MIKROTIK professionals conference
Prague, 7-8 March, 2024

MikroTik Enterprise Wireless Networks

based on

CAPsMAN

- 1999 – LAN Networks Supervisor
- 2001 – IBM Pro Netfinity Servers, WindowsNT
- 2001 – Omega Networking and Service, Linux Servers, Virtualization
- 2006 – ENS, Easy Network Solutions
- 2007 – MUM Egypt, MT Consultant
- 2011 – MUM Budapest, MTCRE
- 2018 – MUM Tirana, Presenter
- 2019 – MUM Budapest, Presenter
- 2020 – Etronic.al
- 2021 – UBIQUITI Certified Trainer (UEWA, UBWS, UBWA, UBRSS, UBRSA)

Erion DEMIRI

Network Architect. MikroTik and Ubiquiti Certified Networks Trainer. Owner at Etronic...

MikroTik CERTIFIED TRAINER
CERTIFICATE No: TR0657

I spend a lot of time on network planning: IP, IPTV, VOIP, CCTV, deployment, configuring, troubleshooting, multivendor.

Especially I like to spend time on virtualization, and cloud services.

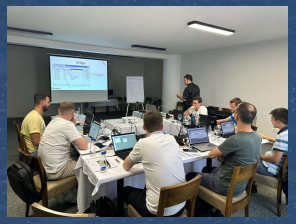
Erion DEMIRI

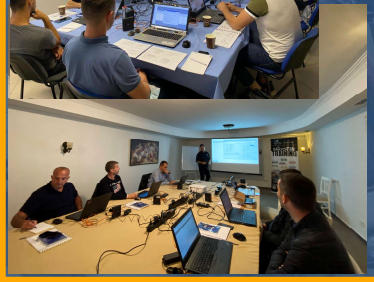
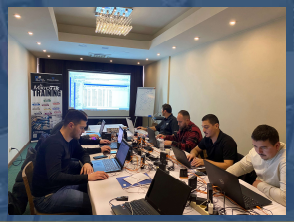
Network Architect. MikroTik and Ubiquiti Certified Networks Trainer. Owner at Etronic...

MikroTik CERTIFIED TRAINER

CERTIFICATE No: TR0657

Active member of the team when Pnetlab was created, especially the learning center features

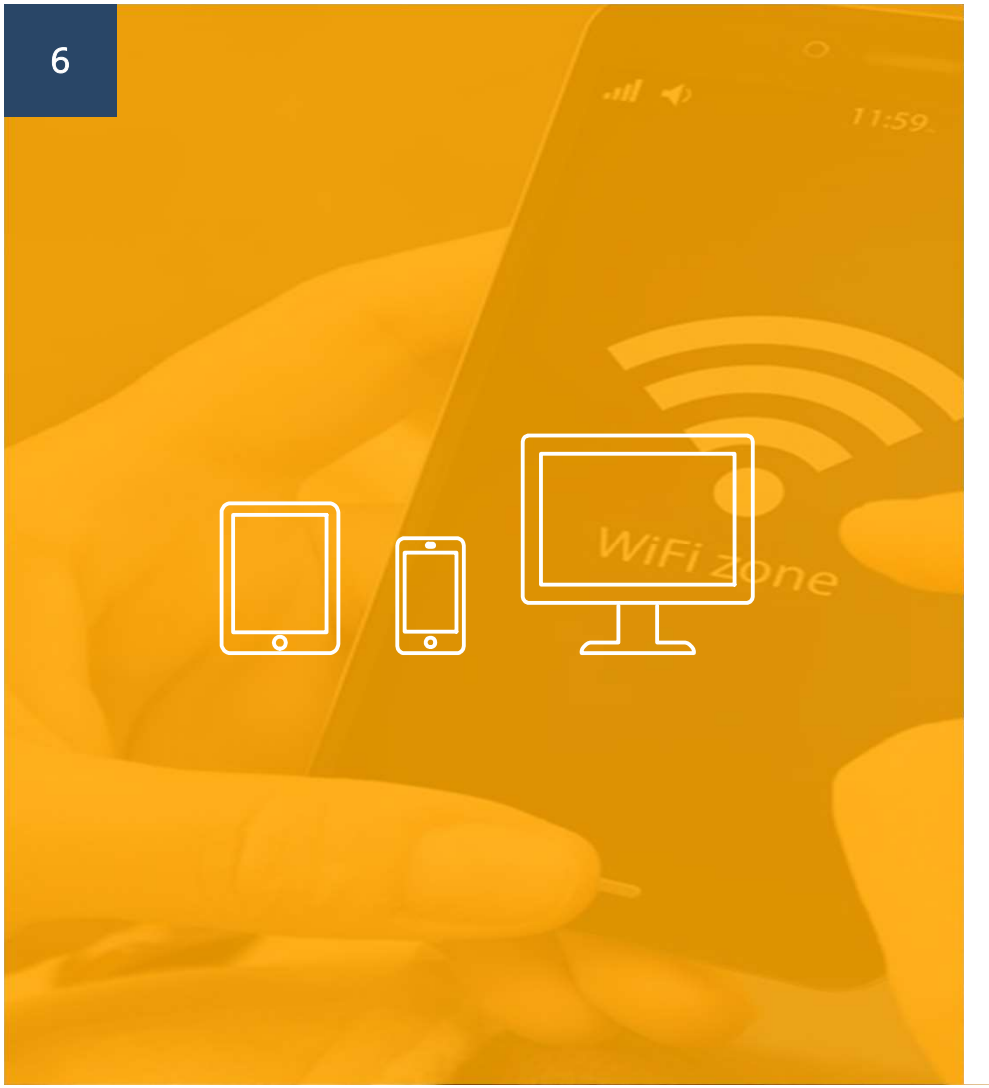


@MIKROTIK.ALBANIA

Wireless Networks are everywhere

- (nearly) All mobile devices support them
- The preferred way of connecting to the internet by most people
- Offer liberty of movement
- Go, where no wire can go.



Enterprise Wireless Networks

- Multiple Access Points are needed for multiple areas to cover
- Necessity for higher bandwidth, and increasing interference, has brought the need for smaller APs
- The bigger the number of the APs, the **more difficult** is their control

Power is Nothing!

Without Control

Have full and fast control over a big number of APs.

MikroTik's Response to this is
CAPsMAN

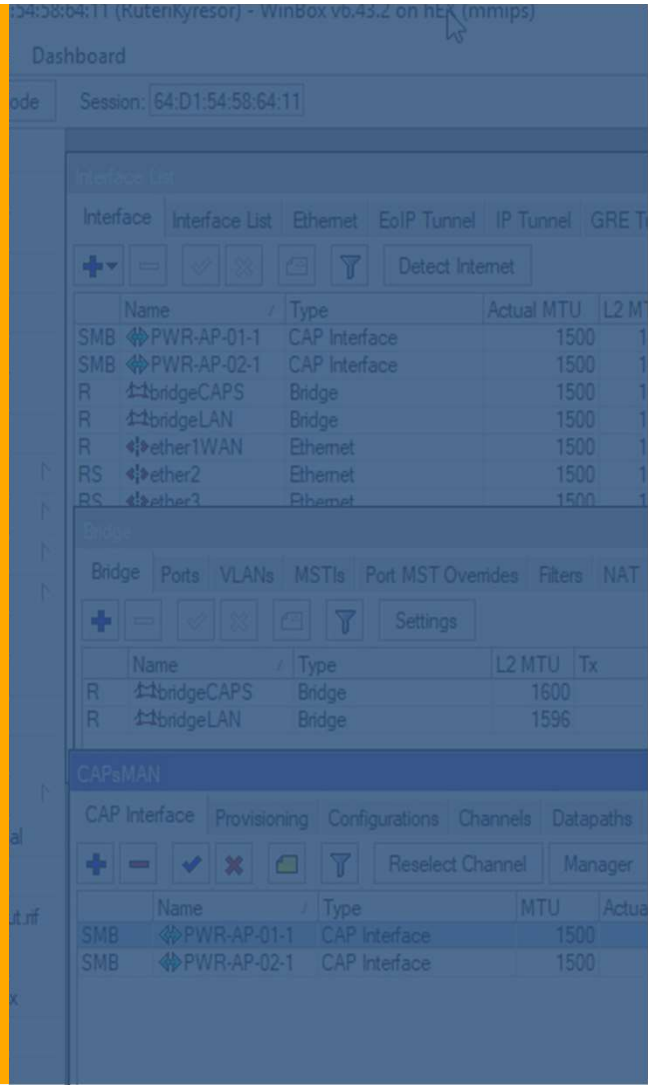
Controlled Access Points
Manager

What is it?

- CAPsMAN, is a centralizing system by MikroTik. It gives the possibility to create a system of controlled access points, called CAPs, by a Controller called CAPsManager.
- It is completely FREE (as in beer). It can be installed in RouterBOARDs and CHR too.
- Since its introduction in 2014, it has changed the way we plan, implement and expand wireless networks.

What is needed

- At least 1 device, with 1 wireless card
- Latest version of RouterOS, with level 4.



Simplest CAPsMAN

hAP Mini – a device I'm in love with.

It is the cheapest RB with 1 wireless card, and 3 Ethernet ports.

Bigger setup?

Durres Harbour Container Terminal:

Latitude: 41° 17' 60.00" N
Longitude: 19° 26' 60.00" E

27 Towers with 2-3 APs (SXT 2, SXT SA5, NetMetal)
27 x RB260GSP
1 x CRS326-24G-2S+RM
1 x CCR2004-16G-2S+

Even BIGGER?

- 123 x wsAP ac Lite
- 10 x wAP ac
- 10 x cAP Ac
- 6 x CRS328-24P-4S+RM
- 1 x CCR2004-16G-2S+

Let’s dive

CAPsMAN VERSIONS

- **Version v1.**
  Introduced in RouterOS 6.11
  Discontinued from 6.37

- **Version v2.**
  Started working from RouterOS 6.22

- **Current version (the WifiWave2 version).**
  Introduced in RouterOS V7.

CAPsMAN

- CAPsMAN server can be installed on any RouterOS device, even if the device itself does not have a wireless interface
- **Unlimited CAPs** supported by CAPsMAN
- Up to 32 Radios per CAP
- Up to 32 Virtual interfaces per master radio interface

CAPs

Any RouterOS device can be a controlled wireless access point (CAP) as long as it has at least a **Level 4** RouterOS license

CAP – Controlled Access Point

VS

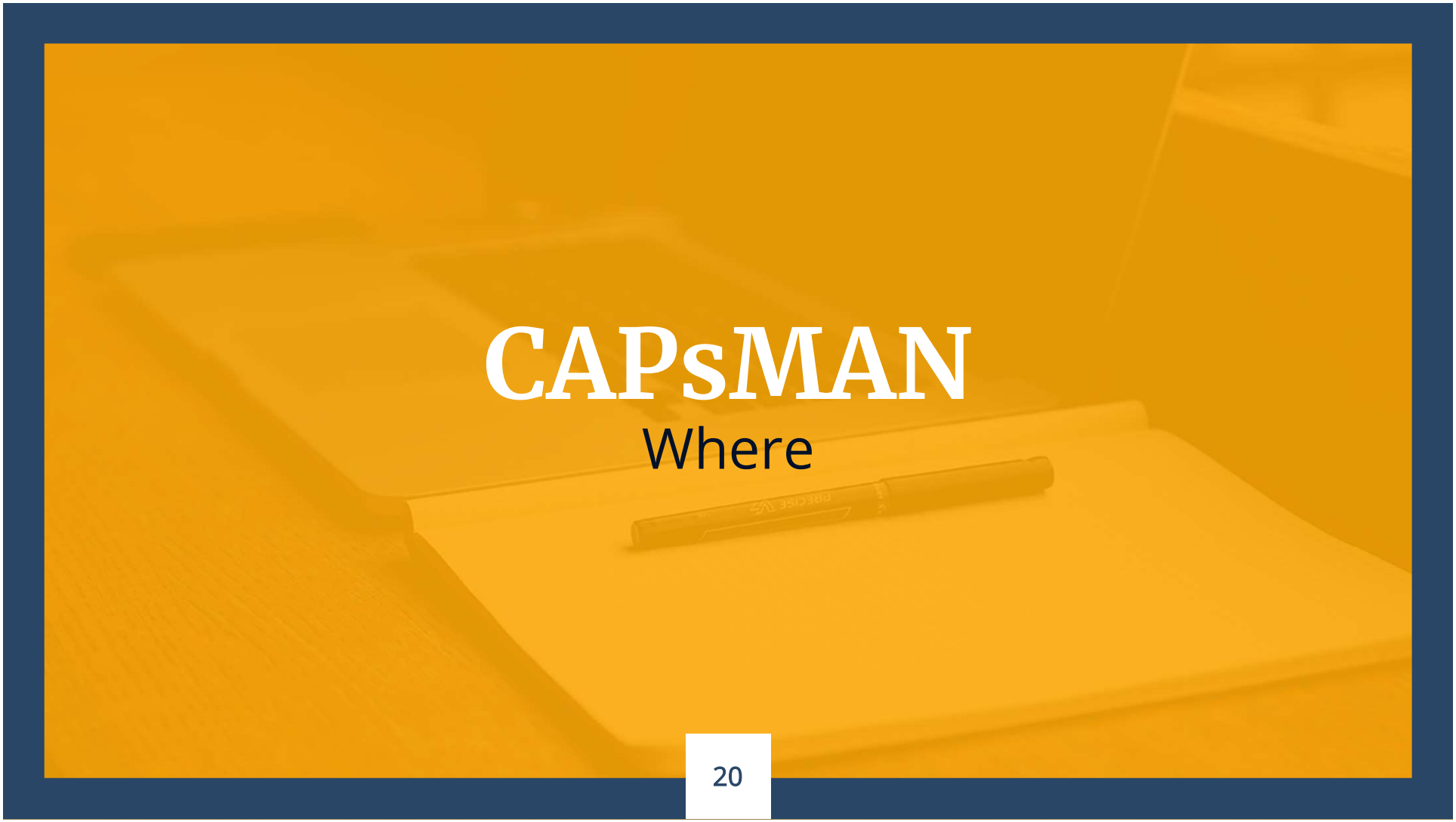
cAP – Ceiling AP

19

CAPs

Indoor

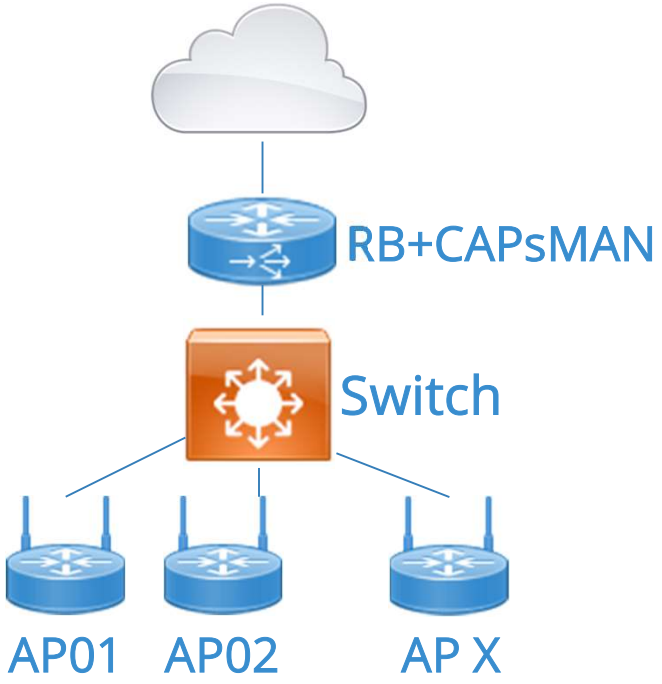
Outoor



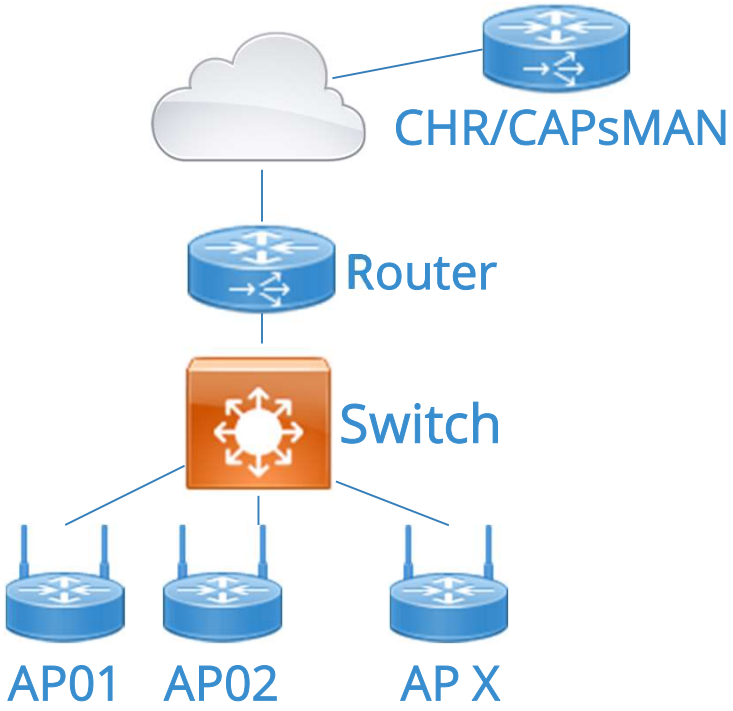
CAPsMAN

Where

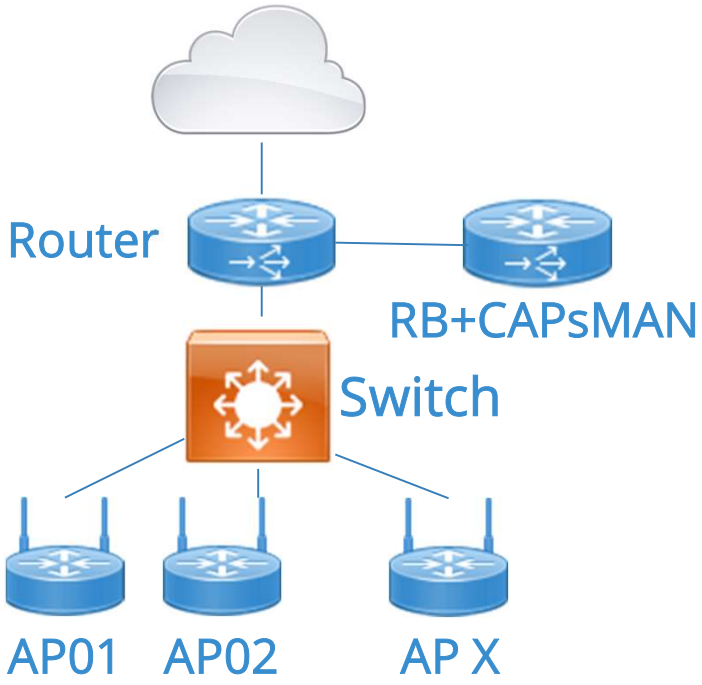
Scenario 1



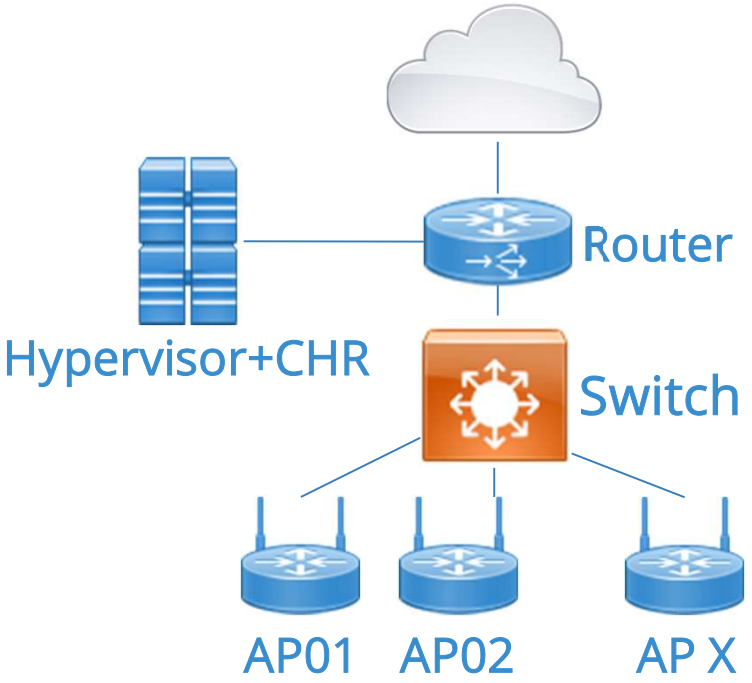
Scenario 2

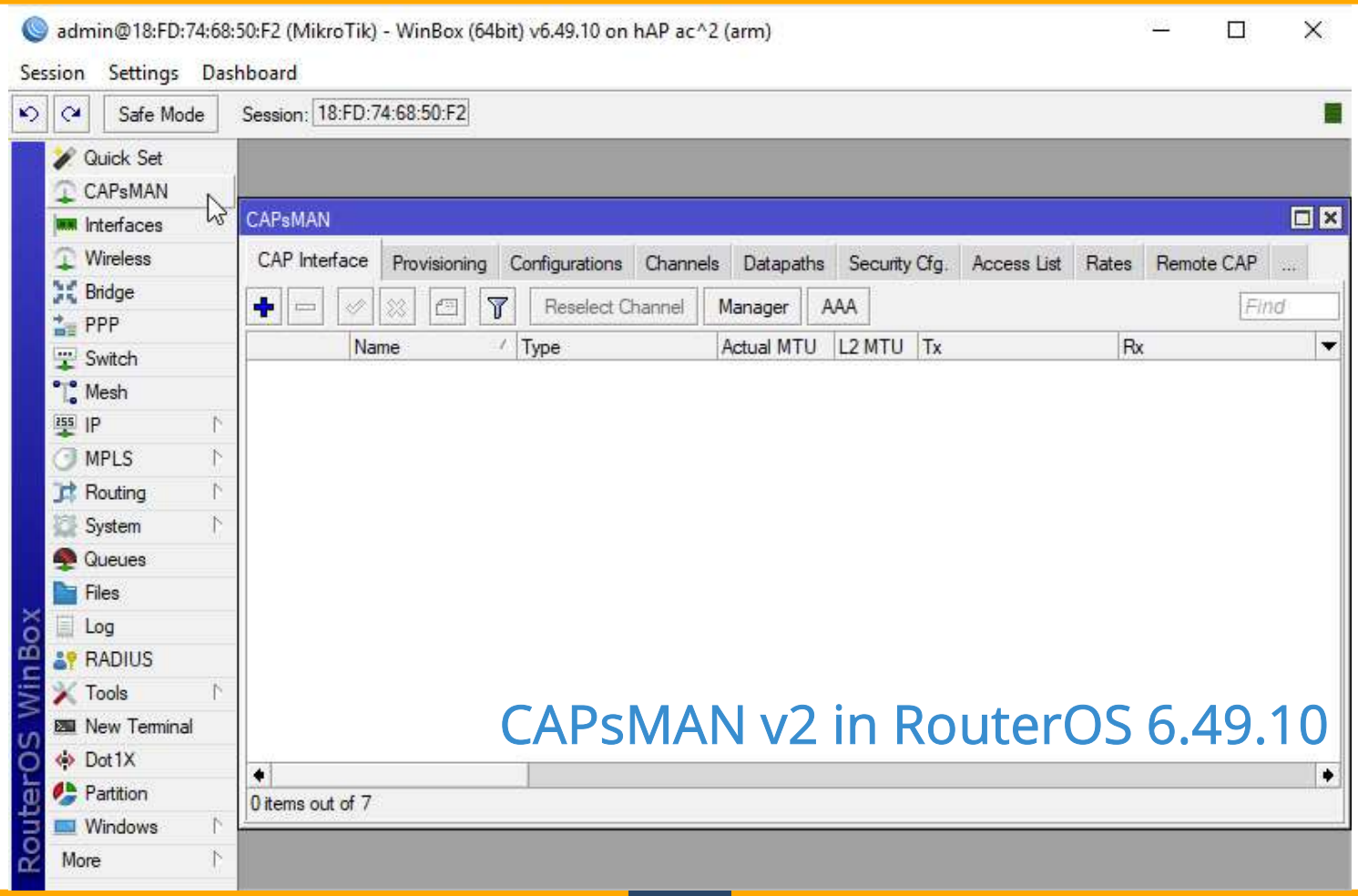


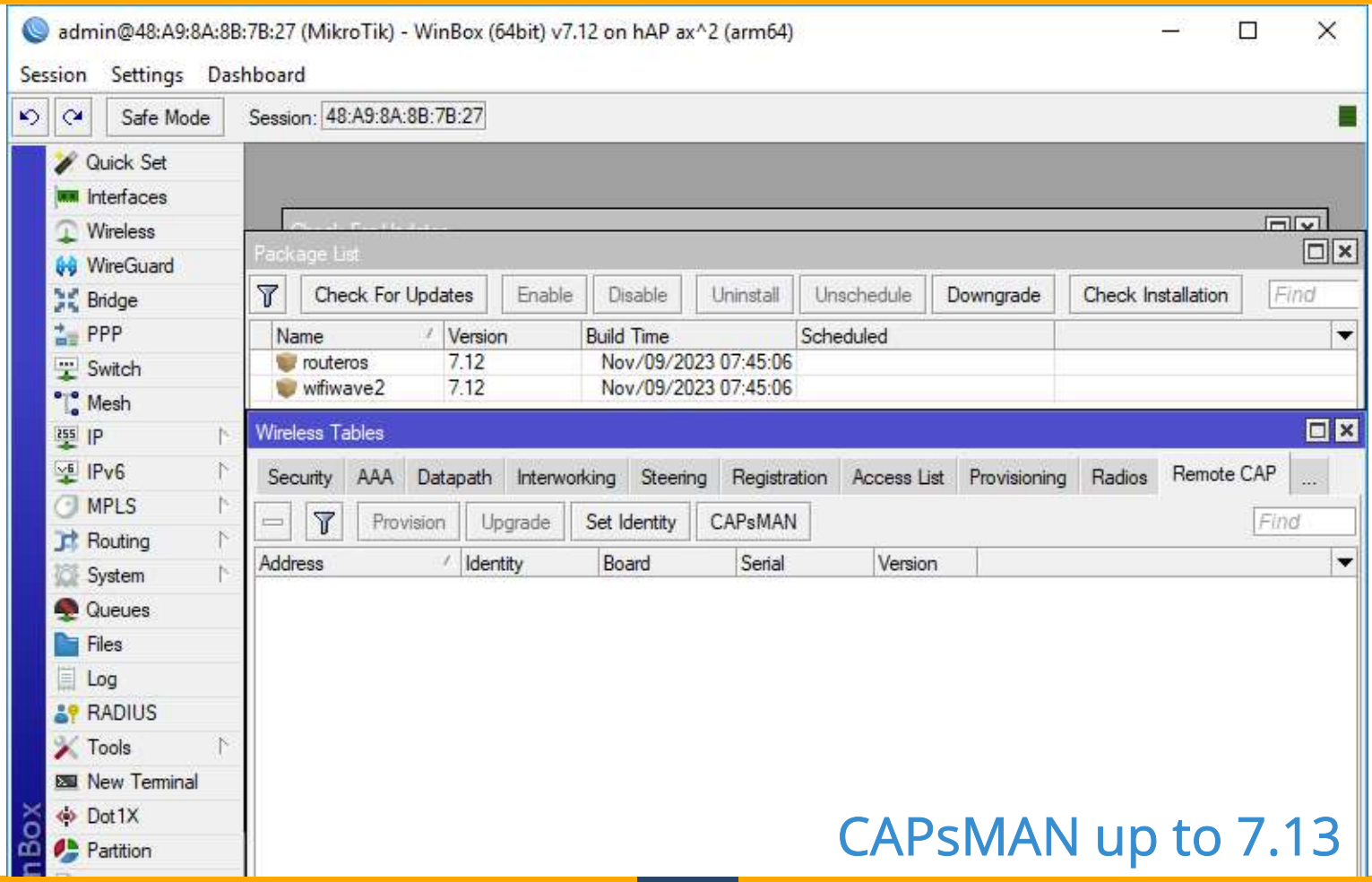
Scenario 3



Scenario 4




admin@18:FD:74:68:50:F2 (MikroTik) - WinBox (64bit) v6.49.10 on hAP ac^2 (arm)
Session Settings Dashboard
Safe Mode
Session: 18:FD:74:68:50:F2
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Partition
Windows
More
RouterOS WinBox
CAPsMAN
CAP Interface
Provisioning
Configurations
Channels
Datapaths
Security Cfg.
Access List
Rates
Remote CAP
Reselect Channel
Manager
AAA
Find
Name
Type
Actual MTU
L2 MTU
Tx
Rx
0 items out of 7
CAPsMAN v2 in RouterOS 6.49.10


admin@48:A9:8A:8B:7B:27 (MikroTik) - WinBox (64bit) v7.12 on hAP ax^2 (arm64)
Session Settings Dashboard
Safe Mode
Session: 48:A9:8A:8B:7B:27
Quick Set
Interfaces
Wireless
WireGuard
Bridge
PPP
Switch
Mesh
IP
IPv6
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Partition
Package List
Check For Updates
Enable
Disable
Uninstall
Unschedule
Downgrade
Check Installation
Find
Name
Version
Build Time
Scheduled
routeros
7.12
Nov/09/2023 07:45:06
wifiwave2
7.12
Nov/09/2023 07:45:06
Wireless Tables
Security
AAA
Datapath
Interworking
Steering
Registration
Access List
Provisioning
Radios
Remote CAP
Provision
Upgrade
Set Identity
CAPsMAN
Find
Address
Identity
Board
Serial
Version
CAPsMAN up to 7.13

Changes from 7.13

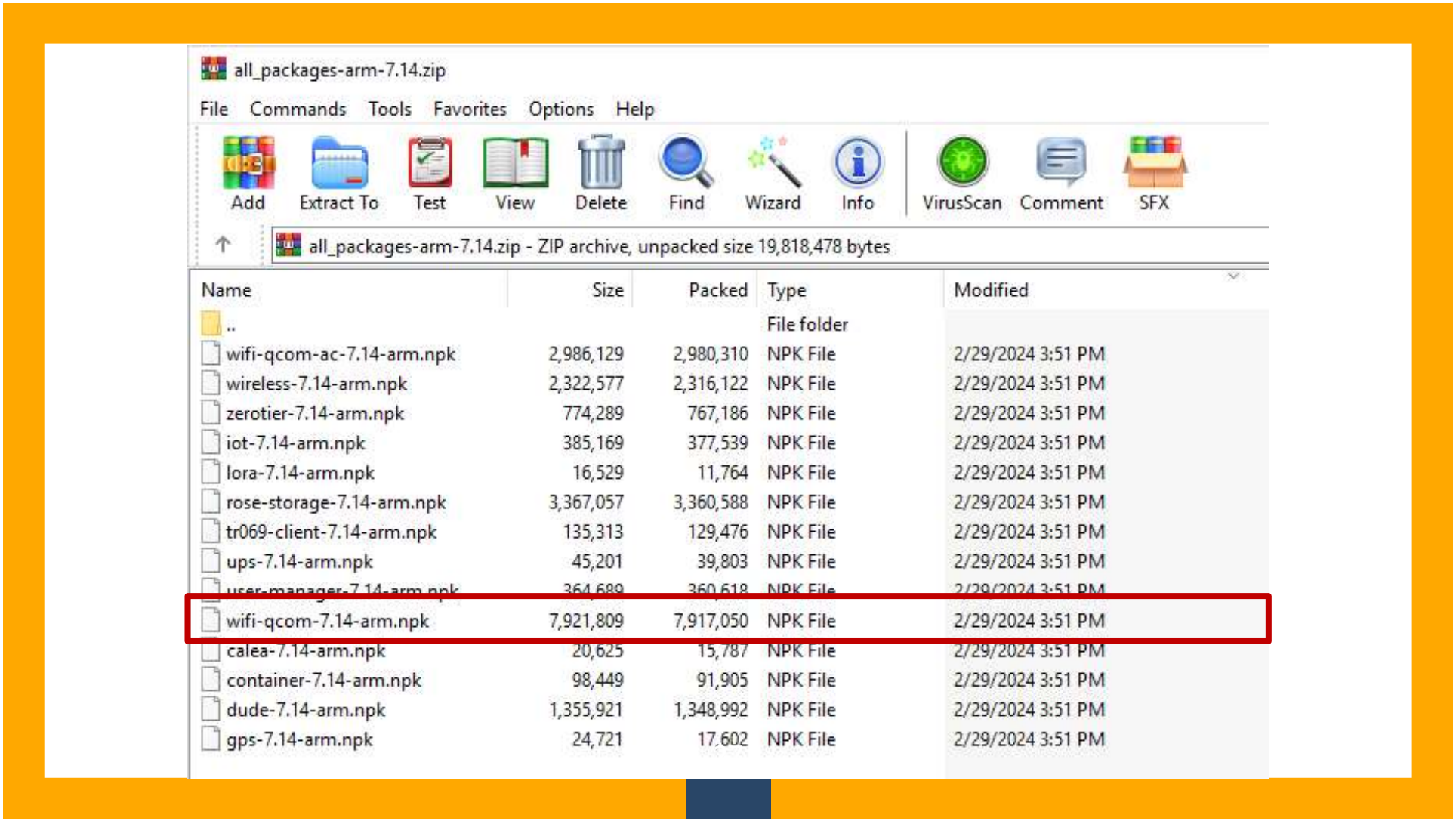
BIG CHANGE from RouterOS 7.13

- The 'WiFi' configuration menu, introduced in RouterOS 7.13, manages Wi-Fi 5 wave2 + newer WiFi interfaces + CAPsMAN.
- 'wifi-qcom-ac' driver package (for 802.11ac chipsets)
- 'wifi-qcom' driver package for 802.11ax and newer chipsets.
- Used to be called 'wifiwave2' in RouterOS versions before 7.13, where it was a part of the 'wifiwave2' software package.

Changes from 7.13

“wifi-qcom-ac” driver package

- **MikroTik Wi-Fi 5 APs**, which ship with their interfaces managed by the 'wireless' menu, can install the additional 'wifi-qcom-ac' package to make their interfaces compatible with the 'wifi' menu.
- To do this, it is necessary to uninstall the 'wireless' package, then install 'wifi-qcom-ac'.


all_packages-arm-7.14.zip
File Commands Tools Favorites Options Help
Add Extract To Test View Delete Find Wizard Info VirusScan Comment SFX
all_packages-arm-7.14.zip - ZIP archive, unpacked size 19,818,478 bytes
Name Size Packed Type Modified
.. File folder
wifi-qcom-ac-7.14-arm.npk 2,986,129 2,980,310 NPK File 2/29/2024 3:51 PM
wireless-7.14-arm.npk 2,322,577 2,316,122 NPK File 2/29/2024 3:51 PM
zerotier-7.14-arm.npk 774,289 767,186 NPK File 2/29/2024 3:51 PM
iot-7.14-arm.npk 385,169 377,539 NPK File 2/29/2024 3:51 PM
lora-7.14-arm.npk 16,529 11,764 NPK File 2/29/2024 3:51 PM
rose-storage-7.14-arm.npk 3,367,057 3,360,588 NPK File 2/29/2024 3:51 PM
tr069-client-7.14-arm.npk 135,313 129,476 NPK File 2/29/2024 3:51 PM
ups-7.14-arm.npk 45,201 39,803 NPK File 2/29/2024 3:51 PM
wifi-qcom-7.14-arm.npk 7,921,809 7,917,050 NPK File 2/29/2024 3:51 PM
calea-7.14-arm.npk 20,625 15,787 NPK File 2/29/2024 3:51 PM
container-7.14-arm.npk 98,449 91,905 NPK File 2/29/2024 3:51 PM
dude-7.14-arm.npk 1,355,921 1,348,992 NPK File 2/29/2024 3:51 PM
gps-7.14-arm.npk 24,721 17,602 NPK File 2/29/2024 3:51 PM

Changes from 7.13

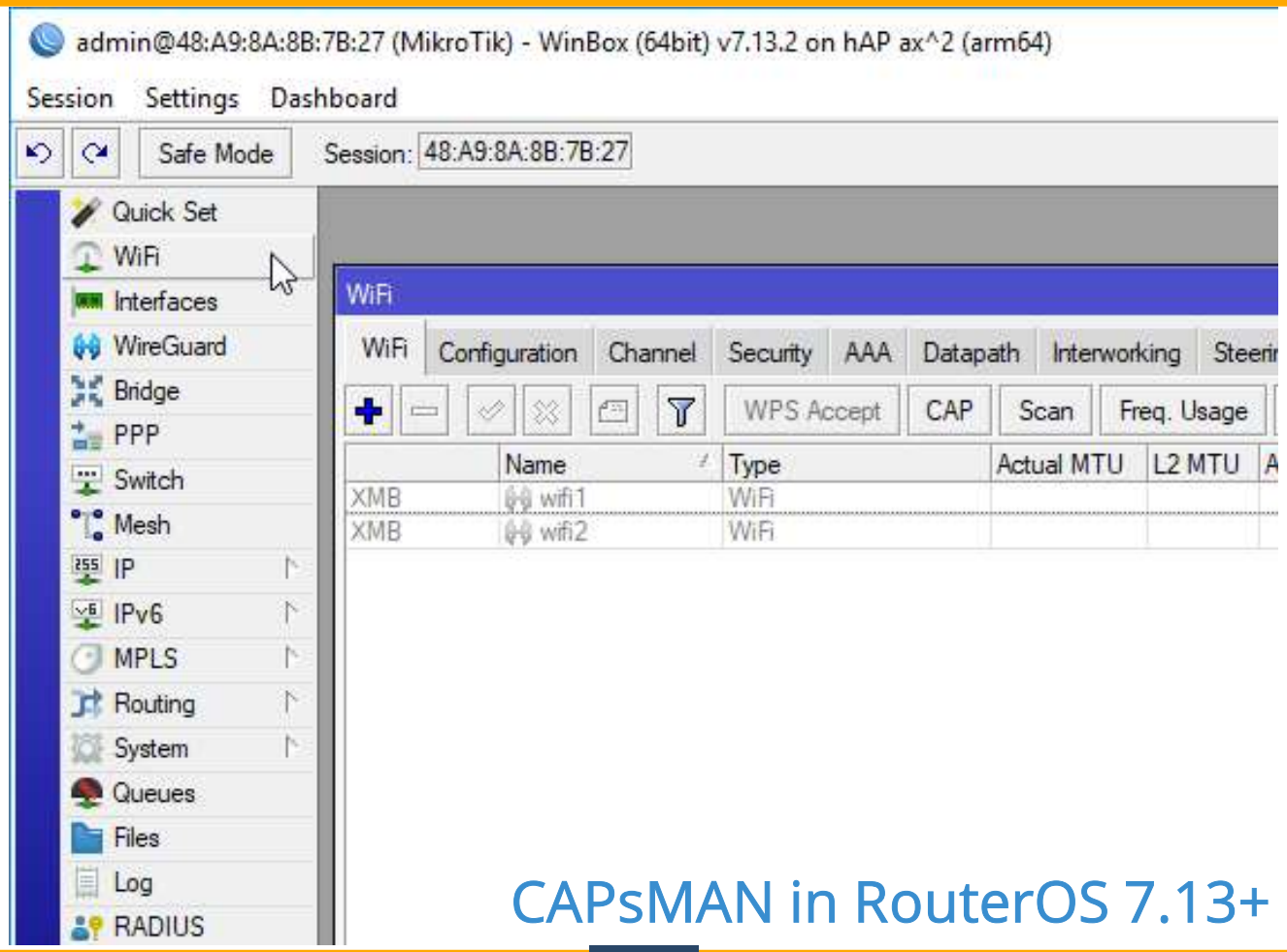
“wifi-qcom-ac” driver package brings

- **WPA3 authentication**
- OWE (opportunistic wireless encryption)
- 802.11w standard management frame protection
- **802.11r/k/v**
- **MU-MIMO and beamforming**
- 400Mb/s maximum data rate in the 2.4GHz band for IPQ4019

Changes from 7.13

"wifi-qcom-ac" driver package compatibility

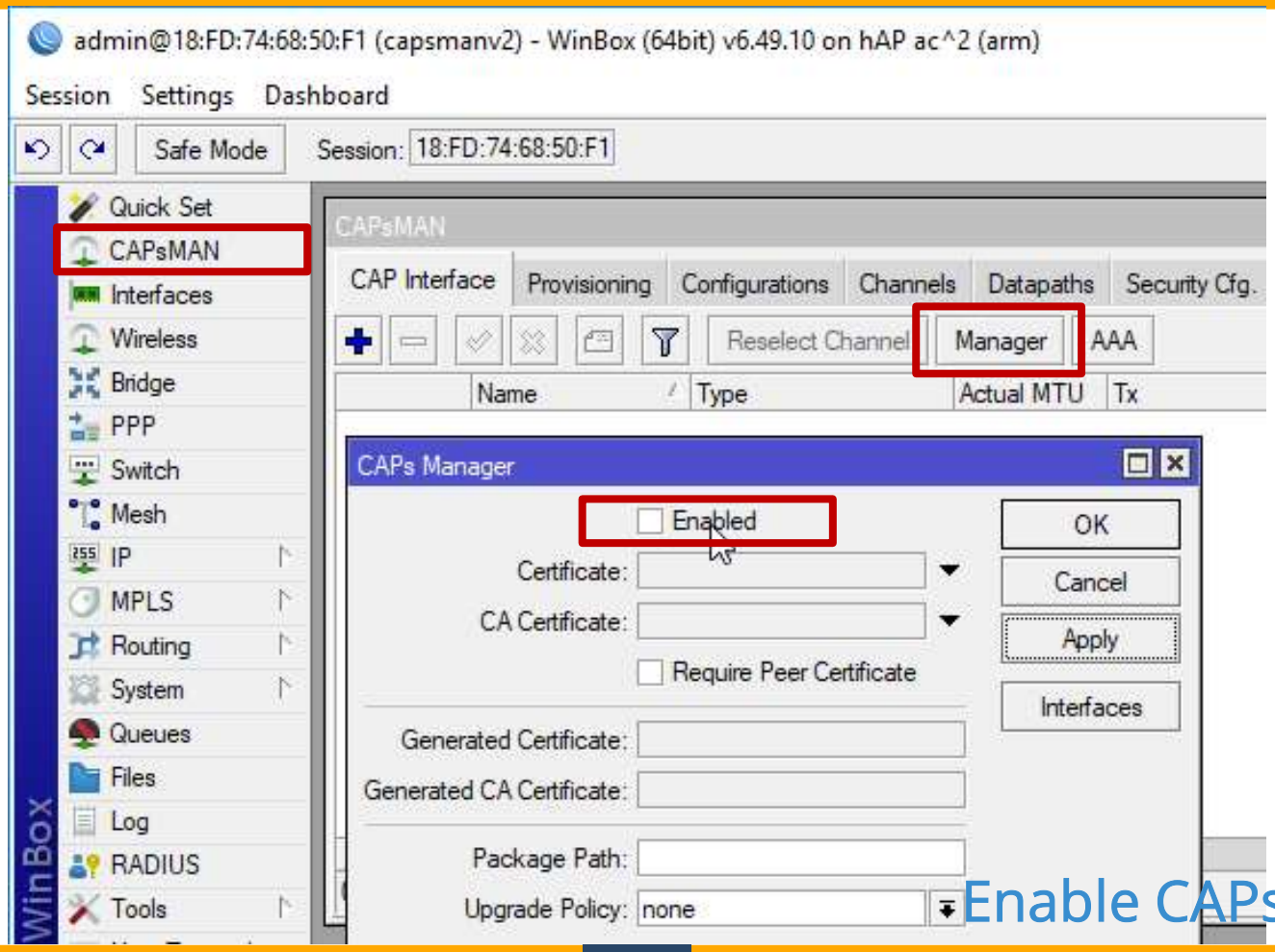
- Audience
- Audience LTE kit
- Chateau (all variants of D53)
- hAP ac^2
- hAP ac^3
- cAP ac (yay ☺)
- cAP XL ac
- LDF 5 ac
- LHG XL 5 ac
- LHG XL 52 ac
- NetMetal ac^2
- mANTBox 52 15s
- wAP ac (RBwAPG-5HacD2HnD)
- SXTsq 5 ac



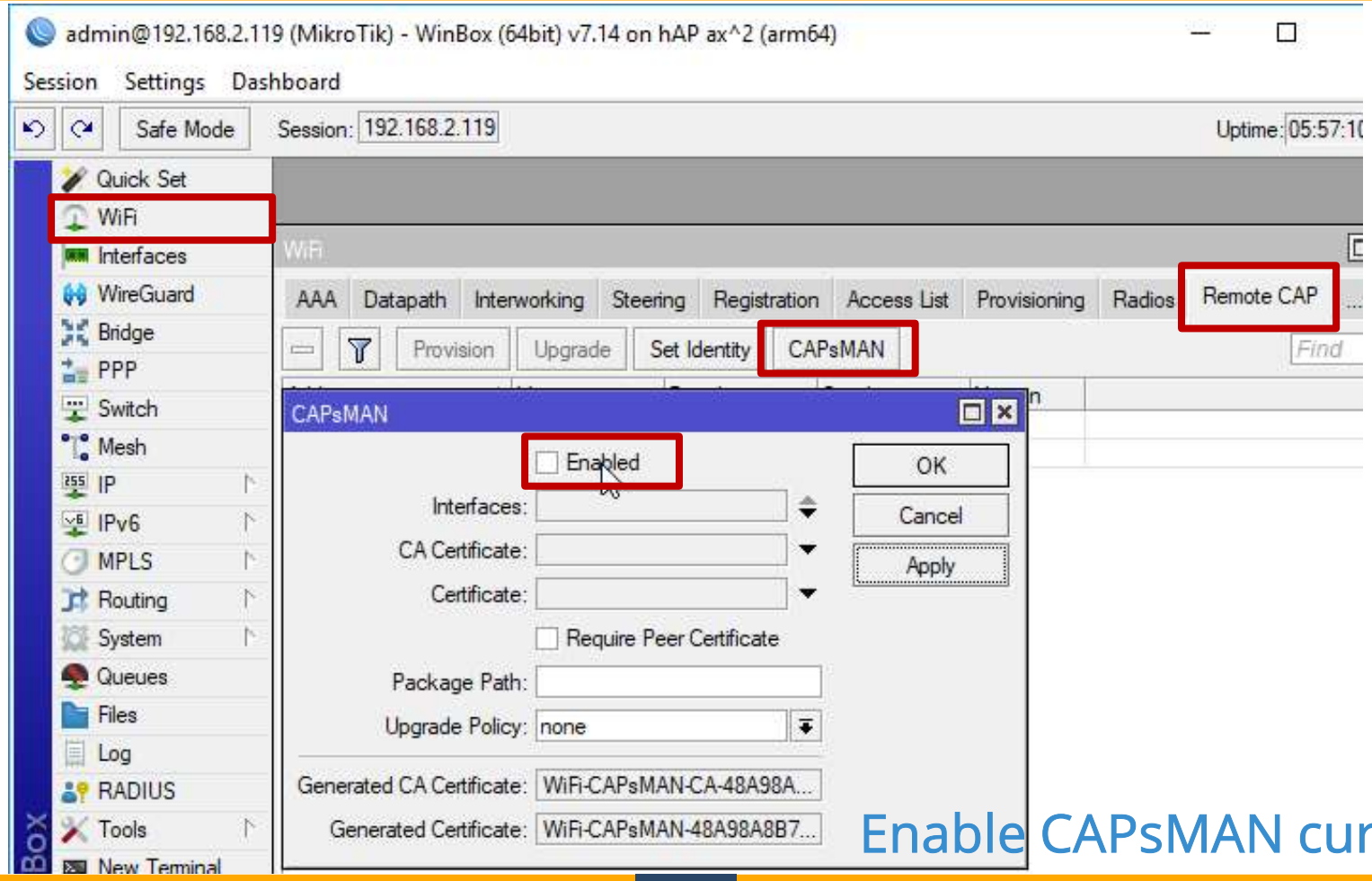
CAPsMAN in RouterOS 7.13+

How to setup CAPsMAN

- CAPsMAN server is configured/enabled
- CAP is configured
- CAP discovers and connects to CAPsMAN
  - Layer 2
  - Layer 3
- Provisioning. CAPsMAN sends to CAP the configurations
- Traffic flow begins, and depending if CAP forwarding (local forwarding) or CAPsMAN forwarding, it flows through the CAP or CAPsMAN

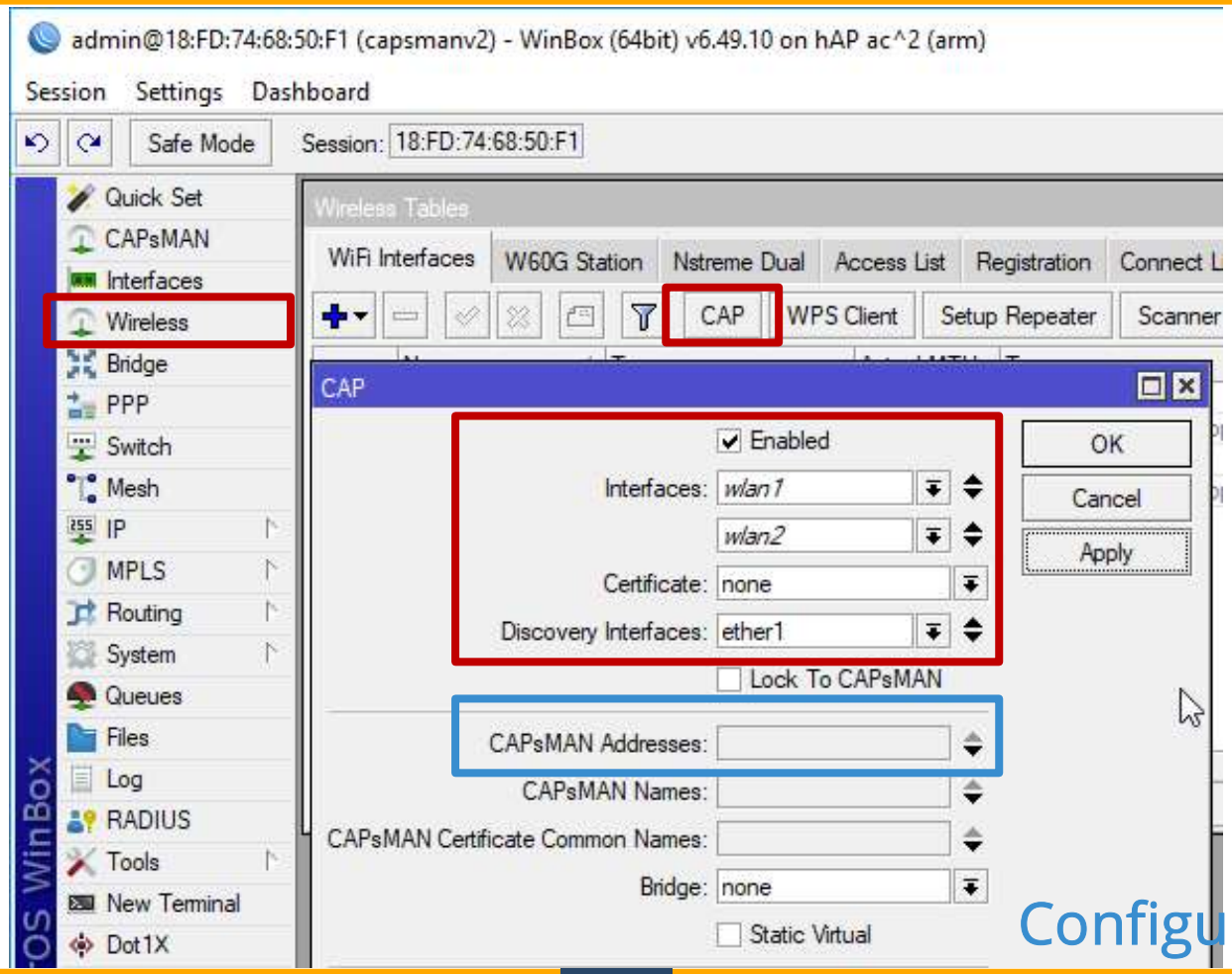


Enable CAPsMAN v2

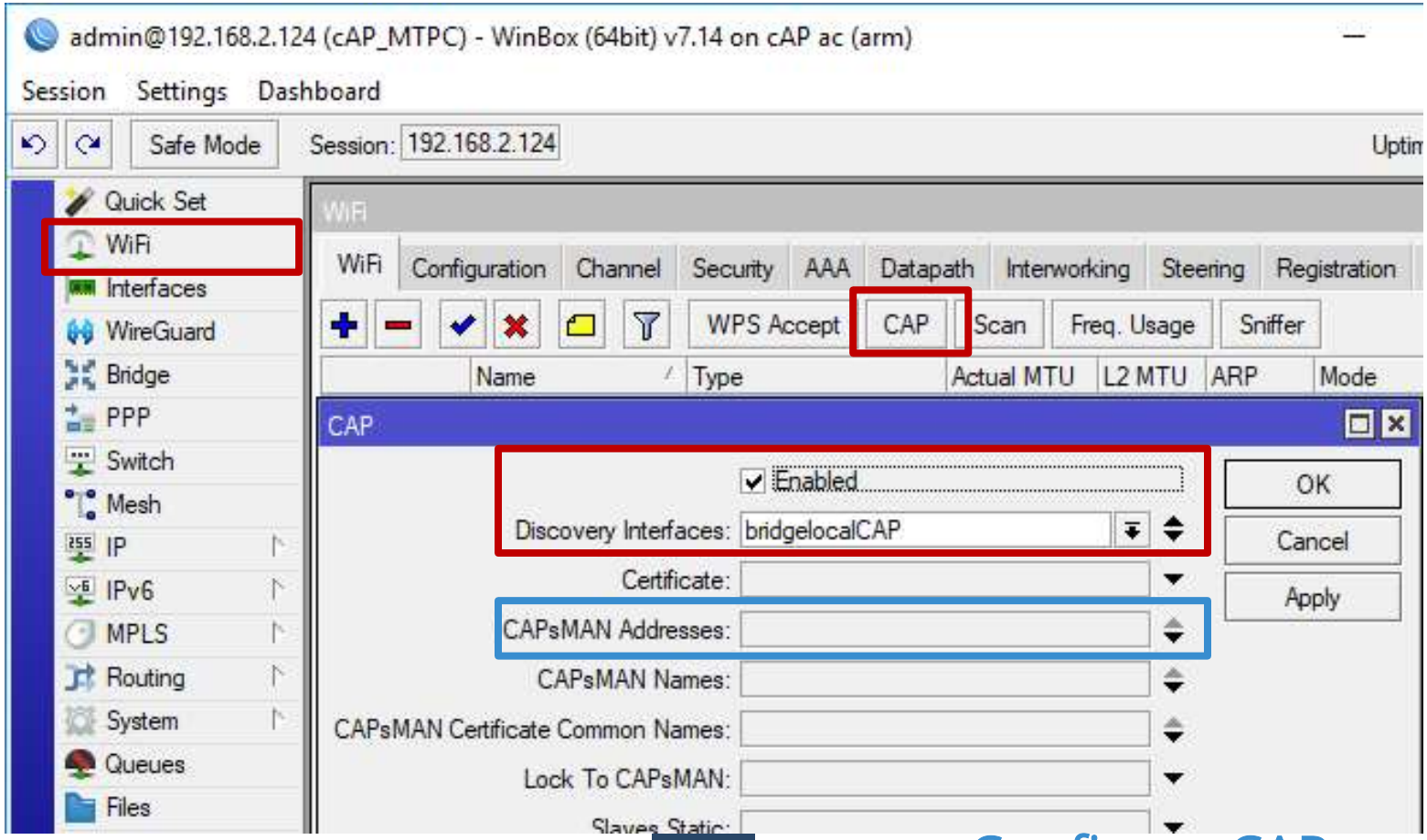

admin@192.168.2.119 (MikroTik) - WinBox (64bit) v7.14 on hAP ax^2 (arm64)
Session
Settings
Dashboard
Safe Mode
Session: 192.168.2.119
Uptime:
Quick Set
WiFi
Interfaces
WireGuard
Bridge
PPP
Switch
Mesh
IP
IPv6
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
WiFi
AAA
Datapath
Interworking
Steering
Registration
Access List
Provisioning
Radios
Remote CAP
Provision
Upgrade
Set Identity
CAPsMAN
Find
CAPsMAN
Enabled
OK
Cancel
Apply
Interfaces:
CA Certificate:
Certificate:
Require Peer Certificate
Package Path:
Upgrade Policy:
none
Generated CA Certificate:
WiFi-CAPsMAN-CA-48A98A...
Generated Certificate:
WiFi-CAPsMAN-48A98A8B7...
Enable CAPsMAN current

How does CAPsMAN work

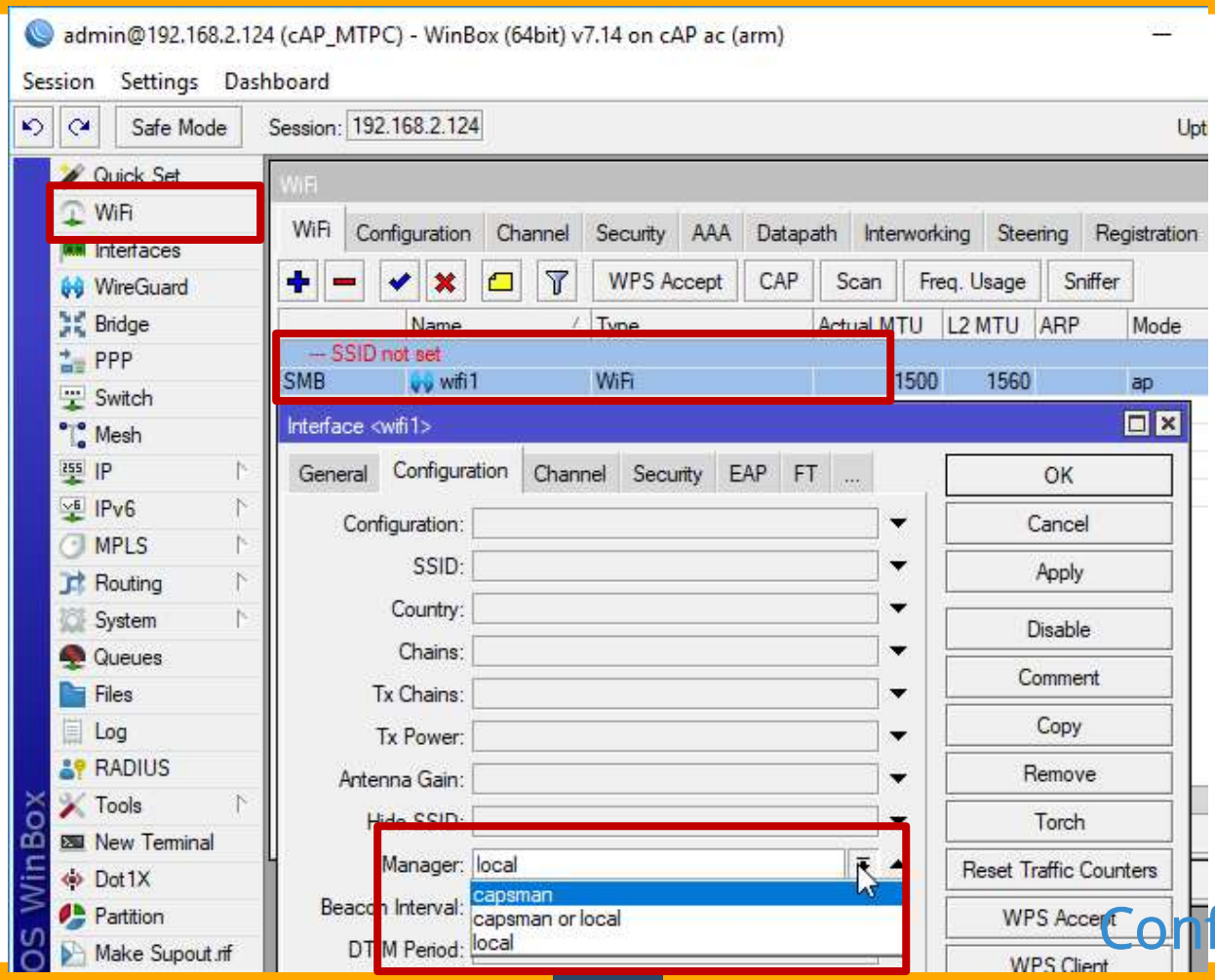
- ~~CAPsMAN server is configured/enabled~~
- CAP is configured
- CAP discovers and connects to CAPsMAN
  - Layer 2
  - Layer 3
- Provisioning. CAPsMAN sends to CAP the configurations
- Traffic flow begins, and depending if CAP forwarding (local forwarding) or CAPsMAN forwarding, it flows through the CAP or CAPsMAN



Configure CAP v2



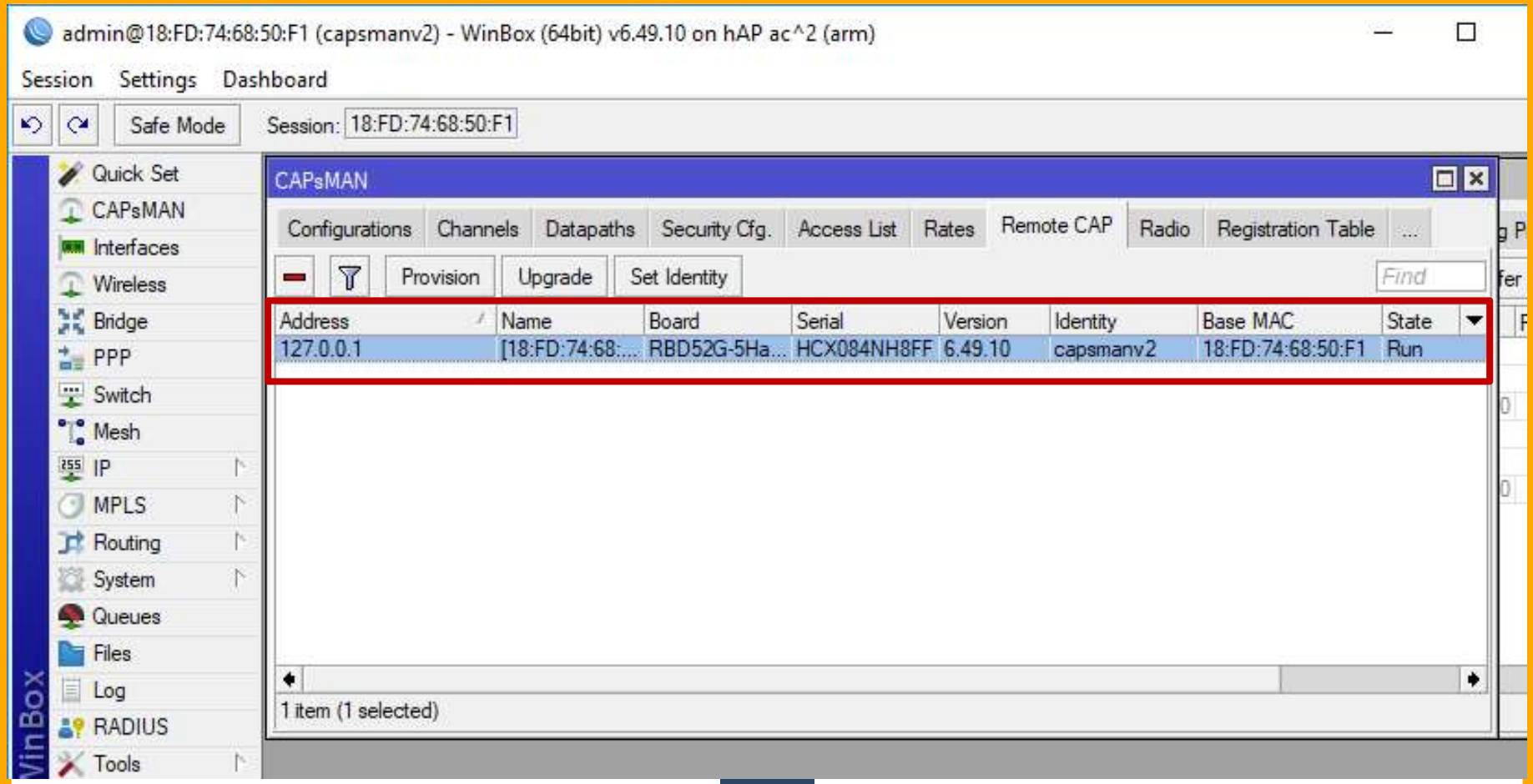
Configure CAP current

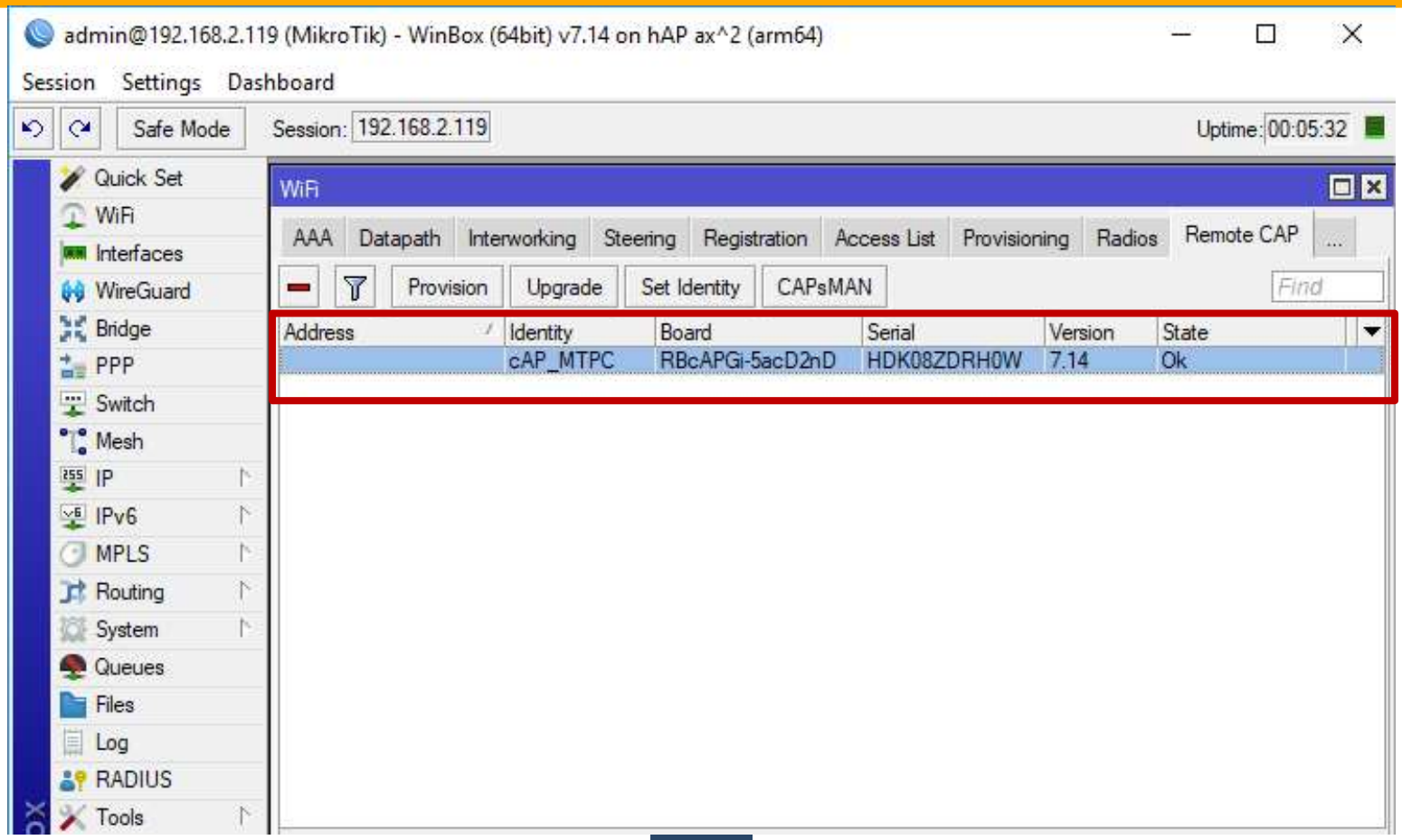


Configure CAP

How does CAPsMAN work

- ~~CAPsMAN server is configured/enabled~~
- ~~CAP is configured~~
- CAP discovers and connects to CAPsMAN
  - Layer 2
  - Layer 3
- Provisioning. CAPsMAN sends to CAP the configurations
- Traffic flow begins, and depending if CAP forwarding (local forwarding) or CAPsMAN forwarding, it flows through the CAP or CAPsMAN


admin@18:FD:74:68:50:F1 (capsmanv2) - WinBox (64bit) v6.49.10 on hAP ac^2 (arm)
Session Settings Dashboard
Safe Mode
Session: 18:FD:74:68:50:F1
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
WinBox
CAPsMAN
Configurations Channels Datapaths Security Cfg. Access List Rates Remote CAP Radio Registration Table ...
Provision Upgrade Set Identity
Find
Address Name Board Serial Version Identity Base MAC State
127.0.0.1 [18:FD:74:68:... RBD52G-5Ha... HCX084NH8FF 6.49.10 capsmanv2 18:FD:74:68:50:F1 Run
1 item (1 selected)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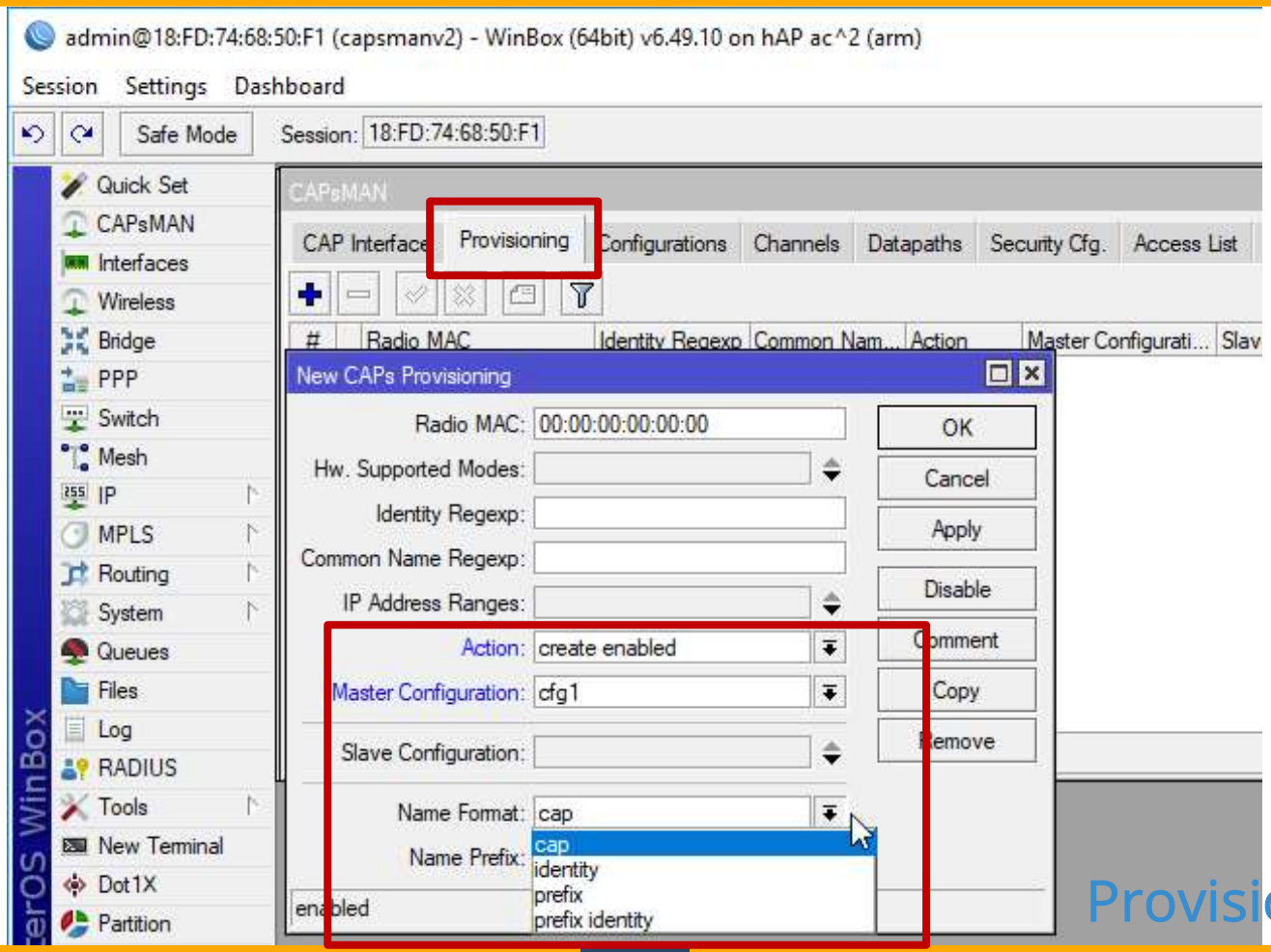
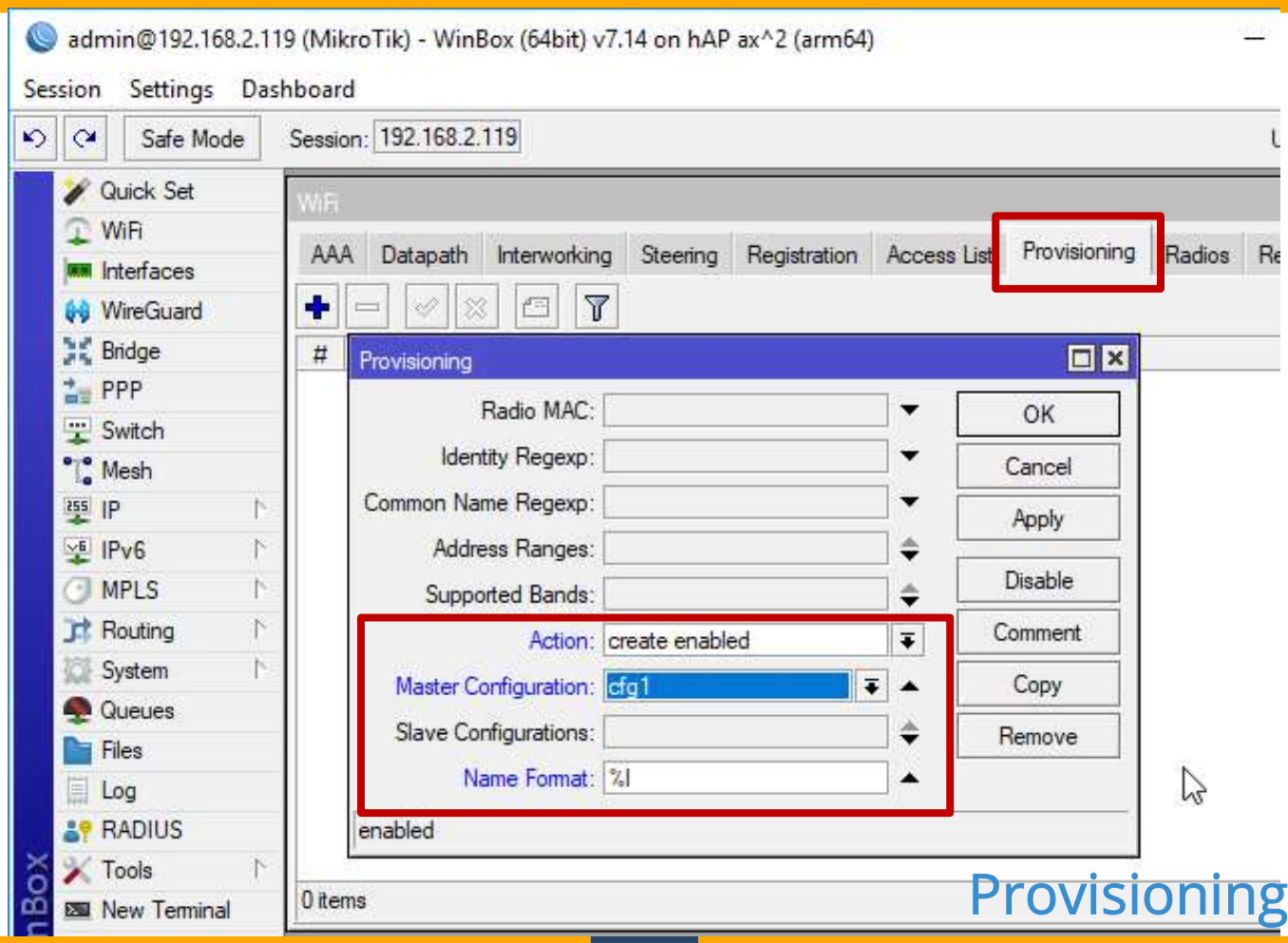
Session
Settings
Dashboard
Safe Mode
Session: 192.168.2.119
Uptime: 00:05:32
Quick Set
WiFi
Interfaces
WireGuard
Bridge
PPP
Switch
Mesh
IP
IPv6
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
WiFi
AAA
Datapath
Interworking
Steering
Registration
Access List
Provisioning
Radios
Remote CAP
Provision
Upgrade
Set Identity
CAPsMAN
Find
Address
Identity
Board
Serial
Version
State
cAP_MTPC
RBcAPGi-5acD2nD
HDK08ZDRH0W
7.14
Ok

How does CAPsMAN work

- ~~CAPsMAN server is configured/enabled~~
- ~~CAP is configured~~
- ~~CAP discovers and connects to CAPsMAN~~
  - ~~Layer 2~~
  - ~~Layer 3~~
- Provisioning. CAPsMAN sends to CAP the configurations
- Traffic flow begins, and depending if CAP forwarding (local forwarding) or CAPsMAN forwarding, it flows through the CAP or CAPsMAN


admin@18:FD:74:68:50:F1 (capsmanv2) - WinBox (64bit) v6.49.10 on hAP ac^2 (arm)
Session Settings Dashboard
Safe Mode
Session: 18:FD:74:68:50:F1
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Partition
CAPsMAN
CAP Interface
Provisioning
Configurations
Channels
Datapaths
Security Cfg.
Access List
Radio MAC Identity Regexp Common Nam... Action Master Configurati... Slav
New CAPs Provisioning
Radio MAC: 00:00:00:00:00:00
Hw. Supported Modes:
Identity Regexp:
Common Name Regexp:
IP Address Ranges:
Action: create enabled
Master Configuration: cfg1
Slave Configuration:
Name Format: cap
Name Prefix:
cap
identity
prefix
prefix identity
OK
Cancel
Apply
Disable
Comment
Copy
Remove
enabled
Provisioning v2



Provisioning current

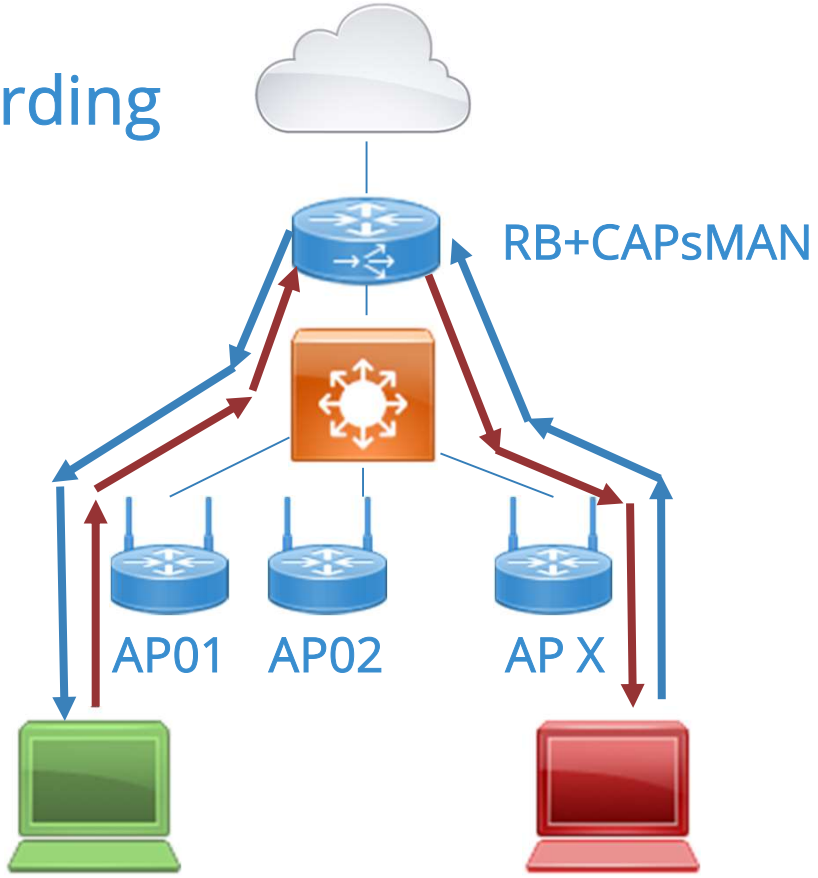
Datapath

Is the path that user data will follow through a CAPsMAN network

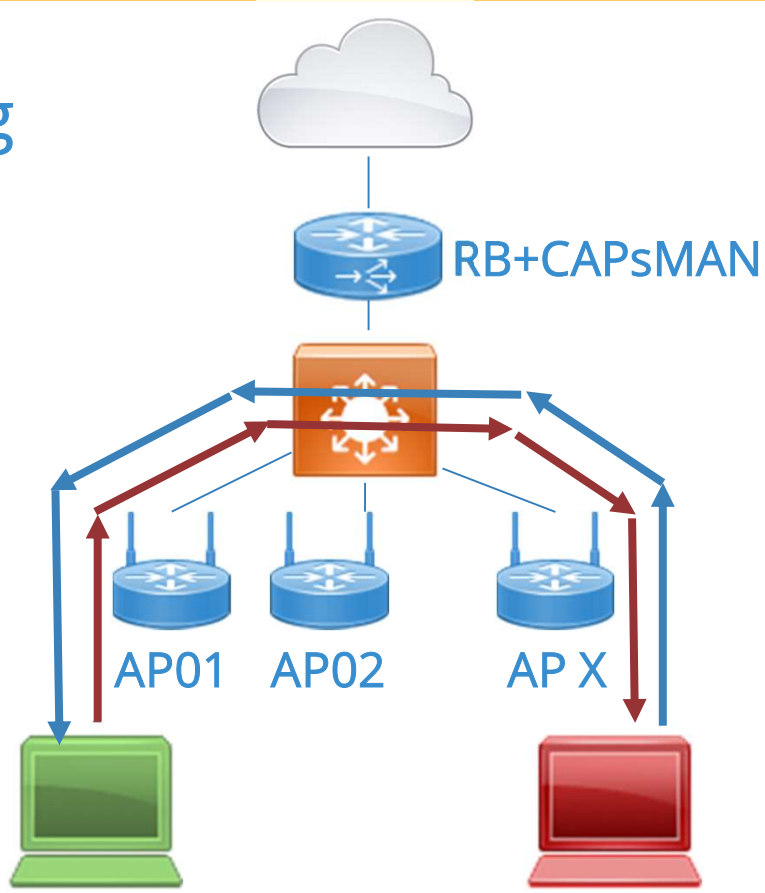
Important concept!

- CAPsMAN forwarding
- Local forwarding

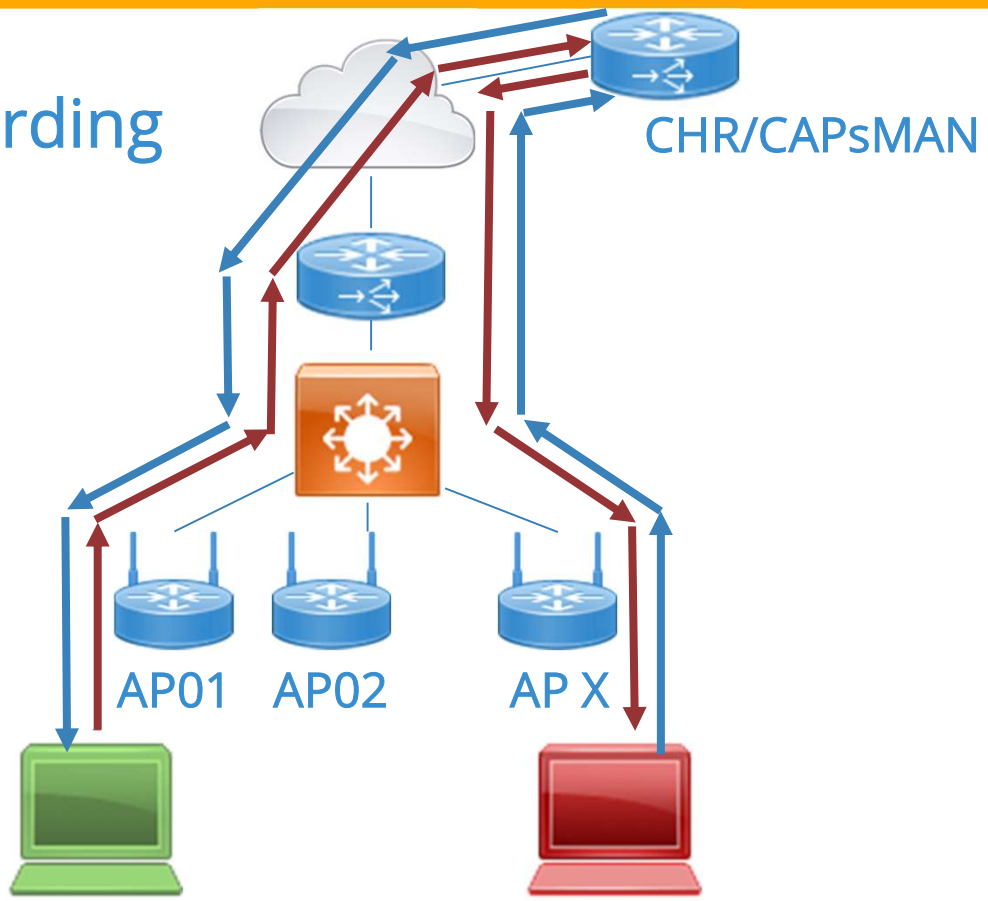
Scenario 1
CAPsMAN Forwarding



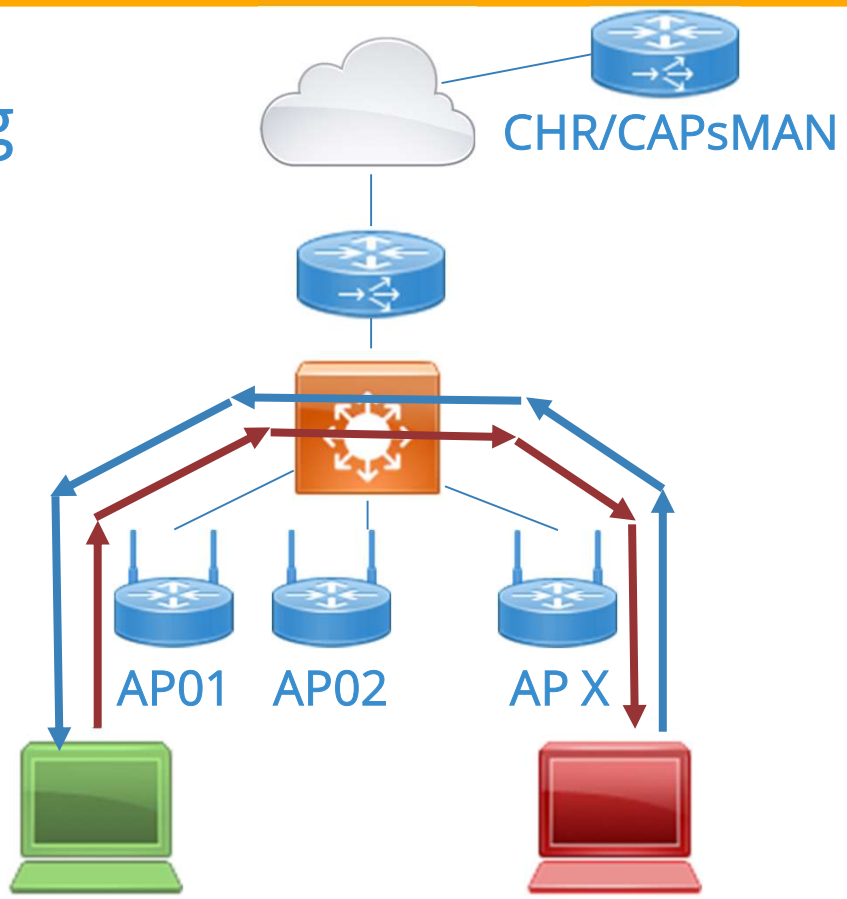
Scenario 1
Local Forwarding

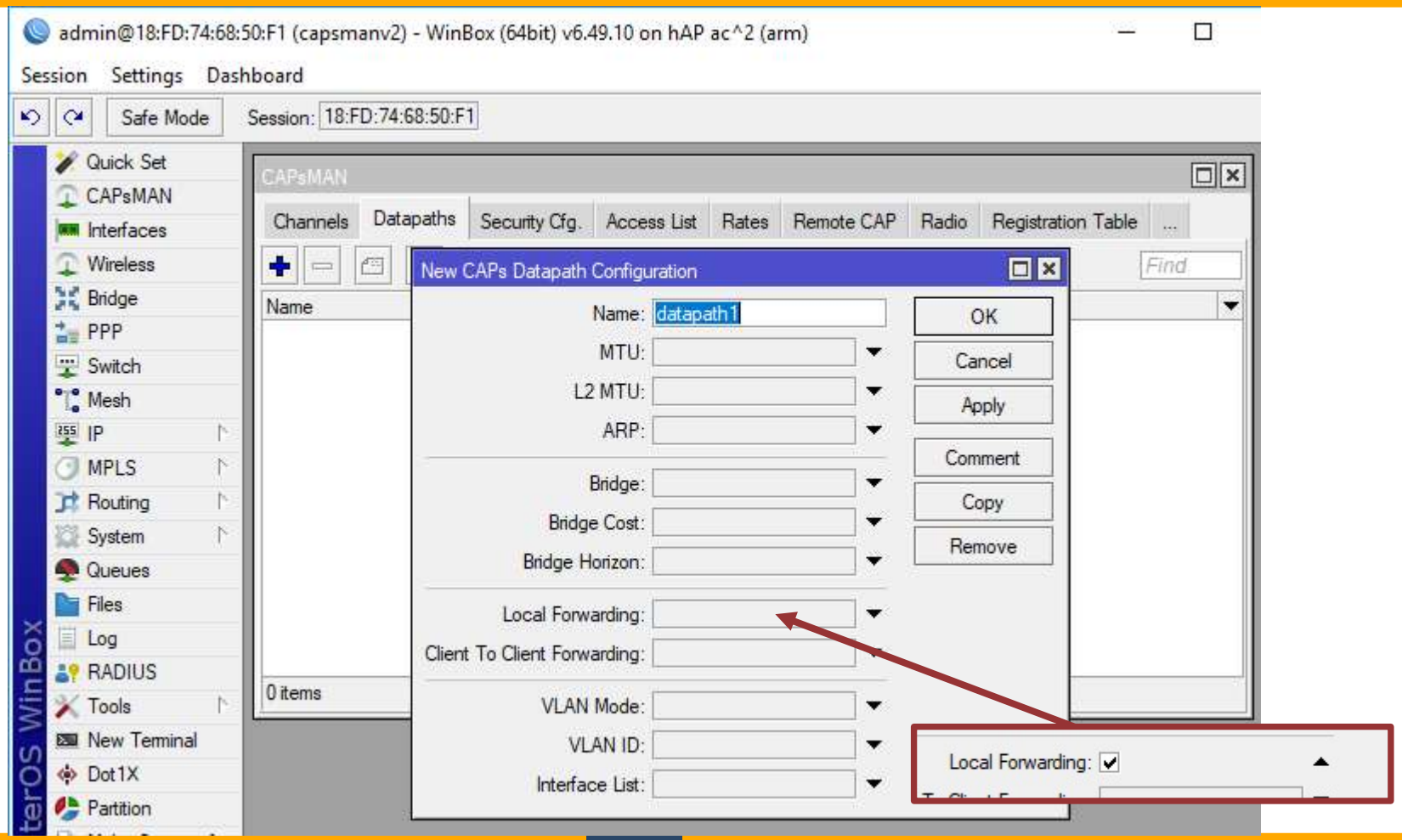


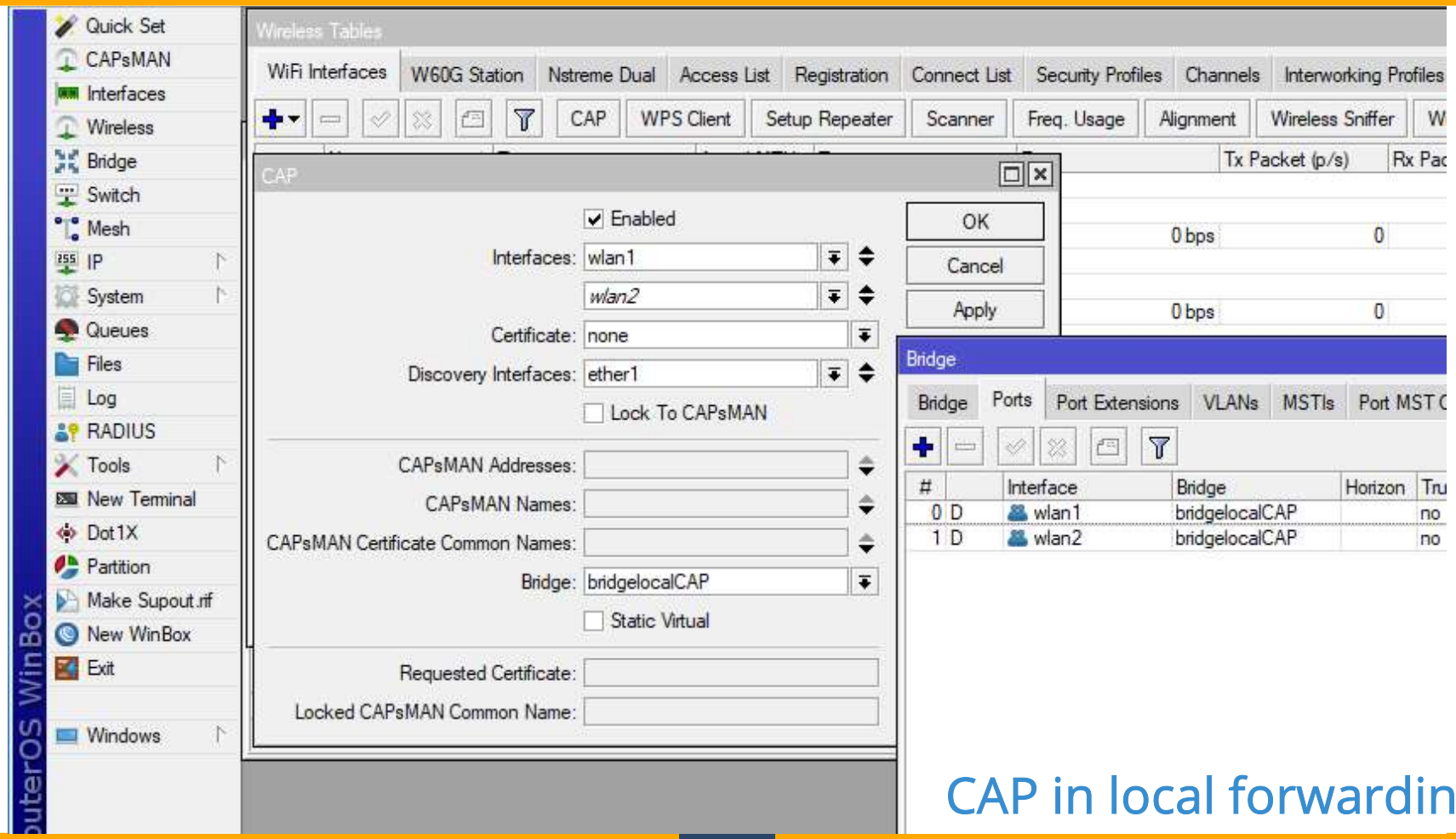
Scenario 2
CAPsMAN Forwarding



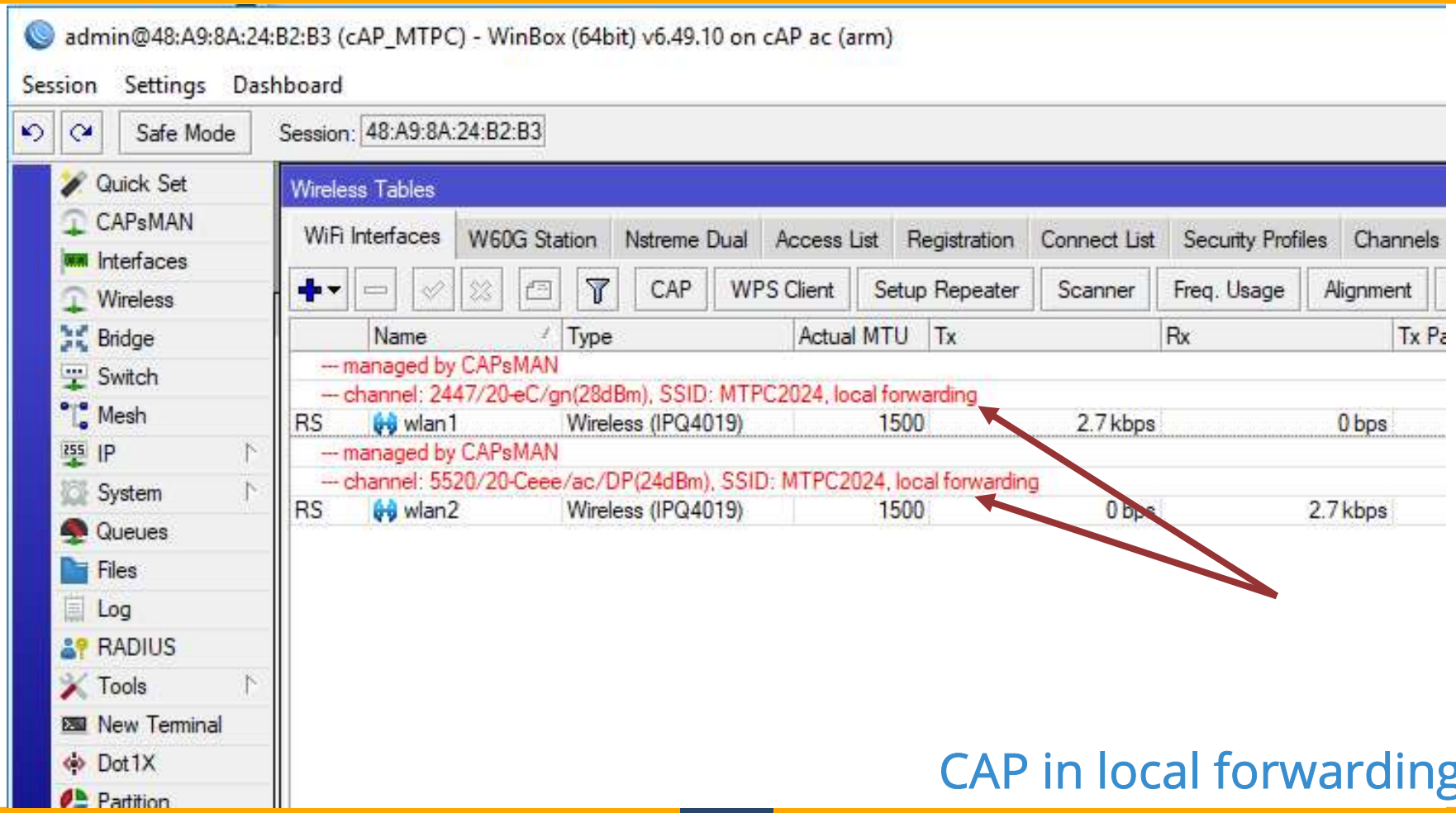
Scenario 2
Local Forwarding



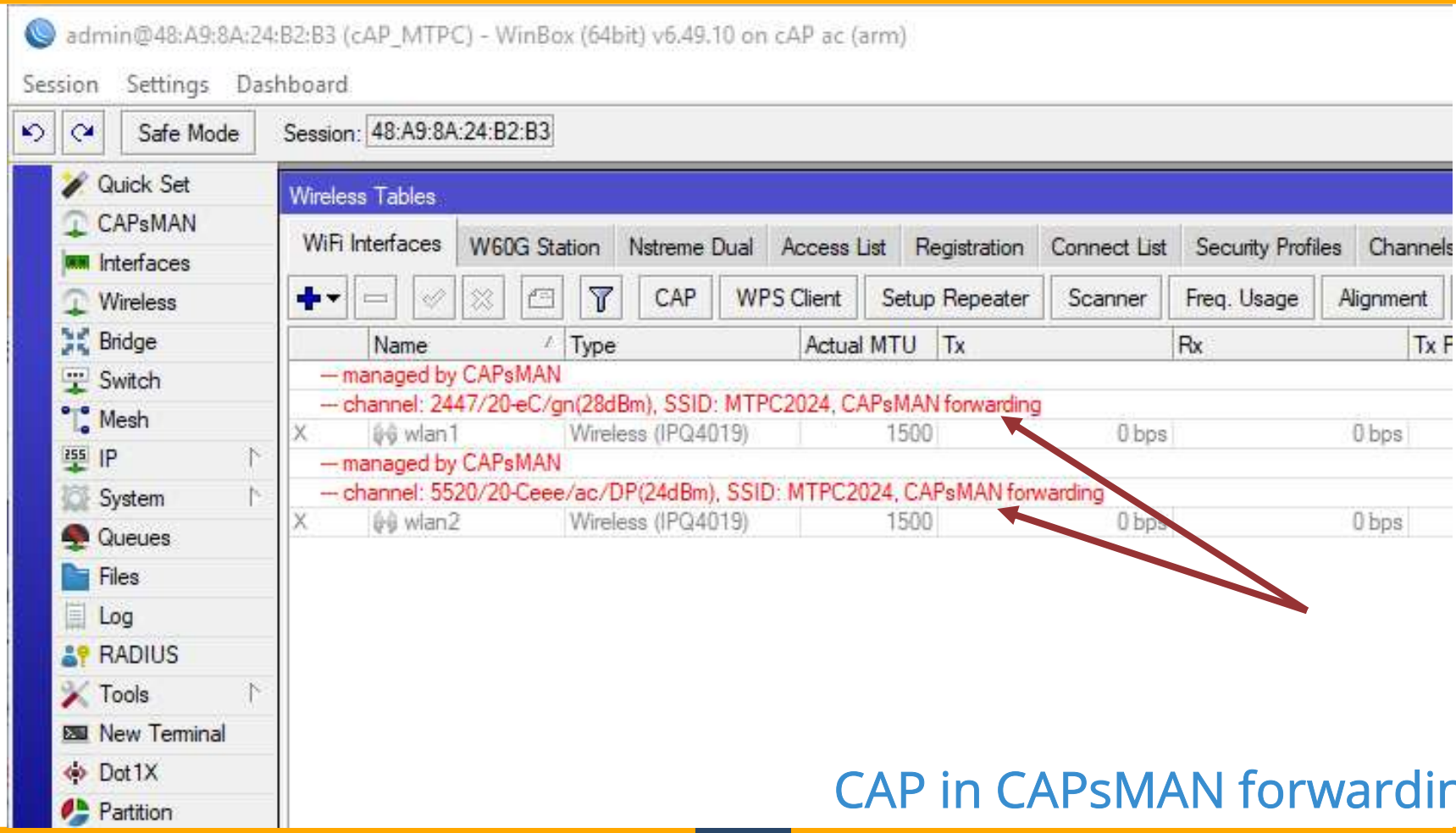

admin@18:FD:74:68:50:F1 (capsmanv2) - WinBox (64bit) v6.49.10 on hAP ac^2 (arm)
Session Settings Dashboard
Safe Mode
Session: 18:FD:74:68:50:F1
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Switch
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Partition
CAPsMAN
Channels
Datapaths
Security Cfg.
Access List
Rates
Remote CAP
Radio
Registration Table
Find
Name
0 items
New CAPs Datapath Configuration
Name: datapath1
MTU:
L2 MTU:
ARP:
Bridge:
Bridge Cost:
Bridge Horizon:
Local Forwarding:
Client To Client Forwarding:
VLAN Mode:
VLAN ID:
Interface List:
OK
Cancel
Apply
Comment
Copy
Remove
Local Forwarding:



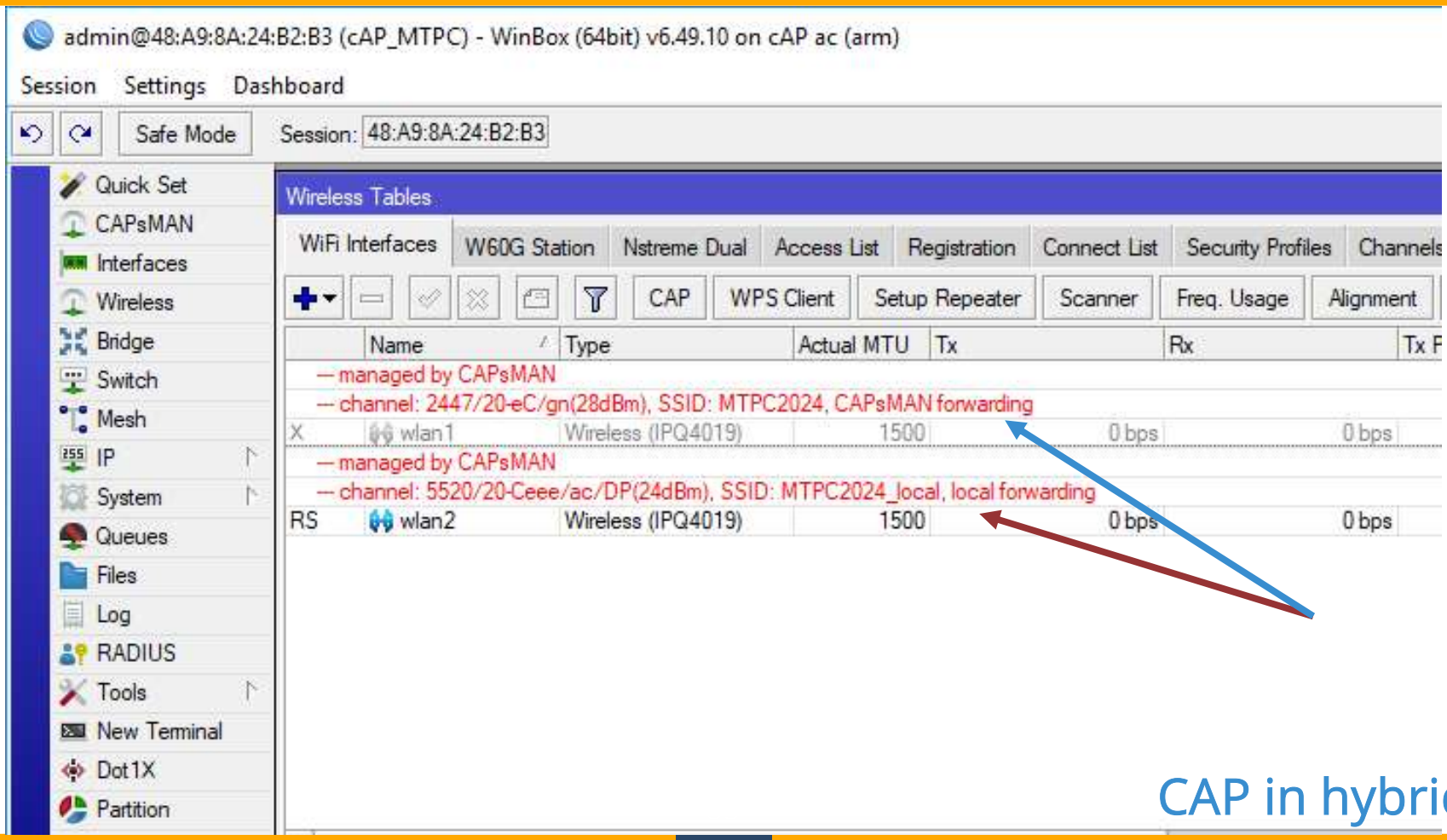
CAP in local forwarding



CAP in local forwarding



CAP in CAPsMAN forwarding


admin@48:A9:8A:24:B2:B3 (cAP_MTPC) - WinBox (64bit) v6.49.10 on cAP ac (arm)
Session Settings Dashboard
Safe Mode
Session: 48:A9:8A:24:B2:B3
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
Switch
Mesh
IP
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Partition
Wireless Tables
WiFi Interfaces
W60G Station
Nstreme Dual
Access List
Registration
Connect List
Security Profiles
Channels
CAP
WPS Client
Setup Repeater
Scanner
Freq. Usage
Alignment
Name
Type
Actual MTU
Tx
Rx
managed by CAPsMAN
channel: 2447/20-eC/gn(28dBm), SSID: MTPC2024, CAPsMAN forwarding
X wlan1 Wireless (IPQ4019) 1500 0 bps 0 bps
managed by CAPsMAN
channel: 5520/20-Ceee/ac/DP(24dBm), SSID: MTPC2024_local, local forwarding
RS wlan2 Wireless (IPQ4019) 1500 0 bps 0 bps
CAP in hybrid

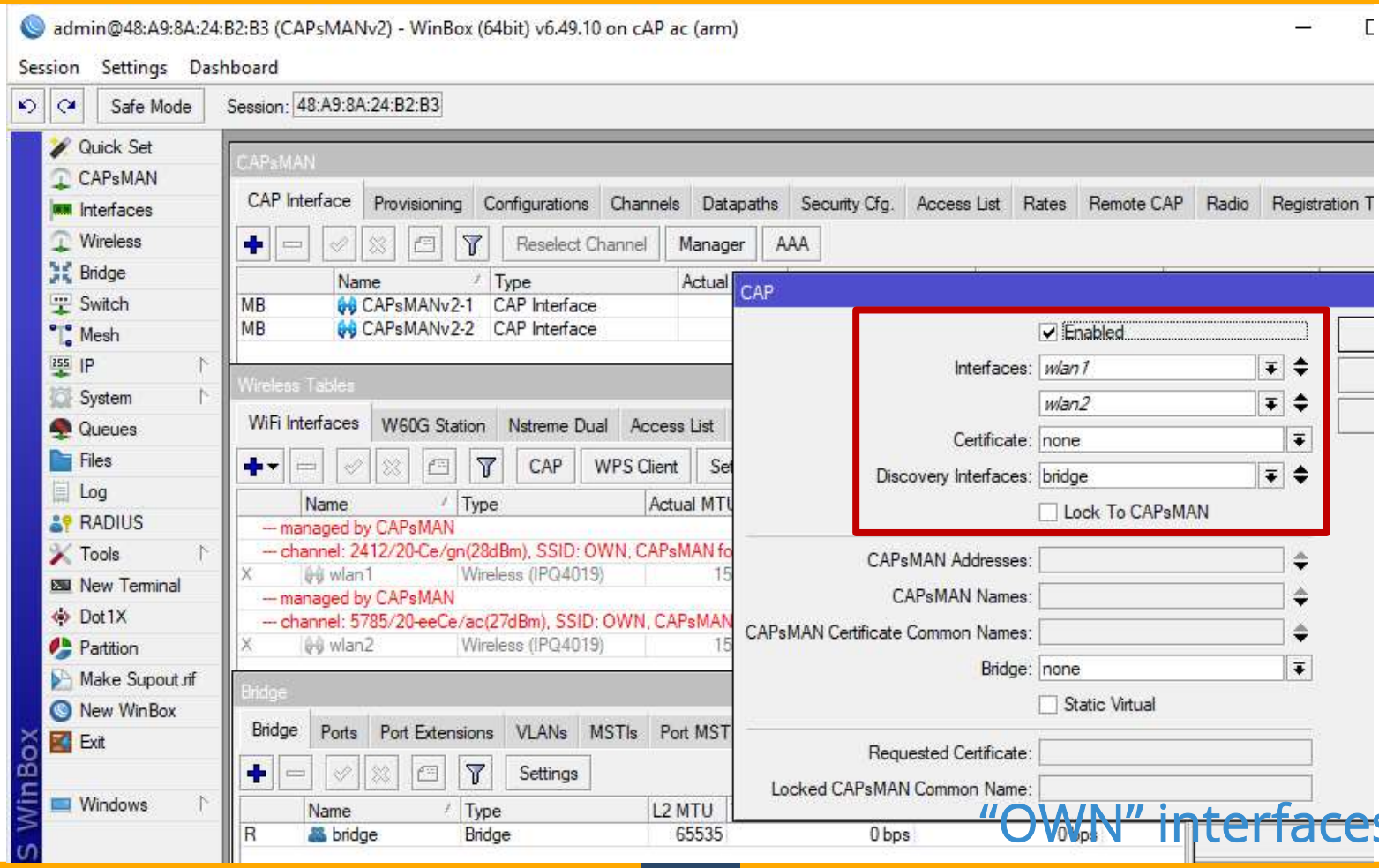
“CAPsMAN forwarding” in current version

For the moment it is not possible in the current version

But the options are there, and are selectable for CAP interfaces in CAPsMAN. That makes us believe that MikroTik is working on it

CAPsMAN own wifi interfaces

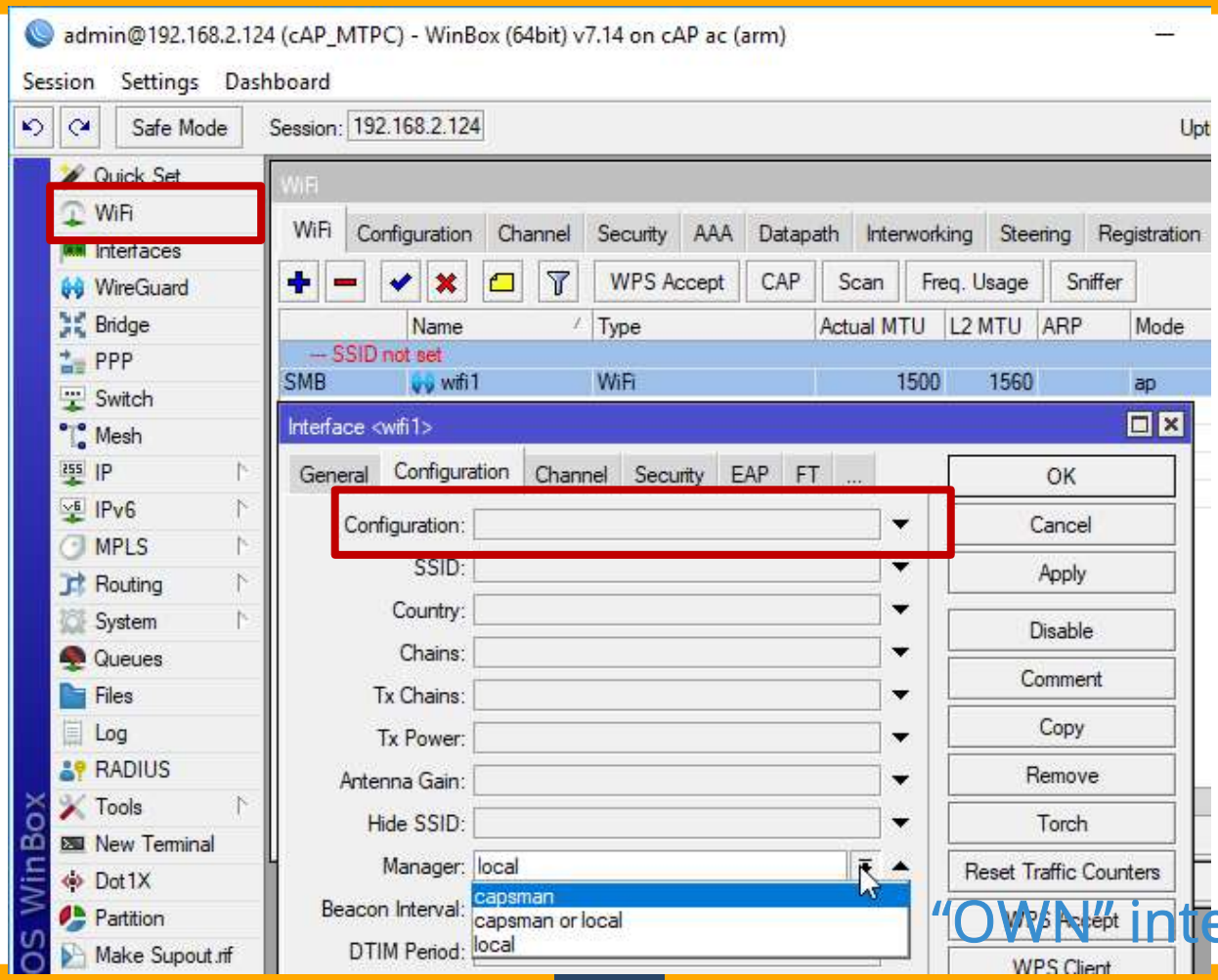
CAPsMAN v2 we used adding the “own wifi interfaces” by creating a bridge and making the cap window option to look for the CAPsMAN in the bridge



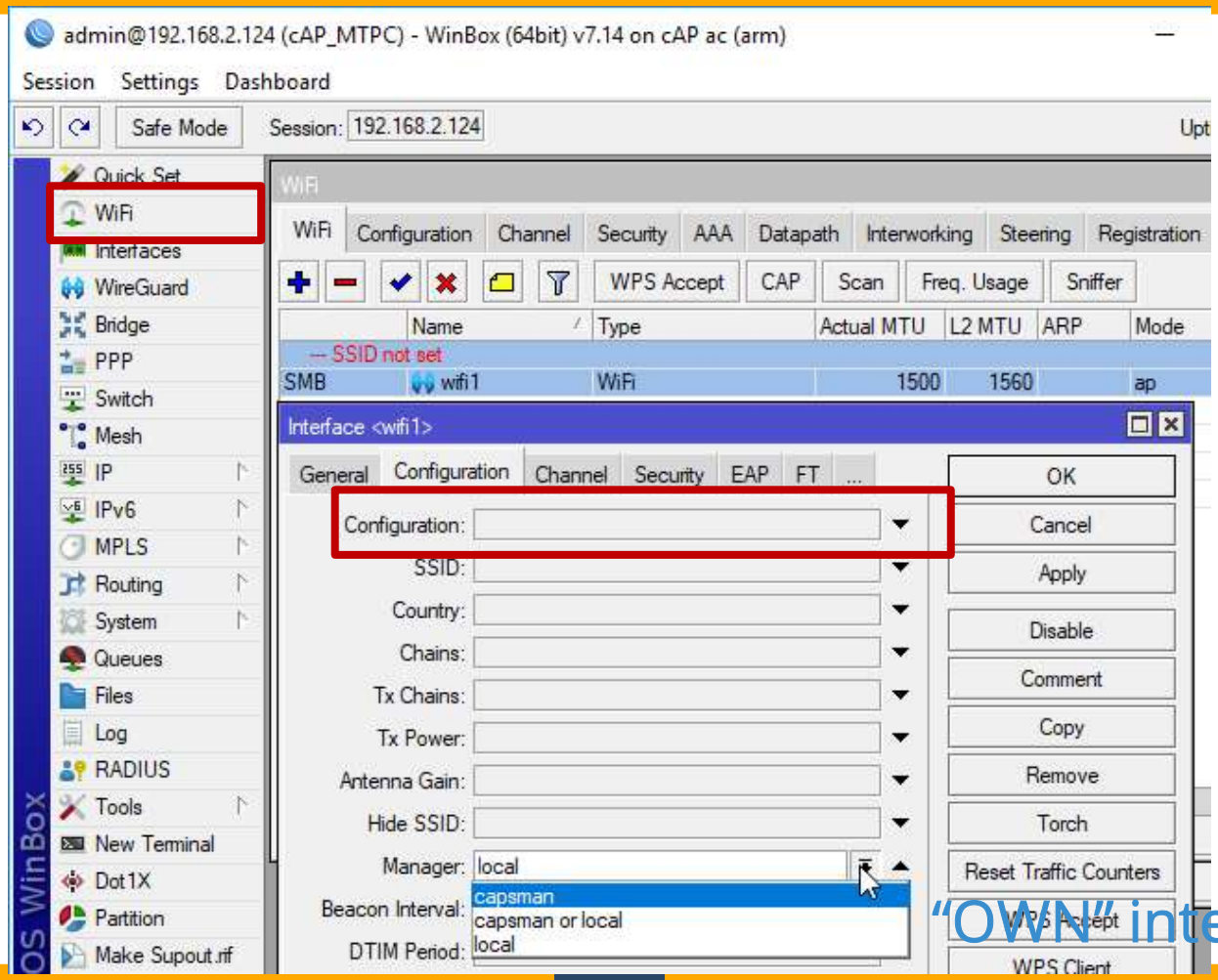
"OWN" interfaces v2

CAPsMAN own wifi interfaces

CAPsMAN v3 all options: security profiles, configurations, etc, are in the same menu and work for both local interfaces and CAP interfaces, so we just need to put “local” in the manager field and apply the desired config.



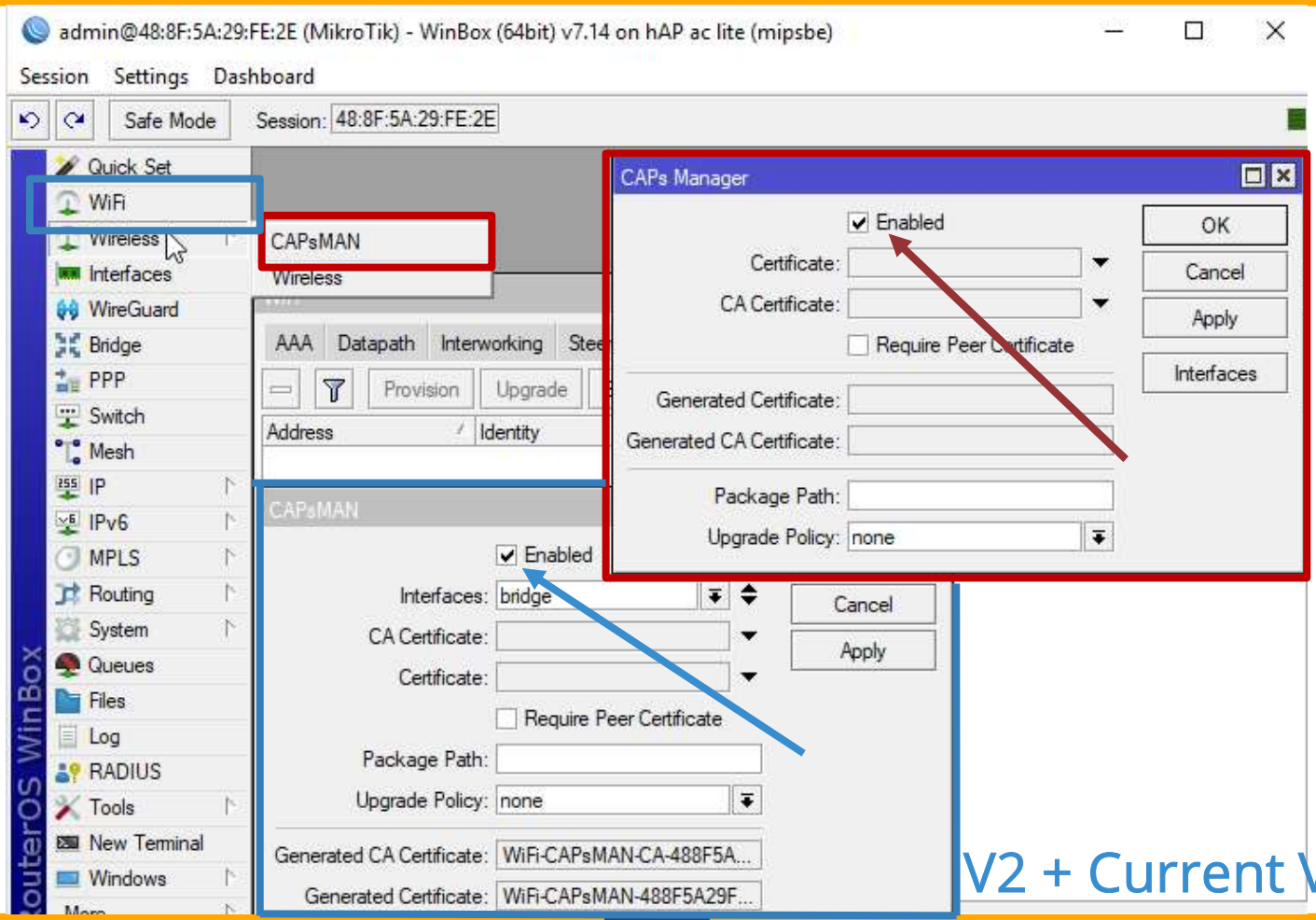
"OWN" interfaces v3



"OWN" interfaces v3

Both Versions simultaneously

- You can have **both versions** Version 2 and Current version run **in the same** RouterBOARD, bare metal or CHR
- The two setups will have **separate configurations** and you will have to do things twice if they are needed to be done in both of them
- Depending on the CAP's version, they will be **added automatically** to their compatible version CAPsMAN

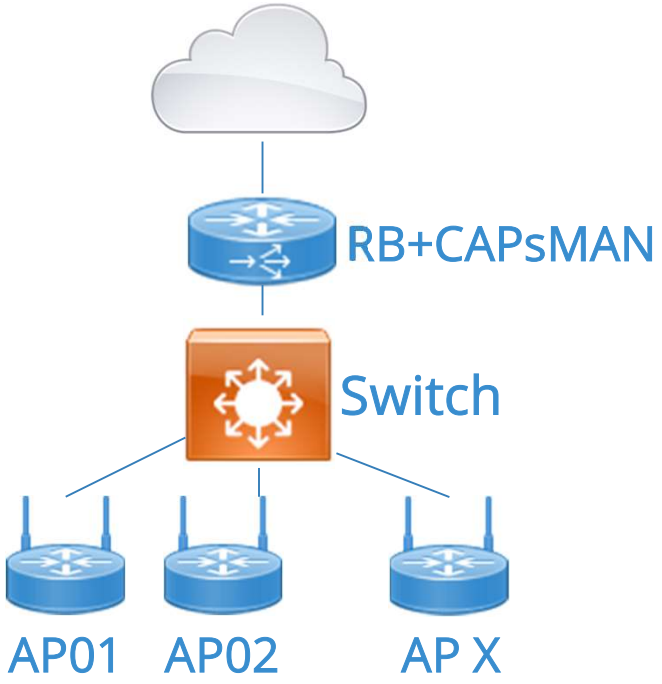

admin@48:8F:5A:29:FE:2E (MikroTik) - WinBox (64bit) v7.14 on hAP ac lite (mipsbe)
Session Settings Dashboard
Safe Mode
Session: 48:8F:5A:29:FE:2E
Quick Set
WiFi
Wireless
Interfaces
WireGuard
Bridge
PPP
Switch
Mesh
IP
IPv6
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Windows
CAPsMAN
Wireless
AAA
Datapath
Interworking
Provision
Upgrade
Address
Identity
CAPs Manager
Enabled
Certificate:
CA Certificate:
Require Peer Certificate
Generated Certificate:
Generated CA Certificate:
Package Path:
Upgrade Policy:
none
OK
Cancel
Apply
Interfaces
CAPsMAN
Enabled
Interfaces:
bridge
CA Certificate:
Certificate:
Require Peer Certificate
Package Path:
Upgrade Policy:
none
Generated CA Certificate:
WiFi-CAPsMAN-CA-488F5A...
Generated Certificate:
WiFi-CAPsMAN-488F5A29F...
Cancel
Apply
V2 + Current Version

A bit of security

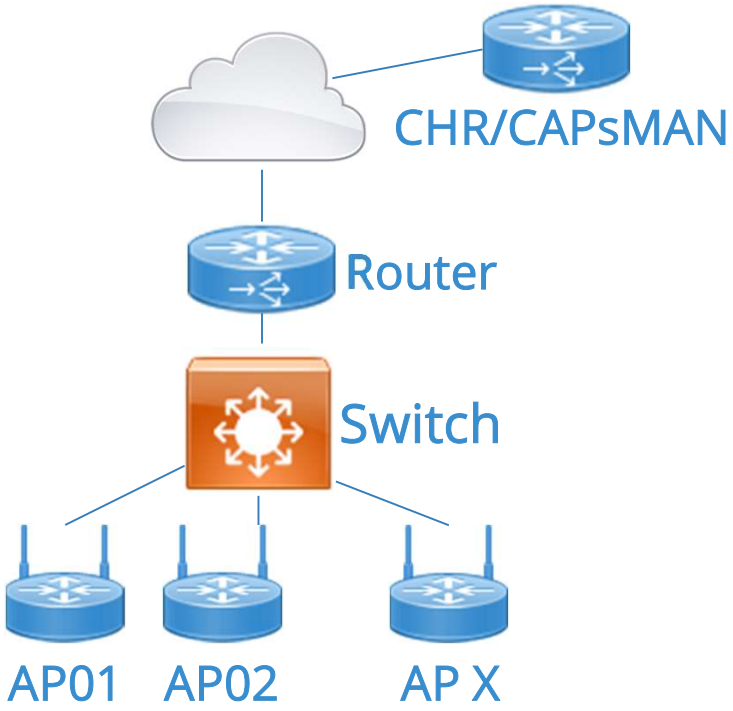
CAPsMAN uses

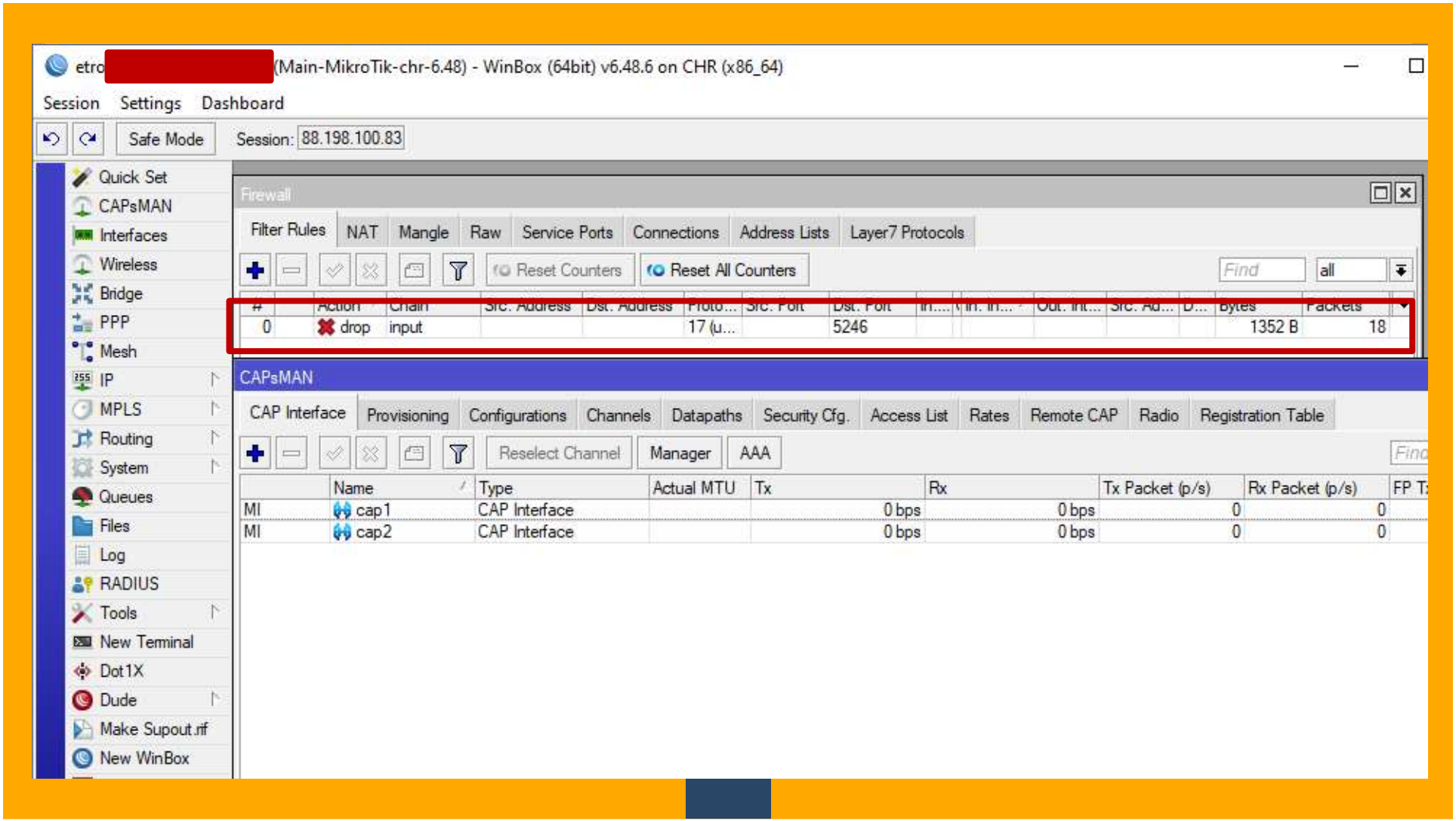
- UDP port 5246 for manager traffic
- UDP port 5247 for data traffic

Scenario 1



Scenario 2




[redacted] (Main-MikroTik-chr-6.48) - WinBox (64bit) v6.48.6 on CHR (x86_64)
Session Settings Dashboard
Safe Mode
Session: 88.198.100.83
Quick Set
CAPsMAN
Interfaces
Wireless
Bridge
PPP
Mesh
IP
MPLS
Routing
System
Queues
Files
Log
RADIUS
Tools
New Terminal
Dot1X
Dude
Make Supout.rif
New WinBox
Firewall
Filter Rules NAT Mangle Raw Service Ports Connections Address Lists Layer7 Protocols
Reset Counters
Reset All Counters
Find
all
Action Chain Src. Address Dst. Address Proto... Src. Port Dst. Port In.... In. In... Out. Int... Src. Ad... D... Bytes Packets
0 drop input 17 (u... 5246 1352 B 18
CAPsMAN
CAP Interface Provisioning Configurations Channels Datapaths Security Cfg. Access List Rates Remote CAP Radio Registration Table
Reselect Channel
Manager
AAA
Name Type Actual MTU Tx Rx Tx Packet (p/s) Rx Packet (p/s) FP T
MI cap1 CAP Interface 0 bps 0 bps 0 0
MI cap2 CAP Interface 0 bps 0 bps 0 0

Feature request (communication section)

- Possibility to disable L2 CAPsMAN and/or L3 CAPsMAN.
- Possibility to change the default ports 5246/5247 in server side and CAP side

Conclusions

- CAPsMAN has gone through a lot of changes during the years
- We should focus on V2 and Current version
- Preferably use devices that support the same protocol
- If old CAPsMAN setups are in need of upgrade we can check their compatibility with the “wifi-qcom-ac” drivers

Conclusions

After deploying we will have:

- Much more control over the Wifi Network
- Easier expansion
- More stable client connections
- A nearly unlimited number of options on configurations of such networks

- Happy Clients
- Paid bills ☺

MIKROTIK professionals conference
Prague, 7-8 March, 2024

Thanks for your attention!

Questions?

Let's connect on LinkedIn