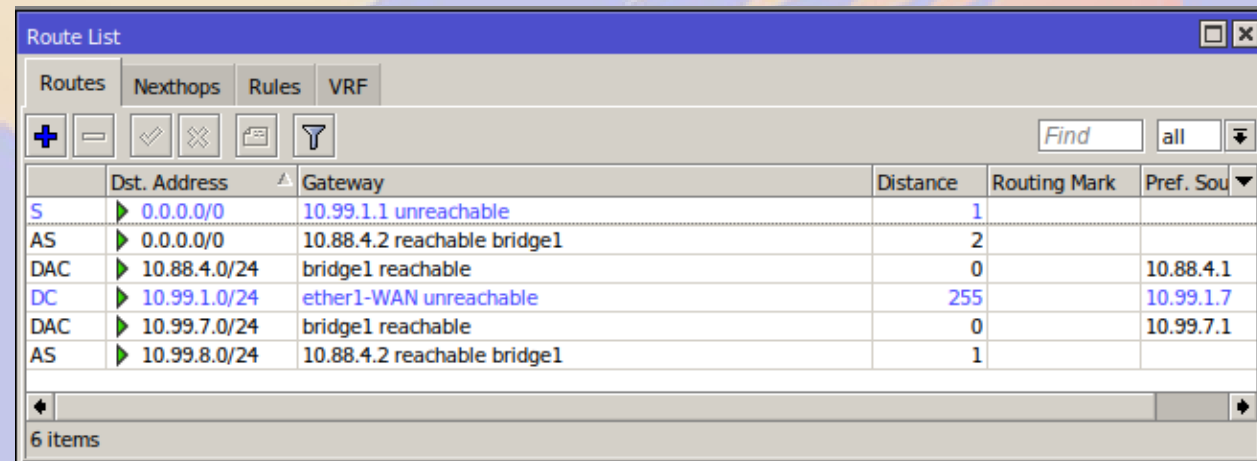
- Normal
  - Blue means it is not active
  - Primary is reachable
- Unplug WAN
  - Blue shows WAN and primary unreachable
  - Fail over to RF



The screenshot shows a 'Route List' window with tabs for Routes, Nexthops, Rules, and VRF. The 'Routes' tab is active. The table lists routes with columns for Dst. Address, Gateway, Distance, Routing Mark, and Pref. Sou. The first row for AS 0.0.0.0/0 shows a primary gateway '10.99.1.1 reachable ether1-WAN' with a distance of 1. The second row for S 0.0.0.0/0 shows a secondary gateway '10.88.4.2 reachable bridge1' with a distance of 2. Other rows show specific network ranges (10.88.4.0/24, 10.99.1.0/24, 10.99.7.0/24) and their respective gateways and distances.

|     | Dst. Address | Gateway                        | Distance | Routing Mark | Pref. Sou |
|-----|--------------|--------------------------------|----------|--------------|-----------|
| AS  | 0.0.0.0/0    | 10.99.1.1 reachable ether1-WAN | 1        |              |           |
| S   | 0.0.0.0/0    | 10.88.4.2 reachable bridge1    | 2        |              |           |
| DAC | 10.88.4.0/24 | bridge1 reachable              | 0        |              | 10.88.4.1 |
| DAC | 10.99.1.0/24 | ether1-WAN reachable           | 0        |              | 10.99.1.7 |
| DAC | 10.99.7.0/24 | bridge1 reachable              | 0        |              | 10.99.7.1 |
| AS  | 10.99.8.0/24 | 10.88.4.2 reachable bridge1    | 1        |              |           |

6 items



The screenshot shows the 'Route List' window after unplugging the WAN. The primary gateway '10.99.1.1' is now marked as 'unreachable' with a distance of 1. The secondary gateway '10.88.4.2' remains reachable with a distance of 2. The route for 10.99.1.0/24 is now marked as 'ether1-WAN unreachable' with a distance of 255. The other routes remain unchanged.

|     | Dst. Address | Gateway                     | Distance | Routing Mark | Pref. Sou |
|-----|--------------|-----------------------------|----------|--------------|-----------|
| S   | 0.0.0.0/0    | 10.99.1.1 unreachable       | 1        |              |           |
| AS  | 0.0.0.0/0    | 10.88.4.2 reachable bridge1 | 2        |              |           |
| DAC | 10.88.4.0/24 | bridge1 reachable           | 0        |              | 10.88.4.1 |
| DC  | 10.99.1.0/24 | ether1-WAN unreachable      | 255      |              | 10.99.1.7 |
| DAC | 10.99.7.0/24 | bridge1 reachable           | 0        |              | 10.99.7.1 |
| AS  | 10.99.8.0/24 | 10.88.4.2 reachable bridge1 | 1        |              |           |

6 items





***Questions?***