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RHIZOMATICA

APC

SCHOOL OF COMMUNITY NETWORK LEARNING MODULE

2026

BUILDING MICRO-SCALE INTERNET NETWORK

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I. Foreword

As the times progress, knowledge of computer networks and the internet has become an essential need for all layers of society. This module is compiled as a brief and practical guide to help rural communities in Indonesia build their understanding of computer networks and internet usage. It is specifically designed with easy-to-understand language and practical steps that anyone can follow.

Through this module, it is hoped that knowledge and skills related to computer network technology and the internet can be strengthened among rural communities.

This module was originally developed to address the specific needs of communities building understanding of internet networks and frugal networking in rural Indonesia and has since been translated into English to serve a wider, global audience, particularly communities in the Philippines and other countries facing similar challenges in rural connectivity.

With this knowledge, communities are expected to become more self-sufficient in accessing information and resources available on the internet.

This module is also part of a broader effort to complement the Indonesian School of Community Networks series, which aims to provide comprehensive education on information and communication technology.

May this module serve as a valuable learning resource.

II. Internet Network Topology

Topology makes it easier to understand the internet network to be built. By creating a topology, we can calculate hardware requirements and power consumption needs, especially when using a solar panel as the power source.

From a cost perspective, creating a topology helps save money, as we can accurately calculate device requirements, making equipment purchases more cost-effective.

To build a micro-scale internet network in a rural area, one technology that can be utilized is the broadband internet network from cellular operators. The LHG LTE modem can be installed outdoors, even on a pole, for better signal reception at height.

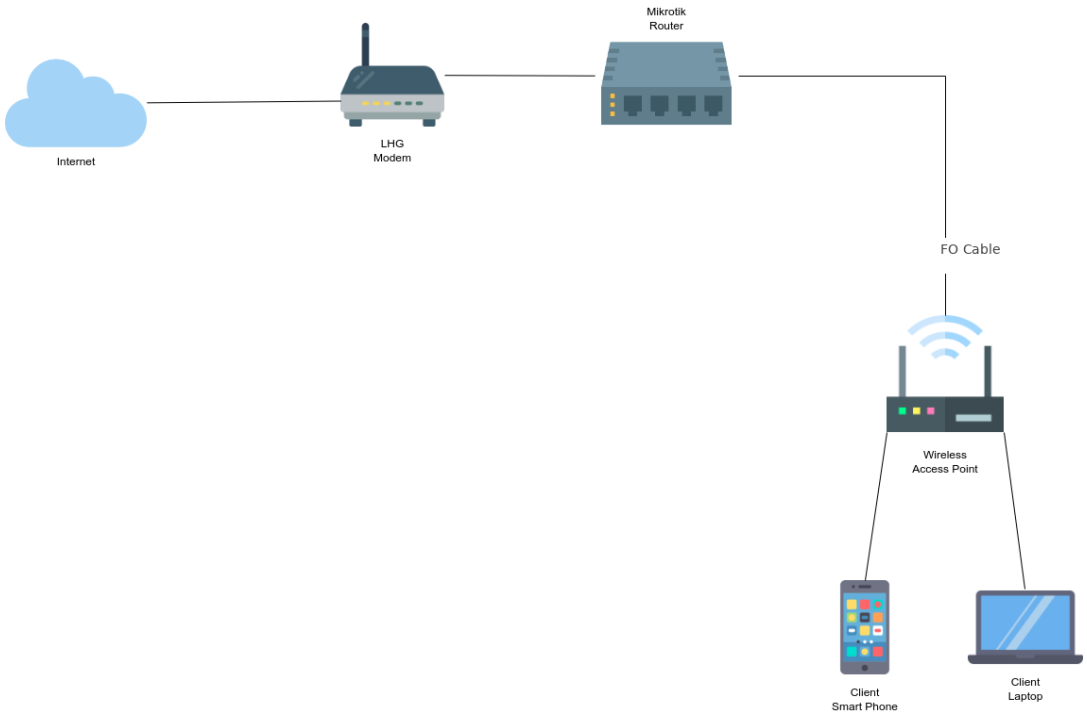


Figure 1. Internet Network Topology

Note: The LHG LTE image does not depict the actual device; it is used only for the topology diagram.

Because the power source to be used is a solar panel, a list of devices must be prepared so power consumption can be calculated.

No	Device Name	Brand / Type / Specification	Quantity
1	Mikrotik LHG LTE	Mikrotik LHG LTE kit	1
2	Mikrotik Router	Mikrotik RB951G-2HnD	1
3	Access Point	Totolink CP300	1
4	HTB Media Converter	Netlink HTB 3100A 3100B	1

Table 1. List of Network Devices Used

III. Network and Internet Device Assembly

Refer to the network topology in Figure 1. Required devices:

No	Device Name	Brand / Type / Specification	Quantity
1	Mikrotik LHG LTE	Mikrotik LHG LTE kit	1 unit
2	Mikrotik Router	Mikrotik RB951G-2HnD	1 unit
3	Access Point	Totolink CP300	1 unit
4	HTB Media Converter	Netlink HTB 3100A 3100B	1 unit

Table 2. List of Network Devices Required

A. Cable Preparation

1. UTP Cable Preparation

UTP cable connects network devices. Connectors must be attached to both ends using the T568B standard.

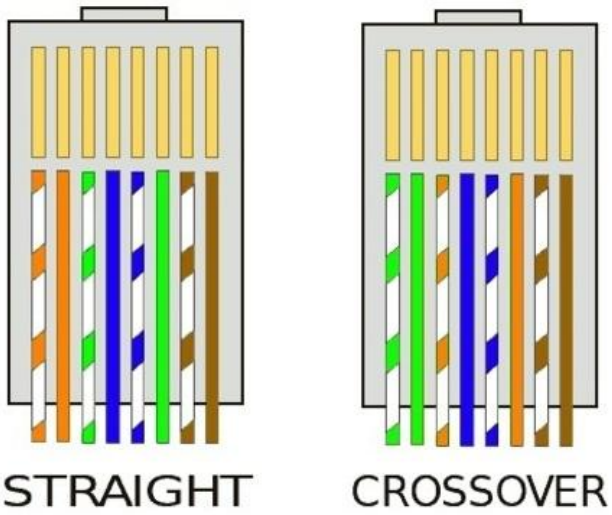


Figure 2. T568B Wiring Standard

Tools needed: UTP cable, RJ45 connectors, crimping tool, LAN tester.

- Prepare the UTP cable.

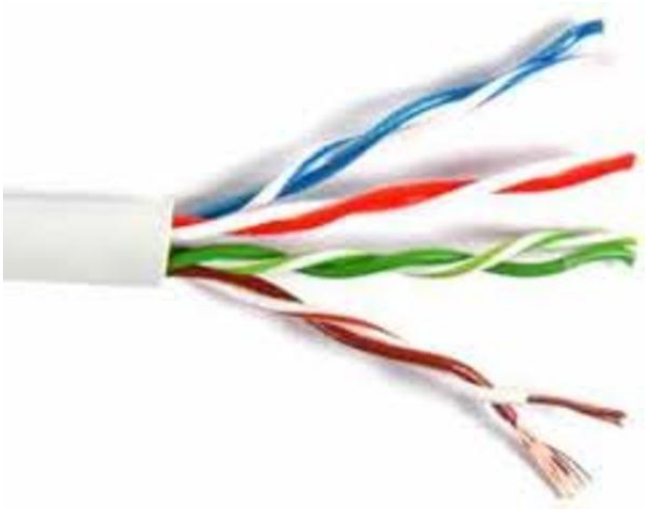


Figure 3. UTP Cable

- Arrange cables to match Figure 3 color order. Trim the ends evenly.



Figure 4. RJ45 Connector

- Insert the cable into the RJ45 connector.



Figure 5. Network Cable Inserted into RJ45

- Crimp firmly with a crimping tool. Repeat on both ends. Test with a LAN tester.



Figure 6. LAN Tester

2. Fiber Optic (FO) Cable Preparation

This module covers attaching a fast connector using FTTH Tools.



Figure 7. FTTH Tools

Tools: FO cable, Fast Connector, Stripper, Cleaver, Optical Power Meter, Jacket Remover, Wire Cutter.

- Strip the outer jacket with the Jacket Remover.
- Strip the fiber optic core protection with the Stripper.
- Cut the fiber tip with the Cleaver.
- Insert fiber into Fast Connector. Lock it, insert bottom locking piece, insert blue jacket until it clicks.
- Test with Optical Power Meter.

B. Installing WinBox

WinBox manages MikroTik device settings. Download from: https://mikrotik.com/download

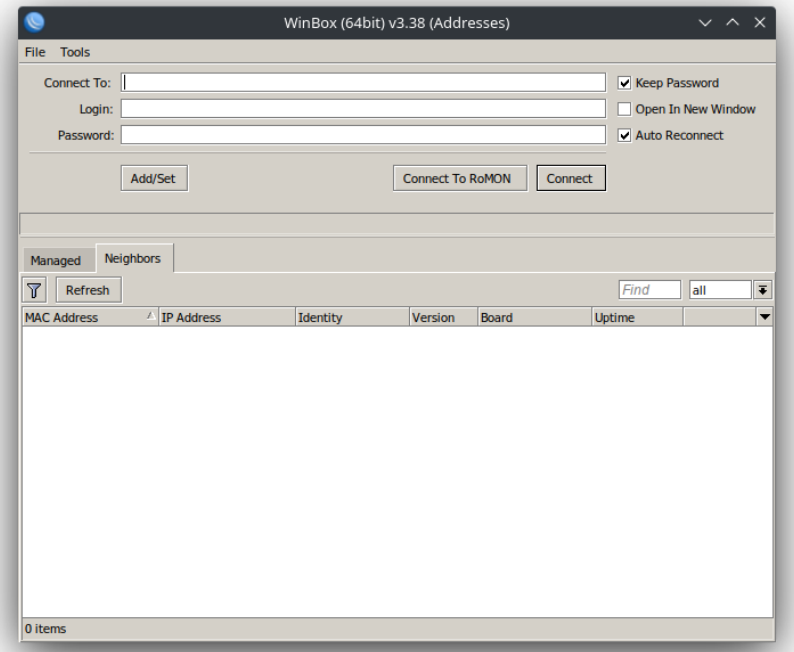


Figure 8. WinBox Application

C. LHG LTE Configuration

The LHG LTE modem accepts a GSM SIM card and can be mounted outdoors on a pole for better signal.

- Assemble the LHG LTE from the box.



Figure 9. Assembled LHG LTE Device

- Insert the SIM card with card facing upward.



Figure 10. Inserting the SIM Card into the LHG LTE

- Connect LAN cable to LHG LTE LAN port; other end to POE.



Figure 11. LHG LTE POE

- Plug adapter into POE. Wait for LTE indicator light to turn on.
- Connect to laptop via POE cable. Open WinBox. Login: admin / (blank password).

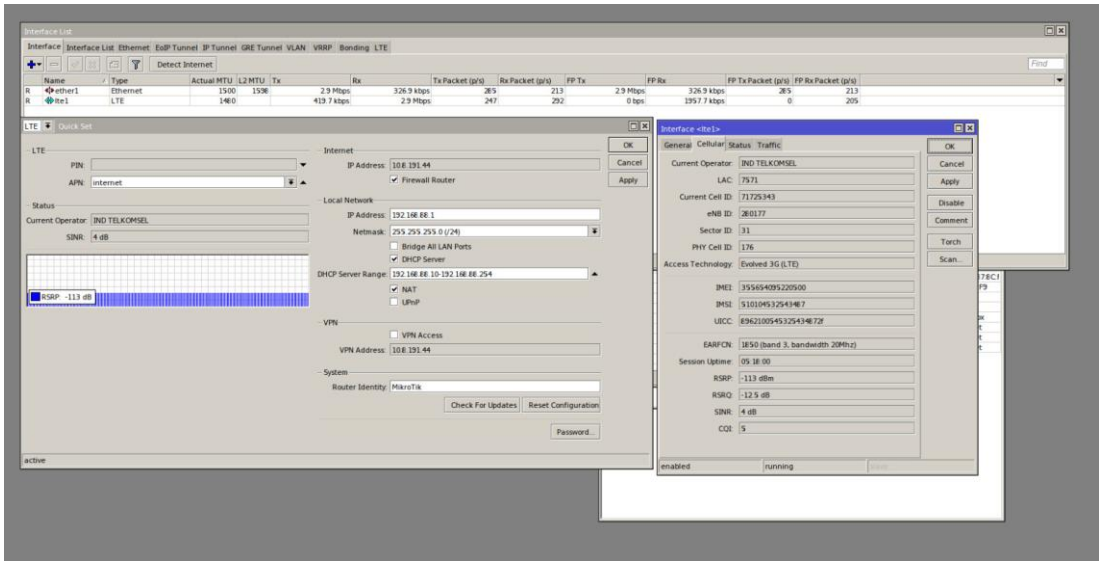


Figure 12. WinBox Interface

- Click Interface menu → click lte1 to view detailed network reception information.

D. Wireless Access Point Configuration

The Wireless Access Point broadcasts WiFi. Two settings are required: SSID name and IP address.



Figure 13. Totolink CP300 Wireless Access Point Device

Tools: Access point device, LAN cable with RJ45 connectors, Computer/laptop.

- Connect LAN cable from access point to the POE port labeled POE. Connect LAN port to laptop.

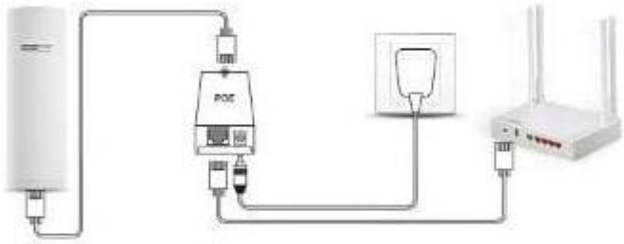


Figure 14. Totolink Wireless Access Point Wiring Scheme

- Open browser, go to http://192.168.1.1. Login: admin / admin.
- Click "Wireless" menu. Set Encryption to Disable. Enter desired SSID name. Click Apply.

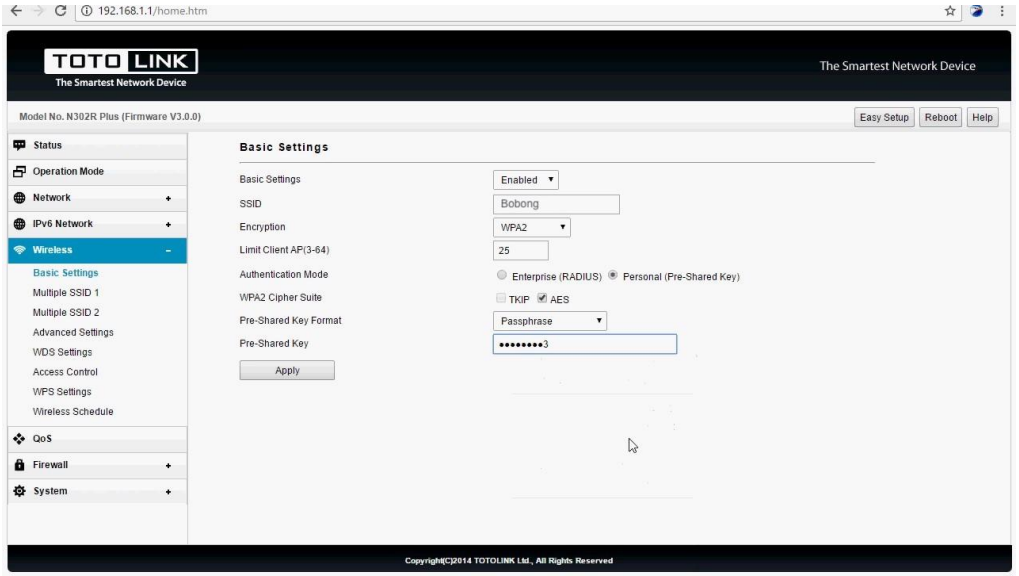


Figure 15. Wireless Access Point SSID Settings

- Click "Network" menu. Adjust IP address to match MikroTik settings.

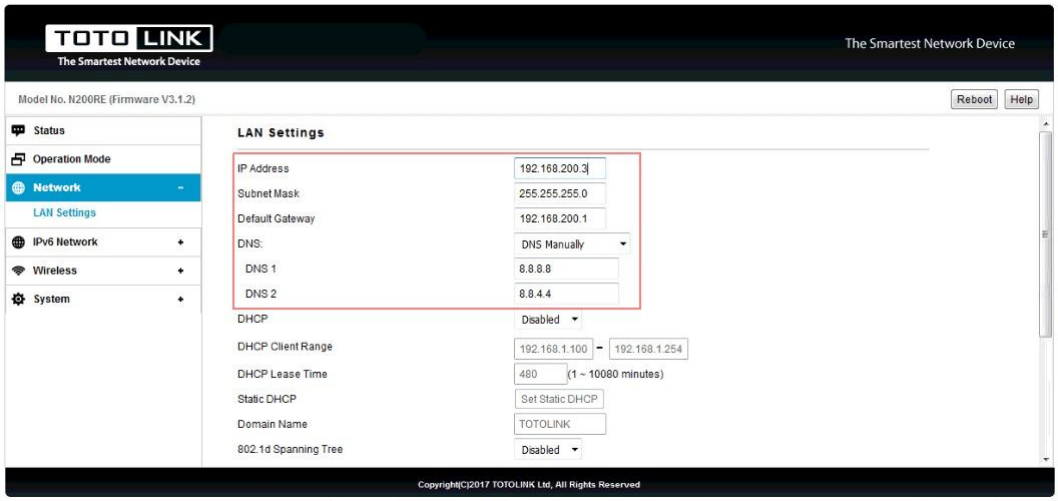


Figure 16. Wireless Access Point IP Settings

- Verify by searching for the SSID on a phone or laptop.

E. MikroTik Router Configuration

The MikroTik Router controls network traffic and bridges all devices to allow internet access.

1. Router Settings

Port assignments: Port 1 → LHG device. Port 2 → management laptop. Ports 3+ → network clients.

- Connect MikroTik to laptop via LAN cable. Power on.
- Open WinBox. Under "Neighbours", the MikroTik appears. Login: admin / (blank).

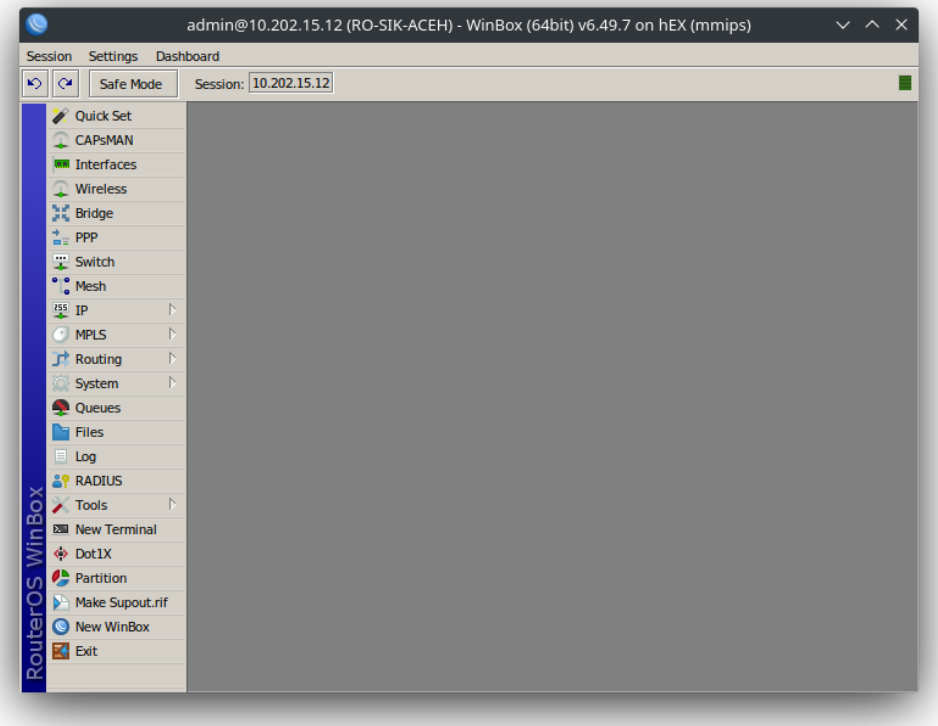


Figure 17. WinBox Application Window

- Go to IP → DHCP Client. Click +. Set Interface to ether1. Click OK.

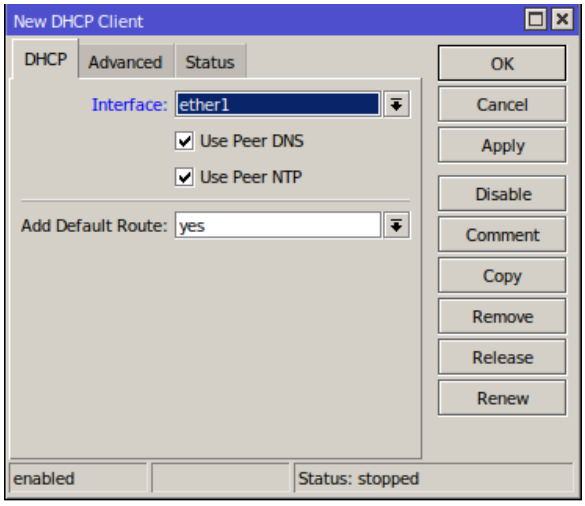


Figure 18. DHCP Client Settings

- Configure NAT Masquerade: IP → Firewall → NAT tab → click +.

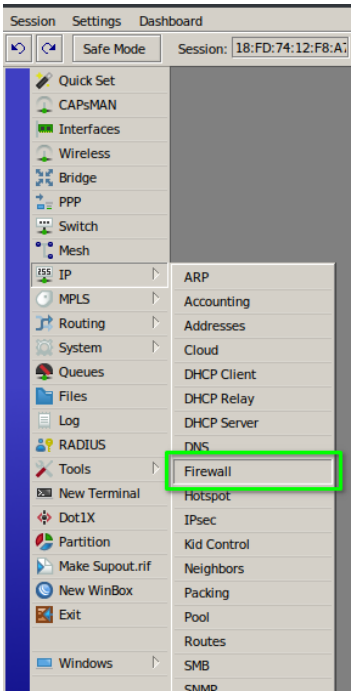


Figure 19. IP → Firewall Menu

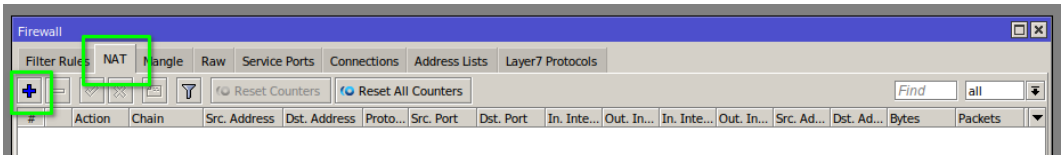


Figure 20. Firewall Window, NAT Tab

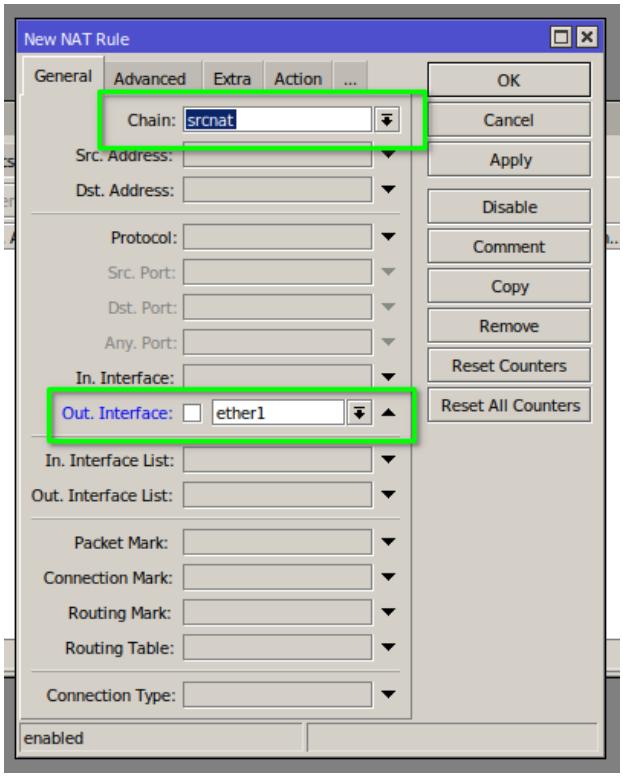


Figure 21. New NAT Rule Window, General Tab

- In Chain select "srcnat"; Out. Interface select "ether1". Action tab → "masquerade". Click OK.

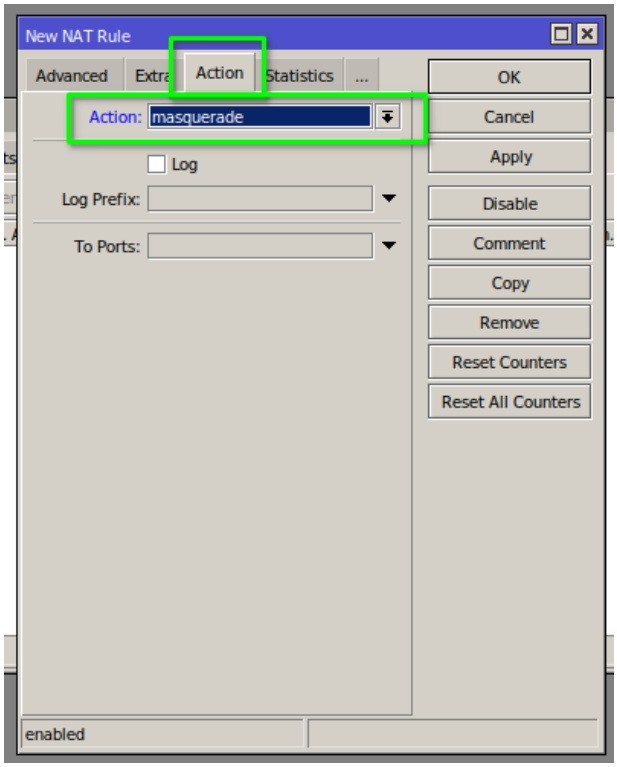


Figure 22. New NAT Rule Window, Action Tab

Devices connected to the MikroTik can now access the internet.

2. Bridge Settings

Bridge configuration makes interface management easier for distributing the network.

- Access Bridge menu. Click + → New Interface → click OK.

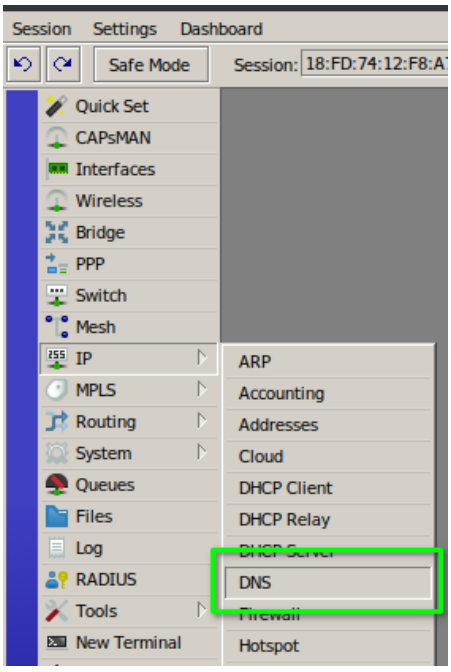


Figure 23. Access Bridge Menu

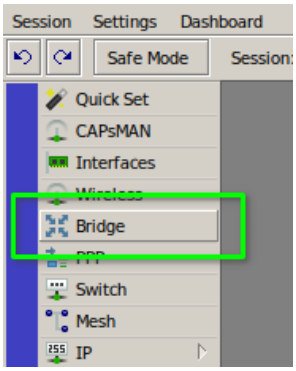


Figure 24. Bridge Settings Window

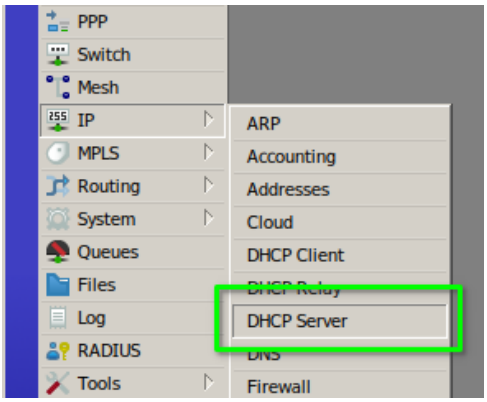


Figure 25. New Interface Window

- In Bridge window, Ports tab, click +. Select ether3. Click OK. Repeat for ether4 and ether5.

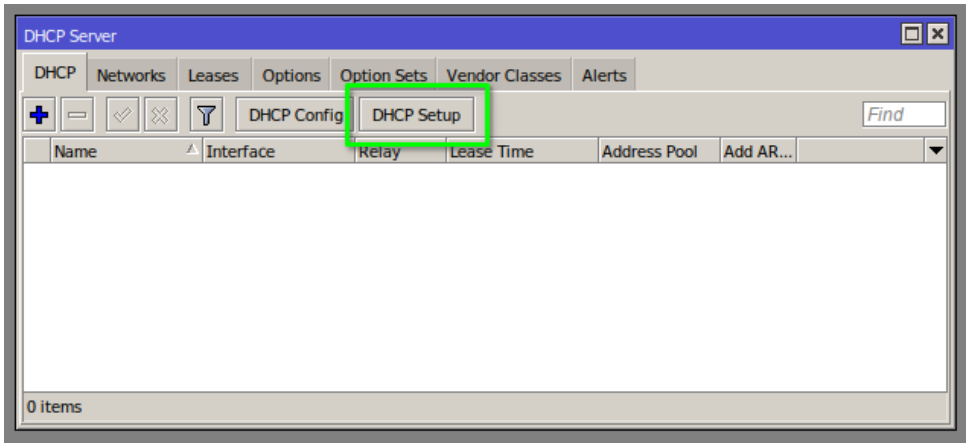


Figure 26. Bridge Window, Ports Tab

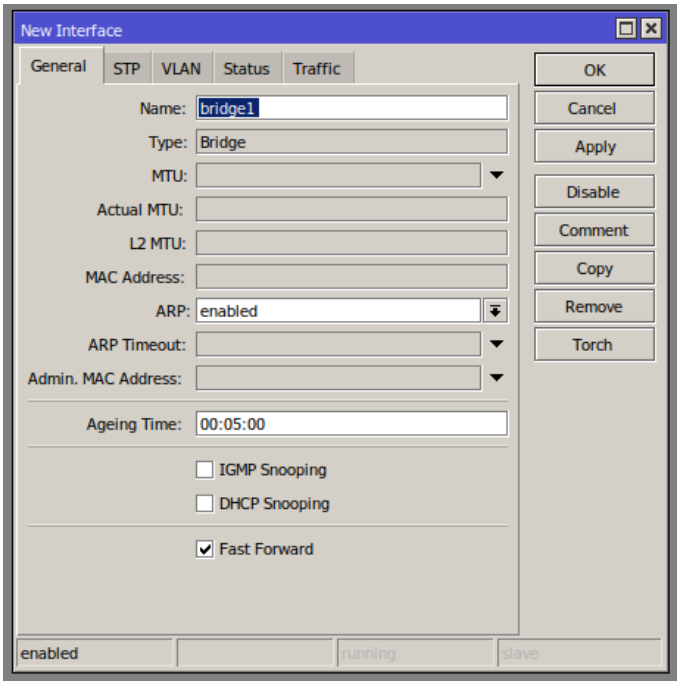


Figure 27. New Bridge Port Window

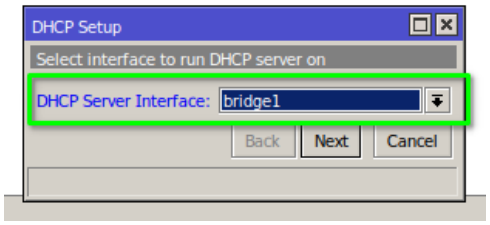


Figure 28. Bridge Window After Completing Port Settings

- Set IP for bridge: IP → Addresses → +. Enter "10.10.10.1/24" and select "bridge1".

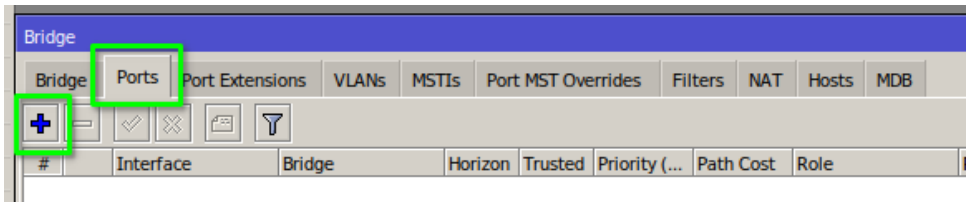


Figure 29. IP → Addresses Menu

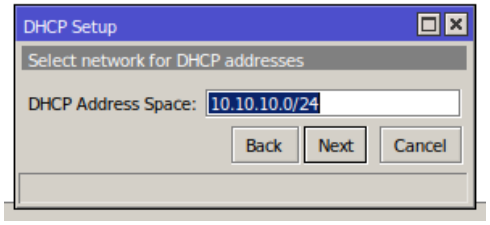


Figure 30. Address List Window

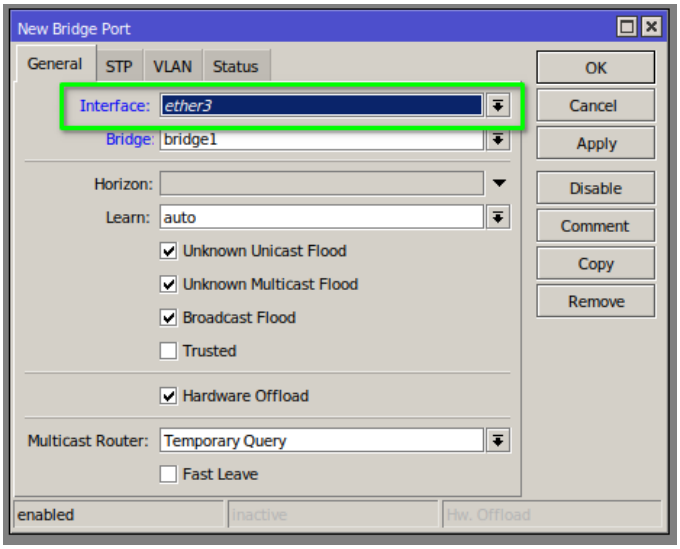


Figure 31. New Address Window

3. DNS Settings

DNS configuration is optional but required for Hotspot functionality.

- IP → DNS. Enable "Allow Remote Requests". Click OK.

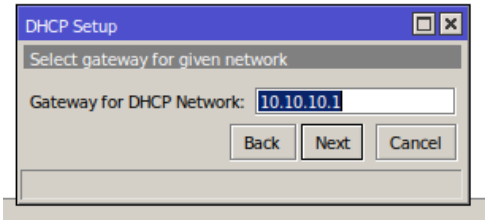


Figure 32. DNS Menu

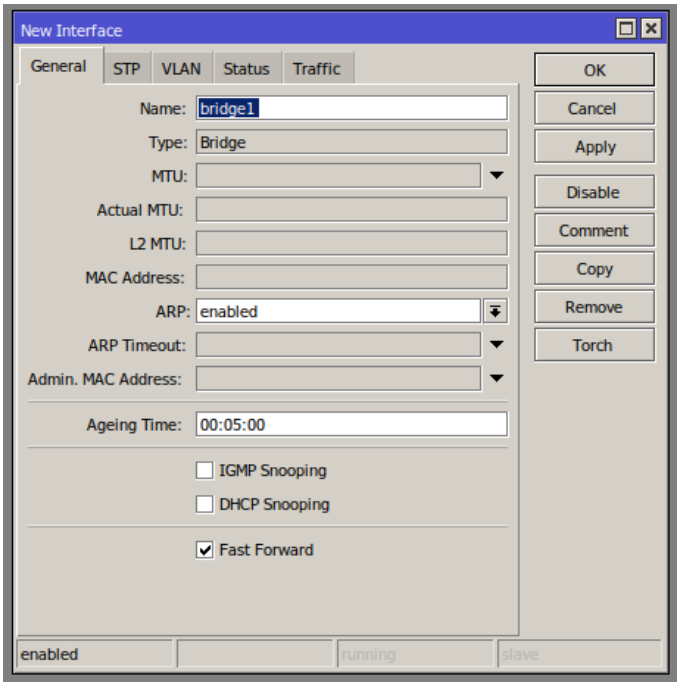


Figure 33. DNS Settings Window

4. DHCP Server Settings

The DHCP Server automatically assigns IP addresses to connected devices.

- IP → DHCP Server → click "DHCP Setup".

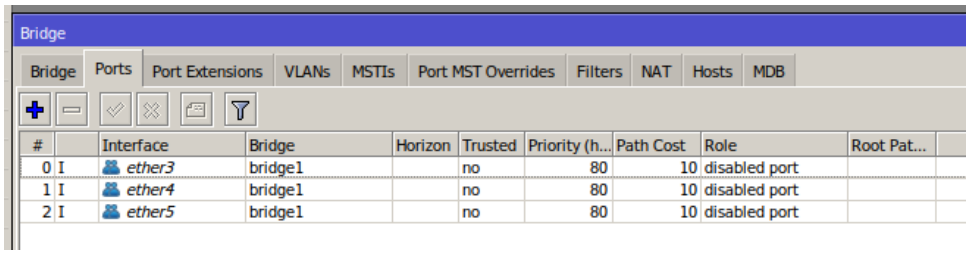


Figure 34. DHCP Server Window

- Select "bridge1" as interface. Click Next.

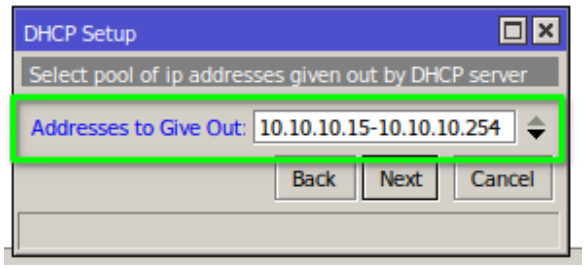


Figure 34b. DHCP Server Interface Window

- Address Space: 10.10.10.0/24. Click Next.

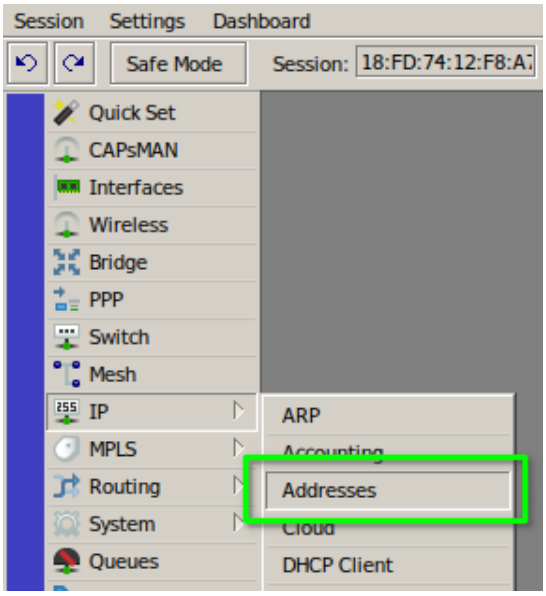


Figure 35. DHCP Address Space Window

- Gateway: 10.10.10.1. Click Next.

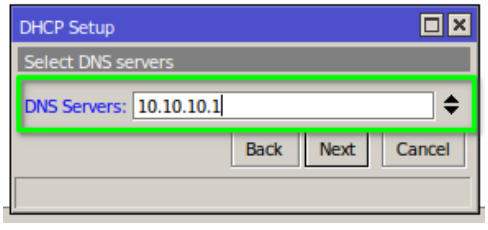


Figure 36. DHCP Gateway Network Window

- IP range: 10.10.10.15-10.10.10.254. Click Next.

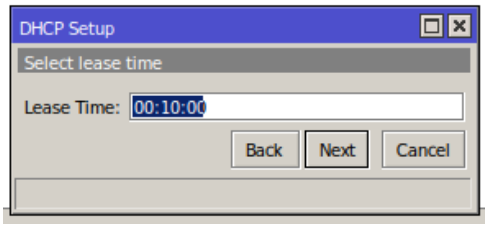


Figure 37. DHCP Address to Give Out Window

- DNS Server: 10.10.10.1. Click Next.

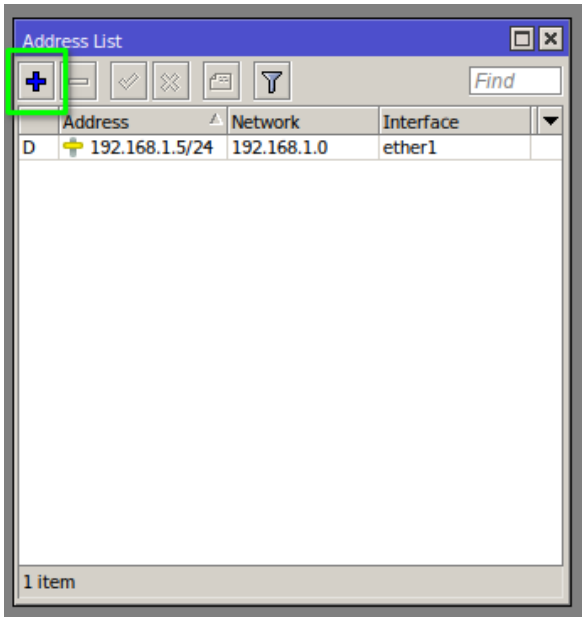


Figure 38. DHCP DNS Servers Window

- Set Lease Time. Click Next. DHCP setup complete.

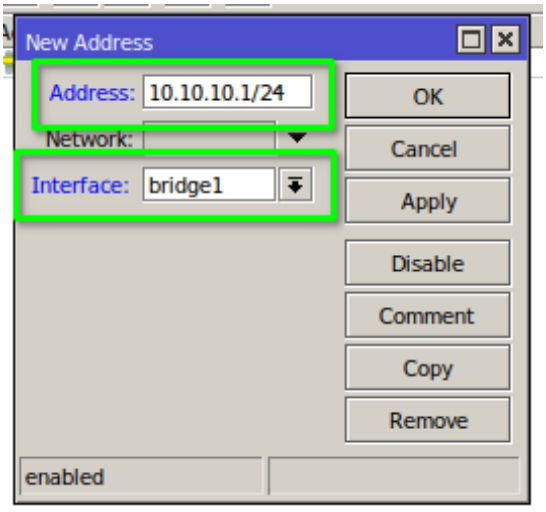


Figure 39. DHCP Lease Time Window

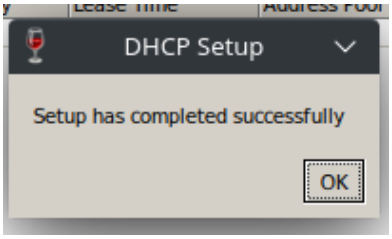


Figure 40. DHCP Setup Complete Window

5. Hotspot Settings

- IP → Hotspot → click "Hotspot Setup".

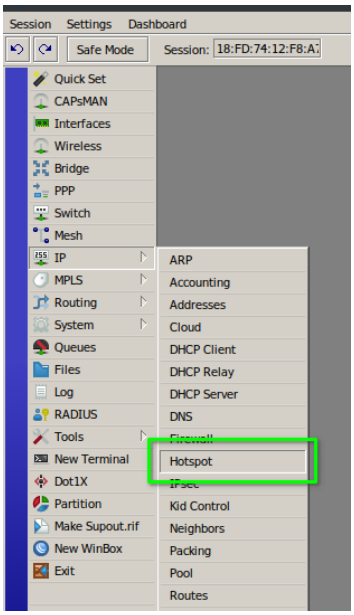


Figure 41. IP → Hotspot Menu

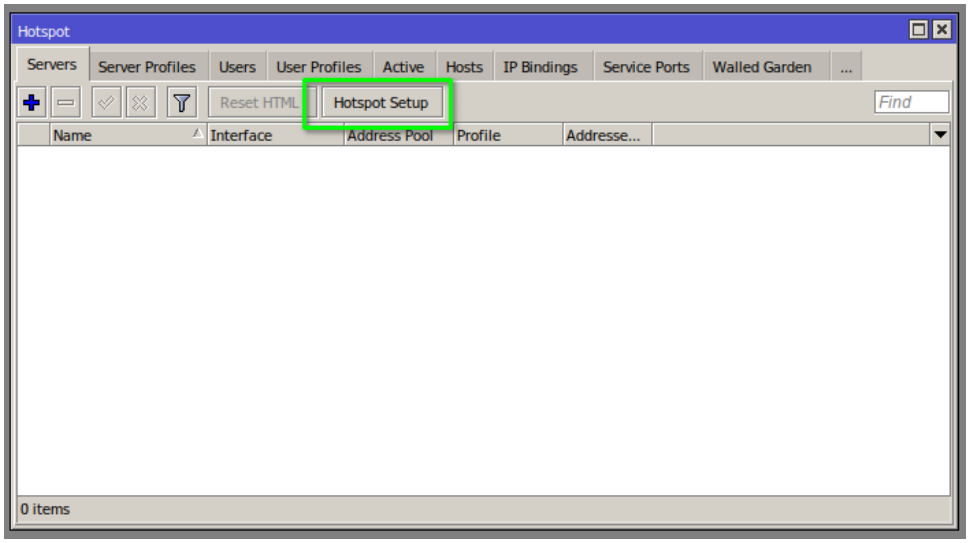


Figure 42. MikroTik Hotspot Window

- Select "bridge1" for HotSpot Interface. Click Next.

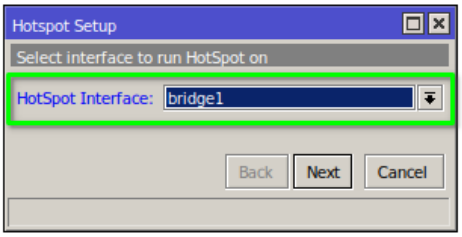


Figure 43. Select Hotspot Interface Window

- IP: 10.10.10.1/24 (default). Click Next.

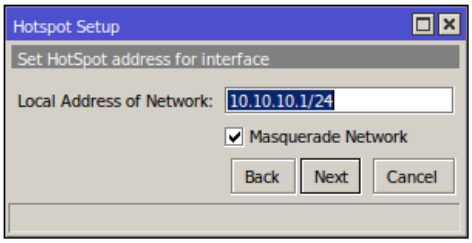


Figure 44. Hotspot IP Settings Window

- IP range: 10.10.10.15-10.10.10.254 (default). Click Next.

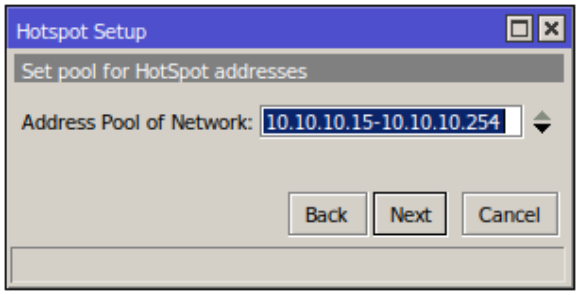


Figure 45. IP Pool Address Settings Window

- Certificate: leave blank. Click Next.

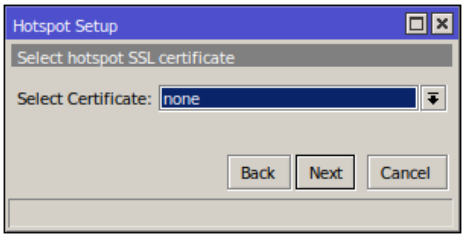


Figure 46. Certificate Selection Window

- SMTP: leave blank. Click Next.

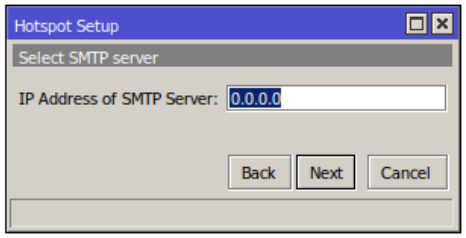


Figure 47. SMTP Settings Window

- DNS: enter 10.10.10.1. Click Next.

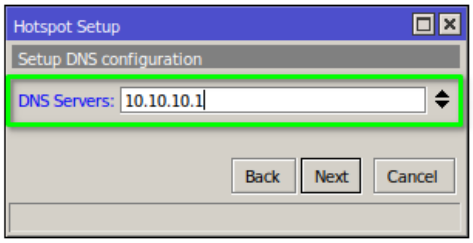


Figure 48. DNS Settings Window

- DNS Name: e.g. "sik-sumba.hotspot". Click Next.

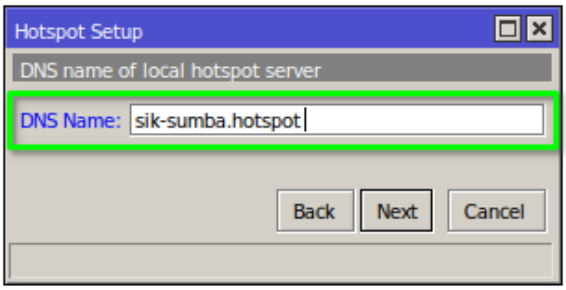


Figure 49. DNS Name Settings Window

- Enter username and password for hotspot access (e.g. admin / nimda). Click Next.

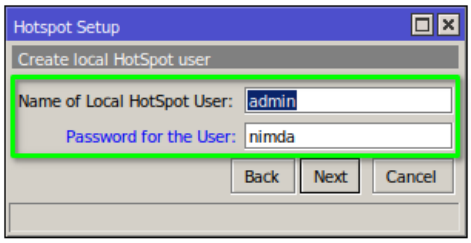


Figure 50. User Settings Window

- "Setup has completed successfully" confirms hotspot is done.

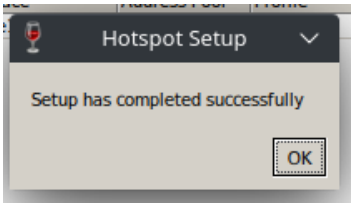


Figure 51. Hotspot Setup Complete

Any device connected to the bridge will now be controlled by the hotspot system.

6. Hotspot User Management with Userman

Userman is a MikroTik-based application for managing hotspot users.

- Check MikroTik version via System → Resources.

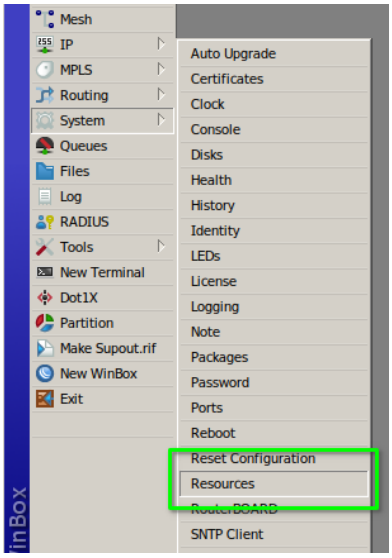


Figure 52. Access System Resources Menu

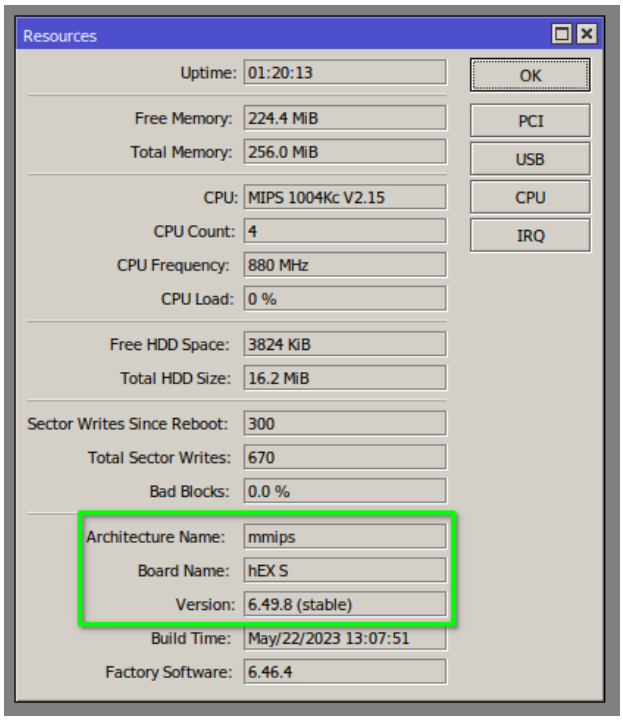


Figure 53. Resources Window

- Download Userman from https://mikrotik.com/download/archive (match version and architecture).



Figure 54. MikroTik Download Web Page

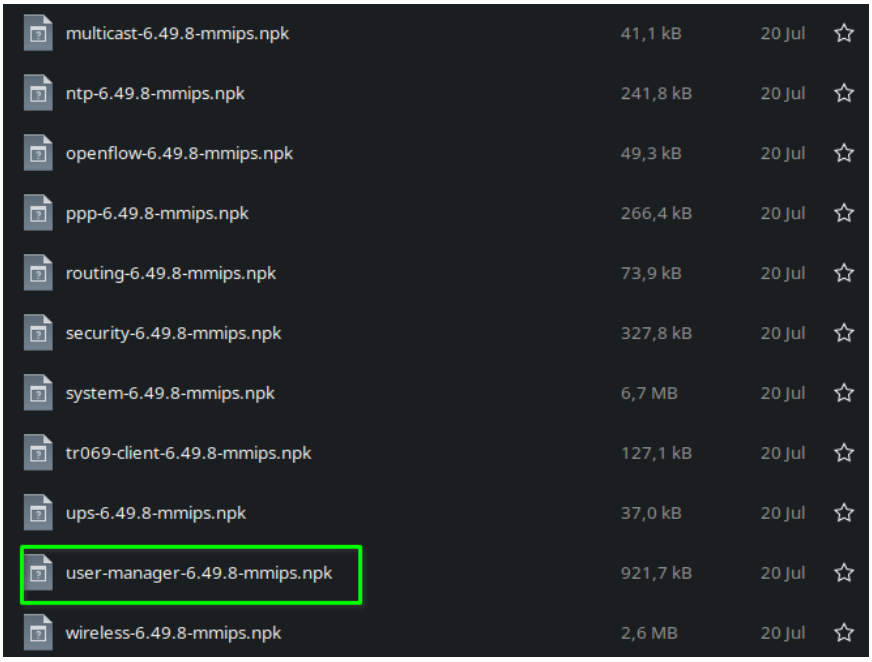


Figure 55. Userman .npk File

- Upload the .npk file to MikroTik via the Files menu.

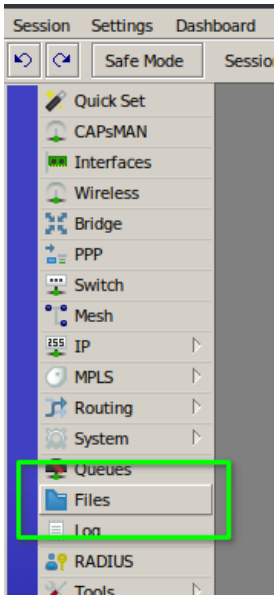


Figure 56. Access Files Menu

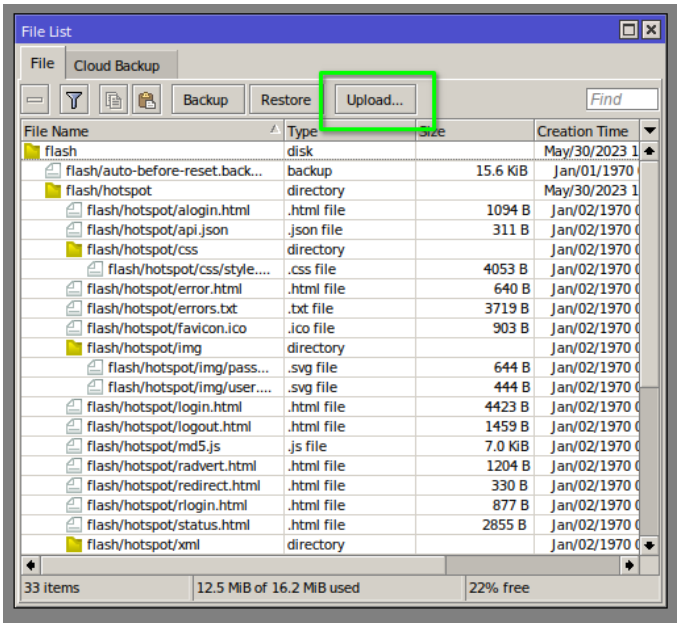


Figure 57. File List Window

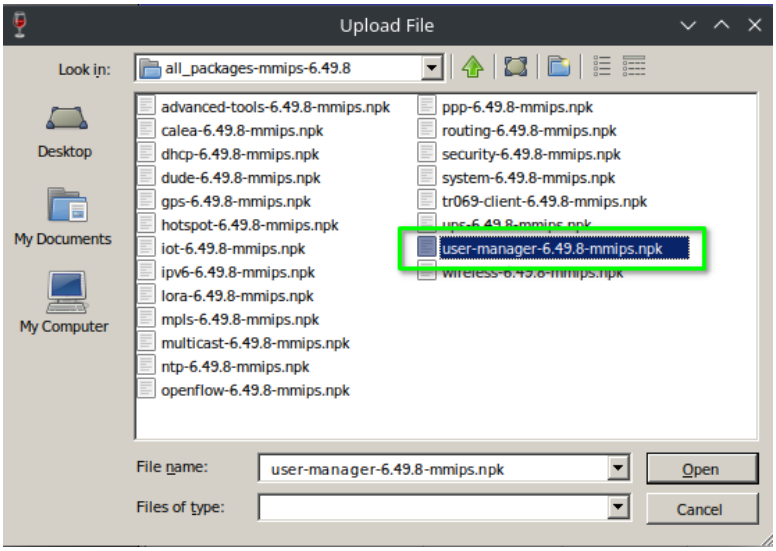


Figure 58. Upload File

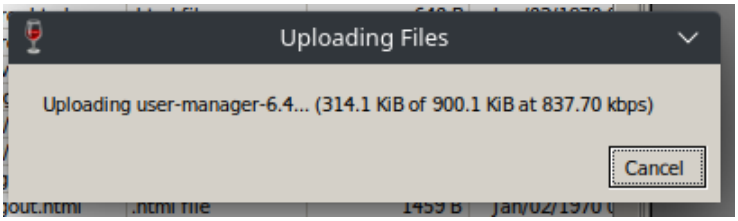


Figure 59. Upload Progress Window

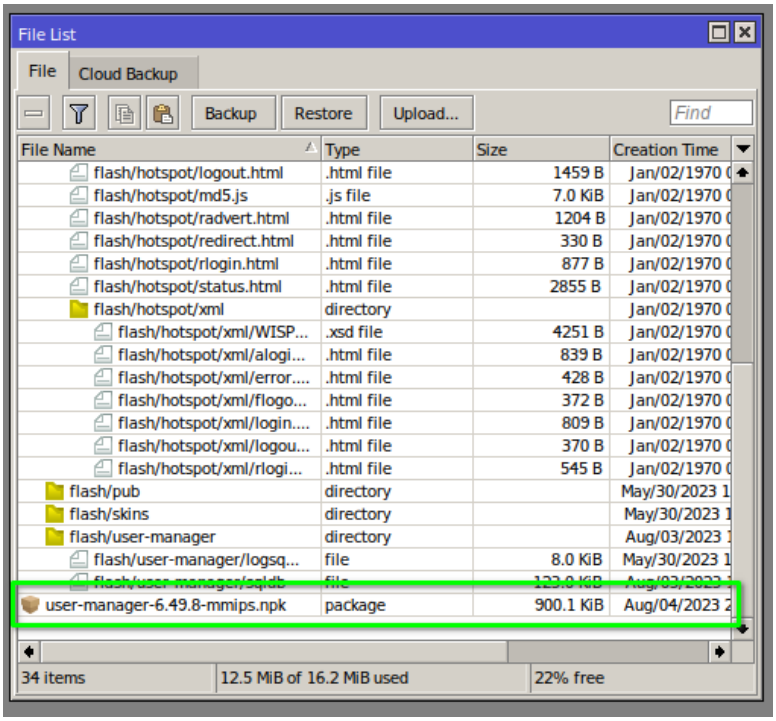


Figure 60. Uploaded Userman File

- Reboot via System → Reboot to install the package.

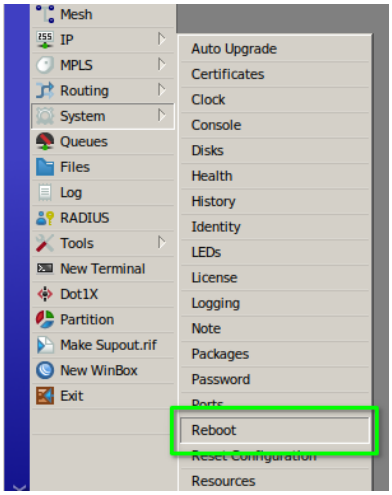


Figure 61. Access System Reboot Menu

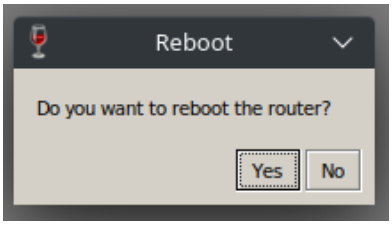


Figure 62. Reboot Confirmation

- After reboot, verify installation via System → Packages.

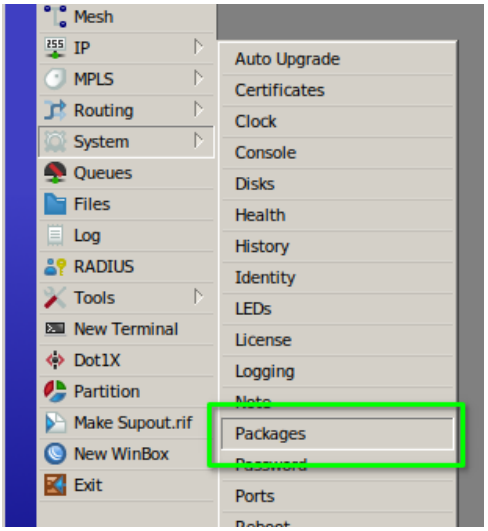


Figure 63. Access System Packages Menu

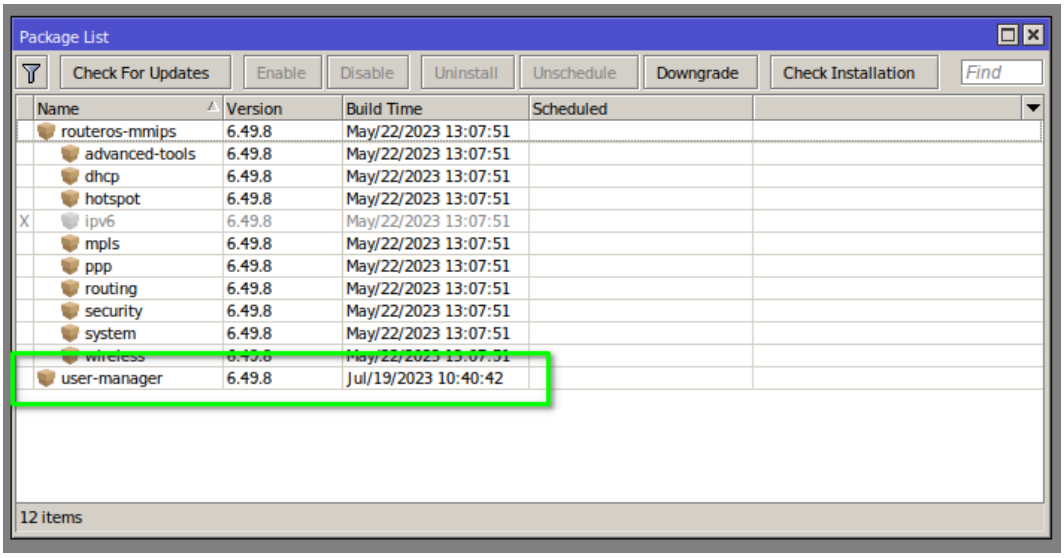


Figure 64. Package List Window

- Enable RADIUS: RADIUS menu → +. Enable hotspot, Address: 127.0.0.1, enter Secret. Click OK.

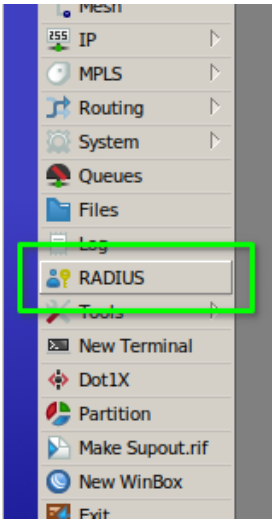


Figure 65. Access RADIUS Menu

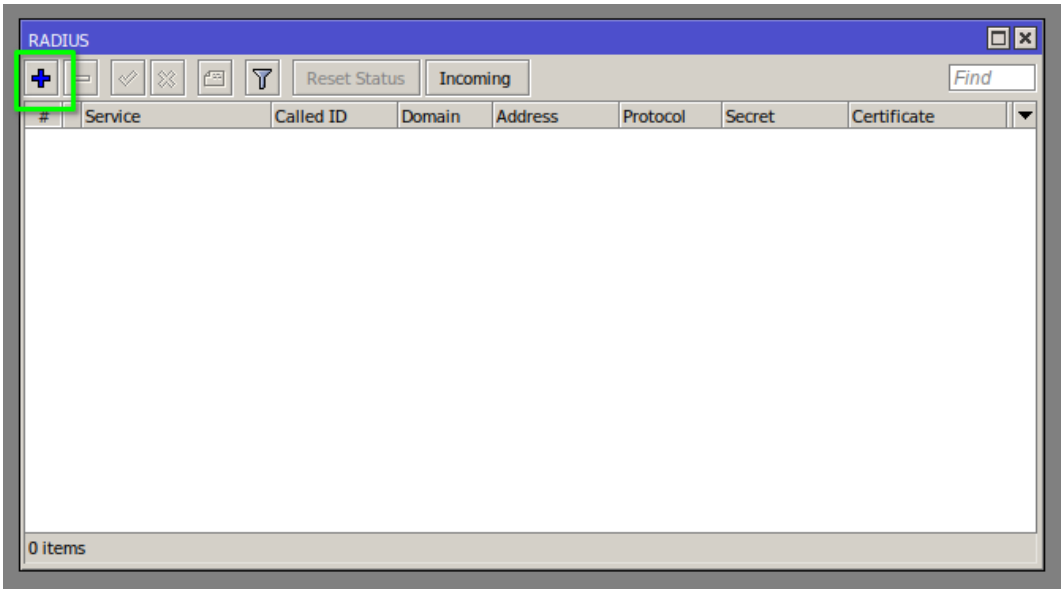


Figure 66. RADIUS Window

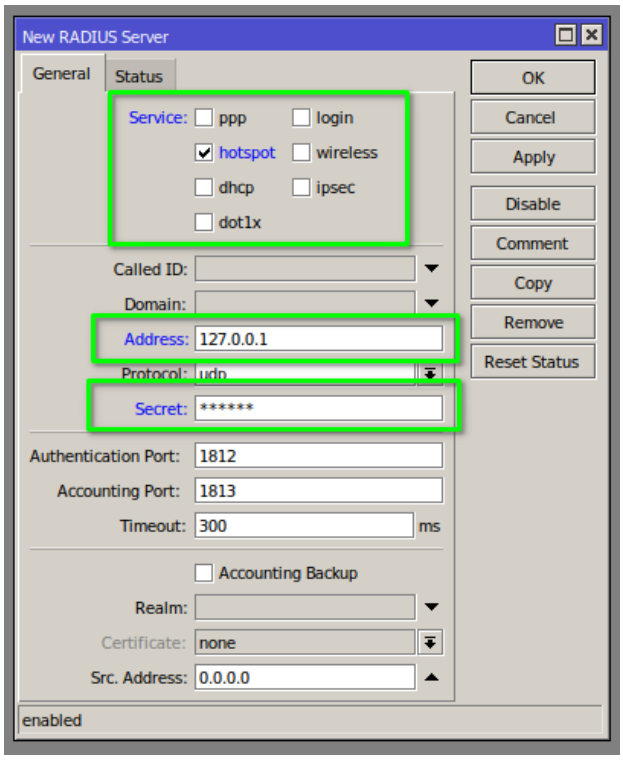


Figure 67. New RADIUS Server Window

- Server Profile tab → double-click hsprof1 → RADIUS tab → enable "Use RADIUS" → OK.

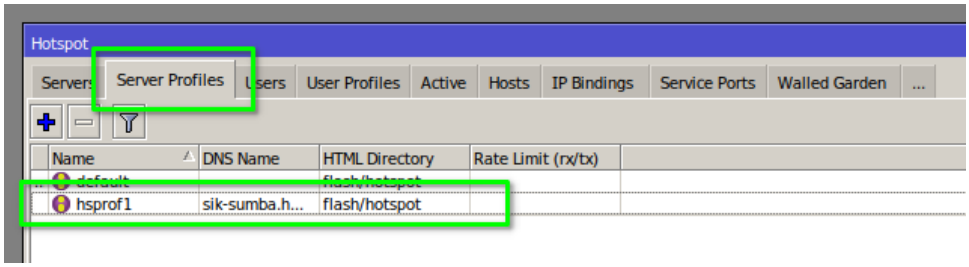


Figure 68. Hotspot Server Profiles Window

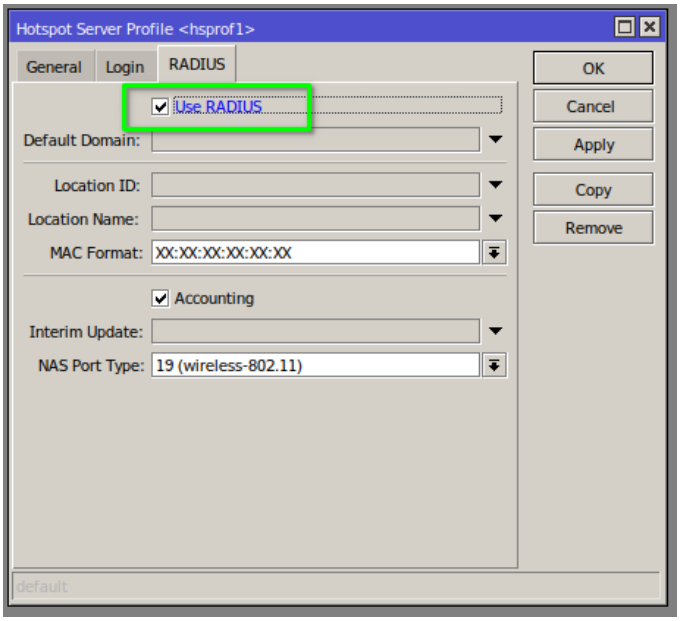


Figure 69. Hotspot Server Profile RADIUS Window

- Open browser: http://11.11.11.1/userman. Login: admin / (blank).

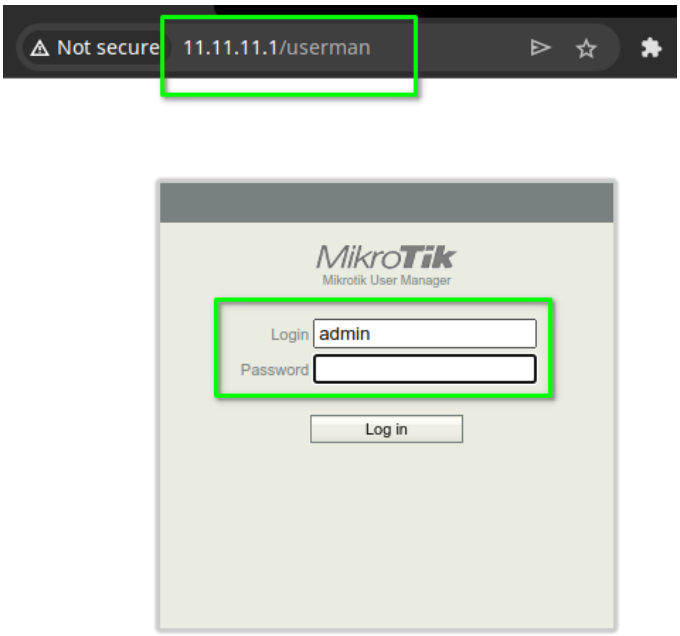


Figure 70. Userman Login Page

- Routers → Add → New. Fill Name, IP: 127.0.0.1, Shared secret: (from RADIUS setup).

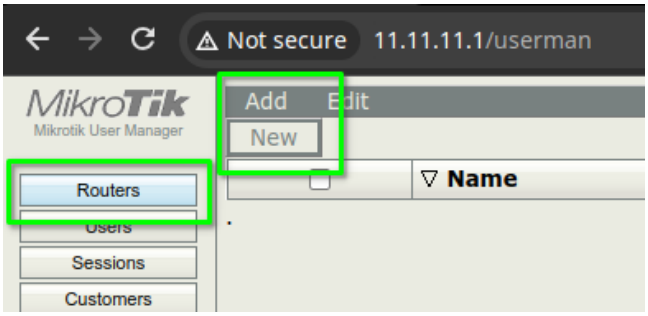


Figure 71. Userman Routers Page

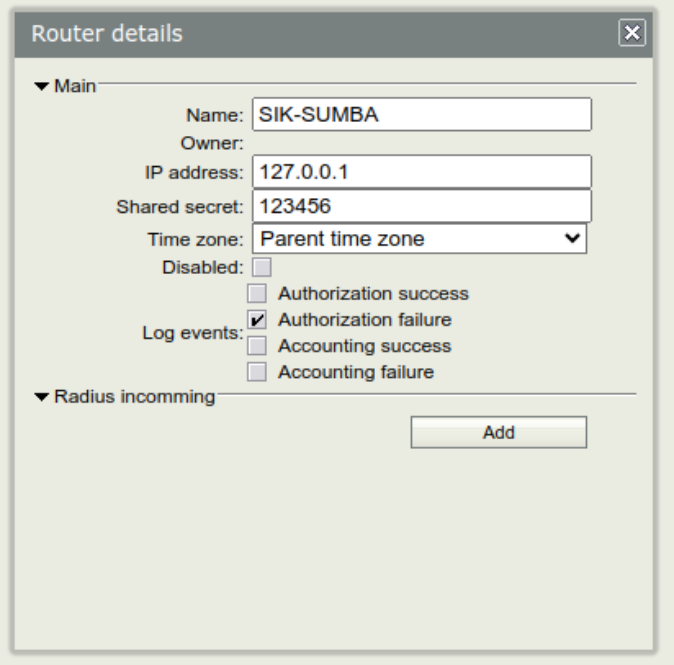


Figure 72. Userman Add Router Page

- Profiles → Limitations tab → Add → New. Set Name, Download, Upload, Transfer limits.

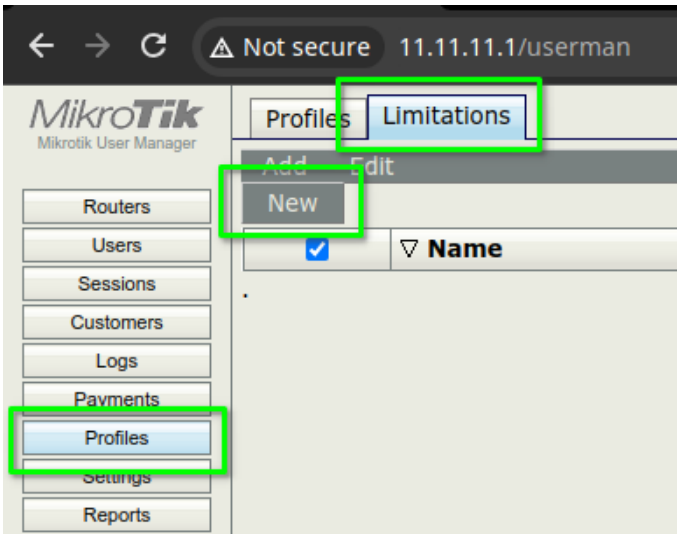


Figure 73. Profiles Limitations Page

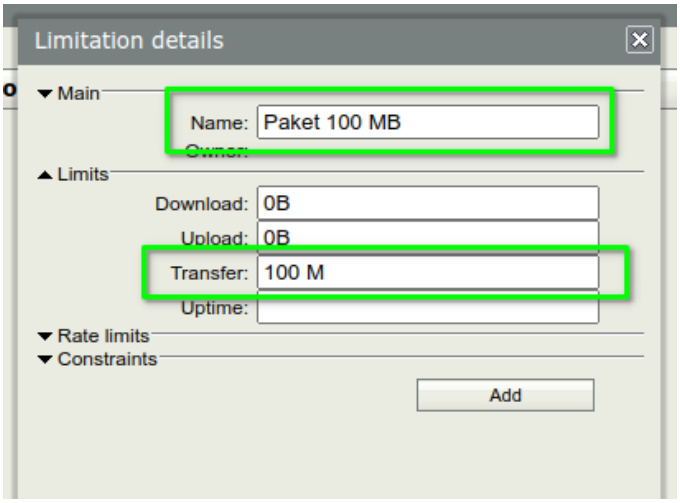


Figure 74. Limitation Details Page

- Profiles tab → + → enter profile name → Create.

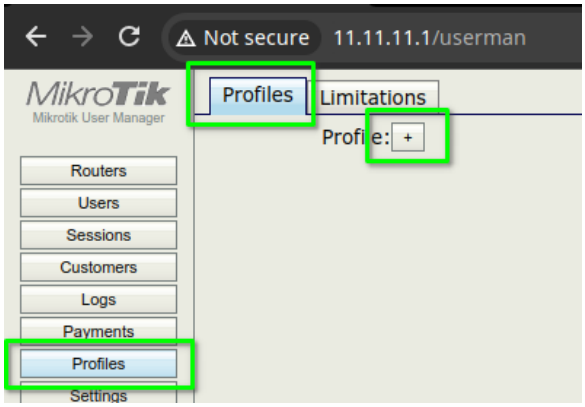


Figure 75. Add Profile Page

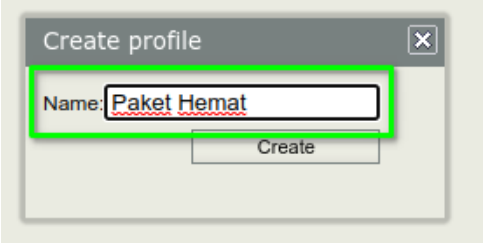


Figure 76. Create Profile Page

- Click "Add New Limitation", select limitation, click Add.

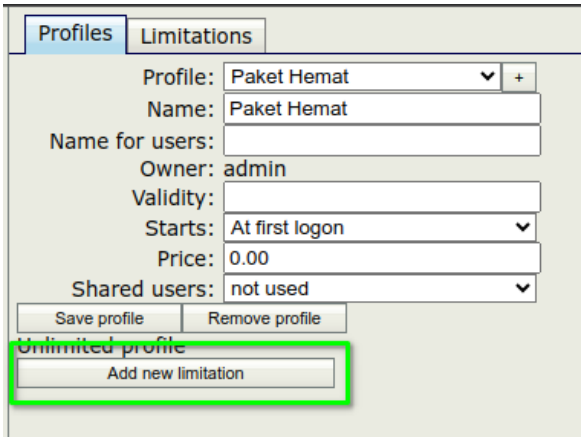


Figure 77. Profile Add New Limitation Page

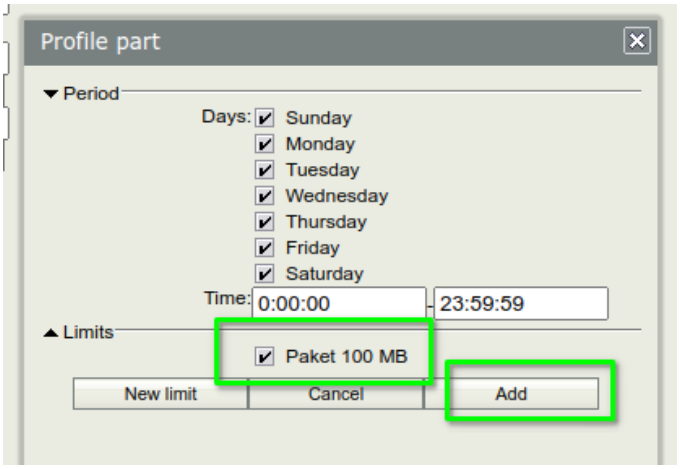


Figure 78. Limitation Selection Window

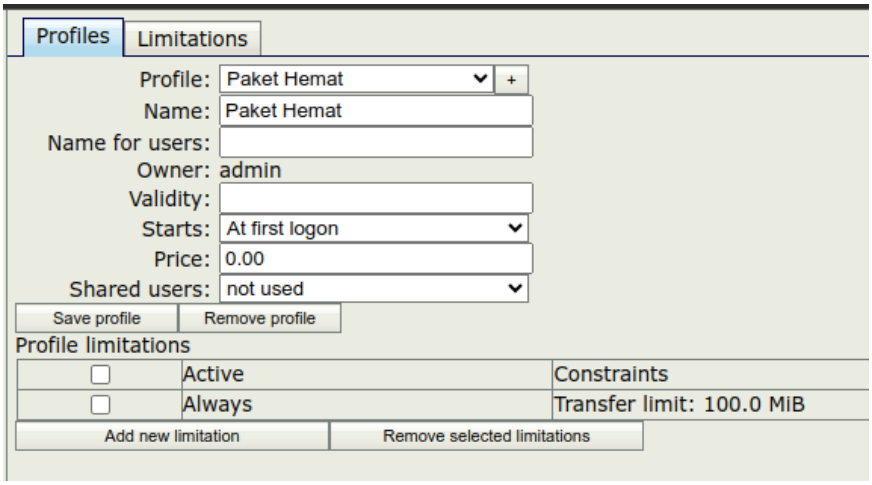


Figure 79. Profile Page

- Generate hotspot users: Users → Add → Batch. Enter number of users. Click Add.

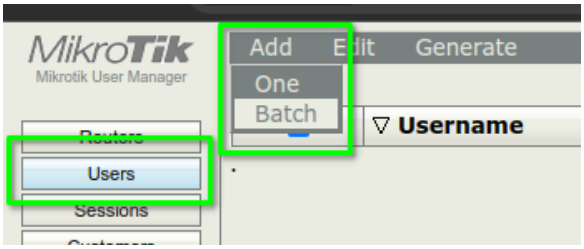


Figure 80. Add User Page

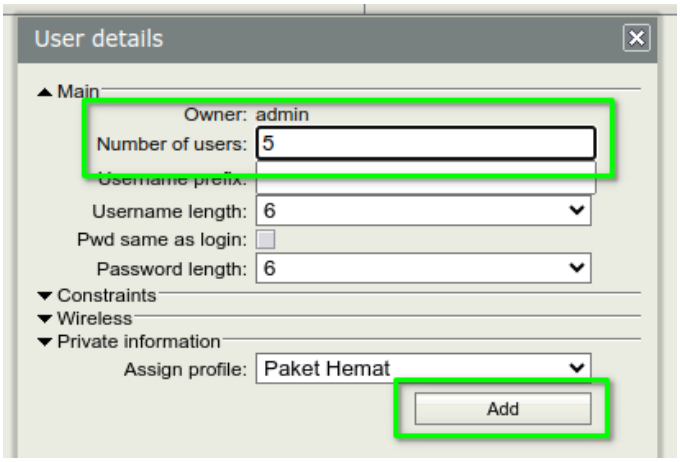


Figure 81. Generate User Page

- Print vouchers: select users → Users → Generate → Vouchers → Generate.

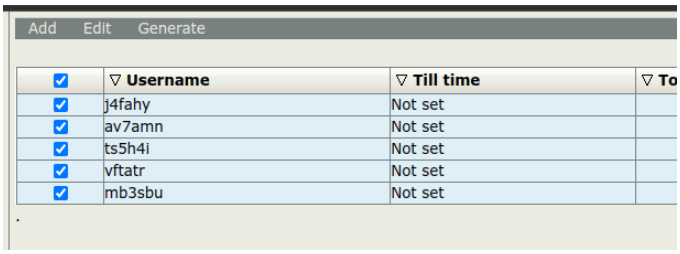


Figure 82. Select Users to Generate Vouchers

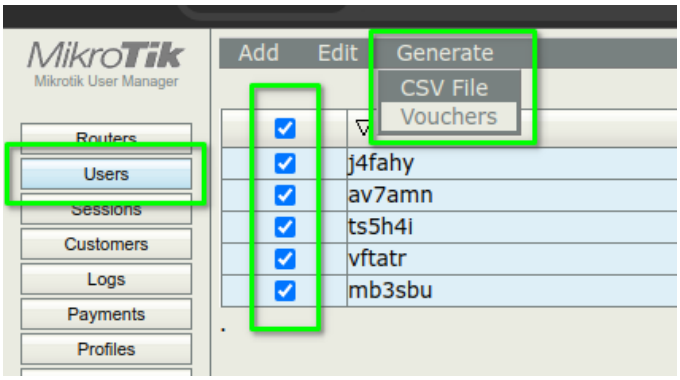


Figure 83. Generate Voucher

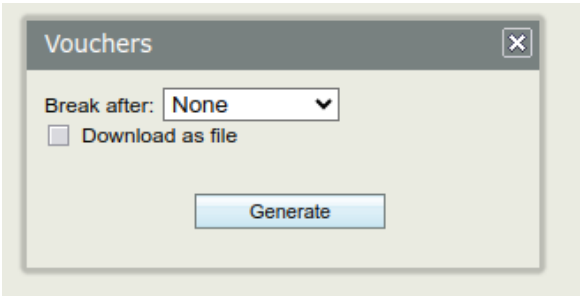


Figure 84. Generate Voucher Confirmation

Prepaid time: **Unlimited**
Login: **j4fahy**

After attempting to open a web page, you should enter this login information

Login: **j4fahy** (login name that you enter at the HotSpot login page)
Password: **ef4yku** (password that you enter at the HotSpot login page)

If you want to extend time, please contact reception

Prepaid time: **Unlimited**
Login: **av7amn**

After attempting to open a web page, you should enter this login information

Login: **av7amn** (login name that you enter at the HotSpot login page)
Password: **5c229q** (password that you enter at the HotSpot login page)

If you want to extend time, please contact reception

Prepaid time: **Unlimited**
Login: **ts5h4i**

After attempting to open a web page, you should enter this login information

Login: **ts5h4i** (login name that you enter at the HotSpot login page)
Password: **bc3rxh** (password that you enter at the HotSpot login page)

If you want to extend time, please contact reception

Prepaid time: **Unlimited**
Login: **vftatr**

After attempting to open a web page, you should enter this login information

Login: **vftatr** (login name that you enter at the HotSpot login page)
Password: **gtjb9w** (password that you enter at the HotSpot login page)

If you want to extend time, please contact reception

Prepaid time: **Unlimited**
Login: **mb3sbu**

After attempting to open a web page, you should enter this login information

Login: **mb3sbu** (login name that you enter at the HotSpot login page)
Password: **qpye9j** (password that you enter at the HotSpot login page)

If you want to extend time, please contact reception

Figure 85. Voucher Display

Hotspot and Userman setup is complete.

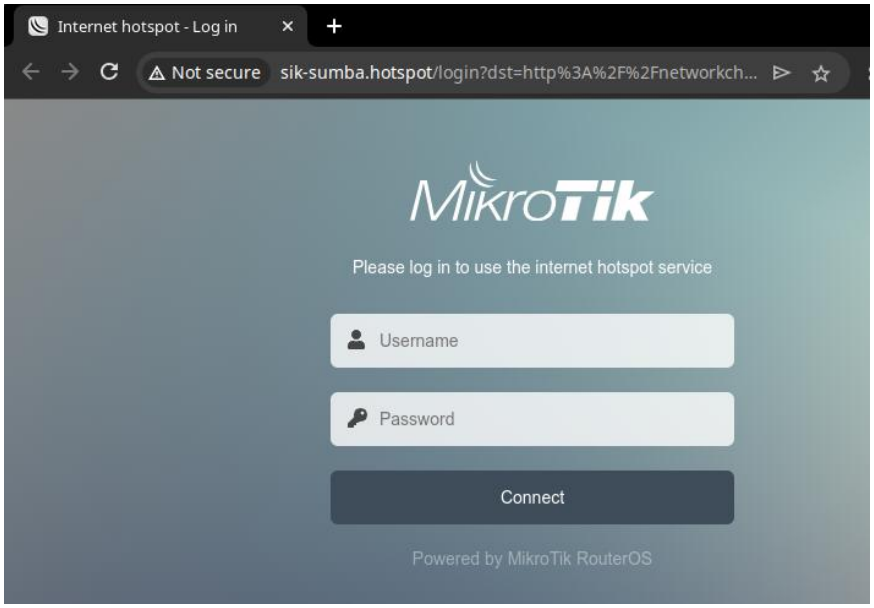


Figure 86. Hotspot Login Page

F. Connecting All Devices

After all devices are configured, connect them as follows:

- **LHG Device:** Connect LAN or FO cable from LHG to MikroTik Port 1.
- **Wireless Access Point:** Connect LAN or FO cable from Access Point to MikroTik Port 3.

- **Power Source:** Connect LHG, MikroTik, and Access Point to the power source.

G. Testing

Connect a laptop or smartphone via WiFi. If no Hotspot was configured, internet access works directly. If a Hotspot was configured, the login page appears — enter the username and password created earlier.

IV. Closing

This guide provides an overview of building micro-scale internet infrastructure in rural areas. The two main requirements are: a power source (PLN grid or solar panels); and network infrastructure (cellular internet via LHG LTE, distributed through a wireless access point managed by a MikroTik router).

V. Author

Akhmat Safrudin is a Computer Engineering professional and graduate of Universitas Nasional. Since 2006, he has actively contributed to open source projects, including playing a significant role in the development of BlankOn Linux.

In addition to software development, Akhmat is involved in community organizations including serving as administrator of the Python Indonesia community. He is currently focused on reducing the digital divide and digital transformation across all layers of Indonesian society.

Follow Akhmat on Instagram and X (Twitter) at @somatomat.