



Load Sharing Internet with MikroTik

**MikroTik User Meeting
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***i*-BEAM**
steering ahead

About Me

- My name is **Lay Minh**
- You can call me **Makito**
- CCIE # 47682
- Chief Technology Officer (CTO) at i-BEAM
- MikroTik Certified Trainer & Consultant
- Experiences:
 - 10 years in ISP industry since 2005
 - Billing solutions for service providers
 - ISP core network design and operations



- MikroTik Certifications:



- Areas of interest:
BGP, MPLS, IPv6

As you might know...

- There are many accidents on internet infrastructure, such as:



Someone cuts your cable quietly with unknown reason



Unexpected electricity explosion, which kills everything on the pole



Or...perhaps, your ISP is in trouble now...

So...

- **Some people did these:**
 1. Simply connect to two ISPs, plug some users to ISP1's router, and some other users to ISP2's router, the key concept will be how fast they can switch the cable when one link has failed;
 2. Or pay more to their existing ISP for secondary cable from different path, however this secondary link is gonna stay idle as long as primary link is up;
 3. Or some rich people might request their own IP block, and buy IP transit from two ISPs, do load sharing and failover by BGP.

What can we do?

IF...

- We want a redundant link
- We want automated failover
- We want the redundant link can be used simultaneously with the primary link for better ROI (Return On Investment) 😊

BUT...

- We have limited budget 😞
- Or the boss is stingy...

THEN...

- We can try to set it up with MikroTik router
- We will do Load Sharing instead of Load Balancing

What will you need?

➤ **2 x Internet connection**

- Connect to different ISPs for better redundancy
Such as: MPT + YTP, or MPT + Ooredoo...etc.
- Not required to have the same speed on both links,
but it is good to have

➤ **1 x MikroTik router**

- Recommended series:
 - **RB750GL** (5 x GE, no Wi-Fi)
 - **RB951Ui-2HnD**
(5 x FE, Wi-Fi 802.11a/b/g/n, dual-chain antenna)
 - **RB1100AHx2**
(If you require up to 300Mbps routing throughput)
 - **hAP** (Gift from MikroTik today! 😊)

Load Sharing vs. Load Balancing

	Load Sharing	Load Balancing
Definition	Share traffic loads to multiple links	Balance traffic loads on multiple links
Mechanism	Policy Based Routing (PBR), IGP Route Leaking, BGP Routing Policy	Equal Cost Multi Path (ECMP), Link Aggregation
Administration	Required explicit policy	Operate automatically according to the technology specs
Application	Utilize multiple WAN links simultaneously	LAN environment, Service provider backbone
Limitation	Hard to balance traffic between multiple links, required more administration involvement on defining policy	Not working well when apply on WAN links of a NATTed network

Why NOT ECMP+NAT?

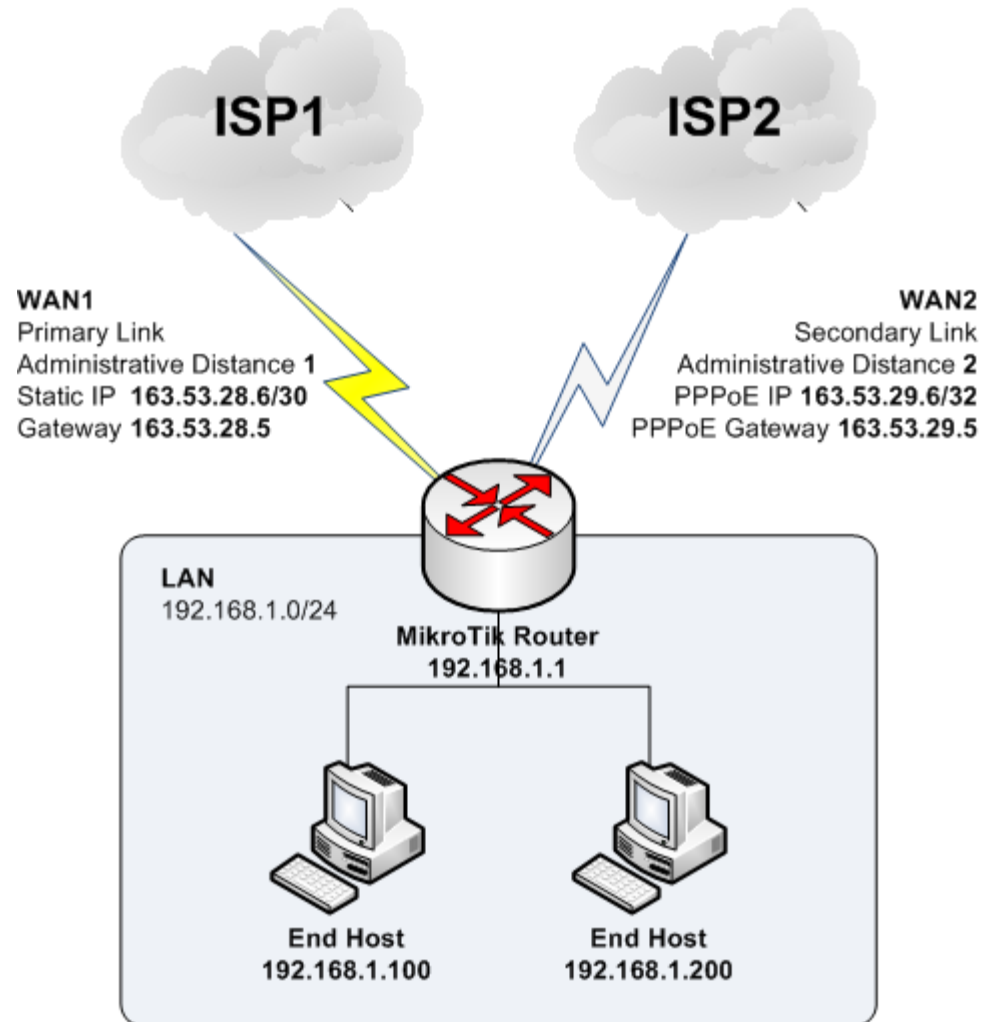
- ECMP behavior is vendor specific:
 - **Per flow** or **per packet** load balancing
 - **MikroTik does per flow load balancing, refresh every 10 minutes**
- ISPs usually apply security filters on their Provider Edge (PE)
 - Firewall rules that permit only their customer's IP
 - RPF (Reverse Path Forwarding) Check
- If the path changed according to ECMP behavior, but NAT table is not updated, router will send packet with wrong source IP to ISP, then it's gonna be dropped by the ISP
 - MikroTik router makes NAT decision on first packet only
 - Once the decision is made, it caches the result for other packets
 - **When ECMP path changed, the result is not flushed and recalculated**

Why NOT Link Aggregation?

- Most ISPs don't support link aggregation to customer, **some might do it if they can charge you an enterprise tariff.** 😊
- Link aggregation **does not work** when you are connecting to two different ISPs.
- If bandwidth of both links is natively unequal (i.e: 4Mbps for Link 1, and 2Mbps for Link 2), according to default behavior of the technology, it will cause packet loss when one of the links is full.

Network Topology

- Let's go ahead to configure this:



Router Initialization

Note: Configuration example in this presentation is based on **MikroTik RB951Ui-2HnD**

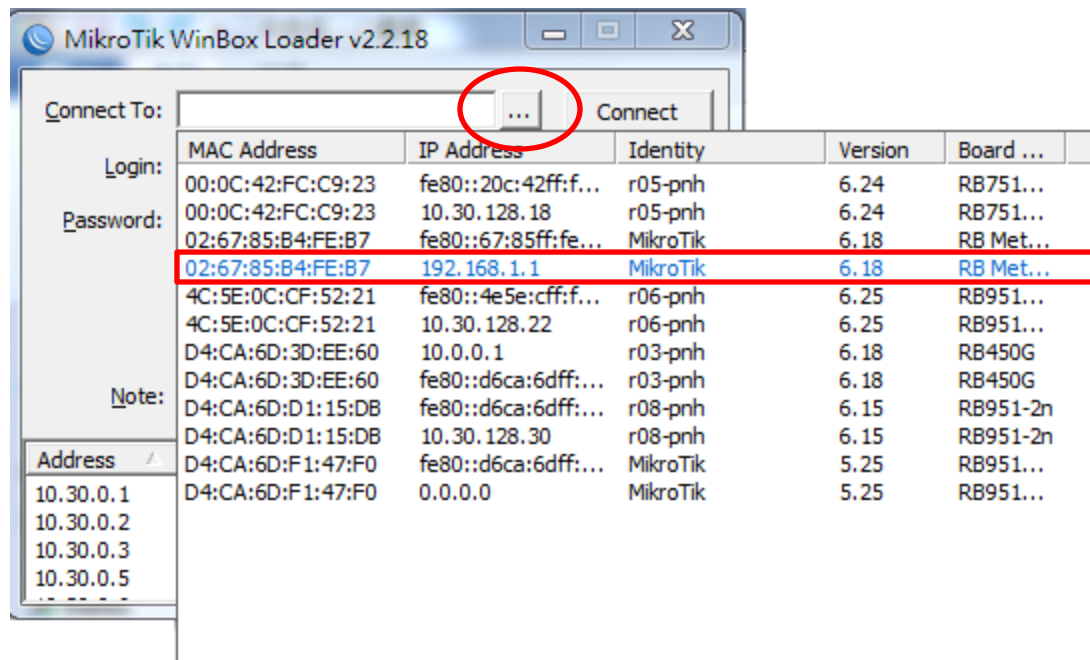
- Download Winbox
 - Winbox is a GUI software for managing MikroTik routers
 - Download from MikroTik website:
<http://download2.mikrotik.com/routeros/winbox/3.0rc5/winbox.exe>

- Connect both of your internet links to your MikroTik Router
 - WAN1 to ether1 (Primary Link, Static IP)
 - WAN2 to ether2 (Secondary Link, PPPoE)

- Connect your PC to one of the LAN ports (ether3-ether5)

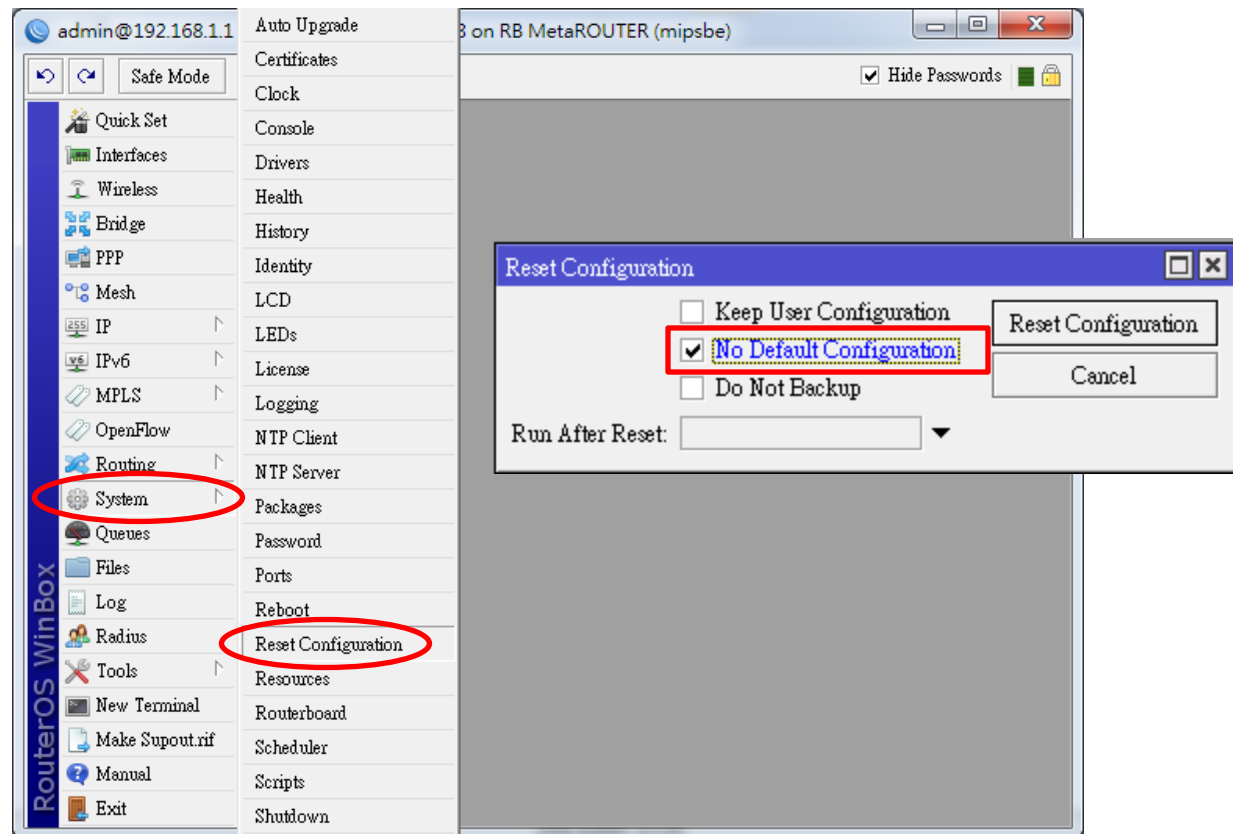
Router Initialization (Cont.)

- Login to the router with MAC Address:
 - Press on [...]
 - Wait a few seconds, if you cannot see the list, turn off your PC firewall
 - Select your router's MAC address
 - Key-in router's **Login** and **Password** and press [**Connect**]
(Default Login: admin, no password)



Router Initialization (Cont.)

- Reset the router to factory default with no default configuration:
 - This step can be skipped if you wanna keep your configuration
 - Select Menu **[System]** -> **[Reset Configuration]**
 - Tick **[No Default Configuration]**, then press **[Reset Configuration]**



Configure WAN1 and LAN

- In our example, WAN1 uses Static IP:
 - Go to menu [IP] -> [Address], press [+]
 - Key-in your IP address in CIDR notation (i.e.: **163.53.28.6/30**)
 - Select appropriate interface which this IP belongs to, then press [OK]
- Configure your LAN IP (192.168.1.1/24) with the same way.

The screenshot shows the Mikrotik WinBox interface. The left sidebar contains a tree view with the following items: Quick Set, Interfaces, Wireless, Bridge, PPP, Mesh, IP, IPv6, MPLS, OpenFlow, Routing, System, Queues, Files, Log, Radius, and Tools. The 'IP' item is selected and highlighted with a red circle. A secondary red circle highlights the 'Addresses' sub-item under 'IP'. The main window displays the 'Address List' dialog box, which is currently showing the configuration for a new address. The 'Address' field is set to '163.53.28.6/30', the 'Interface' dropdown is set to 'ether1', and the 'enabled' checkbox is checked. The 'Address List' dialog box has a table with columns for Address, Network, and Interface. The table contains one row with the following data:

Address	Network	Interface
163.53.28.6/30		ether1

The 'Address List' dialog box also has a 'Find' search bar and several action buttons: +, -, ✓, ✗, a folder icon, and a funnel icon. The 'New Address' dialog box has buttons for OK, Cancel, Apply, Disable, Comment, Copy, and Remove. The status bar at the bottom of the 'Address List' dialog box shows '1 item'.

Add Default Gateway for WAN1

- Since WAN1 was statically configured, we need to manually configure default route for it:
 - Go to menu [IP] -> [Route], press [+]
 - Key-in **0.0.0.0/0** in [Dst. Address], and **163.53.28.5** in [Gateway]
 - [Check Gateway] by ping, [Distance] is **1**, then press [OK]

The screenshot shows the Mikrotik WinBox interface. The left sidebar contains a menu with 'IP' and 'Routes' circled in red. The main window displays the 'New Route' configuration dialog. The 'General' tab is active, and the following fields are highlighted with red boxes:

- Dst. Address:** 0.0.0.0/0
- Gateway:** 163.53.28.5
- Check Gateway:** ping
- Distance:** 1

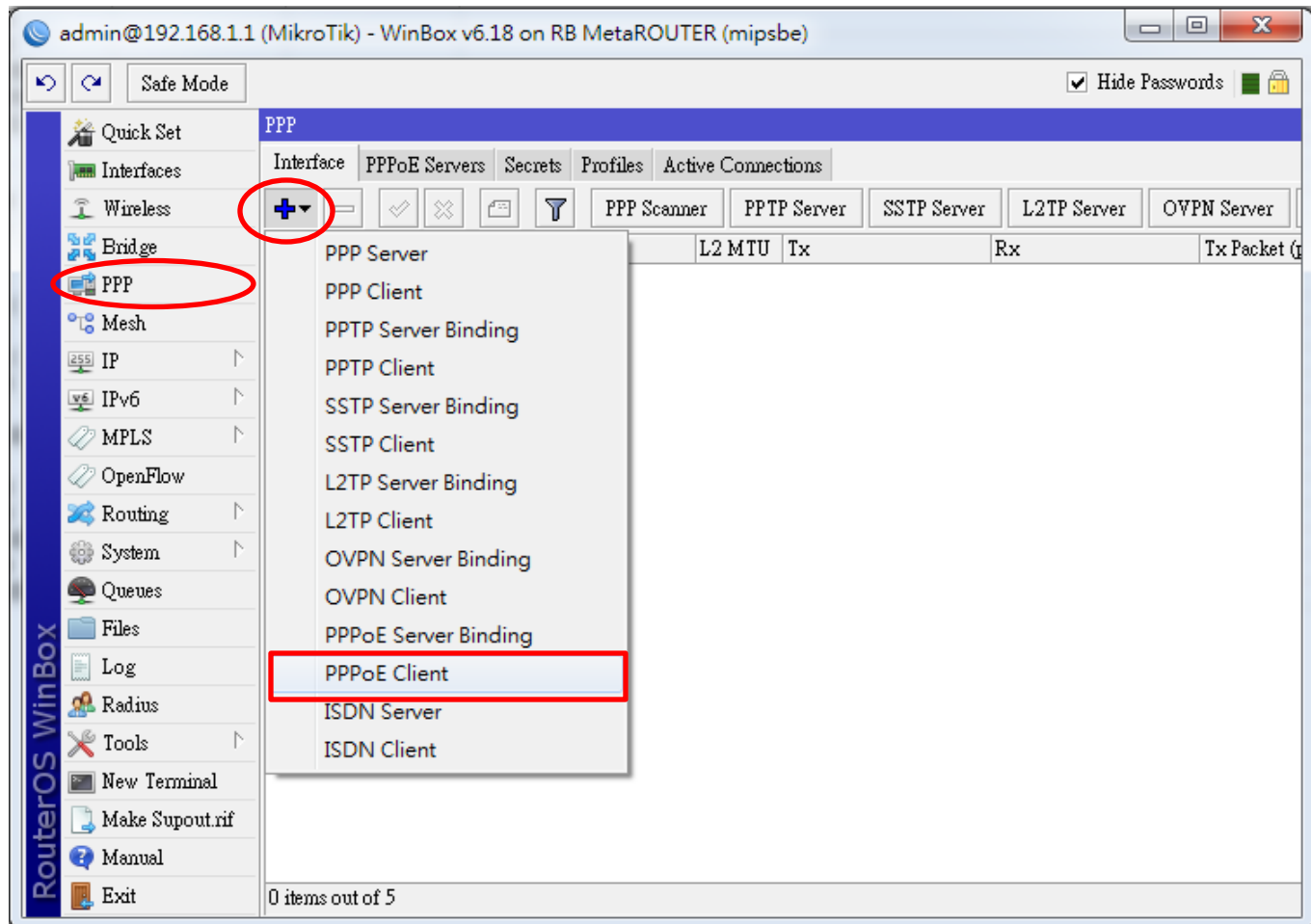
Other visible fields in the 'New Route' dialog include:

- Type: unicast
- Scope: 30
- Target Scope: 10
- Routing Mark: (empty)
- Pref. Source: (empty)

Buttons on the right side of the dialog include OK, Cancel, Apply, Disable, Comment, Copy, and Remove. The status bar at the bottom shows 'enabled' and 'active'.

Configure WAN2 PPPoE

- WAN2 uses PPPoE:
 - Go to menu **[PPP]**, press **[+]**, select **[PPPoE Client]**



Configure WAN2 PPPoE (Cont.)

- Configure PPPoE according to information provided by your ISP
 - Max PPPoE MTU is **1492** for most ISPs
 - Select WAN **[Interface]** that used for dialing PPPoE
 - Fill in your PPPoE **[User]** and **[Password]**
 - Set **[Default Route Distance]** to **2**, then press **[OK]**

New Interface

General Dial Out Status Traffic

Name: PPPOE-OUT-MAXBIT

Type: PPPoE Client

L2 MTU:

Max MTU: 1492

Max MRU: 1492

MRRU: 1600

Interfaces: ether2

OK Cancel Apply Disable Comment Copy Remove Torch PPPoE Scan

enabled running slave Status:

New Interface

General Dial Out Status Traffic

Service:

AC Name:

User: makito@maxbit

Password: *****

Profile: default

Keepalive Timeout: 60

Dial On Demand

Use Peer DNS

Add Default Route

Default Route Distance: 2

Allow

pap chap

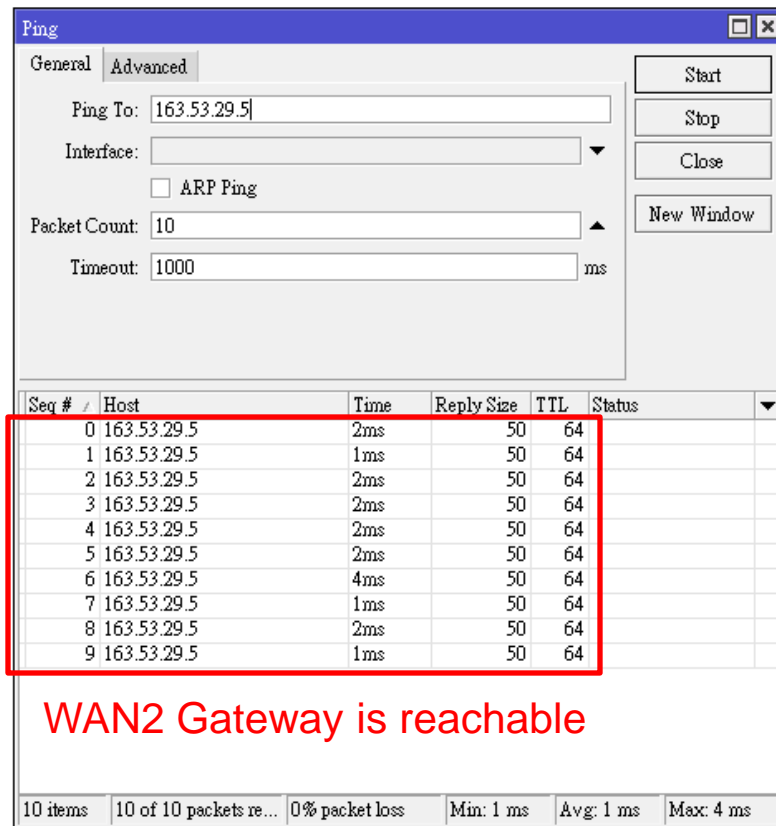
mschap1 mschap2

OK Cancel Apply Disable Comment Copy Remove Torch PPPoE Scan

enabled running slave Status:

Test Connectivity

- Ping to your WAN Gateways
 - WAN1: **163.53.28.5**
 - WAN2: **163.53.29.5**
- Traceroute to Google DNS (**8.8.8.8**)

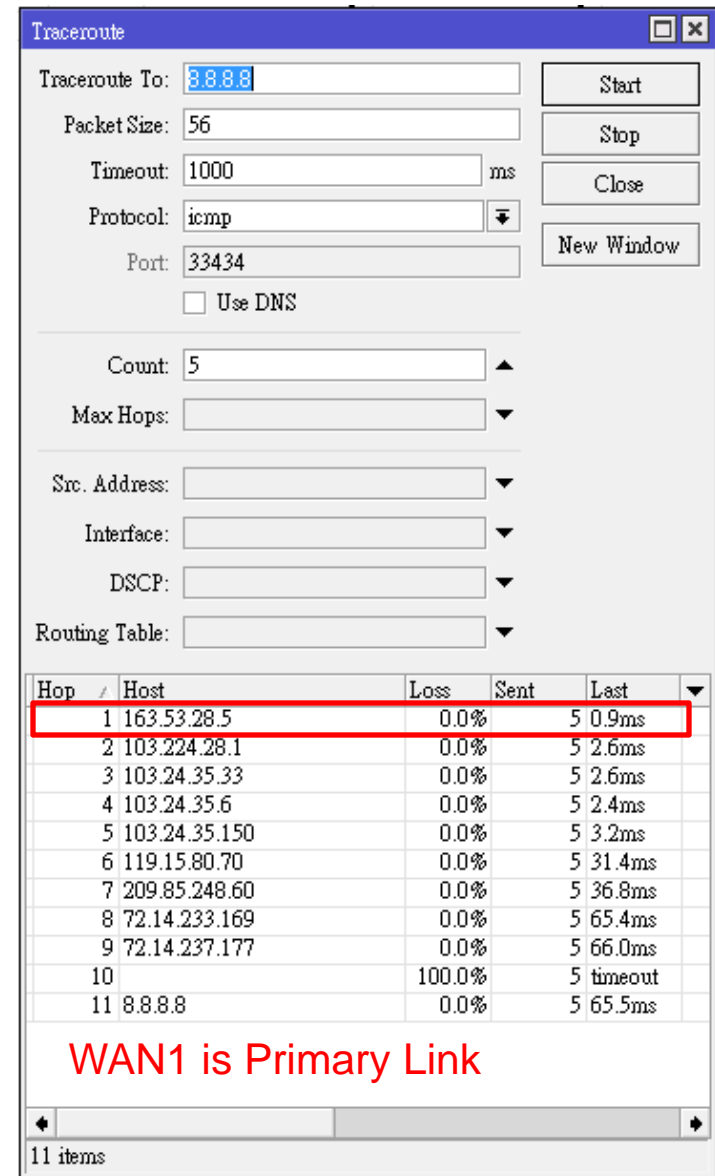


The screenshot shows the 'Ping' utility window with the 'General' tab selected. The 'Ping To' field contains '163.53.29.5'. The 'Packet Count' is set to 10 and the 'Timeout' is 1000 ms. The results table below shows 10 successful pings to 163.53.29.5 with response times between 1ms and 4ms and 0% packet loss.

Seq #	Host	Time	Reply Size	TTL	Status
0	163.53.29.5	2ms	50	64	
1	163.53.29.5	1ms	50	64	
2	163.53.29.5	2ms	50	64	
3	163.53.29.5	2ms	50	64	
4	163.53.29.5	2ms	50	64	
5	163.53.29.5	2ms	50	64	
6	163.53.29.5	4ms	50	64	
7	163.53.29.5	1ms	50	64	
8	163.53.29.5	2ms	50	64	
9	163.53.29.5	1ms	50	64	

WAN2 Gateway is reachable

10 items | 10 of 10 packets received | 0% packet loss | Min: 1 ms | Avg: 1 ms | Max: 4 ms



The screenshot shows the 'Traceroute' utility window with the 'Traceroute To' field containing '8.8.8.8'. The 'Packet Size' is 56, 'Timeout' is 1000 ms, and the 'Protocol' is 'icmp'. The results table below shows 11 hops, with the first hop to 163.53.28.5 highlighted in red, indicating it is the primary link.

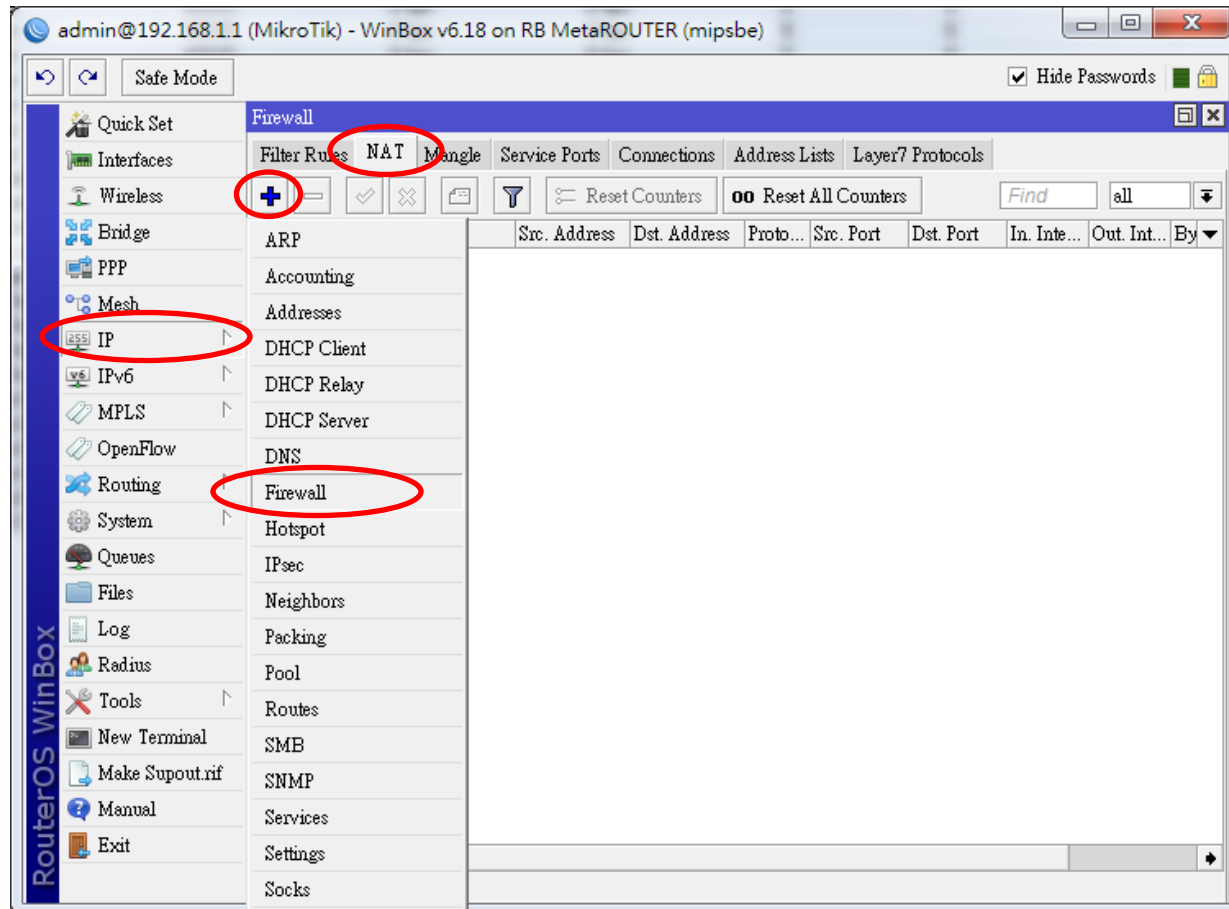
Hop	Host	Loss	Sent	Last
1	163.53.28.5	0.0%	5	0.9ms
2	103.224.28.1	0.0%	5	2.6ms
3	103.24.35.33	0.0%	5	2.6ms
4	103.24.35.6	0.0%	5	2.4ms
5	103.24.35.150	0.0%	5	3.2ms
6	119.15.80.70	0.0%	5	31.4ms
7	209.85.248.60	0.0%	5	36.8ms
8	72.14.233.169	0.0%	5	65.4ms
9	72.14.237.177	0.0%	5	66.0ms
10		100.0%	5	timeout
11	8.8.8.8	0.0%	5	65.5ms

WAN1 is Primary Link

11 items

Configure NAT

- In order to allow clients in LAN to access internet, we need to configure NAT:
 - Go to menu **[IP]** -> **[Firewall]**, select tab **[NAT]**, press **[+]**



Configure NAT (Cont.)

- Select **srcnat** in [Chain], [Out Interface] is WAN1 interface (**ether1**)
- Go to tab [Action], select **masquerade** in [Action], press [OK]
- Repeat above steps again to create another NAT rule for WAN2, select **PPPOE-OUT-MAXBIT** as [Out Interface]

New NAT Rule

General Advanced Extra Action Statistics

Chain: srcnat

Src. Address:

Dst. Address:

Protocol:

Src. Port:

Dst. Port:

Any. Port:

In. Interface:

Out. Interface: ether1

OK

Cancel

Apply

Disable

Comment

Copy

Remove

Reset Counters

Reset All Counters

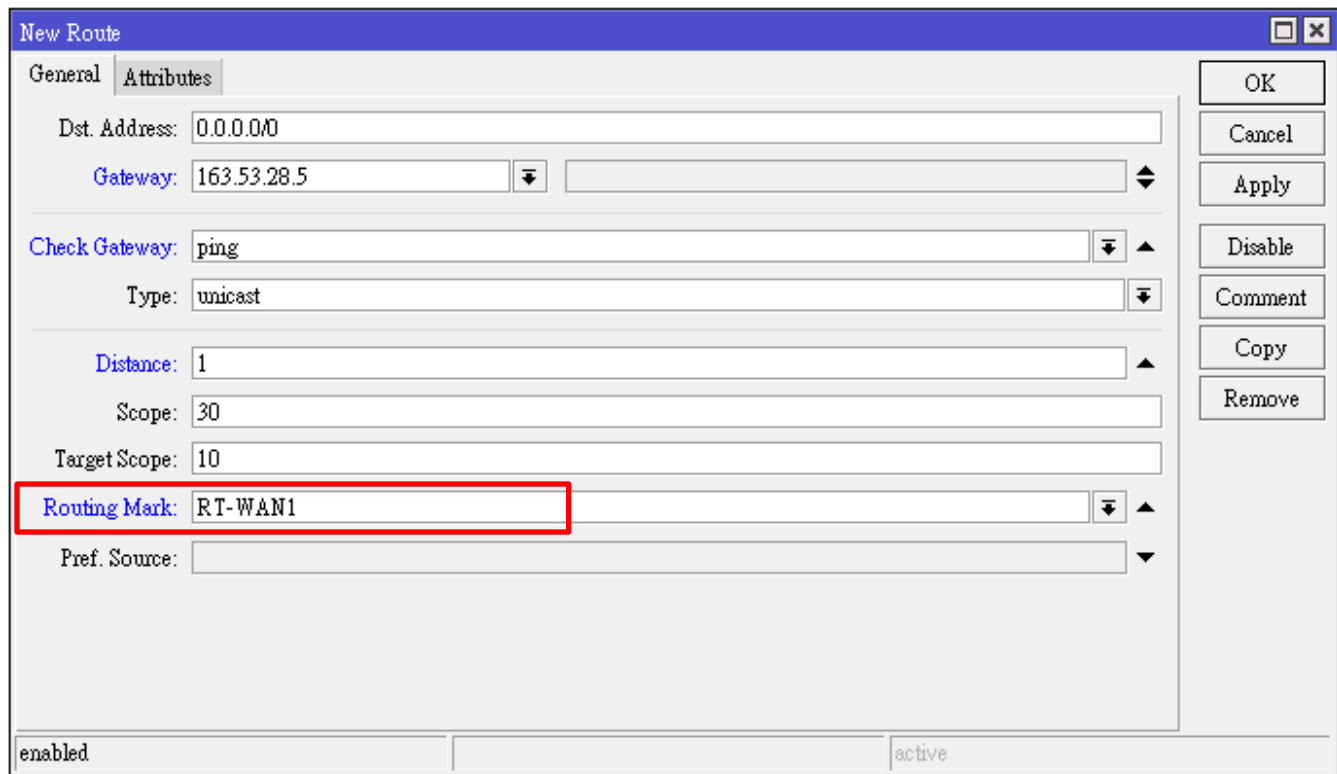
New NAT Rule

General Advanced Extra Action Statistics

Action: masquerade

Create Routing Table for WAN1

- To configure PBR in MikroTik, we need additional routing table (called VRF in Cisco) for each WAN:
 - Go to menu [IP] -> [Route], press [+]
 - Parameters are the same, except we need to specify the routing table name in [Routing Mark], we use **RT-WAN1** for WAN1's routing table



The screenshot shows the 'New Route' dialog box in MikroTik WinBox. The 'General' tab is selected. The 'Dst. Address' is 0.0.0.0/0, the 'Gateway' is 163.53.28.5, and the 'Check Gateway' is set to 'ping'. The 'Type' is 'unicast', 'Distance' is 1, 'Scope' is 30, and 'Target Scope' is 10. The 'Routing Mark' field is highlighted with a red rectangle and contains the value 'RT-WAN1'. The 'Pref. Source' field is empty. The dialog box has 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', and 'Remove' buttons on the right side. At the bottom, there are two checkboxes: 'enabled' (checked) and 'active' (unchecked).

Create Routing Table for WAN2

- WAN2 Routing Table creation
 - Go to menu **[IP]** -> **[Route]**, press **[+]**
 - Parameters are identical to WAN1's, but **[Gateway]** is your PPPoE Client interface **PPPOE-OUT-MAXBIT**
 - We use **RT-WAN2** as WAN2's routing table name

The screenshot shows the 'New Route' dialog box with the following configuration:

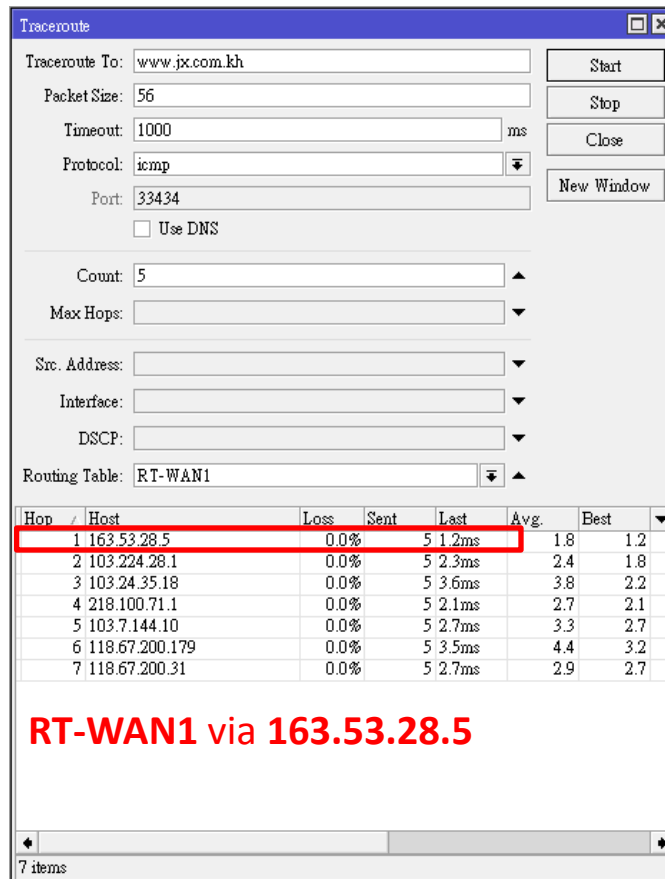
- General tab selected
- Dst. Address: 0.0.0.0/0
- Gateway: PPPOE-OUT-MAXBIT
- Check Gateway: ping
- Type: unicast
- Distance: 1
- Scope: 30
- Target Scope: 10
- Routing Mark: RT-WAN2 (highlighted with a red box)
- Pref. Source: (empty)

Buttons on the right: OK, Cancel, Apply, Disable, Comment, Copy, Remove.

Bottom status: enabled, active

Test Routing Table Connectivity

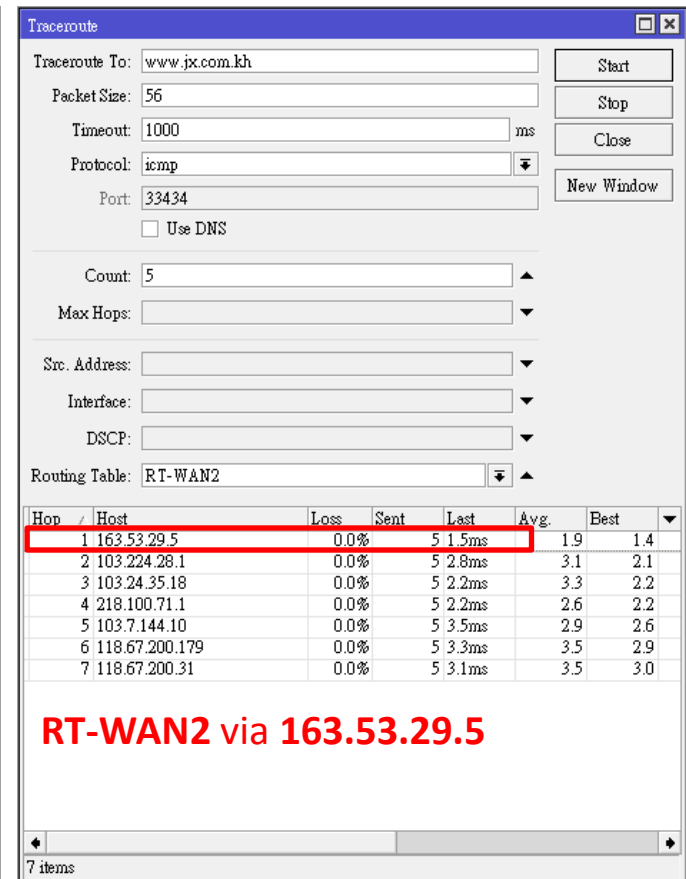
- Do a traceroute to any website (i.e.: www.jx.com.kh)
- Select [**Routing Table**] to test (RT-WAN1, or RT-WAN2)
- Check whether traffic are going through the correct gateway as expected



Traceroute window showing configuration for RT-WAN1. The destination is www.jx.com.kh, packet size is 56, timeout is 1000 ms, protocol is icmp, and port is 33434. The routing table is set to RT-WAN1. The traceroute results are as follows:

Hop	Host	Loss	Sent	Last	Avg.	Best
1	163.53.28.5	0.0%	5	1.2ms	1.8	1.2
2	103.224.28.1	0.0%	5	2.3ms	2.4	1.8
3	103.24.35.18	0.0%	5	3.6ms	3.8	2.2
4	218.100.71.1	0.0%	5	2.1ms	2.7	2.1
5	103.7.144.10	0.0%	5	2.7ms	3.3	2.7
6	118.67.200.179	0.0%	5	3.5ms	4.4	3.2
7	118.67.200.31	0.0%	5	2.7ms	2.9	2.7

RT-WAN1 via 163.53.28.5



Traceroute window showing configuration for RT-WAN2. The destination is www.jx.com.kh, packet size is 56, timeout is 1000 ms, protocol is icmp, and port is 33434. The routing table is set to RT-WAN2. The traceroute results are as follows:

Hop	Host	Loss	Sent	Last	Avg.	Best
1	163.53.29.5	0.0%	5	1.5ms	1.9	1.4
2	103.224.28.1	0.0%	5	2.8ms	3.1	2.1
3	103.24.35.18	0.0%	5	2.2ms	3.3	2.2
4	218.100.71.1	0.0%	5	2.2ms	2.6	2.2
5	103.7.144.10	0.0%	5	3.5ms	2.9	2.6
6	118.67.200.179	0.0%	5	3.3ms	3.5	2.9
7	118.67.200.31	0.0%	5	3.1ms	3.5	3.0

RT-WAN2 via 163.53.29.5

Check Point

➤ **Let's summarize what we have done so far:**

- Configured WAN1, which uses Static IP
- Configured LAN (No DHCP)
- Pointed default route to WAN1, set WAN1 as primary link, check gateway reachability by PING, if WAN1 fails, fallback to WAN2
- Configured WAN2, which uses PPPoE
- Configured default route of WAN2 as secondary link
- Configured NAT rules for both WANs
- Created routing table for each WAN:
 1. RT-WAN1, default to WAN1, if fails then fallback to main routing table
 2. RT-WAN2, default to WAN2, if fails then fallback to main routing table

➤ **Next, we have to decide...**

- **Which users we wanna put them into which link?**
- **Which services we wanna put into which link?**

Define Policy

- **Let's say we wanna apply following policy to the network**
 - Users with IP from 192.168.1.2 to 192.168.1.127, use WAN1
 - Users with IP from 192.168.1.128 to 192.168.1.254 use WAN2

 - Destinations to Google use WAN1
 - Destinations to Facebook use WAN2
 - Destinations in DIX use WAN1

 - The router itself (192.168.1.1) will not be affected by any policy

Note:

DIX = Domestic Internet eXchange, usually includes all IP prefixes belong to local ISPs.

Policy Configuration Logic

➤ **Our policy can be translated to following configuration:**

Packets with...

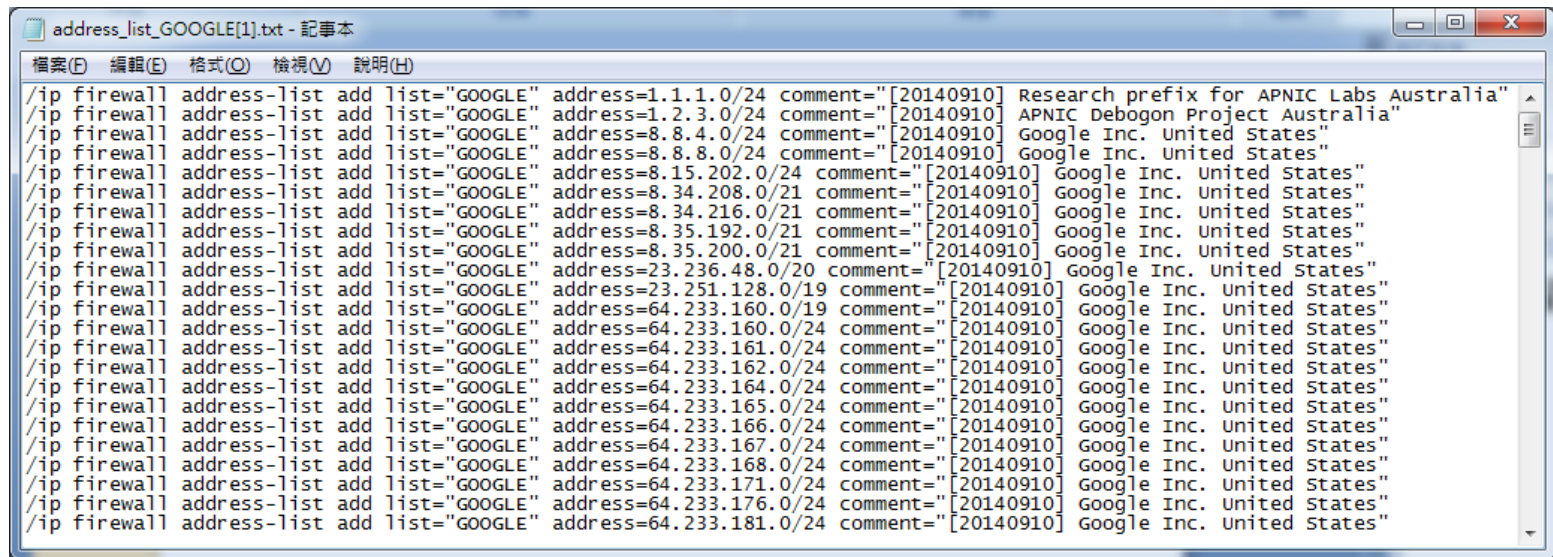
1. Destination IP **192.168.1.0/24**, look up **main** routing table
2. Destination IP in **GOOGLE** address list, look up **RT-WAN1**
3. Destination IP in **FACEBOOK** address list, look up **RT-WAN2**
4. Destination IP in **DIX** address list, look up **RT-WAN1**
5. Source IP **192.168.1.1**, look up **main** routing table
6. Source IP **192.168.1.0/25**, look up **RT-WAN1**
7. Source IP **192.168.1.128/25**, look up **RT-WAN2**

Note:

- (1) Order of the rules is important, the router will process from top to bottom
- (2) Address list in MikroTik is similar to access list in Cisco
- (3) Address list scripts can be downloaded in **i-BEAM** Facebook Group:
<https://www.facebook.com/groups/1481854632142914/>

Create Address Lists

- Download address lists from **i-BEAM** Facebook Group
- Open the address list text file

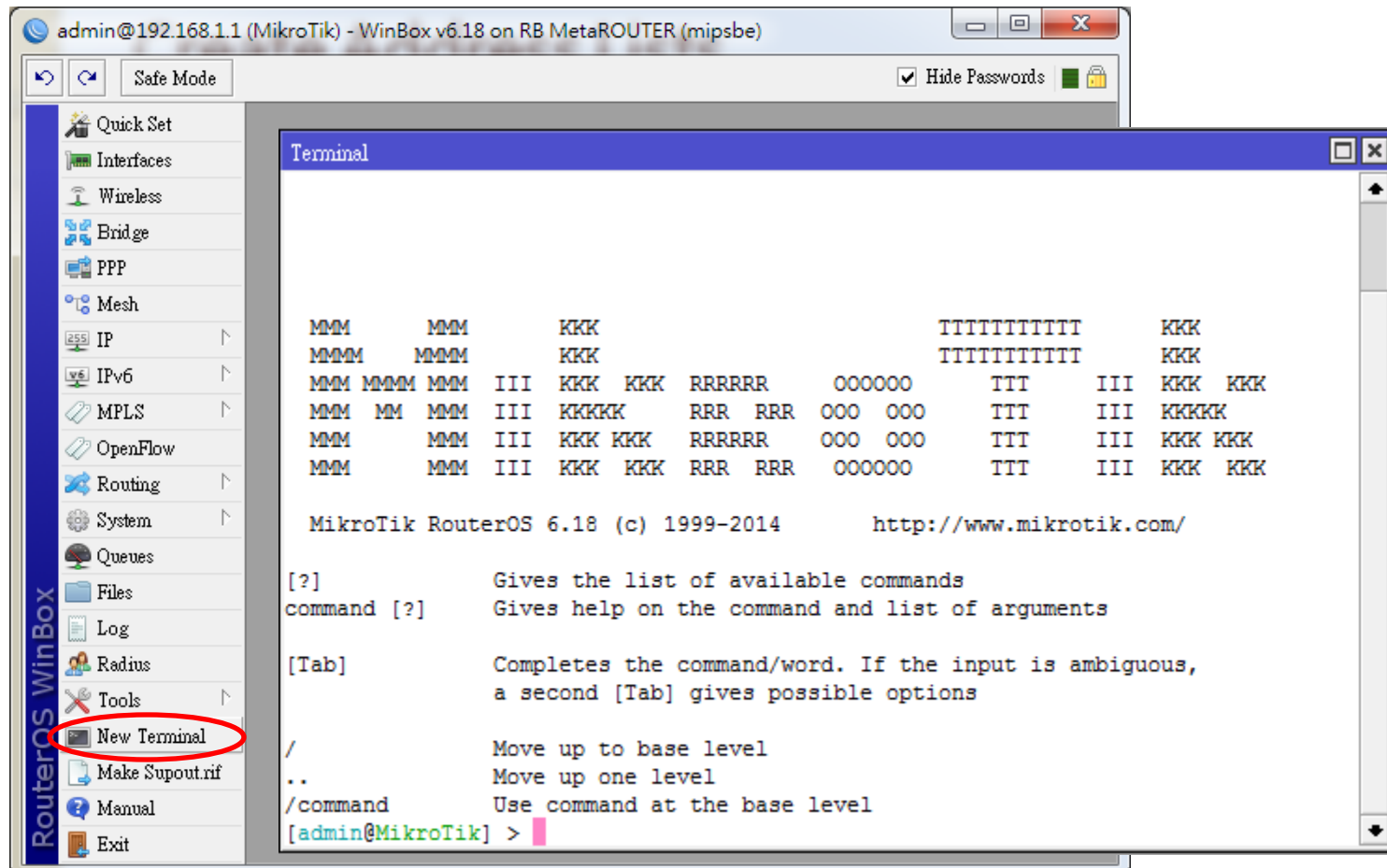


```
address_list_GOOGLE[1].txt - 記事本
複製(F)  編輯(E)  格式(O)  檢視(V)  說明(H)
/ip firewall address-list add list="GOOGLE" address=1.1.1.0/24 comment="[20140910] Research prefix for APNIC Labs Australia"
/ip firewall address-list add list="GOOGLE" address=1.2.3.0/24 comment="[20140910] APNIC Debogon Project Australia"
/ip firewall address-list add list="GOOGLE" address=8.8.4.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.8.8.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.15.202.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.34.208.0/21 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.34.216.0/21 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.35.192.0/21 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=8.35.200.0/21 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=23.236.48.0/20 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=23.251.128.0/19 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.160.0/19 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.160.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.161.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.162.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.164.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.165.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.166.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.167.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.168.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.171.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.176.0/24 comment="[20140910] Google Inc. United States"
/ip firewall address-list add list="GOOGLE" address=64.233.181.0/24 comment="[20140910] Google Inc. United States"
```

- The file includes all commands to create GOOGLE address list in your Mikrotik router
- Just simply select all and copy

Create Address Lists (Cont.)

- Then go to Winbox menu **[New Terminal]**
- Right click on the new **[Terminal]** window, select **[Paste]**
- Repeat these steps for each address list



The screenshot shows the MikroTik WinBox interface. The left sidebar contains a menu with the following items: Quick Set, Interfaces, Wireless, Bridge, PPP, Mesh, IP, IPv6, MPLS, OpenFlow, Routing, System, Queues, Files, Log, Radius, Tools, **New Terminal** (highlighted with a red circle), Make Supout.tif, Manual, and Exit. The main window displays a terminal window titled "Terminal" with the following content:

```
admin@192.168.1.1 (MikroTik) - WinBox v6.18 on RB MetaROUTER (mipsbe)
Safe Mode
Hide Passwords

Terminal

MMM      MMM      KKK
MMM      MMM      KKK
MMM MMMM MMM III KKK KKK RRRRRR 000000 TTT III KKK KKK
MMM MM  MMM III KKKKK RRR RRR 000 000 TTT III KKKKK
MMM      MMM III KKK KKK RRRRRR 000 000 TTT III KKK KKK
MMM      MMM III KKK KKK RRR RRR 000000 TTT III KKK KKK

MikroTik RouterOS 6.18 (c) 1999-2014      http://www.mikrotik.com/

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

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

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

Mark Traffic

- Now we have address lists, we can start to mark traffic:
 - Go to menu [IP] -> [Firewall], select tab [Mangle], press [+]

The screenshot shows the Mikrotik WinBox v6.18 interface. The window title is "admin@192.168.1.1 (MikroTik) - WinBox v6.18 on RB MetaROUTER (mipsbe)". The interface includes a "Safe Mode" button and a "Hide Passwords" checkbox. The left sidebar contains a tree view of system components, with "IP" and "Firewall" highlighted by red circles. The main panel displays the "Firewall" configuration page, with the "Mangle" tab selected and also circled in red. A red circle around a "+" icon in the toolbar indicates the next step in the process. The main content area shows a table with columns for "Src. Address", "Dst. Address", "Proto...", "Src. Port", "Dst. Port", "In. Inte...", "Out. Inte...", and "Byte".

Mark Traffic (Cont.)

- Select **prerouting** in **[Chain]**
- Go to tab **[Advanced]**, select **GOOGLE** in **[Dst. Address List]**
- Go to tab **[Action]**, select **mark routing** in **[Action]**, fill in a name in field **[New Routing Mark]**, in this example, we will use routing mark exact same as address list name, which is **GOOGLE**, then press **[OK]**
- Repeat these steps for each address list

The image displays three sequential screenshots of the Mikrotik 'New Mangle Rule' configuration dialog, illustrating the steps to configure a rule for marking traffic.

Top Screenshot: The 'Chain' field is set to 'prerouting'. The 'Src. Address' field is empty. The 'OK', 'Cancel', and 'Apply' buttons are visible on the right.

Middle Screenshot: The 'Src. Address List' field is empty. The 'Dst. Address List' field is set to 'GOOGLE'. The 'OK', 'Cancel', and 'Apply' buttons are visible on the right.

Bottom Screenshot: The 'Action' field is set to 'mark routing'. The 'New Routing Mark' field is set to 'GOOGLE'. The 'Passthrough' checkbox is checked. The 'OK', 'Cancel', and 'Apply' buttons are visible on the right.

Note: All variable names in Mikrotik are case-sensitive!

Create Route Rules

- Before you start, make sure your routing table has routes as below:
- Default route via **168.53.28.5** in **main** routing table, state **Active**
 - Default route via **168.53.29.5** in **main** routing table, state **Inactive**
 - Default route via **163.53.28.5** in **RT-WAN1** routing table, state **Active**
 - Default route via **168.53.29.5** in **RT-WAN2** routing table, state **Active**

	Dest. Address	Gateway	Distance	Routing M...	Pref. Source
AS	▶ 0.0.0.0/0	163.53.28.5 reachable ether1	1		
DS	▶ 0.0.0.0/0	163.53.29.5 reachable PPPOE-OUT-MAXBIT	2		
DAC	▶ 163.53.28.4/30	ether1 reachable	0		163.53.28.6
DAC	▶ 163.53.29.5	PPPOE-OUT-MAXBIT reachable	0		163.53.29.6
DAC	▶ 192.168.1.0/24	ether3 reachable	0		192.168.1.1
AS	▶ 0.0.0.0/0	163.53.28.5 reachable ether1	1	RT-WAN1	
AS	▶ 0.0.0.0/0	PPPOE-OUT-MAXBIT reachable	1	RT-WAN2	

Routing Flag:
D = Dynamic, A = Active, S = Static, C = Connected

7 items

Create Route Rules (Cont.)

- Configure rules according to configuration logic in previous slides
 - **Rule 1:** Destination IP **192.168.1.0/24**, look up **main** routing table
 - Go to tab **[Rules]**, press **[+]**
 - Fill in **192.168.1.0/24** in **[Dst. Address]**
 - Select **main** in **[Table]**, then press **[OK]**

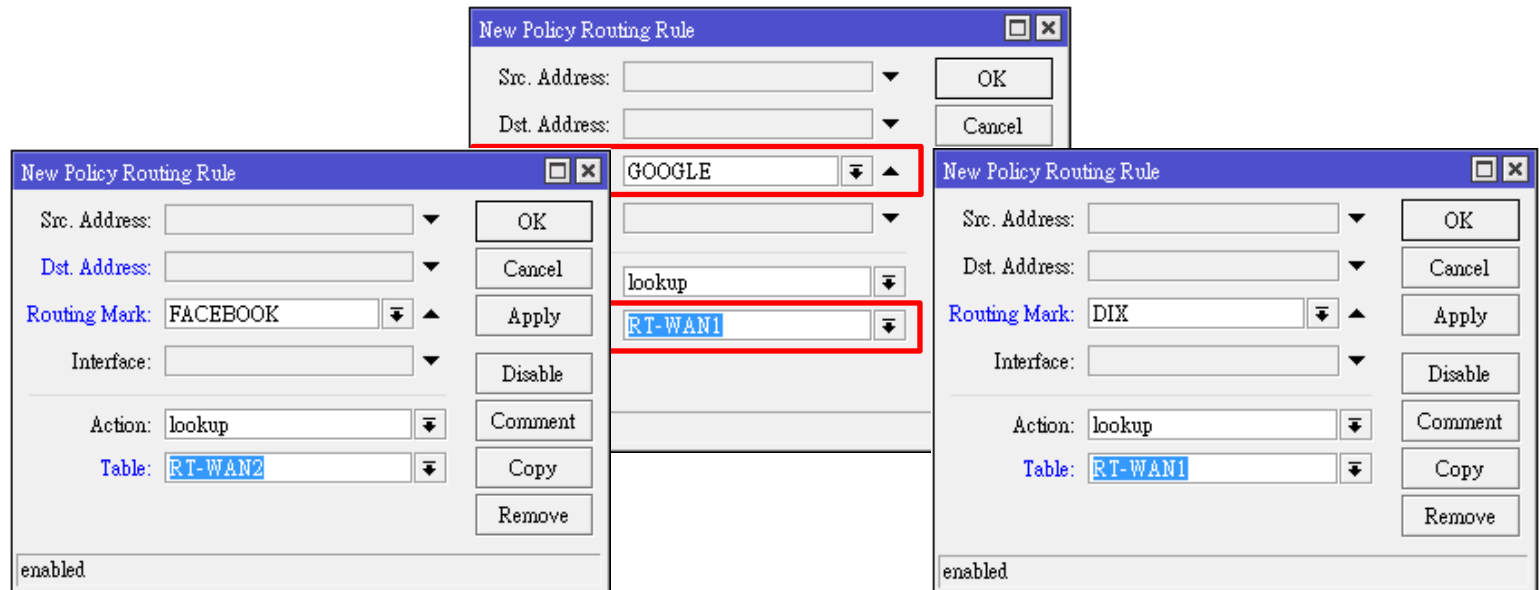
The screenshot shows the 'Route List' configuration window with the 'Rules' tab selected. A '+' icon in the toolbar is circled in red. A 'New Policy Routing Rule' dialog box is open, with the following fields highlighted in red:

- Dst. Address:** 192.168.1.0/24
- Table:** main

The dialog box also includes fields for Src. Address, Routing Mark, Interface, and Action (set to 'lookup'). Buttons for OK, Cancel, Apply, Disable, Comment, Copy, and Remove are visible on the right. The 'enabled' checkbox is checked at the bottom. The main window shows a table with columns: #, Src. Address, Dst. Address, Routing Mark, Interface, Action, and Table. The status bar at the bottom indicates '0 items'.

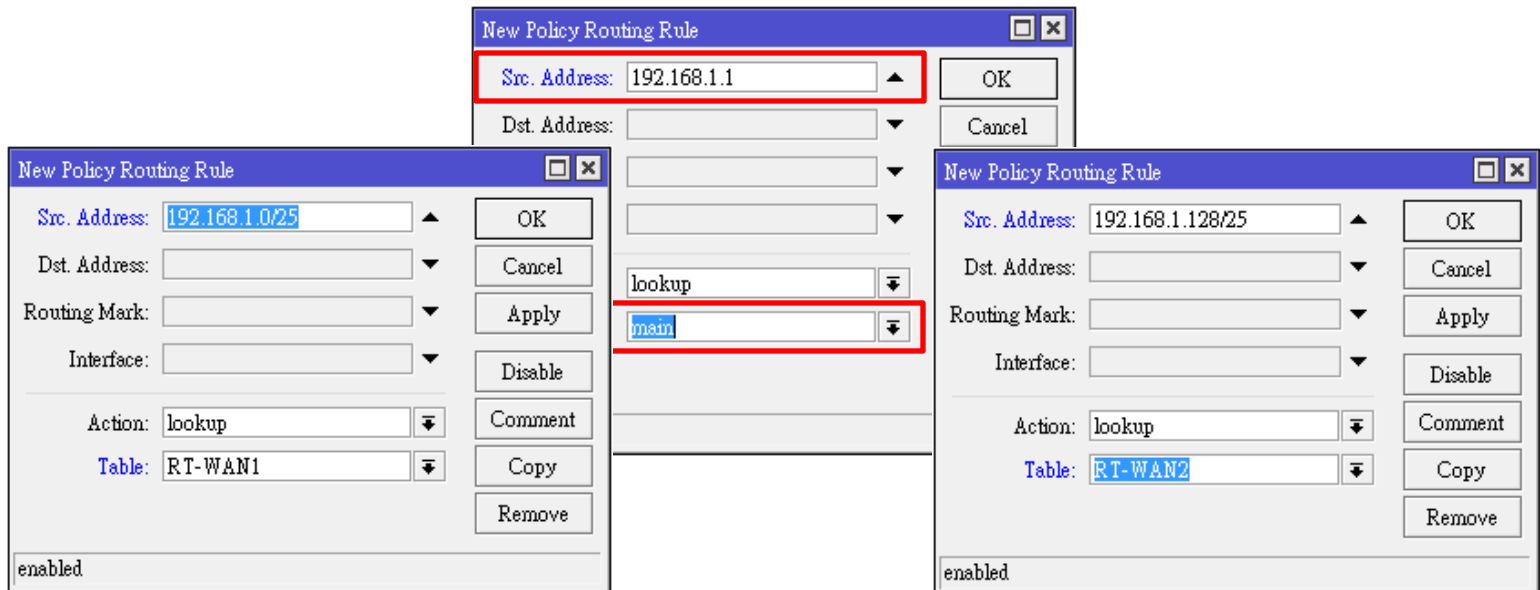
Create Route Rules (Cont.)

- Configure rules according to configuration logic in previous slides
 - **Rule 2:** Destination IP in **GOOGLE** address list, look up **RT-WAN1**
 - press **[+]** to add new rule
 - Select **GOOGLE** in **[Routing Mark]**
 - Select **RT-WAN1** in **[Table]**, then press **[OK]**
 - Configure **Rule 3** and **Rule 4** with the same way, just select the appropriate **[Routing Mark]** and **[Table]** according to our policy



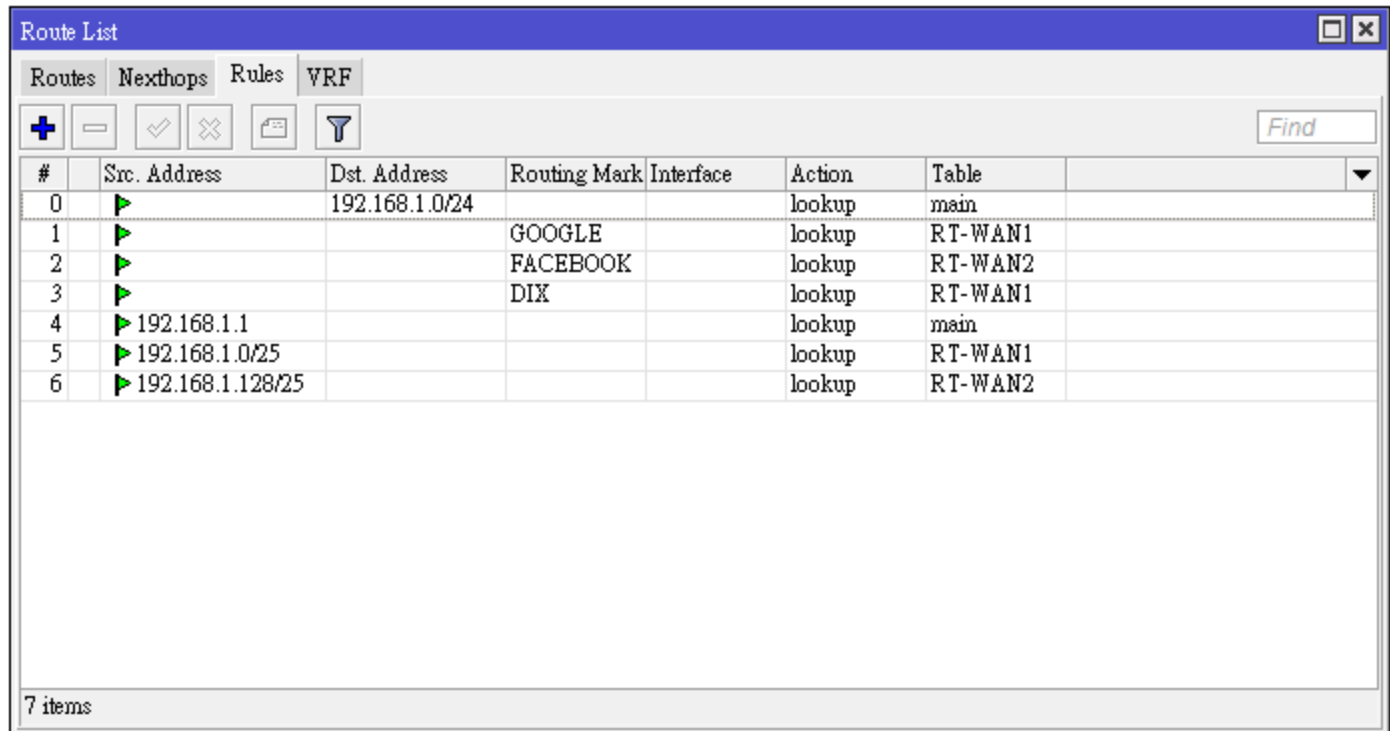
Create Route Rules (Cont.)

- Configure rules according to configuration logic in previous slides
 - **Rule 5:** Source IP **192.168.1.1**, look up **main** routing table
 - press **[+]** to add new rule
 - Fill in **192.168.1.1** in **[Src. Address]**
 - Select **main** in **[Table]**, then press **[OK]**
 - Configure **Rule 6** and **Rule 7** with the same way, just fill in the appropriate **[Src. Address]** and select **[Table]** according to our policy



Create Route Rules (Cont.)

- Let's verify all rules that we have created, make sure you see 7 routing rules totally the same as output below:

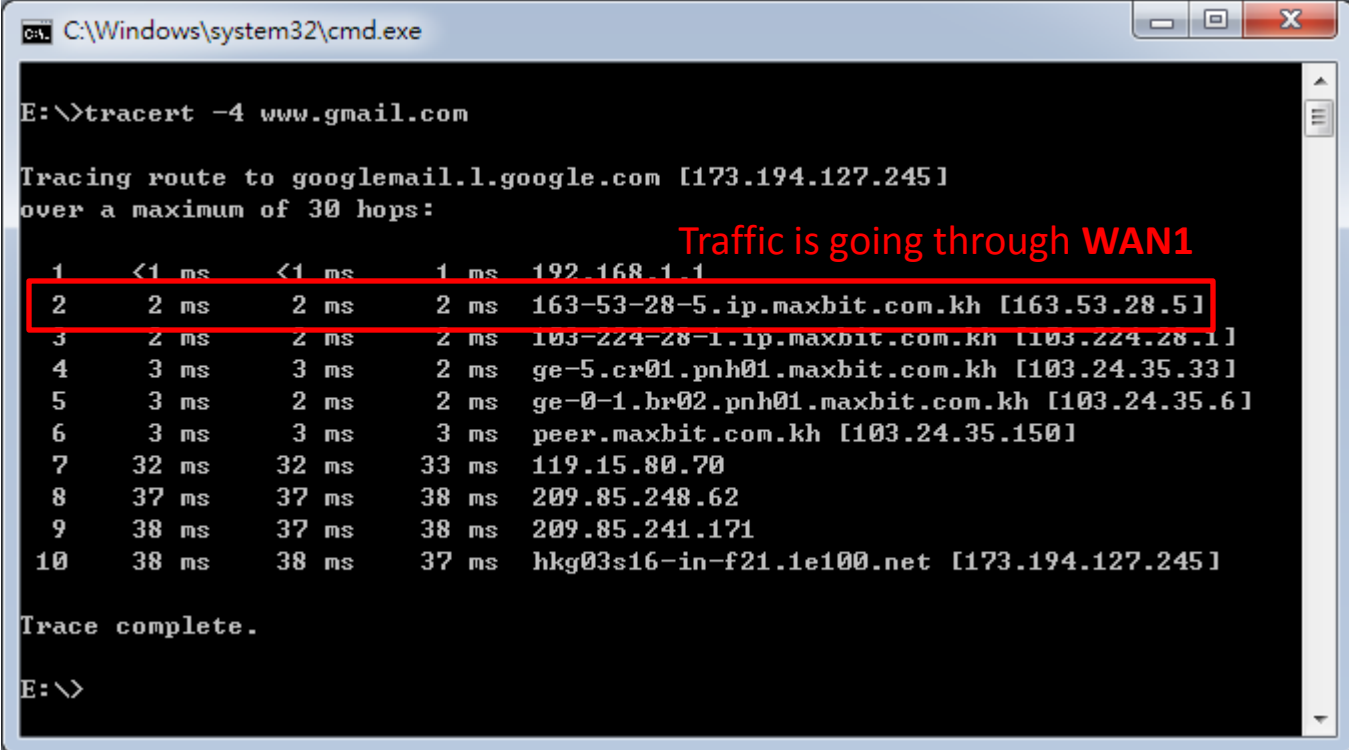


The screenshot shows a 'Route List' window with a blue title bar and standard window controls. Below the title bar are tabs for 'Routes', 'Nexthops', 'Rules', and 'VRF', with 'Routes' selected. A toolbar contains icons for adding (+), removing (-), checking (✓), deleting (✕), and filtering (funnel), along with a 'Find' search box. The main area is a table with 7 rows and 7 columns: '#', 'Src. Address', 'Dst. Address', 'Routing Mark', 'Interface', 'Action', and 'Table'. The status bar at the bottom indicates '7 items'.

#	Src. Address	Dst. Address	Routing Mark	Interface	Action	Table
0		192.168.1.0/24			lookup	main
1			GOOGLE		lookup	RT-WAN1
2			FACEBOOK		lookup	RT-WAN2
3			DIX		lookup	RT-WAN1
4	192.168.1.1				lookup	main
5	192.168.1.0/25				lookup	RT-WAN1
6	192.168.1.128/25				lookup	RT-WAN2

End Host Connectivity Test

- Traceroute from user **192.168.1.100** to **GMail**



```
C:\Windows\system32\cmd.exe

E:\>tracert -4 www.gmail.com

Tracing route to googlemail.l.google.com [173.194.127.245]
over a maximum of 30 hops:

    1  <1 ms  <1 ms  <1 ms  192.168.1.1
    2  2 ms    2 ms    2 ms   163-53-28-5.ip.maxbit.com.kh [163.53.28.5]
    3  2 ms    2 ms    2 ms   103-224-28-1.ip.maxbit.com.kh [103.224.28.1]
    4  3 ms    3 ms    2 ms   ge-5-cr01.pnh01.maxbit.com.kh [103.24.35.33]
    5  3 ms    2 ms    2 ms   ge-0-1-br02.pnh01.maxbit.com.kh [103.24.35.6]
    6  3 ms    3 ms    3 ms   peer.maxbit.com.kh [103.24.35.150]
    7  32 ms   32 ms   33 ms  119.15.80.70
    8  37 ms   37 ms   38 ms  209.85.248.62
    9  38 ms   37 ms   38 ms  209.85.241.171
   10  38 ms   38 ms   37 ms  hkg03s16-in-f21.1e100.net [173.194.127.245]

Trace complete.

E:\>
```

Traffic is going through WAN1

End Host Connectivity Test (Cont.)

- Traceroute from user **192.168.1.100** to Facebook

```
C:\Windows\system32\cmd.exe

E:\>tracert -4 www.facebook.com

Tracing route to star.c10r.facebook.com [31.13.70.1]
over a maximum of 30 hops:

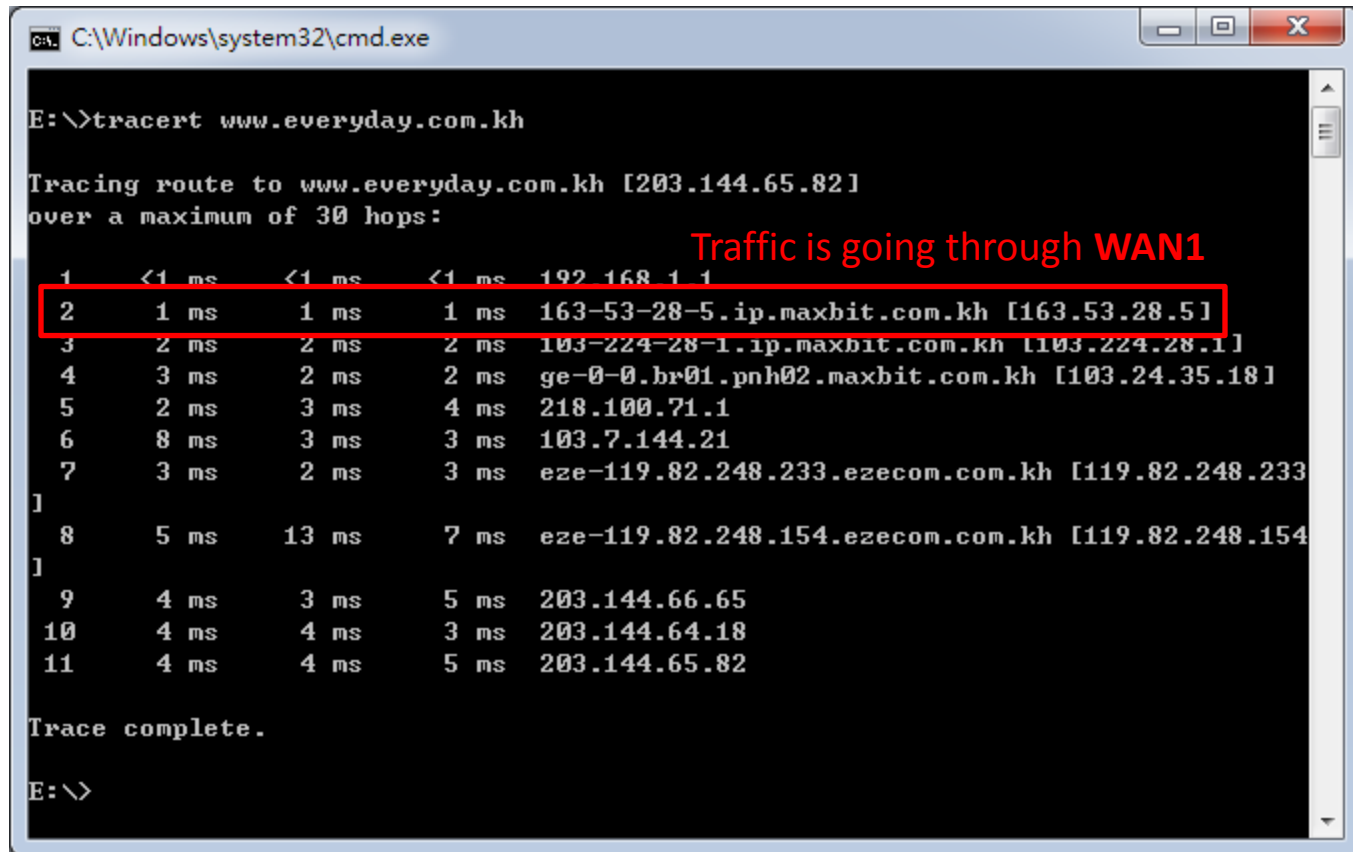
  0  0 ms  0 ms  0 ms  192.168.1.1
  1  1 ms  <1 ms  1 ms  192.168.1.1
  2  2 ms  2 ms  2 ms  163-53-29-5.ip.maxbit.com.kh [163.53.29.5]
  3  2 ms  2 ms  3 ms  103-224-28-1.ip.maxbit.com.kh [103.224.28.1]
  4  3 ms  2 ms  3 ms  ge-5-cr01.pnh01.maxbit.com.kh [103.24.35.33]
  5  3 ms  3 ms  3 ms  ge-0-1-br02.pnh01.maxbit.com.kh [103.24.35.6]
  6  39 ms  40 ms  38 ms  peer.maxbit.com.kh [103.24.35.142]
  7  37 ms  37 ms  38 ms  103.17.212.201
  8  9 ms  8 ms  8 ms  118.69.39.225
  9  9 ms  10 ms  9 ms  118.69.247.246
 10  32 ms  39 ms  40 ms  118.70.2.165
 11  38 ms  41 ms  37 ms  203.208.191.97
 12  39 ms  38 ms  49 ms  203.208.178.6
 13  187 ms  190 ms  187 ms  203.208.172.122
 14  198 ms  197 ms  197 ms  203.208.172.186
 15  183 ms  183 ms  182 ms  ae18-pr01.lax1.tfbnw.net [103.4.96.50]
 16  *      *      *      Request timed out.
 17  *      *      *      Request timed out.
 18  183 ms  183 ms  183 ms  edge-star-shv-01-lax1.facebook.com [31.13.70.1]

Trace complete.

E:\>
```

End Host Connectivity Test (Cont.)

- Traceroute from user **192.168.1.100** to www.everyday.com.kh



```
C:\Windows\system32\cmd.exe

E:\>tracert www.everyday.com.kh

Tracing route to www.everyday.com.kh [203.144.65.82]
over a maximum of 30 hops:

  0  <1 ms  <1 ms  <1 ms  192.168.1.1
  1  1 ms    1 ms    1 ms    163-53-28-5.ip.maxbit.com.kh [163.53.28.5]
  2  2 ms    2 ms    2 ms    103-224-28-1.ip.maxbit.com.kh [103.224.28.1]
  3  3 ms    2 ms    2 ms    ge-0-0.br01.pnh02.maxbit.com.kh [103.24.35.18]
  4  2 ms    3 ms    4 ms    218.100.71.1
  5  8 ms    3 ms    3 ms    103.7.144.21
  6  3 ms    2 ms    3 ms    eze-119.82.248.233.ezecom.com.kh [119.82.248.233]
  7  5 ms    13 ms   7 ms    eze-119.82.248.154.ezecom.com.kh [119.82.248.154]
  8  4 ms    3 ms    5 ms    203.144.66.65
  9  4 ms    4 ms    3 ms    203.144.64.18
 10  4 ms    4 ms    5 ms    203.144.65.82

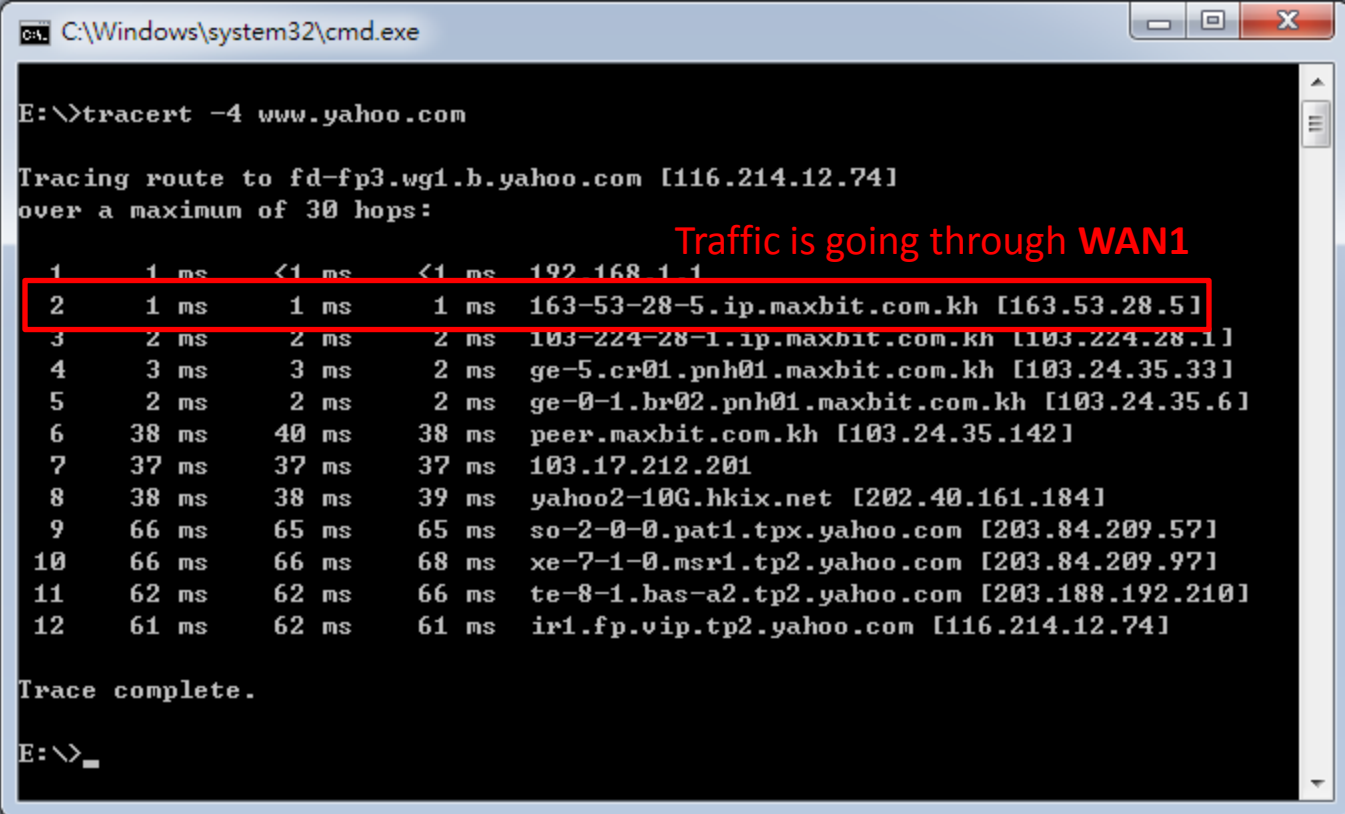
Trace complete.

E:\>
```

Traffic is going through WAN1

End Host Connectivity Test (Cont.)

- Traceroute from user **192.168.1.100** to Yahoo



```
C:\Windows\system32\cmd.exe

E:\>tracert -4 www.yahoo.com

Tracing route to fd-fp3.wg1.b.yahoo.com [116.214.12.74]
over a maximum of 30 hops:

  0  0 ms  0 ms  0 ms  192.168.1.1
  1  1 ms  <1 ms  <1 ms  192.168.1.1
  2  1 ms  1 ms  1 ms  163-53-28-5.ip.maxbit.com.kh [163.53.28.5]
  3  2 ms  2 ms  2 ms  103-224-28-1.ip.maxbit.com.kh [103.224.28.1]
  4  3 ms  3 ms  2 ms  ge-5.cr01.pnh01.maxbit.com.kh [103.24.35.33]
  5  2 ms  2 ms  2 ms  ge-0-1.br02.pnh01.maxbit.com.kh [103.24.35.6]
  6  38 ms  40 ms  38 ms  peer.maxbit.com.kh [103.24.35.142]
  7  37 ms  37 ms  37 ms  103.17.212.201
  8  38 ms  38 ms  39 ms  yahoo2-10G.hkix.net [202.40.161.184]
  9  66 ms  65 ms  65 ms  so-2-0-0.pat1.tpx.yahoo.com [203.84.209.57]
 10  66 ms  66 ms  68 ms  xe-7-1-0.msrl.tp2.yahoo.com [203.84.209.97]
 11  62 ms  62 ms  66 ms  te-8-1.bas-a2.tp2.yahoo.com [203.188.192.210]
 12  61 ms  62 ms  61 ms  ir1.fp.vip.tp2.yahoo.com [116.214.12.74]

Trace complete.

E:\>_
```

End Host Connectivity Test (Cont.)

- Traceroute from user **192.168.1.200** to Yahoo

```
C:\Windows\system32\cmd.exe

E:\>tracert -4 www.yahoo.com

Tracing route to fd-fp3.wg1.b.yahoo.com [116.214.12.74]
over a maximum of 30 hops:

    1     1 ms    <1 ms   <1 ms   192.168.1.1
    2     2 ms    2 ms    1 ms    163-53-29-5.ip.maxbit.com.kh [163.53.29.5]
    3     3 ms    3 ms    3 ms    103-224-28-1.ip.maxbit.com.kh [103.224.28.1]
    4     4 ms    3 ms    2 ms    ge-5-cr01.pnh01.maxbit.com.kh [103.24.35.33]
    5     3 ms    3 ms    4 ms    ge-0-1-br02.pnh01.maxbit.com.kh [103.24.35.6]
    6    39 ms   38 ms   38 ms   peer.maxbit.com.kh [103.24.35.142]
    7    39 ms   38 ms   37 ms   103.17.212.201
    8    38 ms   42 ms   39 ms   yahoo2-10G.hkix.net [202.40.161.184]
    9    66 ms   65 ms   68 ms   so-2-0-0.pat1.tpx.yahoo.com [203.84.209.57]
   10    66 ms   66 ms   67 ms   xe-7-1-0.msrl.tp2.yahoo.com [203.84.209.97]
   11    63 ms   61 ms   61 ms   te-8-1.bas-a2.tp2.yahoo.com [203.188.192.210]
   12    62 ms   61 ms   62 ms   ir1.fp.vip.tp2.yahoo.com [116.214.12.74]

Trace complete.

E:\>
```


Questions and Answers





Thank you for your attention!

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