

Load Balancing Using PCC & RouterOS

About Me



- Steve Discher, from College Station, Texas, USA
- Class of '87 Texas A&M University
- Using MikroTik since early 2004 when I started my first WVISP
- Author of the book “RouterOS by Example”
- MikroTik Certified Trainer and teach RouterOS classes, MyWISPTraining.com
- Operate a wireless distribution company, ISPSupplies.com

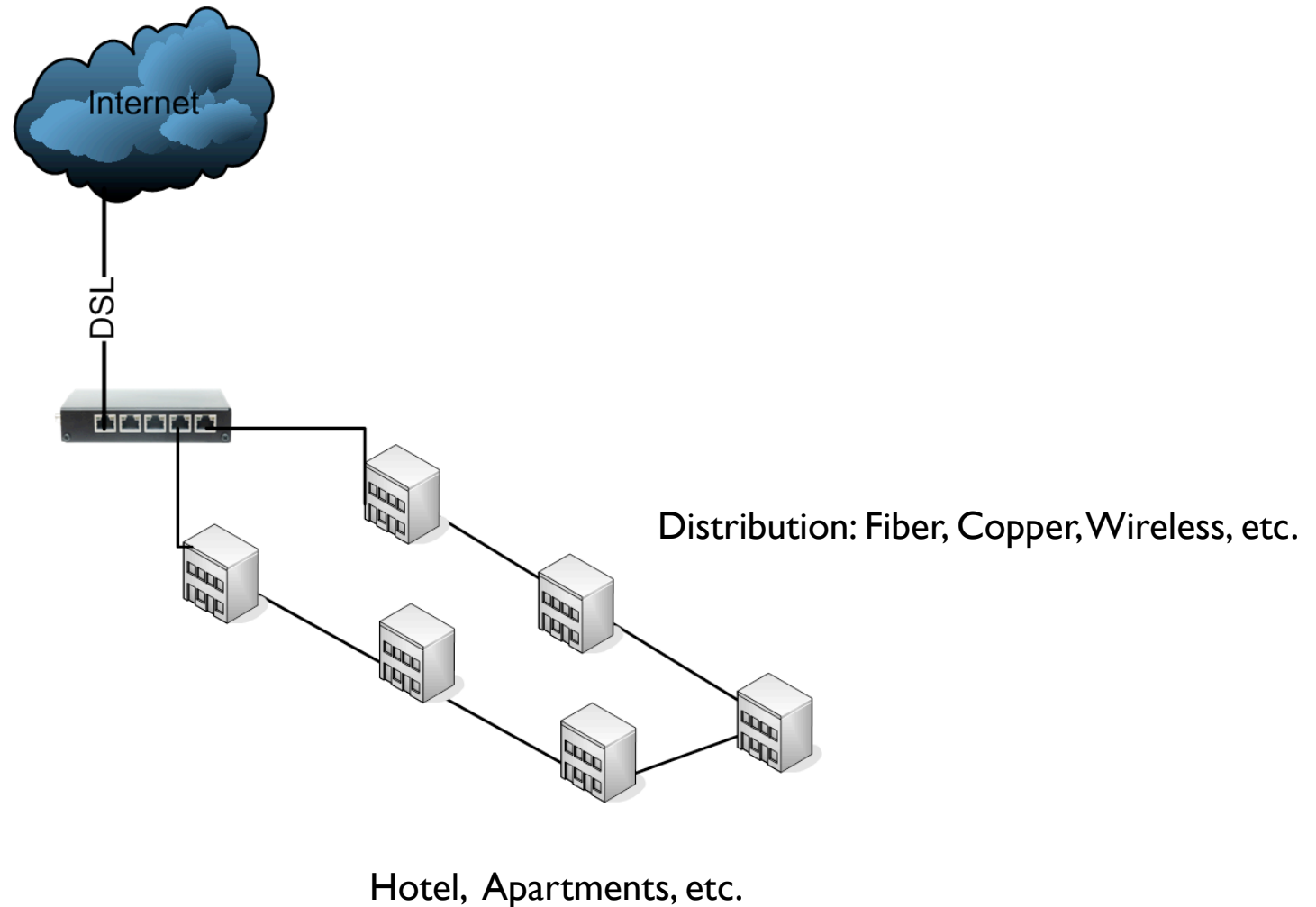
I. What is load balancing and why would I want it?

2. Which method should I pick and how does it work?

3. Ok, I want it but how do I set it up?

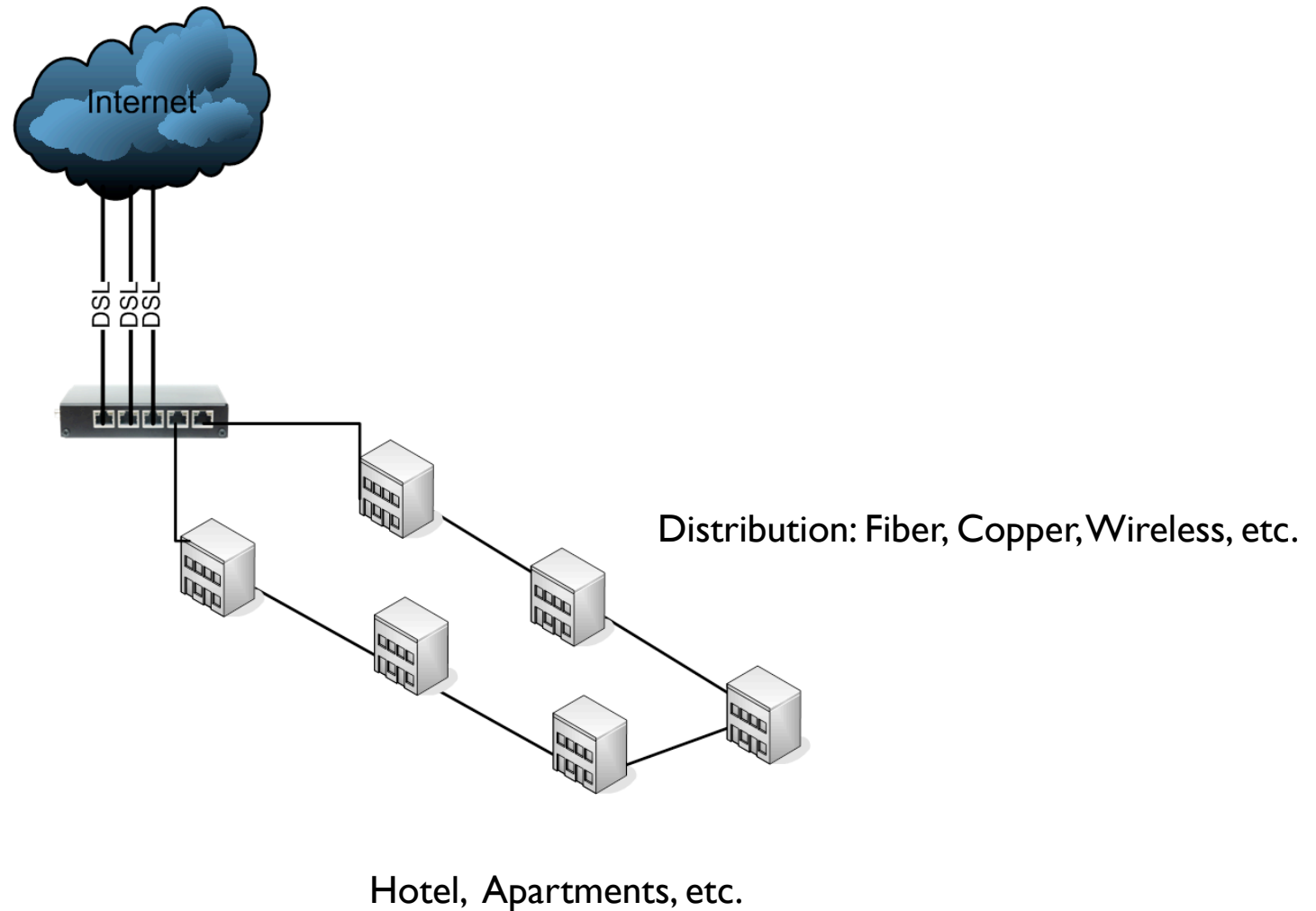
Typical Scenario Requiring Load Balancing

Problem: No high capacity circuits available, DSL only



Typical Scenario Requiring Load Balancing

Solution: Multiple low capacity circuits, RouterOS load balancing



I. What is load balancing and why would I want it?

I. What is load balancing and why would I want it?

- Process to utilize multiple internet connections in such a manner as to proportionately distribute internet traffic across all the connections.

I. What is load balancing and why would I want it?

- Process to utilize multiple internet connections in such a manner as to proportionately distribute internet traffic across all the connections.
- Distribution may be symmetrical or asymmetrical depending on circuit availability.

I. What is load balancing and why would I want it?

- Process to utilize multiple internet connections in such a manner as to proportionately distribute internet traffic across all the connections.
- Distribution may be symmetrical or asymmetrical depending on circuit availability.
- Useful when the downstream bandwidth requirement to a single routing device exceeds the capabilities of a single internet circuit.

Options Available

Load Balancing in General

Options Available

Load Balancing in General

- First, the type of load balancing we are discussing today should not be confused with any type of bonding protocol or sub-packet based load balancing.

Options Available

Load Balancing in General

- First, the type of load balancing we are discussing today should not be confused with any type of bonding protocol or sub-packet based load balancing.
- Bonding, MLPP, etc. require that the protocol be recognized on both the subscriber and provider ends. Not available with commodity internet connections.

Options Available

Load Balancing in General

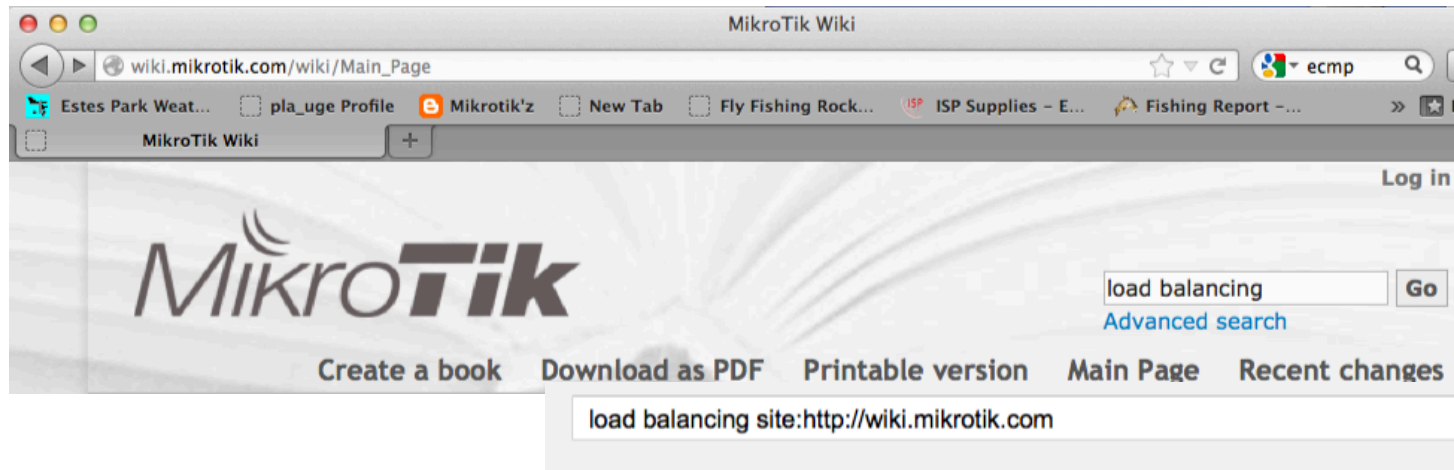
- First, the type of load balancing we are discussing today should not be confused with any type of bonding protocol or sub-packet based load balancing.
- Bonding, MLPP, etc. require that the protocol be recognized on both the subscriber and provider ends. Not available with commodity internet connections.
- Can't simply bridge two DSL or Cable modem connections, doesn't work.

Options Available

Load Balancing in General

- First, the type of load balancing we are discussing today should not be confused with any type of bonding protocol or sub-packet based load balancing.
- Bonding, MLPP, etc. require that the protocol be recognized on both the subscriber and provider ends. Not available with commodity internet connections.
- Can't simply bridge two DSL or Cable modem connections, doesn't work.
- There are several methods to provide load balancing in RouterOS.

Example



88 hits!

Ads related to [load balancing site:http://wiki.mikrotik.com](http://wiki.mikrotik.com) [Why these ads?](#)

[Load Balancing Solution | BarracudaNetworks.com](#)
www.barracudanetworks.com/
Easy-To-Use Appliance Distributes Network Traffic Across Servers.

[Load Balancing 101 | f5.com](#)
www.f5.com/load_balancing
Learn the 'Nuts & Bolts' of **Load Balancing** with F5's White Paper

[Citrix® Load Balancer | Citrix.com](#)
www.citrix.com/NetScaler
5X Capacity On-Demand App Delivery. 10+ Free **Load Balancing** Whitepapers
Choose Your NetScaler Trial - How NetScaler Helps Your Business

[ECMP load balancing with masquerade - MikroTik Wiki](#)
wiki.mikrotik.com/wiki/ECMP_load_balancing_with_masquerade
Apr 7, 2009 – This example is improved (different) version of round-robin **load balancing** example. It adds persistent user sessions, i.e. a particular user ...

[Per-Traffic Load Balancing - MikroTik Wiki](#)
wiki.mikrotik.com/wiki/Per-Traffic_Load_Balancing
Sep 3, 2010 – As a result of this limitation **load-balancing** multiple internet backbone

Options Available

Load Balancing Options With RouterOS:

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections
- **Hybrid / Custom Setups** - Solutions based on one or more methods above with the addition of scripts or policy routing to make the solution more intelligent.

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections
- **Hybrid / Custom Setups** - Solutions based on one or more methods above with the addition of scripts or policy routing to make the solution more intelligent.
- **Bandwidth based load balancing** - MPLS, Traffic Engineering, etc.

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections
- **Hybrid / Custom Setups** - Solutions based on one or more methods above with the addition of scripts or policy routing to make the solution more intelligent.
- **Bandwidth based load balancing** - MPLS, Traffic Engineering, etc.
- **PCC** - Per Connection Classifier

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections
- **Hybrid / Custom Setups** - Solutions based on one or more methods above with the addition of scripts or policy routing to make the solution more intelligent.
- **Bandwidth based load balancing** - MPLS, Traffic Engineering, etc.
- **PCC** - Per Connection Classifier
 - Simple, effective, scalable, no nasty side effects

Options Available

Load Balancing Options With RouterOS:

- **ECMP** - Equal Cost Multi-Path Routing
 - Per-address pair load balancing
 - Doesn't work well for certain protocols, connections break when routing table flushes every ten minutes to prevent DOS attacks
- **Nth Load Balancing** - Per connection load balancing, with the addition of persistent connections
- **Hybrid / Custom Setups** - Solutions based on one or more methods above with the addition of scripts or policy routing to make the solution more intelligent.
- **Bandwidth based load balancing** - MPLS, Traffic Engineering, etc.
- **PCC** - Per Connection Classifier
 - Simple, effective, scalable, no nasty side effects
 - Per-address pair load balancing method

2. How does it work?

2. How does it work?

- PCC divides the incoming data into streams and then uses routing rules to sort the traffic evenly (or not) across multiple WAN connections.

2. How does it work?

- PCC divides the incoming data into streams and then uses routing rules to sort the traffic evenly (or not) across multiple WAN connections.
- This is done by:

2. How does it work?

- PCC divides the incoming data into streams and then uses routing rules to sort the traffic evenly (or not) across multiple WAN connections.
- This is done by:
 1. Using a hashing algorithm to first sort the traffic based on source address, source port, destination address, destination port or various combinations thereof.

2. How does it work?

- PCC divides the incoming data into streams and then uses routing rules to sort the traffic evenly (or not) across multiple WAN connections.
- This is done by:
 1. Using a hashing algorithm to first sort the traffic based on source address, source port, destination address, destination port or various combinations thereof.
 2. Using packet marking and routing marks and several routing tables to ensure traffic follows a specified route out the specified WAN interface.

2. How does it work?

- PCC divides the incoming data into streams and then uses routing rules to sort the traffic evenly (or not) across multiple WAN connections.
- This is done by:
 1. Using a hashing algorithm to first sort the traffic based on source address, source port, destination address, destination port or various combinations thereof.
 2. Using packet marking and routing marks and several routing tables to ensure traffic follows a specified route out the specified WAN interface.

Understand the Solution

Understand the Solution

- MikroTik RouterOS is extremely powerful and configurable, so this can be a double edged sword, several possible solutions to the same problem

Understand the Solution

- MikroTik RouterOS is extremely powerful and configurable, so this can be a double edged sword, several possible solutions to the same problem
- Each has multiple moving pieces

Understand the Solution

- MikroTik RouterOS is extremely powerful and configurable, so this can be a double edged sword, several possible solutions to the same problem
- Each has multiple moving pieces
- Greatest success with any solution by understanding the pieces and what they do.

Understanding the PCC Load Balancing Solution

Terms...

Understanding the PCC Load Balancing Solution

Terms...

I. **Packet** - The container for our data, header and payload.

Understanding the PCC Load Balancing Solution

Terms...

1. **Packet** - The container for our data, header and payload.
2. **Connections** - “Conduit” through which host to host communication occurs, based on Src/Dst addresses and ports

Understanding the PCC Load Balancing Solution

Terms...

1. **Packet** - The container for our data, header and payload.
2. **Connections** - “Conduit” through which host to host communication occurs, based on Src/Dst addresses and ports
3. **Mangle Facility** - Firewall function within RouterOS that allows you to create a mark which is then associated with packets that can be identified later by other functions like firewall rules or routing tables.

Understanding the PCC Load Balancing Solution

Understanding the PCC Load Balancing Solution

4. **PCC** - Per Connection Classifier, function contained with the “Mangle Facility” to sort traffic into streams

Understanding the PCC Load Balancing Solution

4. **PCC** - Per Connection Classifier, function contained with the “Mangle Facility” to sort traffic into streams
5. **Routing Table** - Route rules, the rules the router uses to determine what to do with a packet. By comparing the destination address in the packet to the list of routes, the router decides which interface to send the packet out. By adding a routing mark with mangle, we can have multiple routing tables!

Understanding the PCC Load Balancing Solution

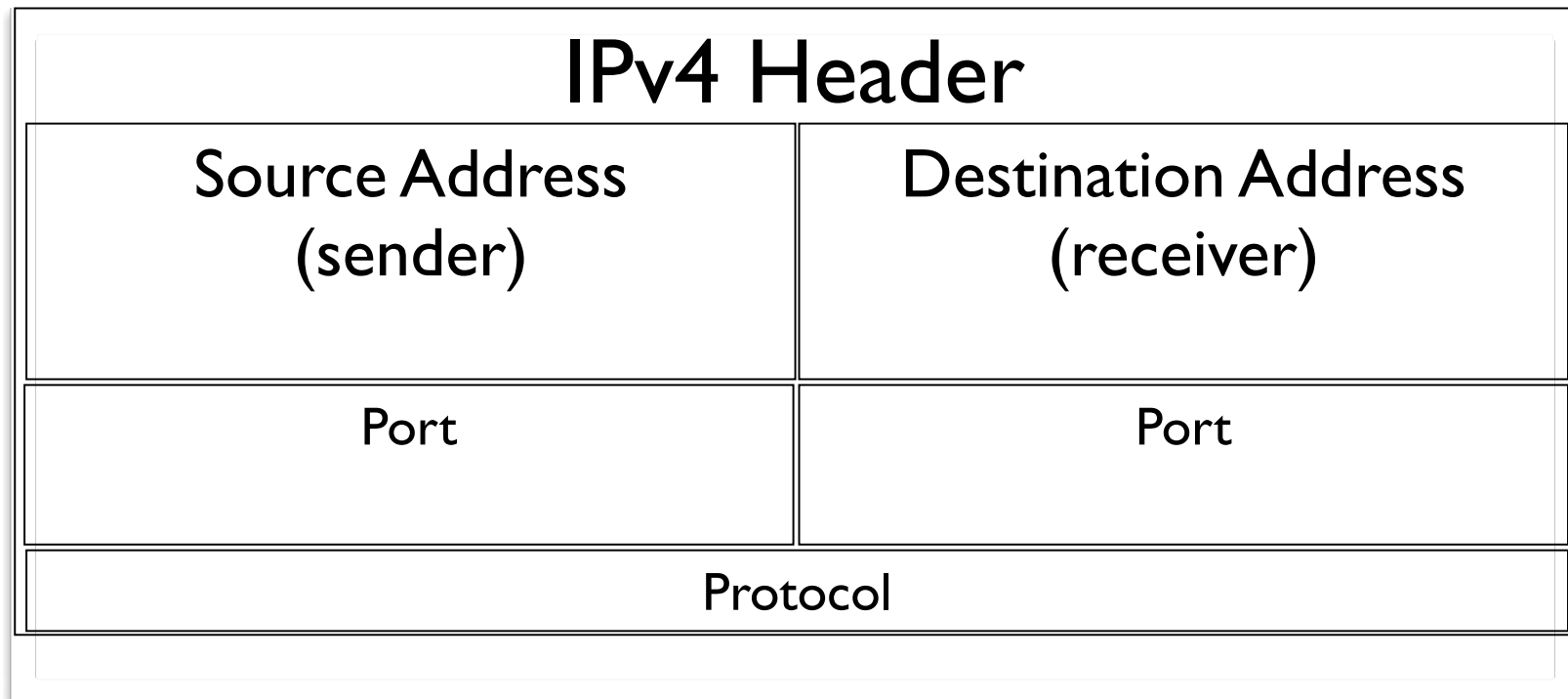
1. What is a packet?

A packet is like a letter & envelope.

The front is the header and the letter inside the envelope is the payload.

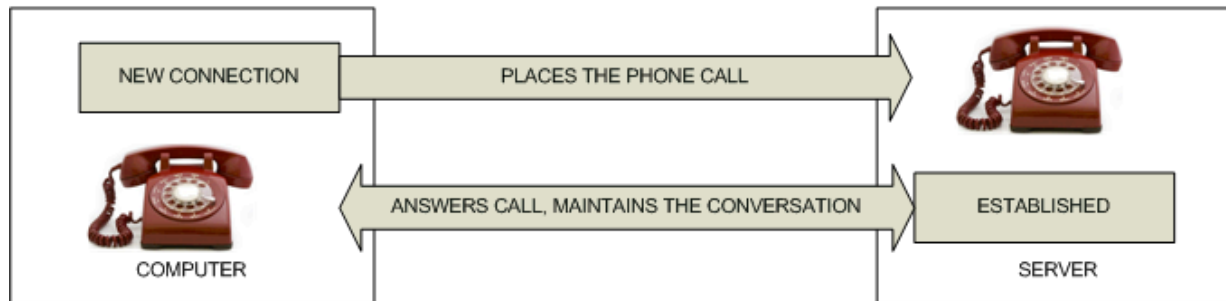


Understanding the PCC Load Balancing Solution

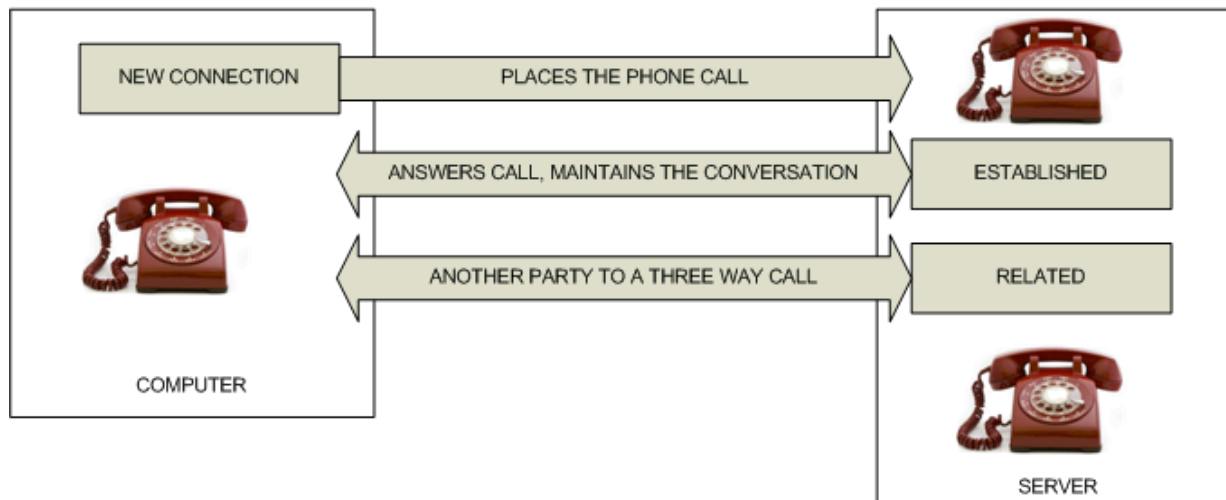


Understanding the PCC Load Balancing Solution

2. What are connections?



Connections are always in one of three states - new, established, or related.



Understanding the PCC Load Balancing Solution

3. What is the mangle facility?

If - Then: Identify and then perform some action.

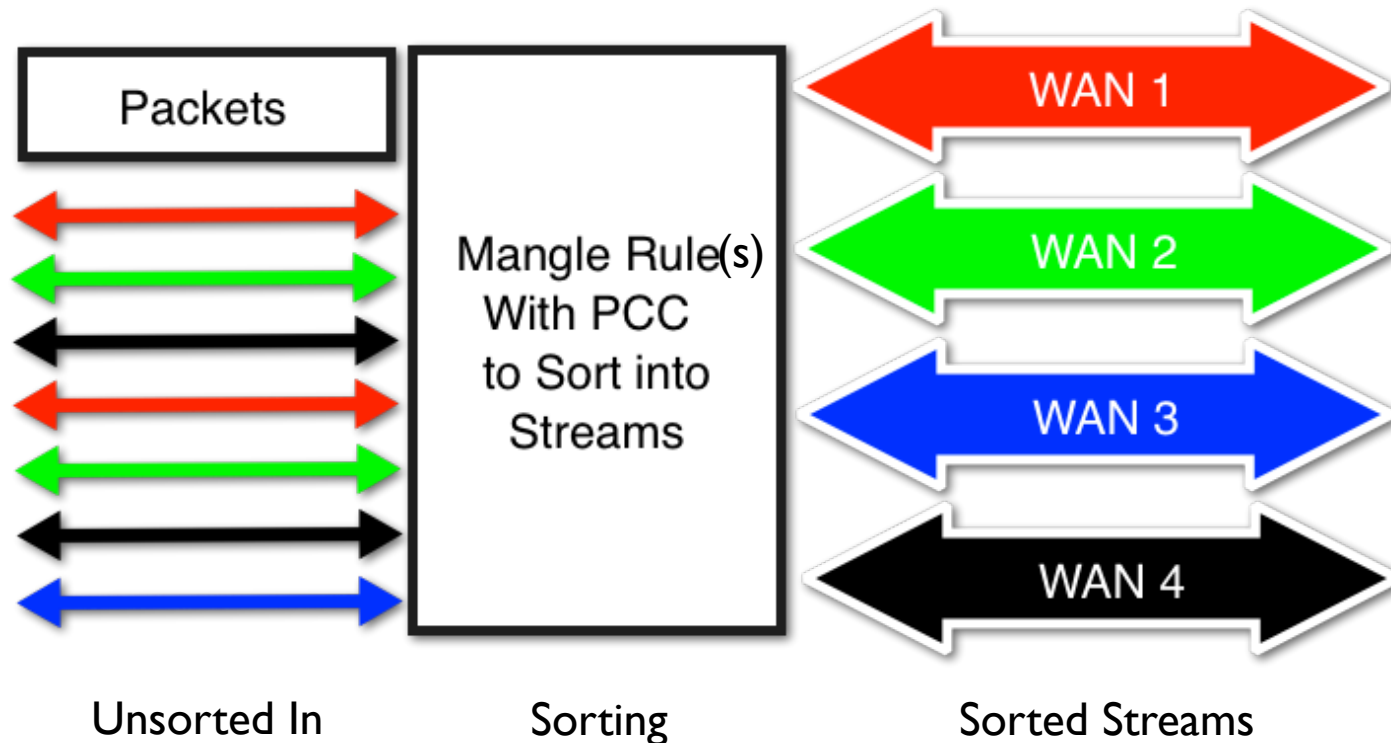
The screenshot shows the Mikrotik WinBox Firewall configuration interface. The 'Mangle' tab is selected, displaying a list of rules. A 'New Mangle Rule' dialog box is open, showing the 'General' tab with 'Chain' set to 'prerouting'. A callout box explains the 'If-Then' logic: 'If - Then: Identify and then perform some action.'

| # | Action | Chain | Any. Port | Ro... | Src. Ad... | Ds... | New Packet Mark | New Connection ... | Bytes | Packets |
|----|-------------------|------------|-----------|-------|------------|-------|-----------------|--------------------|----------|---------|
| 5 | passthrough | prerouting | | | | | | | 13.0 GiB | 40 88 |
| 6 | jump | prerout | | | | | | | | |
| 10 | mark connection | prerout | | | | | | | | |
| 11 | mark connection | prerout | | | | | | | | |
| 12 | mark connection | prerout | | | | | | | | |
| 13 | mark connection | prerout | | | | | | | | |
| 14 | mark connection | prerout | | | | | | | | |
| 15 | change DSCP (TOS) | prerout | | | | | | | | |
| 16 | mark connection | prerout | | | | | | | | |

Understanding the PCC Load Balancing Solution

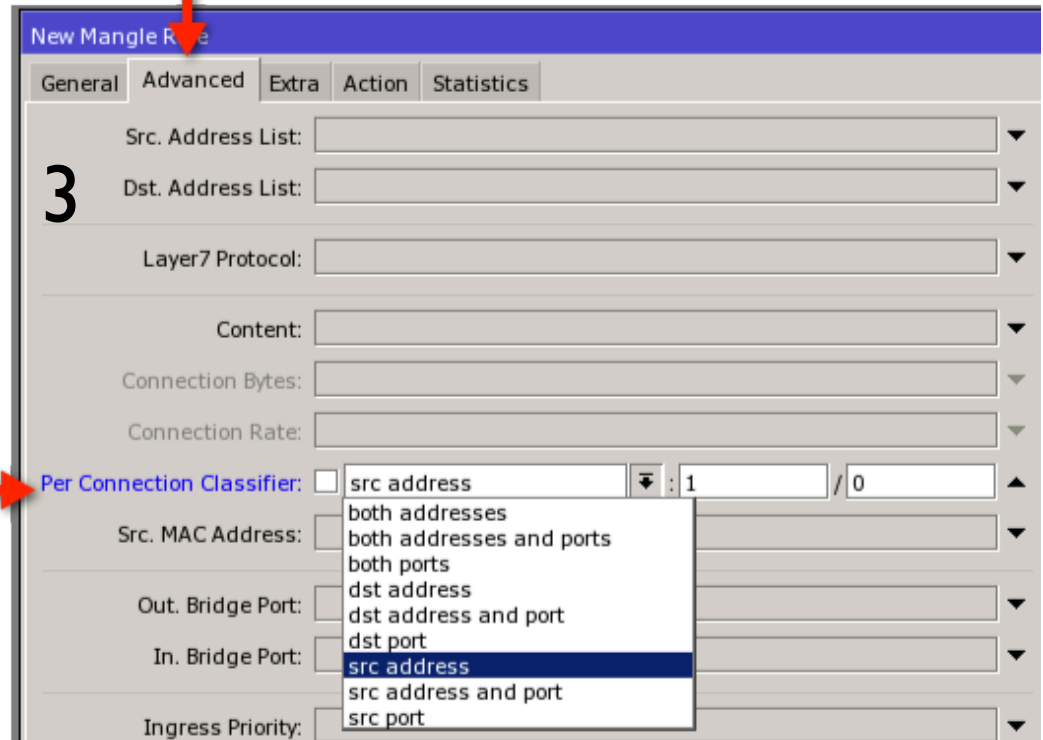
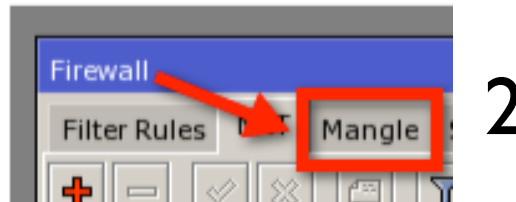
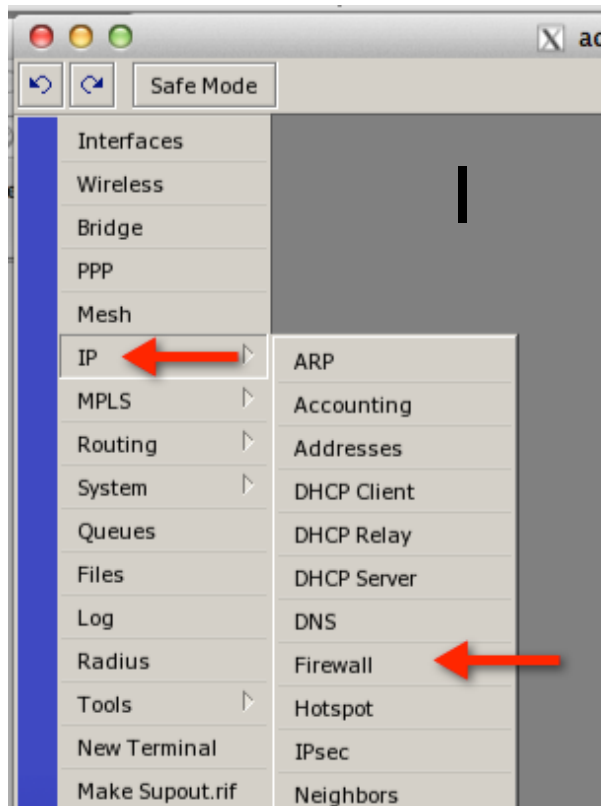
4. What is PCC?

Per Connection Classifier is a mangle option that sorts data into streams that can be marked for identification later.



Understanding the PCC Load Balancing Solution

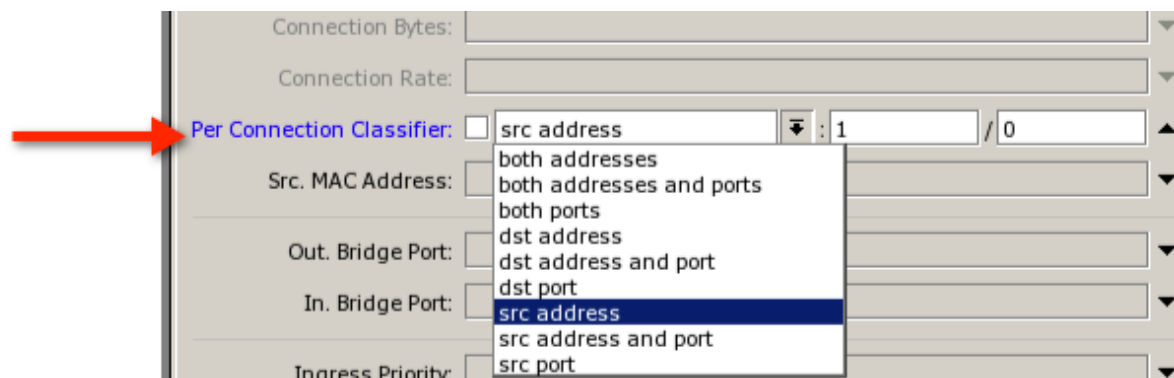
Where is it found?



Understanding the PCC Load Balancing Solution

How does PCC work?

- "PCC takes selected fields from IP header, and with the help of a hashing algorithm converts selected fields into 32-bit value.
- This value then is divided by a Denominator and the Remainder then is compared to a specified Remainder, if equal then packet will be captured.
- You can choose from src-address, dst-address, src-port, dst-port (or various combinations) from the header to use in this operation."



Understanding the PCC Load Balancing Solution

PCC uses a hashing algorithm.

- A hashing algorithm is a mathematical function that takes an input and returns an output.
- The output will always be the same for a specified input.
- Example of a simple hash:

Input x 100 = hash value

Understanding the PCC Load Balancing Solution

PCC uses modular arithmetic (clock arithmetic).

- Numerators, Denominators and Remainders are parts of modular arithmetic.
- It is represented by a % sign and it is spoken as “mod”.
- To work modular math, think of it as "how many are left over (Remainder) after you've subtracted the second value (Denominator) from the first (Numerator) as many times as possible without going negative?"
- Here are some examples of modular math:

Numerator = 3 Denominator = 3

$3 \% 3 = 0$ because $3 - 3 = 0$ left over

or

$4 \% 3 = 1$ because $4 - 3 = 1$ left over

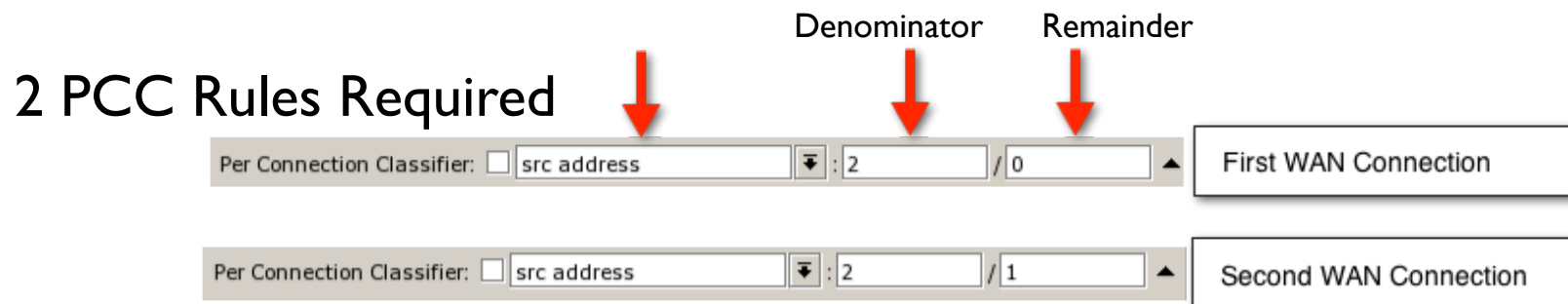
$5 \% 3 = 2$ because $5 - 3 = 2$ left over

$6 \% 3 = 0$, because $6 - 3 = 3$, subtract 3 again = 0 left over

Understanding the PCC Load Balancing Solution

Modular math helps us understand how to create the PCC rules!

Example: 2 WAN Connections



- The first line means "produce the output of the hash function given the packet's source IP address, divide it by 2 and if the remainder is 0, perform the action of marking the connection as WAN1".
- The second line means "produce the output of the hash function given the packet's source IP address, divide it by 2 and if the remainder is 1, perform the action of marking the connection as WAN2".

Understanding the PCC Load Balancing Solution

How to set PCC, Remember:

2 WAN connections:

2 / 0 First WAN

2 / 1 Second WAN

3 WAN connections:

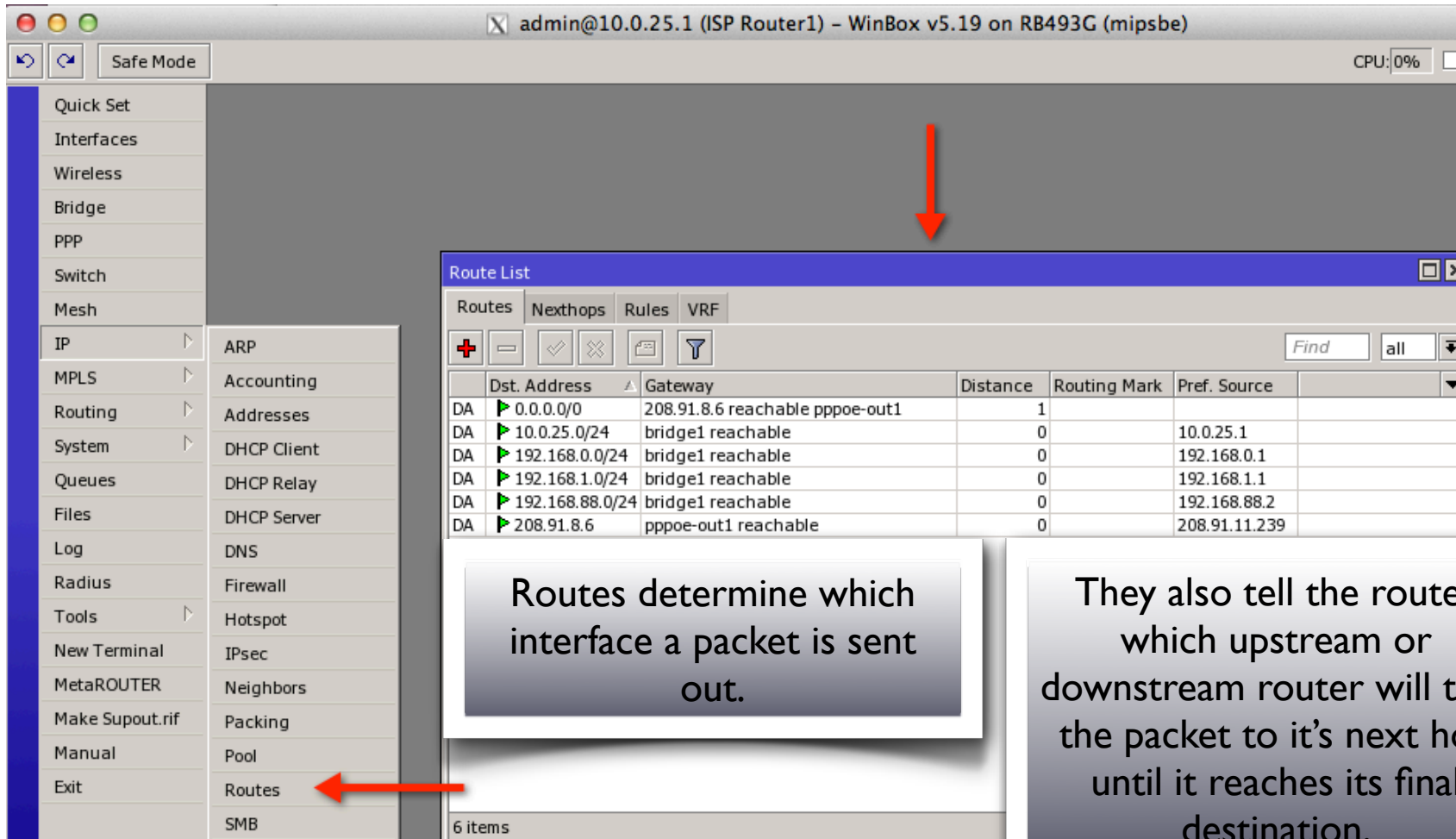
3 / 0 First WAN

3 / 1 Second WAN

3 / 2 Third WAN and so on...

Understanding the PCC Load Balancing Solution

5. What is a routing table?



The screenshot shows the WinBox interface for an ISP Router. The 'Route List' window is open, displaying a table of routes. The table has columns for Dst. Address, Gateway, Distance, Routing Mark, and Pref. Source. The routes listed are:

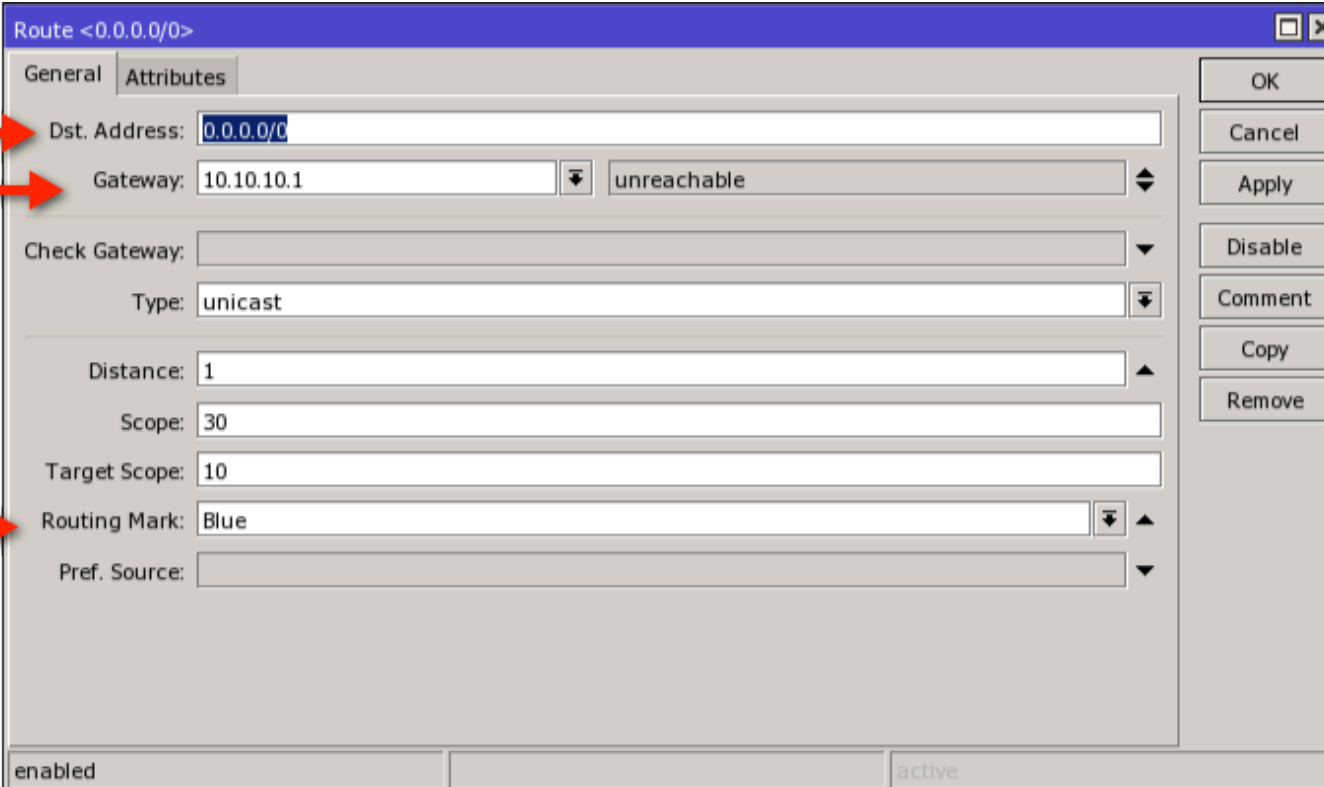
| Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|-----------------|---------------------------------|----------|--------------|---------------|
| 0.0.0.0/0 | 208.91.8.6 reachable pppoe-out1 | 1 | | |
| 10.0.25.0/24 | bridge1 reachable | 0 | | 10.0.25.1 |
| 192.168.0.0/24 | bridge1 reachable | 0 | | 192.168.0.1 |
| 192.168.1.0/24 | bridge1 reachable | 0 | | 192.168.1.1 |
| 192.168.88.0/24 | bridge1 reachable | 0 | | 192.168.88.2 |
| 208.91.8.6 | pppoe-out1 reachable | 0 | | 208.91.11.239 |

Two callout boxes provide additional information:

- Routes determine which interface a packet is sent out.**
- They also tell the router which upstream or downstream router will take the packet to its next hop until it reaches its final destination.**

Understanding the PCC Load Balancing Solution

Details of a route, key pieces are destination and gateway.



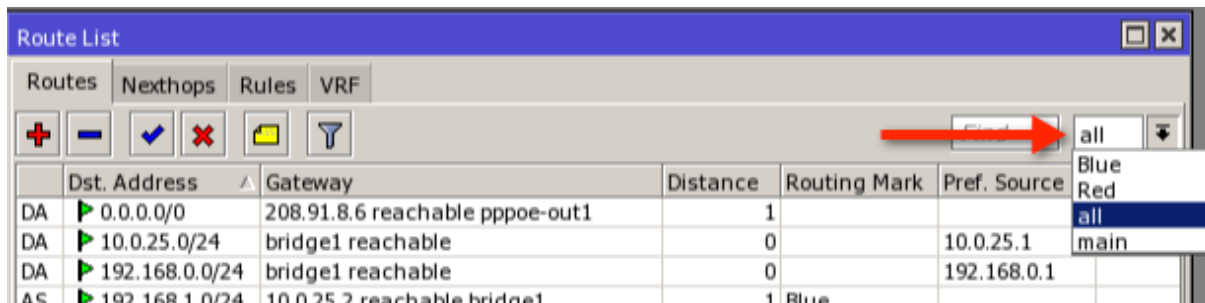
The screenshot shows the Mikrotik Route configuration window for the destination 0.0.0.0/0. The window has two tabs: 'General' and 'Attributes'. The 'General' tab is active. The configuration fields are as follows:

- Dst. Address:** 0.0.0.0/0 (highlighted with a red arrow)
- Gateway:** 10.10.10.1 (highlighted with a red arrow)
- Check Gateway:** (empty)
- Type:** unicast
- Distance:** 1
- Scope:** 30
- Target Scope:** 10
- Routing Mark:** Blue (highlighted with a red arrow)
- Pref. Source:** (empty)

On the right side of the window, there are several buttons: OK, Cancel, Apply, Disable, Comment, Copy, and Remove. At the bottom of the window, there are two status indicators: 'enabled' and 'active'.

Understanding the PCC Load Balancing Solution

Multiple routing tables with route marks



The screenshot shows the Mikrotik WinBox 'Route List' window. The 'Routing Mark' column has a dropdown menu open, with a red arrow pointing to it. The dropdown menu contains the following options: 'all', 'Blue', 'Red', 'all', and 'main'. The table below shows several routes with their respective destinations, gateways, distances, and routing marks.

| | Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|----|----------------|---------------------------------|----------|--------------|--------------|
| DA | 0.0.0.0/0 | 208.91.8.6 reachable pppoe-out1 | 1 | | |
| DA | 10.0.25.0/24 | bridge1 reachable | 0 | | 10.0.25.1 |
| DA | 192.168.0.0/24 | bridge1 reachable | 0 | | 192.168.0.1 |
| AS | 192.168.1.0/24 | 10.0.25.2 reachable bridge1 | 1 | Blue | |

May have multiple routes to same destination network, different gateways in different routing tables!

Understanding the PCC Load Balancing Solution

Multiple routing tables with route marks

May have multiple routes to same destination network, different gateways in different routing tables!

The image displays two screenshots of the Mikrotik WinBox 'Route List' window. The top screenshot shows a dropdown menu for the 'Find' field with options 'all', 'Blue', 'Red', 'all', and 'main'. A red arrow points to the 'all' option. The bottom screenshot shows the 'Find' field set to 'main', which is highlighted with a red box.

| DA | Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|----|-----------------|---------------------------------|----------|--------------|---------------|
| DA | 0.0.0.0/0 | 208.91.8.6 reachable pppoe-out1 | 1 | | |
| DA | 10.0.25.0/24 | bridge1 reachable | 0 | | 10.0.25.1 |
| DA | 192.168.0.0/24 | bridge1 reachable | 0 | | 192.168.0.1 |
| DA | 192.168.1.0/24 | bridge1 reachable | 0 | | 192.168.1.1 |
| DA | 192.168.88.0/24 | bridge1 reachable | 0 | | 192.168.88.2 |
| DA | 208.91.8.6 | pppoe-out1 reachable | 0 | | 208.91.11.239 |

Understanding the PCC Load Balancing Solution

Multiple routing tables with route marks

May have multiple routes to same destination network, different gateways in different routing tables!

The image shows three overlapping screenshots of the Mikrotik WinBox 'Route List' window, illustrating how different routing tables are filtered. The top window shows a list of routes with a dropdown menu open, showing options: 'all', 'Blue', 'Red', 'all', and 'main'. A red arrow points to the 'all' option. The middle window shows the same window with the dropdown set to 'main' and highlighted with a red box. The bottom window shows the same window with the dropdown set to 'Red' and highlighted with a red box. The table below shows the routes for the 'Red' filter.

| Src | Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|-----|----------------|-----------------------------|----------|--------------|--------------|
| AS | 192.168.4.0/24 | 10.0.25.2 reachable bridge1 | 1 | Red | |
| AS | 192.168.5.0/24 | 10.0.25.2 reachable bridge1 | 1 | Red | |

Understanding the PCC Load Balancing Solution

Multiple routing tables with route marks

May have multiple routes to same destination network, different gateways in different routing tables!

The image displays four overlapping screenshots of the Mikrotik WinBox 'Route List' window, illustrating how different routing tables are filtered to show specific route marks.

- Top Window:** Shows a list of routes. A red arrow points to the 'Find' dropdown menu, which is open and shows options: 'all', 'Blue', 'Red', 'all', and 'main'.
- Second Window:** Shows the same route list. The 'Find' dropdown is set to 'main' and is highlighted with a red box.
- Third Window:** Shows the same route list. The 'Find' dropdown is set to 'Red' and is highlighted with a red box.
- Bottom Window:** Shows the same route list. The 'Find' dropdown is set to 'Blue' and is highlighted with a red box. The table below shows routes with a 'Blue' routing mark.

| Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|-------------------|-----------------------------|----------|--------------|--------------|
| AS 192.168.1.0/24 | 10.0.25.2 reachable bridge1 | 1 | Blue | |
| AS 192.168.2.0/24 | 10.0.25.2 reachable bridge1 | 1 | Blue | |
| AS 192.168.3.0/24 | 10.0.25.2 reachable bridge1 | 1 | Blue | |

Understanding the PCC Load Balancing Solution

Review:

Understanding the PCC Load Balancing Solution

Review:

I. **Packet** - Container for IP data

Understanding the PCC Load Balancing Solution

Review:

1. **Packet** - Container for IP data
2. **Connections** - Bi-directional conduit for communication between two hosts

Understanding the PCC Load Balancing Solution

Review:

1. **Packet** - Container for IP data
2. **Connections** - Bi-directional conduit for communication between two hosts
3. **Mangle Facility** - Manipulates packets by adding marks

Understanding the PCC Load Balancing Solution

Review:

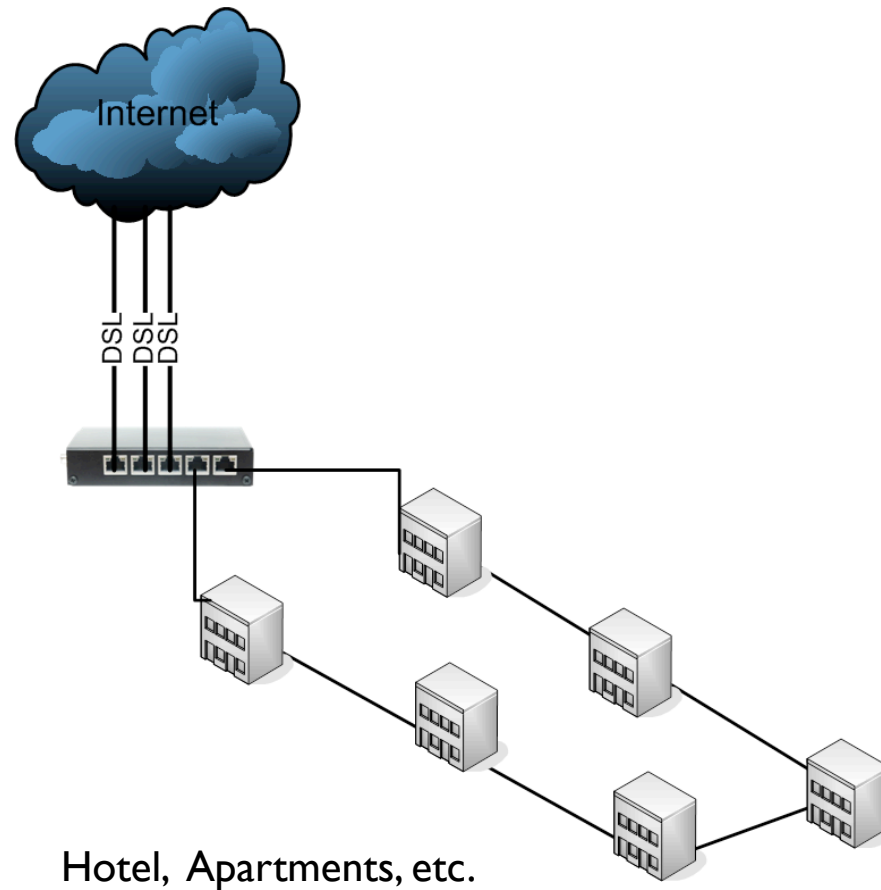
1. **Packet** - Container for IP data
2. **Connections** - Bi-directional conduit for communication between two hosts
3. **Mangle Facility** - Manipulates packets by adding marks
4. **PCC** - Divides data into streams (based on marks)

Understanding the PCC Load Balancing Solution

Review:

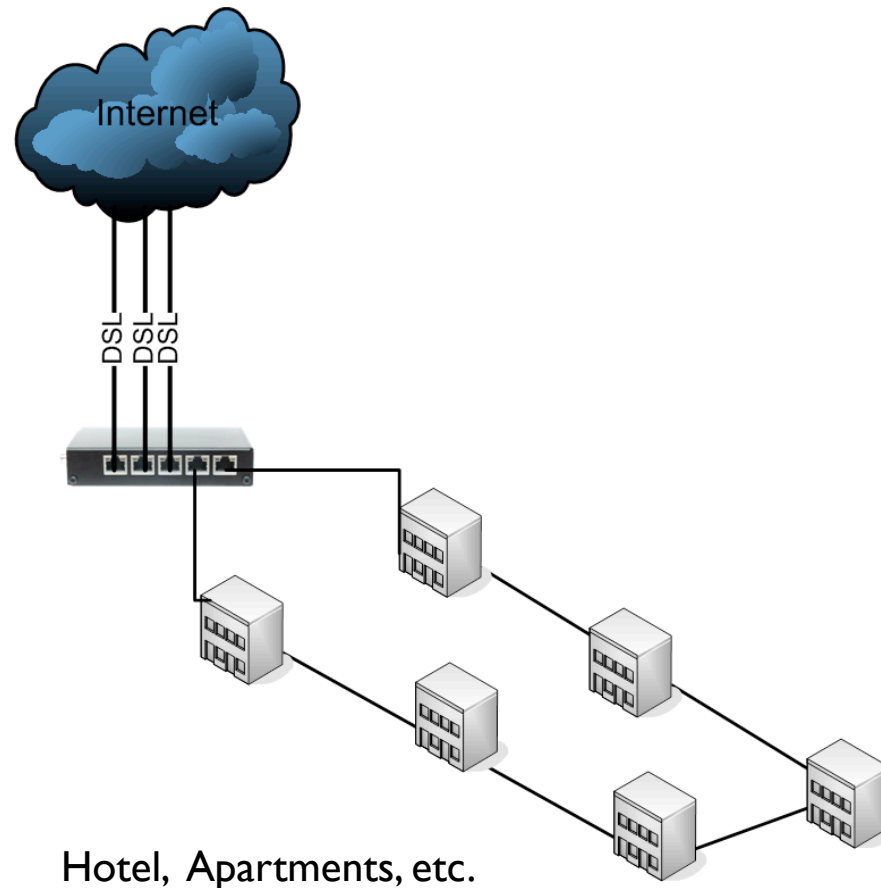
1. **Packet** - Container for IP data
2. **Connections** - Bi-directional conduit for communication between two hosts
3. **Mangle Facility** - Manipulates packets by adding marks
4. **PCC** - Divides data into streams (based on marks)
5. **Routing Table** - List of route rules to direct packets and we can have multiple tables based on routing marks

3. Ok, I want it but how do I set it up?



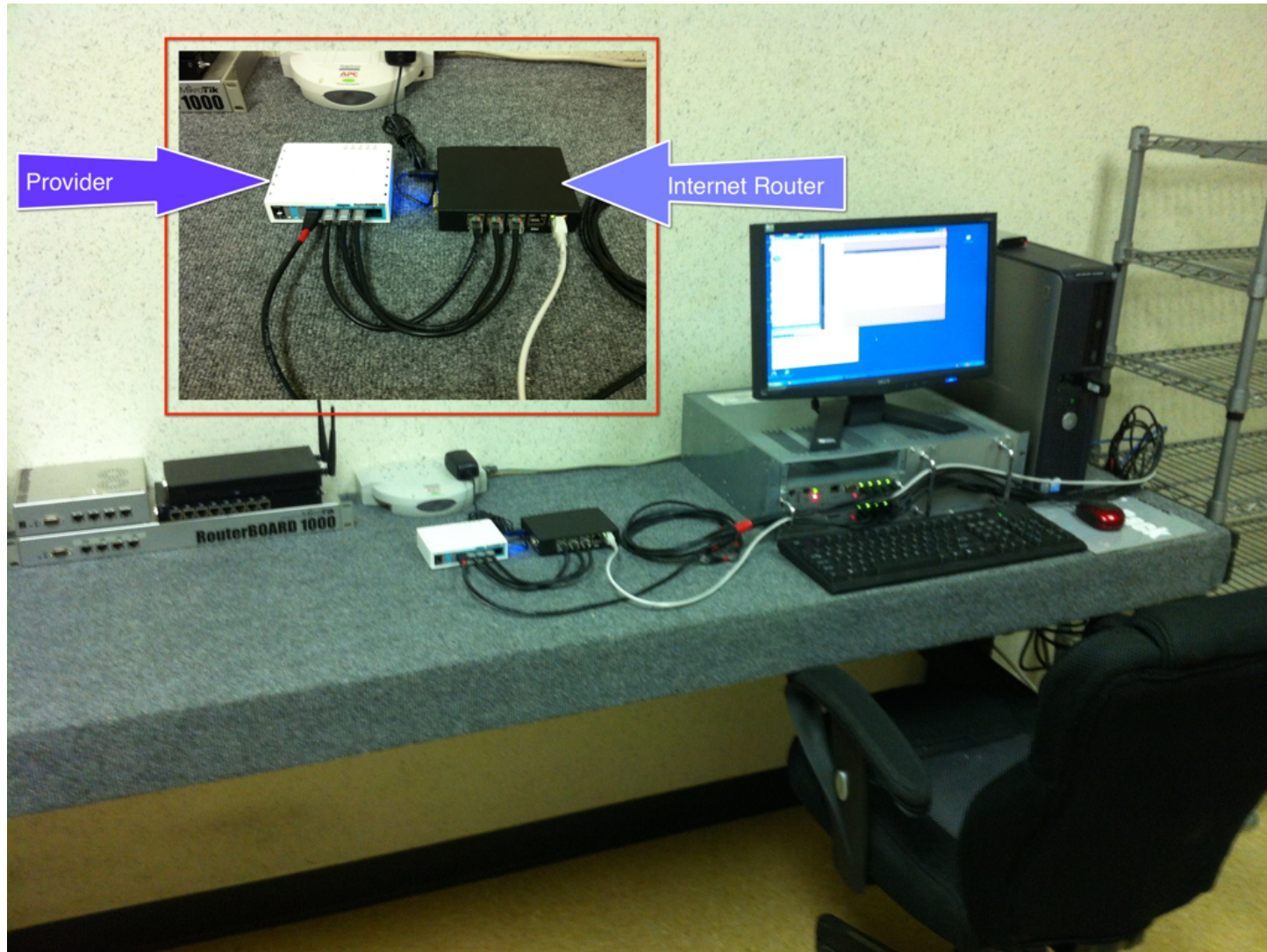
3. Ok, I want it but how do I set it up?

Scenario: One router, many clients, three DSL connections



Step by Step Configuration

Test Setup



Step by Step Configuration

I. Set up the basic portion of the network (MTCNA, Wiki, etc):

- Private IP address on LAN interface
- DHCP Server on LAN interface
- DNS server
- Static IP for WAN or DHCP client on WAN
- Firewall if required

Step by Step Configuration

1. Set up the basic portion of the network (MTCNA, Wiki, etc):

- Private IP address on LAN interface
- DHCP Server on LAN interface
- DNS server
- Static IP for WAN or DHCP client on WAN
- Firewall if required

2. Create load balancing part of the configuration:

- Mangle rules
- Routing tables

Step by Step Configuration

1. Set up the basic portion of the network (MTCNA, Wiki, etc):

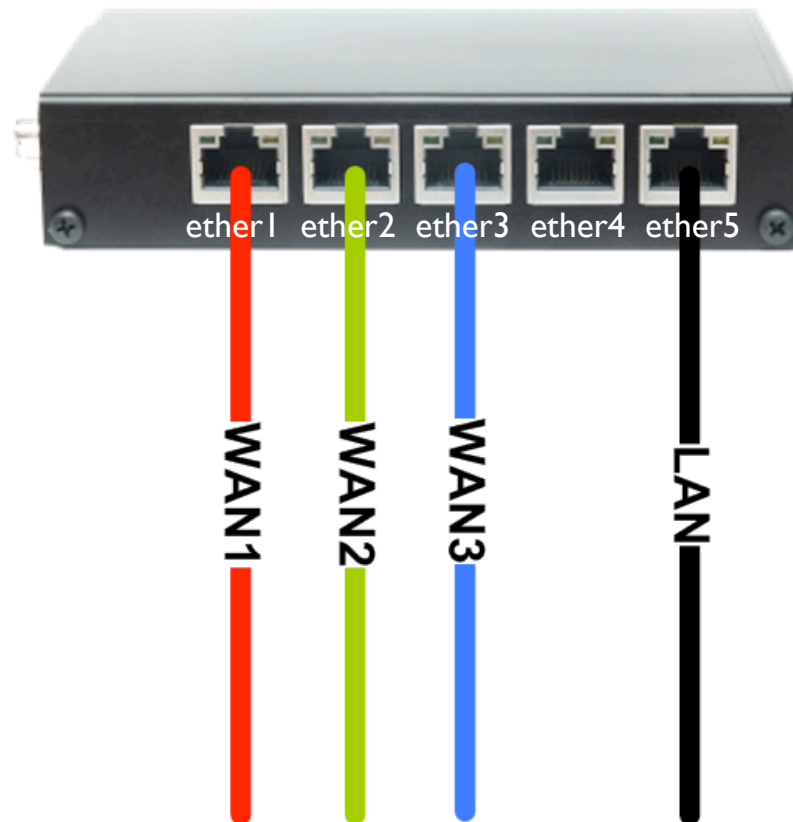
- Private IP address on LAN interface
- DHCP Server on LAN interface
- DNS server
- Static IP for WAN or DHCP client on WAN
- Firewall if required

2. Create load balancing part of the configuration:

- Mangle rules
- Routing tables

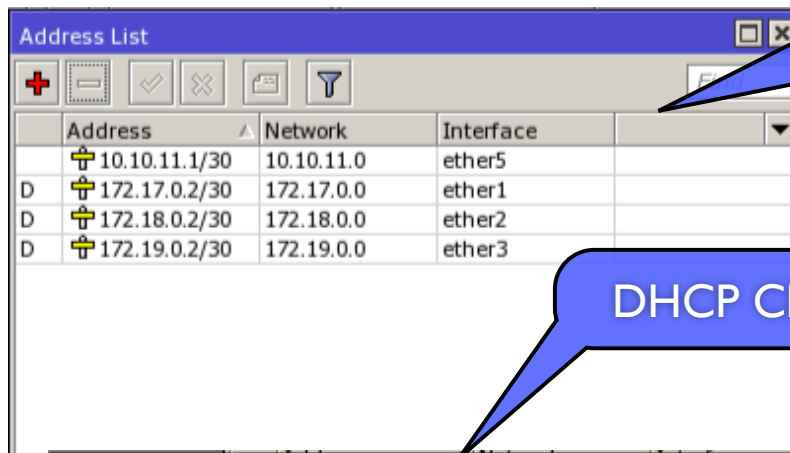
Step by Step Configuration

Physical interface connections



Step by Step Configuration

I. Set up the basic portion of the network (MTCNA, Wiki, etc):

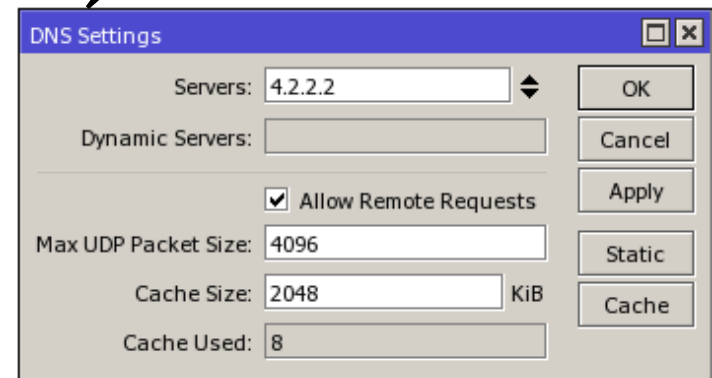


Address List

| Address | Network | Interface |
|-----------------|------------|-----------|
| 10.10.11.1/30 | 10.10.11.0 | ether5 |
| D 172.17.0.2/30 | 172.17.0.0 | ether1 |
| D 172.18.0.2/30 | 172.18.0.0 | ether2 |
| D 172.19.0.2/30 | 172.19.0.0 | ether3 |

IP Addresses

DNS Client & Caching



DNS Settings

Servers: 4.2.2.2

Dynamic Servers:

Allow Remote Requests

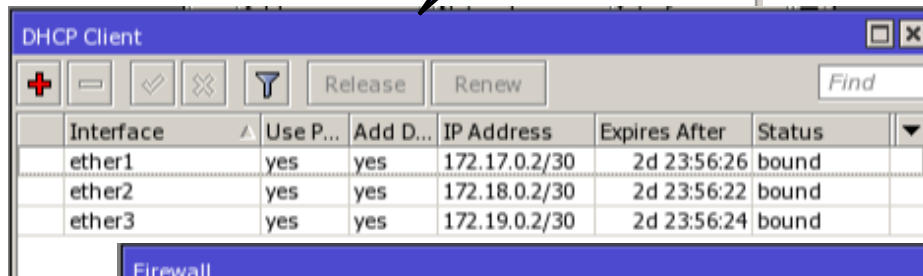
Max UDP Packet Size: 4096

Cache Size: 2048 KiB

Cache Used: 8

Buttons: OK, Cancel, Apply, Static, Cache

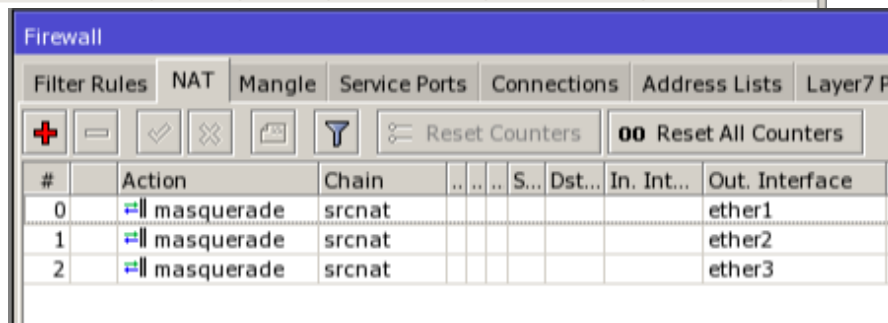
DHCP Client - WAN



DHCP Client

| Interface | Use P... | Add D... | IP Address | Expires After | Status |
|-----------|----------|----------|---------------|---------------|--------|
| ether1 | yes | yes | 172.17.0.2/30 | 2d 23:56:26 | bound |
| ether2 | yes | yes | 172.18.0.2/30 | 2d 23:56:22 | bound |
| ether3 | yes | yes | 172.19.0.2/30 | 2d 23:56:24 | bound |

Masquerade Rules



Firewall

Filter Rules NAT Mangle Service Ports Connections Address Lists Layer7 P...

Reset Counters 00 Reset All Counters

| # | Action | Chain | In. Int... | Out. Interface |
|---|------------|--------|------------|----------------|
| 0 | masquerade | srcnat | | ether1 |
| 1 | masquerade | srcnat | | ether2 |
| 2 | masquerade | srcnat | | ether3 |

Step by Step Configuration

2. Create load balancing part of the configuration:

- Create various mangle rules to mark connections
- Create mangle rules to associate routing marks with packets based on their connection mark.
- Create routes to send traffic out the WAN connections in a predetermined manner.

Step by Step Configuration

Step 1: Create some accept rules.

We have to manually force local traffic to connected networks to stay in the main routing table.

- Background - Any subnet for which the router has an IP address configured is called a connected network, meaning packets to that network are sent out an interface and can reach their destination without using another router to get there.

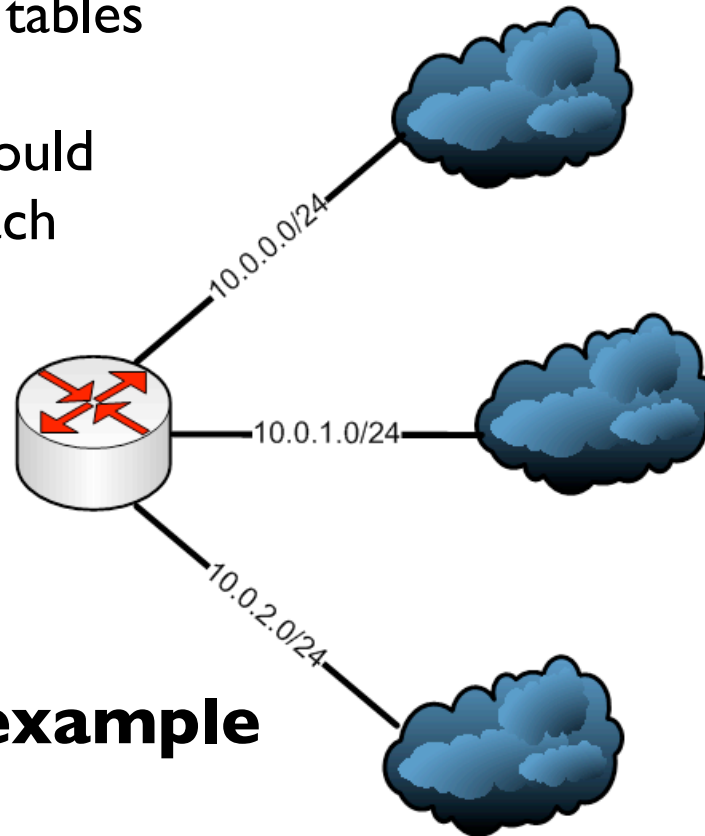
Step by Step Configuration

Step 1 continued...

The problem using mangles here is it will force traffic to follow alternate routing tables (not main)

Traffic to these connected networks would go out the WAN interfaces and not reach their intended destinations.

10.0.0.1/24
10.0.1.1/24
10.0.2.1/24



Connected network example

Step by Step Configuration

Step 1 continued...

Solution:

- The “accept” action causes the packet to leave the mangle chain, thereby not marking it and allowing that traffic to use the main routing table.

Step by Step Configuration

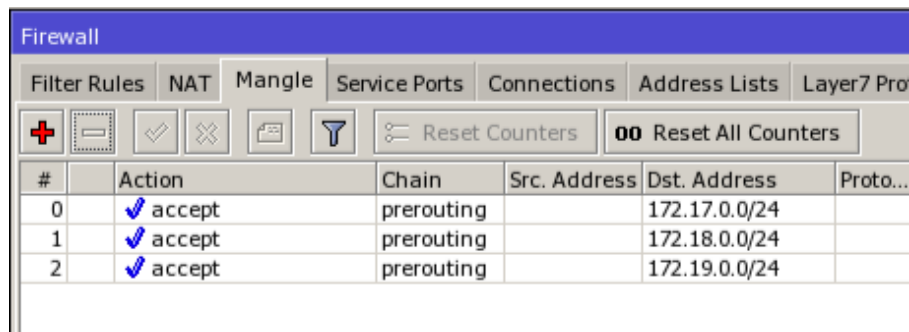
Step 1 continued...

The image shows three overlapping Mikrotik WinBox configuration windows for Mangle Rules. Each window is titled 'Mangle Rule <[IP Address]/24>'. The first window is for 172.17.0.0/24, the second for 172.18.0.0/24, and the third for 172.19.0.0/24. All three windows have the 'Chain' field set to 'prerouting'. The 'Dst. Address' field is set to the respective network address. The 'Action' field in the third window is set to 'accept'. The windows are arranged in a staggered fashion, with the third window in the foreground.

- One rule for each connected network, in this example these are our WAN networks

Step by Step Configuration

Step 1 Completed



The screenshot shows the Mikrotik WinBox Firewall configuration interface, specifically the Mangle tab. It displays three rules in a table:

| # | Action | Chain | Src. Address | Dst. Address | Proto... |
|---|----------|------------|--------------|---------------|----------|
| 0 | ✓ accept | prerouting | | 172.17.0.0/24 | |
| 1 | ✓ accept | prerouting | | 172.18.0.0/24 | |
| 2 | ✓ accept | prerouting | | 172.19.0.0/24 | |

Create one rule for
each connected
network (WAN's)

Completed accept
mangle rules

```
/ip firewall mangle
add action=accept chain=prerouting disabled=no dst-address=172.17.0.0/24
add action=accept chain=prerouting disabled=no dst-address=172.18.0.0/24
add action=accept chain=prerouting disabled=no dst-address=172.19.0.0/24
```

Step by Step Configuration

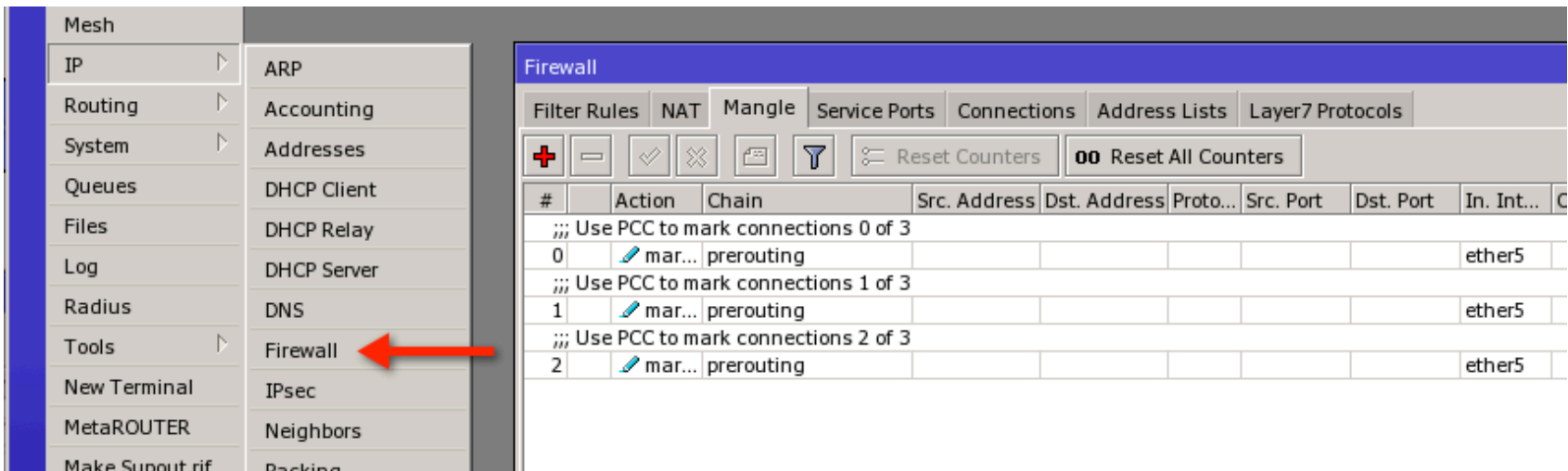
Step 2: Create Mangle rules that will sort the traffic into streams.

Create the PCC mangles:

- We will use optimal mangle method of marking connections first and then packets because it is the most efficient way to mark traffic, uses least resources.
 - First identify traffic and mark the connection.
 - Second, look for that connection mark and mark the routes.

Step by Step Configuration

Step 2 Continued...



The screenshot shows the Mikrotik WinBox interface for Firewall configuration. The left sidebar has a tree view with 'Firewall' selected, indicated by a red arrow. The main window shows the Firewall configuration page with the following table:

| # | Action | Chain | Src. Address | Dst. Address | Proto... | Src. Port | Dst. Port | In. Int... | C |
|--|--------|------------|--------------|--------------|----------|-----------|-----------|------------|---|
| ;;; Use PCC to mark connections 0 of 3 | | | | | | | | | |
| 0 | mar... | prerouting | | | | | | ether5 | |
| ;;; Use PCC to mark connections 1 of 3 | | | | | | | | | |
| 1 | mar... | prerouting | | | | | | ether5 | |
| ;;; Use PCC to mark connections 2 of 3 | | | | | | | | | |
| 2 | mar... | prerouting | | | | | | ether5 | |

Step by Step Configuration

Step 2 Continued...

The screenshot shows the Mikrotik WinBox configuration interface for a Firewall Mangle Rule. The left sidebar contains a menu with items: Mesh, IP, Routing, System, Queues, Files, Log, Radius, Tools, New Terminal, MetaROUTER, and Make Support rif. The main window is titled 'Firewall' and shows the 'Mangle Rule <>' configuration page. The 'General' tab is active, and the 'Chain' is set to 'prerouting'. The 'In. Interface' is set to 'ether5' and the 'Connection Mark' is set to 'no-mark'. A table on the right shows the rule's configuration for different ports.

| Proto... | Src. Port | Dst. Port | In. Int... | C |
|----------|-----------|-----------|------------|---|
| | | | ether5 | |
| | | | ether5 | |
| | | | ether5 | |

Step by Step Configuration

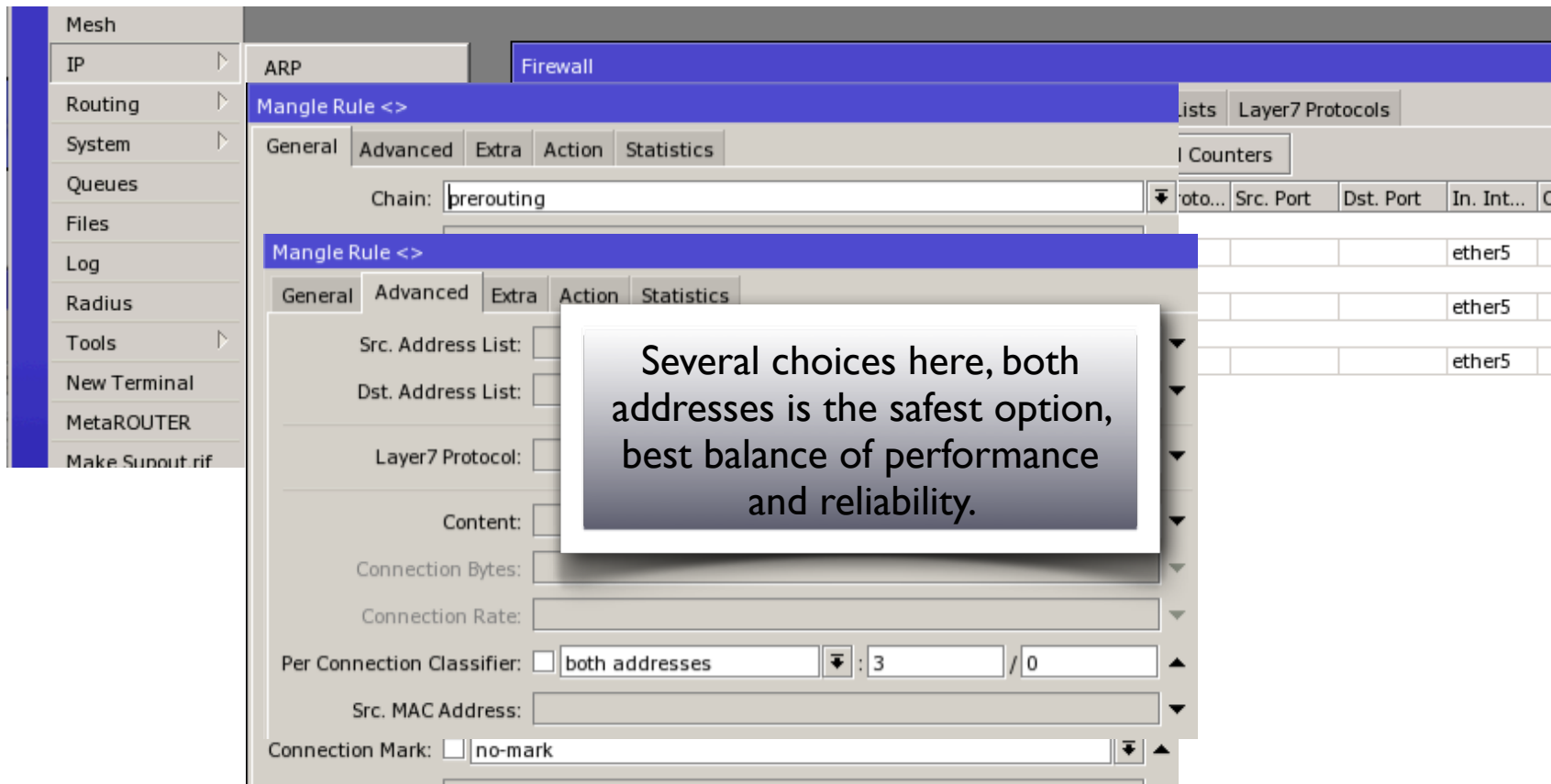
Step 2 Continued...

The screenshot shows the Mikrotik WinBox configuration interface for a Firewall Mangle Rule. The left sidebar contains a menu with items: Mesh, IP, Routing, System, Queues, Files, Log, Radius, Tools, New Terminal, MetaROUTER, and Make Support rif. The main window is titled 'Firewall' and shows the configuration for a 'Mangle Rule <>' in the 'prerouting' chain. The 'General' tab is active, showing fields for 'Chain: prerouting', 'Src. Address List', 'Dst. Address List', 'Layer7 Protocol', 'Content', 'Connection Bytes', 'Connection Rate', 'Per Connection Classifier' (set to 'both addresses' with a value of '3' and a slash '0'), 'Src. MAC Address', and 'Connection Mark' (set to 'no-mark'). A table on the right side of the window shows the rule's configuration for different interfaces, with 'ether5' listed in the 'In. Int...' column.

| Chain | Src. Port | Dst. Port | In. Int... | C |
|----------------|-----------|-----------|------------|---|
| Mangle Rule <> | | | ether5 | |
| Mangle Rule <> | | | ether5 | |
| Mangle Rule <> | | | ether5 | |

Step by Step Configuration

Step 2 Continued...



The screenshot shows the Mikrotik WinBox interface for configuring a Firewall Mangle Rule. The left sidebar contains a menu with options like Mesh, IP, Routing, System, Queues, Files, Log, Radius, Tools, New Terminal, MetaROUTER, and Make Support rif. The main window is titled 'Firewall' and shows the 'Mangle Rule <>' configuration page. The 'Chain' is set to 'prerouting'. The 'Per Connection Classifier' dropdown is set to 'both addresses', with a value of '3' and a slash followed by '0'. A callout box with a white background and a grey border is overlaid on the configuration, containing the text: 'Several choices here, both addresses is the safest option, best balance of performance and reliability.'

Step by Step Configuration

Step 2 Continued...

The screenshot displays the Mikrotik WinBox configuration interface for a Firewall Mangle Rule. The left sidebar shows the navigation menu with options like Mesh, IP, Routing, System, Queues, Files, Log, Radius, Tools, New Terminal, MetaROUTER, and Make Support. The main window is titled 'Firewall' and shows the 'Mangle Rule <>' configuration. The 'Chain' is set to 'prerouting'. The 'General' tab is active, showing fields for 'Src. Address List', 'Dst. Address List', 'Layer7 Protocol', 'Content', 'Connection Bytes', 'Connection Rate', 'Per Connection Classifier', 'Src. MAC Address', and 'Connection Mark' (set to 'no-mark'). A secondary window is open over the 'Advanced' tab, showing a list of advanced options: 'Connection Limit', 'Limit', 'Dst. Limit', 'Nth', 'Time', 'Src. Address Type', 'Dst. Address Type', 'Address Type' (set to 'local'), 'Invert' (checked), 'PSD', 'Hotspot', and 'IP Fragment'.

Step by Step Configuration

Step 2 Continued...

The screenshot shows the Mikrotik WinBox Firewall Mangle Rule configuration interface. The 'Chain' is set to 'prerouting'. The 'Advanced' tab is selected, showing the following options:

- Connection Limit
- Limit
- Dst. Limit
- Nth
- Time
- Src. Address Type
- Dst. Address Type
- PSD
- Hotspot
- IP Fragment

The 'Address Type' is set to 'local' and 'Invert' is checked.

The mangle chain prerouting will be capturing all traffic, even traffic that is going to the router itself. To avoid this we will use `dst-address-type=!local`.

Step by Step Configuration

Step 2 Continued...

The screenshot displays the Mikrotik WinBox interface for configuring a Firewall Mangle Rule. The left sidebar shows the navigation menu with 'Firewall' selected. The main window shows the 'Mangle Rule <>' configuration page, with the 'Action' tab active. The 'Chain' is set to 'prerouting'. The 'Action' dropdown is set to 'mark connection', and the 'New Connection Mark' is set to 'WAN1'. The 'Passthrough' checkbox is checked. The 'General' tab shows the 'Chain' field and a table of rule actions. The 'Advanced' tab shows various limit and classification options. The 'Extra' tab shows additional configuration options.

Chain: prerouting

Mangle Rule <> Action Statistics

Action: mark connection

New Connection Mark: WAN1

Passthrough

Step by Step Configuration

Step 2 Continued...

The screenshot displays the Mikrotik WinBox interface for configuring a Firewall Mangle Rule. The left sidebar shows the navigation menu with 'Firewall' selected. The main window shows the 'Mangle Rule <>' configuration page, with the 'Action' tab active. The 'Chain' is set to 'prerouting'. The 'Action' dropdown is set to 'mark connection', and the 'New Connection Mark' is set to 'WAN1'. The 'Passthrough' checkbox is checked. The 'General' tab shows the 'Chain' field and a table of rule actions. The 'Advanced' tab shows various limit and classification options. The 'Extra' tab shows the 'Action' and 'Statistics' sub-tabs.

Chain: prerouting

Mangle Rule <>

General Advanced Extra Action Statistics

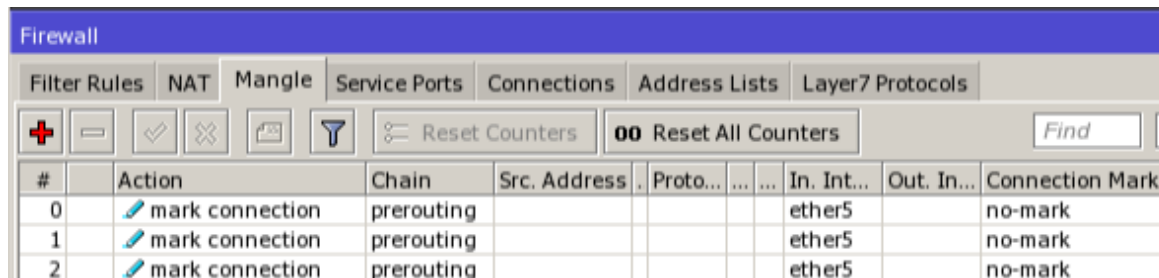
Action: mark connection

New Connection Mark: WAN1

Passthrough

Step by Step Configuration

Step 2 Completed



| # | Action | Chain | Src. Address | Proto... | ... | In. Int... | Out. In... | Connection Mark |
|---|-----------------|------------|--------------|----------|-----|------------|------------|-----------------|
| 0 | mark connection | prerouting | | | | ether5 | | no-mark |
| 1 | mark connection | prerouting | | | | ether5 | | no-mark |
| 2 | mark connection | prerouting | | | | ether5 | | no-mark |

Create one PCC mangle rule for each WAN connection

Completed PCC Mangle Rules

```
ip firewall mangle
```

```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no dst-address-type=!local \
in-interface=ether5 new-connection-mark=WAN1 passthrough=yes per-connection-classifier=both-addresses:3/0
```

```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no dst-address-type=!local \
in-interface=ether5 new-connection-mark=WAN2 passthrough=yes per-connection-classifier=both-addresses:3/1
```

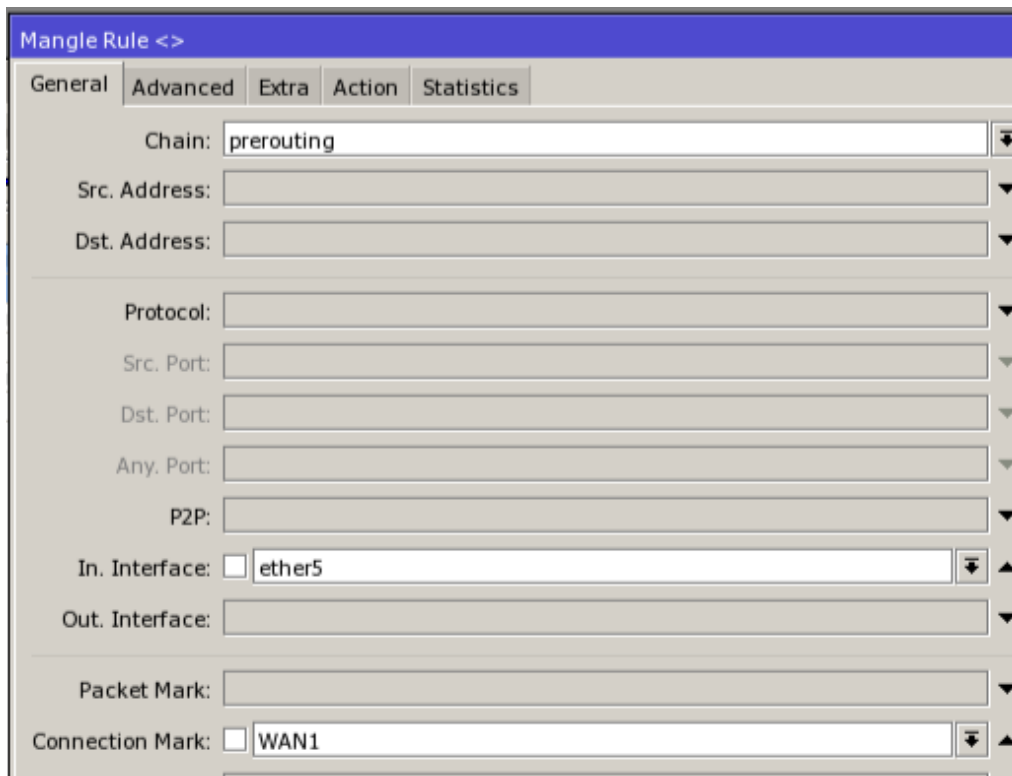
```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no dst-address-type=!local \
in-interface=ether5 new-connection-mark=WAN3 passthrough=yes per-connection-classifier=both-addresses:3/2
```

Step by Step Configuration

Step 3: Create the mangles to add the routing marks to the packets based on the connection mark in the PREROUTING CHAIN:

Step by Step Configuration

Step 3: Create the mangles to add the routing marks to the packets based on the connection mark in the PREROUTING CHAIN:



The screenshot shows the Mikrotik WinBox interface for configuring a Mangle Rule. The window title is "Mangle Rule <>". The "General" tab is selected, and the "Chain" is set to "prerouting". The "In. Interface" is set to "ether5" and the "Connection Mark" is set to "WAN1".

| Field | Value |
|-----------------|---------------------------------|
| Chain | prerouting |
| Src. Address | |
| Dst. Address | |
| Protocol | |
| Src. Port | |
| Dst. Port | |
| Any. Port | |
| P2P | |
| In. Interface | <input type="checkbox"/> ether5 |
| Out. Interface | |
| Packet Mark | |
| Connection Mark | <input type="checkbox"/> WAN1 |

Step by Step Configuration

Step 3: Create the mangles to add the routing marks to the packets based on the connection mark in the PREROUTING CHAIN:

The screenshot displays the Mikrotik WinBox interface for configuring a Mangle Rule. The main window is titled "Mangle Rule <>" and has tabs for "General", "Advanced", "Extra", "Action", and "Statistics". The "General" tab is active, showing the following configuration:

- Chain: prerouting
- Src. Address: (empty)
- Dst. Address: (empty)
- Protocol: (empty)
- Src. Port: (empty)
- Dst. Port: (empty)
- Any. Port: (empty)
- P2P: (empty)
- In. Interface: ether5
- Out. Interface: (empty)
- Packet Mark: (empty)
- Connection Mark: WAN1

An inset window, also titled "Mangle Rule <>", shows the "Action" tab configuration:

- Action: mark routing
- New Routing Mark: ether1-mark
- Passthrough

Step by Step Configuration

Step 3: Create the mangles to add the routing marks to the packets based on the connection mark in the PREROUTING CHAIN:

The screenshot displays the Mikrotik WinBox interface for configuring a Mangle Rule. The rule is named "prerouting" and is applied to the "prerouting" chain. The "Action" tab is selected, showing the action "mark routing" with a "New Routing Mark" of "ether1-mark" and the "Passthrough" checkbox checked. The "Connection Mark" is set to "WAN1".

| Field | Value |
|------------------|-------------------------------------|
| Chain | prerouting |
| Src. Address | |
| Dst. Address | |
| Protocol | |
| Src. Port | |
| Dst. Port | |
| Any. Port | |
| P2P | |
| In. Interface | <input type="checkbox"/> ether5 |
| Out. Interface | |
| Packet Mark | |
| Connection Mark | <input type="checkbox"/> WAN1 |
| Action | mark routing |
| New Routing Mark | ether1-mark |
| Passthrough | <input checked="" type="checkbox"/> |

This is where we mark routing for the bulk of our traffic

Step by Step Configuration

Step 3 Continued for OUTPUT CHAIN...

Step by Step Configuration

Step 3 Continued for OUTPUT CHAIN...

Mangle Rule <>

General | Advanced | Extra | Action | Statistics

Chain:

Src. Address:

Dst. Address:

Protocol:

Src. Port:

Dst. Port:

Any. Port:

P2P:

In. Interface:

Out. Interface:

Packet Mark:

Connection Mark:

Routing Mark:

Routing Table:

Step by Step Configuration

Step 3 Continued for OUTPUT CHAIN...

The image shows two overlapping screenshots of the Mikrotik WinBox Mangle Rule configuration interface. The background window shows the 'General' tab with the following settings:

- Chain: output
- Src. Address: (empty)
- Dst. Address: (empty)
- Protocol: (empty)
- Src. Port: (empty)
- Dst. Port: (empty)
- Any. Port: (empty)
- P2P: (empty)
- In. Interface: (empty)
- Out. Interface: (empty)
- Packet Mark: (empty)
- Connection Mark: WAN1
- Routing Mark: (empty)
- Routing Table: (empty)

The foreground window shows the 'Action' tab with the following settings:

- Action: mark routing
- New Routing Mark: ether1-mark
- Passthrough

Step by Step Configuration

Step 3 Continued for OUTPUT CHAIN...

The screenshot shows the Mikrotik WinBox configuration interface for a Mangle Rule. The rule is named "Mangle Rule <>" and is configured for the "output" chain. The "Action" tab is selected, showing the "mark routing" action with a "New Routing Mark" of "ether1-mark" and the "Passthrough" checkbox checked. The "General" tab shows the "Chain" set to "output" and the "Connection Mark" set to "WAN1".

Mangle Rule <>

General | Advanced | Extra | Action | Statistics

Chain: output

Src. Address: []

Dst. Address: []

Protocol: []

Src. Port: []

Dst. Port: []

Any. Port: []

P2P: []

In. Interface: []

Out. Interface: []

Packet Mark: []

Connection Mark: WAN1

Routing Mark: []

Routing Table: []

Mangle Rule <>

General | Advanced | Extra | Action | Statistics

Action: mark routing

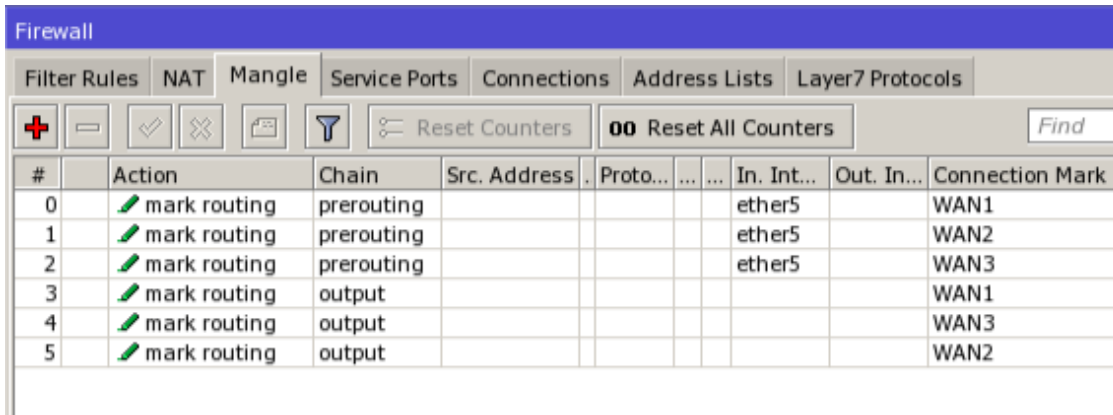
New Routing Mark: ether1-mark

Passthrough

This rule ensures traffic from the router itself returns through the proper interface

Step by Step Configuration

Step 3 Completed



| # | Action | Chain | Src. Address | Proto... | ... | In. Int... | Out. In... | Connection Mark |
|---|----------------|------------|--------------|----------|-----|------------|------------|-----------------|
| 0 | ✓ mark routing | prerouting | | | | ether5 | | WAN1 |
| 1 | ✓ mark routing | prerouting | | | | ether5 | | WAN2 |
| 2 | ✓ mark routing | prerouting | | | | ether5 | | WAN3 |
| 3 | ✓ mark routing | output | | | | | | WAN1 |
| 4 | ✓ mark routing | output | | | | | | WAN3 |
| 5 | ✓ mark routing | output | | | | | | WAN2 |

Create one rule for for each WAN connection, in prerouting chain and same in output chain

Completed route marking rules

```
/ip firewall mangle
```

```
add action=mark-routing chain=prerouting connection-mark=WAN1 disabled=no in-interface=ether5 \  
new-routing-mark=ether1-mark passthrough=yes
```

```
add action=mark-routing chain=prerouting connection-mark=WAN2 disabled=no in-interface=ether5 \  
new-routing-mark=ether2-mark passthrough=yes
```

```
add action=mark-routing chain=prerouting connection-mark=WAN3 disabled=no in-interface=ether5 \  
new-routing-mark=ether3-mark passthrough=yes
```

```
add action=mark-routing chain=output connection-mark=WAN1 disabled=no new-routing-mark=ether1-mark passthrough=yes
```

```
add action=mark-routing chain=output connection-mark=WAN3 disabled=no new-routing-mark=ether3-mark passthrough=yes
```

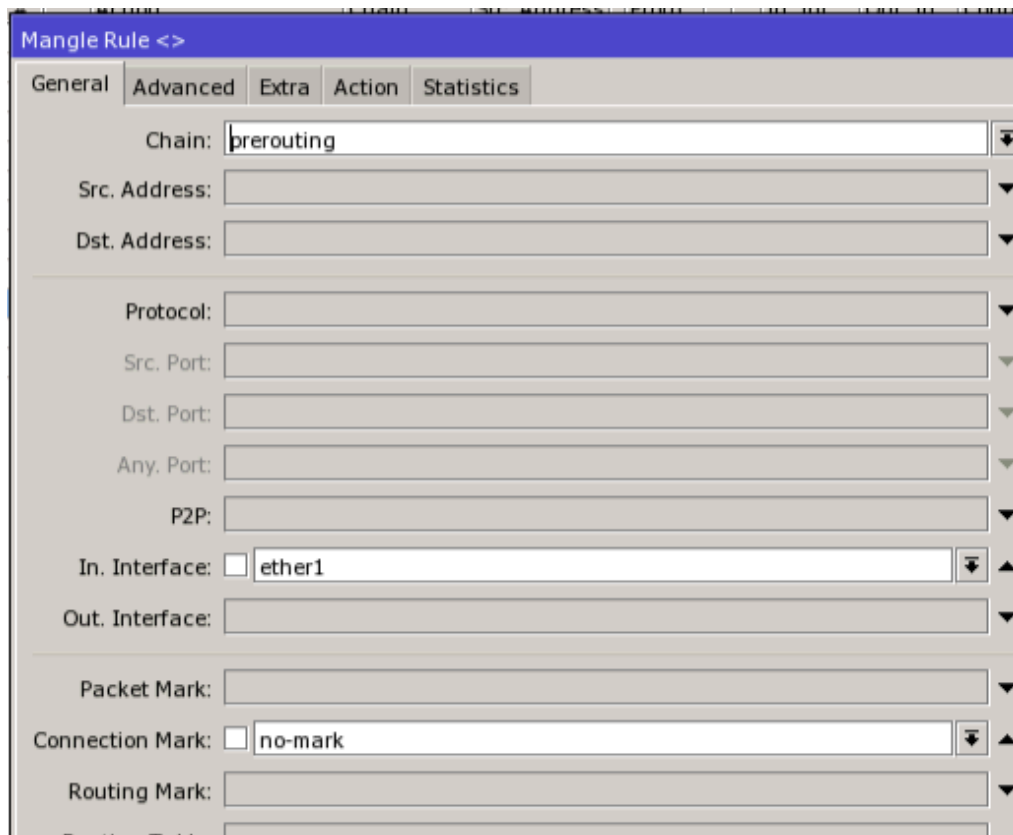
```
add action=mark-routing chain=output connection-mark=WAN2 disabled=no new-routing-mark=ether2-mark passthrough=yes
```

Step by Step Configuration

Step 4: Identify which WAN interface the traffic came in and mark the connections appropriately.

Step by Step Configuration

Step 4: Identify which WAN interface the traffic came in and mark the connections appropriately.



The screenshot shows the Mikrotik WinBox configuration window for a Mangle Rule. The window title is "Mangle Rule <>". It has several tabs: "General", "Advanced", "Extra", "Action", and "Statistics". The "General" tab is selected. The configuration fields are as follows:

- Chain:
- Src. Address:
- Dst. Address:
- Protocol:
- Src. Port:
- Dst. Port:
- Any. Port:
- P2P:
- In. Interface:
- Out. Interface:
- Packet Mark:
- Connection Mark:
- Routing Mark:
- Routing Table:

Step by Step Configuration

Step 4: Identify which WAN interface the traffic came in and mark the connections appropriately.

The image shows the Mikrotik WinBox configuration interface for a Mangle Rule. The main window is titled "Mangle Rule <>" and has tabs for "General", "Advanced", "Extra", "Action", and "Statistics". The "General" tab is selected. The configuration fields are as follows:

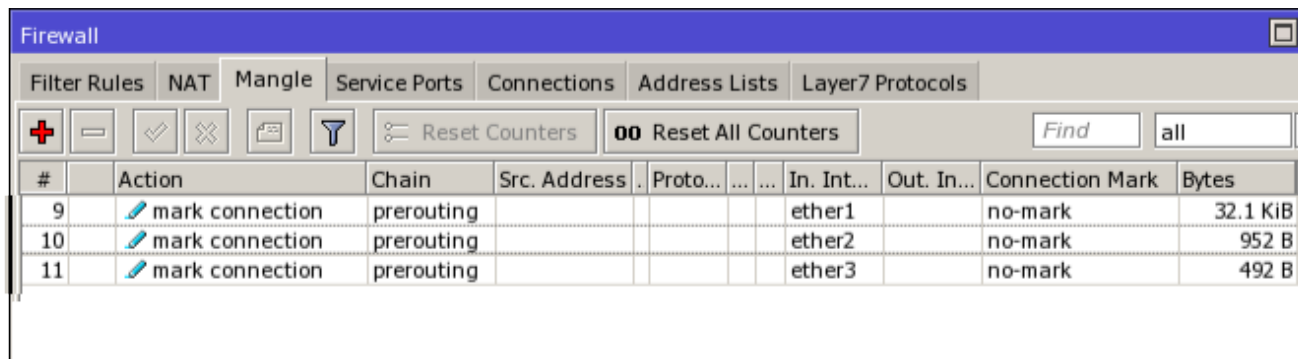
- Chain: prerouting
- Src. Address: (empty)
- Dst. Address: (empty)
- Protocol: (empty)
- Src. Port: (empty)
- Dst. Port: (empty)
- Any. Port: (empty)
- P2P: (empty)
- In. Interface: ether1
- Out. Interface: (empty)
- Packet Mark: (empty)
- Connection Mark: no-mark
- Routing Mark: (empty)

An "Action" dialog box is overlaid on top of the main window, also titled "Mangle Rule <>". It has tabs for "General", "Advanced", "Extra", "Action", and "Statistics". The "Action" tab is selected. The configuration fields in the dialog are:

- Action: mark connection
- New Connection Mark: WAN1
- Passthrough

Step by Step Configuration

Step 4 Completed



The screenshot shows the Mikrotik WinBox Firewall configuration window, specifically the Mangle tab. It displays three rules (9, 10, and 11) configured for connection marking on different WAN interfaces. Rule 9 is for ether1, rule 10 for ether2, and rule 11 for ether3. All rules are set to 'prerouting' chain, 'no-mark' connection mark, and 'passthrough=yes'.

| # | Action | Chain | Src. Address | Proto... | In. Int... | Out. In... | Connection Mark | Bytes |
|----|-----------------|------------|--------------|----------|------------|------------|-----------------|----------|
| 9 | mark connection | prerouting | | | ether1 | | no-mark | 32.1 KiB |
| 10 | mark connection | prerouting | | | ether2 | | no-mark | 952 B |
| 11 | mark connection | prerouting | | | ether3 | | no-mark | 492 B |

Create one rule for each WAN connection

Completed WAN connection marking rules

```
/ip firewall mangle
```

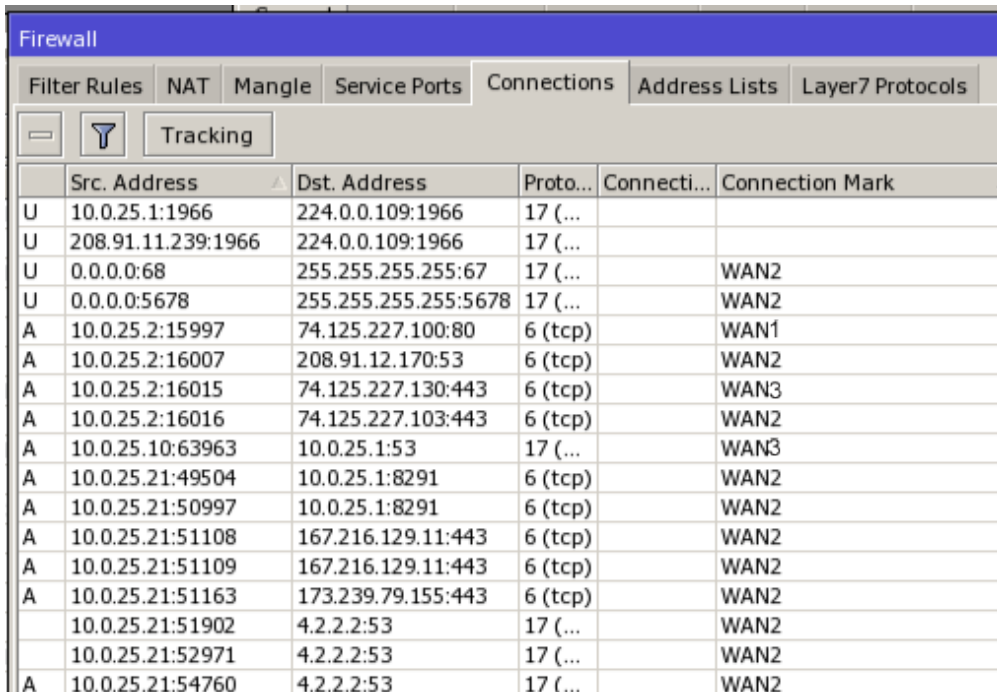
```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no \
in-interface=ether1 new-connection-mark=WAN1 passthrough=yes
```

```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no \
in-interface=ether3 new-connection-mark=WAN3 passthrough=yes
```

```
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=no \
in-interface=ether2 new-connection-mark=WAN2 passthrough=yes
```


Step by Step Configuration

Final result: Connections should be marked, route marks added to packets based on connection mark.



The screenshot shows the Mikrotik WinBox Firewall configuration interface. The 'Connections' tab is selected, and the 'Tracking' sub-tab is active. A table displays the current state of connections, including source and destination addresses, protocols, and assigned connection marks.

| | Src. Address | Dst. Address | Proto... | Connecti... | Connection Mark |
|---|--------------------|----------------------|----------|-------------|-----------------|
| U | 10.0.25.1:1966 | 224.0.0.109:1966 | 17 (...) | | |
| U | 208.91.11.239:1966 | 224.0.0.109:1966 | 17 (...) | | |
| U | 0.0.0.0:68 | 255.255.255.255:67 | 17 (...) | | WAN2 |
| U | 0.0.0.0:5678 | 255.255.255.255:5678 | 17 (...) | | WAN2 |
| A | 10.0.25.2:15997 | 74.125.227.100:80 | 6 (tcp) | | WAN1 |
| A | 10.0.25.2:16007 | 208.91.12.170:53 | 6 (tcp) | | WAN2 |
| A | 10.0.25.2:16015 | 74.125.227.130:443 | 6 (tcp) | | WAN3 |
| A | 10.0.25.2:16016 | 74.125.227.103:443 | 6 (tcp) | | WAN2 |
| A | 10.0.25.10:63963 | 10.0.25.1:53 | 17 (...) | | WAN3 |
| A | 10.0.25.21:49504 | 10.0.25.1:8291 | 6 (tcp) | | WAN2 |
| A | 10.0.25.21:50997 | 10.0.25.1:8291 | 6 (tcp) | | WAN2 |
| A | 10.0.25.21:51108 | 167.216.129.11:443 | 6 (tcp) | | WAN2 |
| A | 10.0.25.21:51109 | 167.216.129.11:443 | 6 (tcp) | | WAN2 |
| A | 10.0.25.21:51163 | 173.239.79.155:443 | 6 (tcp) | | WAN2 |
| | 10.0.25.21:51902 | 4.2.2.2:53 | 17 (...) | | WAN2 |
| | 10.0.25.21:52971 | 4.2.2.2:53 | 17 (...) | | WAN2 |
| A | 10.0.25.21:54760 | 4.2.2.2:53 | 17 (...) | | WAN2 |

Always check the connection table to ensure mangles are working for connections

Step by Step Configuration

Mangles are done, we now create the routes:

Step by Step Configuration

Mangles are done, we now create the routes:

- We will need one default route for each routing mark, corresponding to each of the WAN connections.

Step by Step Configuration

Mangles are done, we now create the routes:

- We will need one default route for each routing mark, corresponding to each of the WAN connections.
- We will also need one unmarked default route corresponding to each of the WAN connections.

Step by Step Configuration

Step 5: Create the unmarked default routes.

Step by Step Configuration

Step 5: Create the unmarked default routes.

The screenshot shows the Mikrotik WinBox configuration window for a static route. The window title is "Route <0.0.0.0/0>". It has two tabs: "General" (selected) and "Attributes". The configuration fields are as follows:

- Dst. Address:** 0.0.0.0/0
- Gateway:** 172.17.0.1 (with a dropdown menu showing "reachable ether1")
- Check Gateway:** (empty dropdown)
- Type:** unicast
- Distance:** 1
- Scope:** 30
- Target Scope:** 10
- Routing Mark:** (empty dropdown)
- Pref. Source:** (empty dropdown)

On the right side of the window, there are several buttons: OK, Cancel, Apply, Disable, Comment, Copy, and Remove. At the bottom of the window, there are three status indicators: "enabled", "active", and "static".

Step by Step Configuration

Step 5: Create the unmarked default routes.

The screenshot shows the Mikrotik WinBox configuration window for a static route. The window title is 'Route <0.0.0.0/0>'. The 'General' tab is selected, and the 'Attributes' sub-tab is active. The configuration fields are as follows:

- Dst. Address:** 0.0.0.0/0
- Gateway:** 172.18.0.1 (with a dropdown arrow) and reachable ether2 (with a double-headed arrow)
- Check Gateway:** (empty dropdown)
- Type:** unicast (with a dropdown arrow)
- Distance:** 1 (with an up arrow)
- Scope:** 30
- Target Scope:** 10
- Routing Mark:** (empty dropdown)
- Pref. Source:** (empty dropdown)

On the right side of the window, there are several buttons: OK, Cancel, Apply, Disable, Comment, Copy, and Remove. At the bottom of the window, there are four status indicators: 'enabled', 'active', and 'static'.

Step by Step Configuration

Step 5: Create the unmarked default routes.

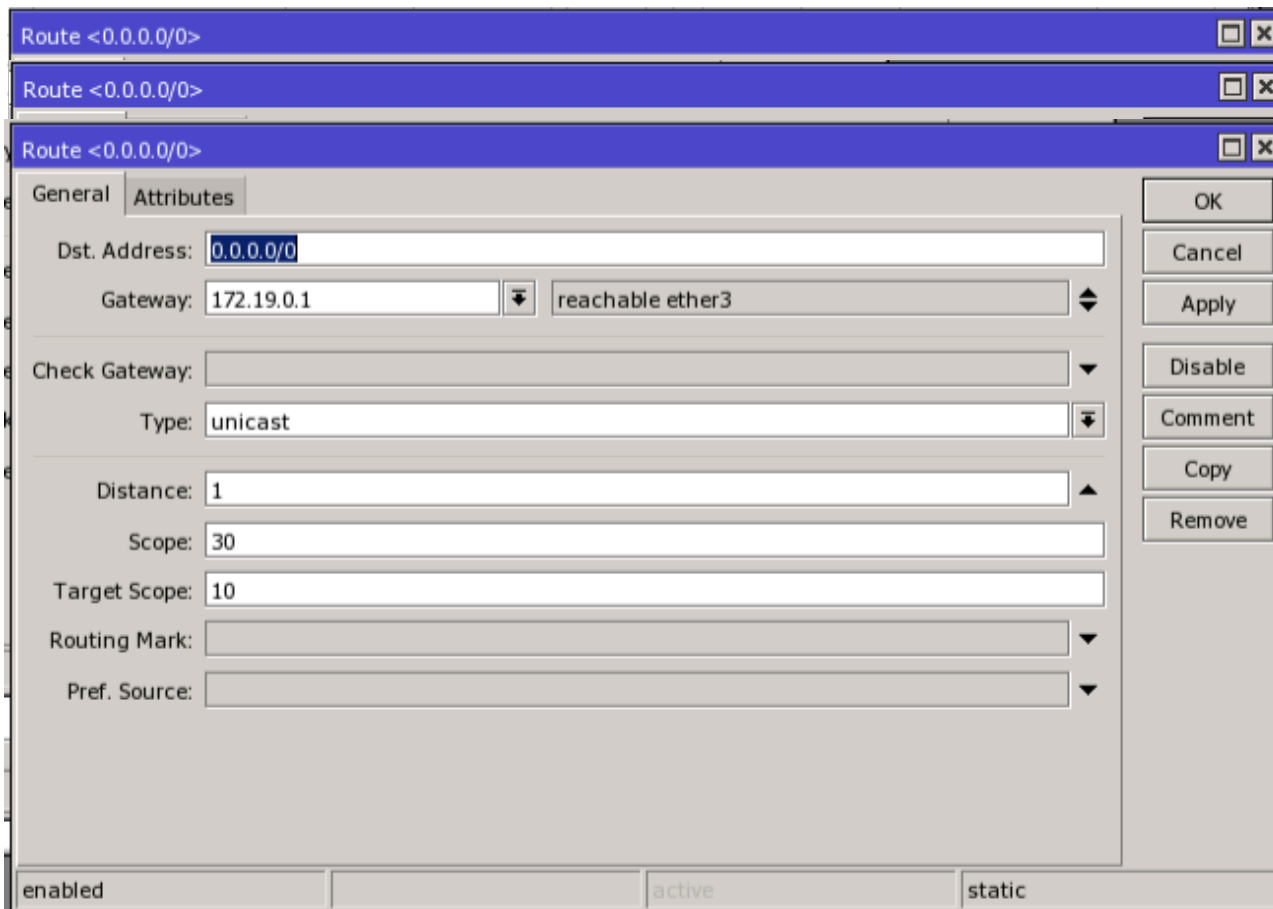
The screenshot shows the Mikrotik WinBox configuration window for a static route. The window title is "Route <0.0.0.0/0>". The "General" tab is selected, and the "Attributes" sub-tab is active. The configuration fields are as follows:

- Dst. Address: 0.0.0.0/0
- Gateway: 172.19.0.1 (with a dropdown arrow) and reachable ether3 (with a double-headed arrow)
- Check Gateway: (dropdown arrow)
- Type: unicast (with a dropdown arrow)
- Distance: 1 (with an up arrow)
- Scope: 30
- Target Scope: 10
- Routing Mark: (dropdown arrow)
- Pref. Source: (dropdown arrow)

On the right side of the dialog, there are buttons for OK, Cancel, Apply, Disable, Comment, Copy, and Remove. At the bottom of the dialog, there are three checkboxes: "enabled" (checked), "active" (checked), and "static" (checked).

Step by Step Configuration

Step 5: Create the unmarked default routes.



The screenshot shows the Mikrotik WinBox interface for configuring a static route. The window title is "Route <0.0.0.0/0>". The "General" tab is selected, and the "Attributes" sub-tab is active. The configuration fields are as follows:

- Dst. Address: 0.0.0.0/0
- Gateway: 172.19.0.1 (with a dropdown menu showing "reachable ether3")
- Check Gateway: (unchecked)
- Type: unicast
- Distance: 1
- Scope: 30
- Target Scope: 10
- Routing Mark: (empty)
- Pref. Source: (empty)

At the bottom of the window, there are three checkboxes: "enabled" (checked), "active" (unchecked), and "static" (checked). On the right side of the window, there are buttons for "OK", "Cancel", "Apply", "Disable", "Comment", "Copy", and "Remove".

Provides failover - ensures traffic always has a default route because if there is no active marked route to match a packet, it follows the main routing table!

Step by Step Configuration

Step 5: Create the unmarked default routes.

The screenshot shows the Mikrotik WinBox interface for configuring a static route. The window title is "Route <0.0.0.0/0>". The "General" tab is selected, and the "Attributes" sub-tab is active. The configuration fields are as follows:

- Dst. Address: 0.0.0.0/0
- Gateway: 172.19.0.1 (with a dropdown menu showing "reachable ether3")
- Check Gateway: (unchecked)
- Type: unicast
- Distance: 1
- Scope: 30
- Target Scope: 10
- Routing Mark: (empty)
- Pref. Source: (empty)

At the bottom of the window, there are three status indicators: "enabled", "active", and "static". On the right side of the window, there are several buttons: "OK", "Cancel", "Apply", "Disable", "Comment", "Copy", and "Remove".

Provides failover - ensures traffic always has a default route because if there is no active marked route to match a packet, it follows the main routing table!

Considering using distance to prefer one default over another.

Step by Step Configuration

Step 6: Create the marked default routes.

Step by Step Configuration

Step 6: Create the marked default routes.

Route <0.0.0.0/0>

General Attributes

Dst. Address: 0.0.0.0/0

Gateway: 172.17.0.1 reachable ether1

Check Gateway: ping

Type: unicast

Distance: 1

Scope: 30

Target Scope: 10

Routing Mark: ether1-mark

Pref. Source:

OK
Cancel
Apply
Disable
Comment
Copy
Remove

enabled active static

Step by Step Configuration

Step 6: Create the marked default routes.

The screenshot shows the Mikrotik WinBox configuration window for a static route. The window title is "Route <0.0.0.0/0>". The "General" tab is selected. The configuration fields are as follows:

- Dst. Address: 0.0.0.0/0
- Gateway: 172.18.0.1 (with a dropdown arrow) and reachable ether2 (with a double-headed arrow)
- Check Gateway: ping (with a dropdown arrow and an up arrow)
- Type: unicast (with a dropdown arrow)
- Distance: 1 (with an up arrow)
- Scope: 30
- Target Scope: 10
- Routing Mark: ether2-mark (with a dropdown arrow and an up arrow)
- Pref. Source: (empty dropdown)

On the right side of the window, there are several buttons: OK, Cancel, Apply, Disable, Comment, Copy, and Remove. At the bottom of the window, there are four checkboxes: "enabled" (checked), "active" (checked), and "static" (checked).

Step by Step Configuration

Step 6: Create the marked default routes.

Route <0.0.0.0/0>

Route <0.0.0.0/0>

Route <0.0.0.0/0>

General Attributes

Dst. Address: 0.0.0.0/0

Gateway: 172.19.0.1 reachable ether3

Check Gateway: ping

Type: unicast

Distance: 1

Scope: 30

Target Scope: 10

Routing Mark: ether3-mark

Pref. Source:

OK
Cancel
Apply
Disable
Comment
Copy
Remove

enabled active static

Step by Step Configuration

Step 6: Create the marked default routes.

The screenshot shows the Mikrotik WinBox interface for configuring a static route. The window title is "Route <0.0.0.0/0>". The "General" tab is selected, and the "Attributes" sub-tab is active. The configuration fields are as follows:

- Dst. Address: 0.0.0.0/0
- Gateway: 172.19.0.1 (with a dropdown menu showing "reachable ether3")
- Check Gateway: ping (with a dropdown menu showing "unicast")
- Distance: 1
- Scope: 30
- Target Scope: 10
- Routing Mark: ether3-mark
- Pref. Source: (empty)

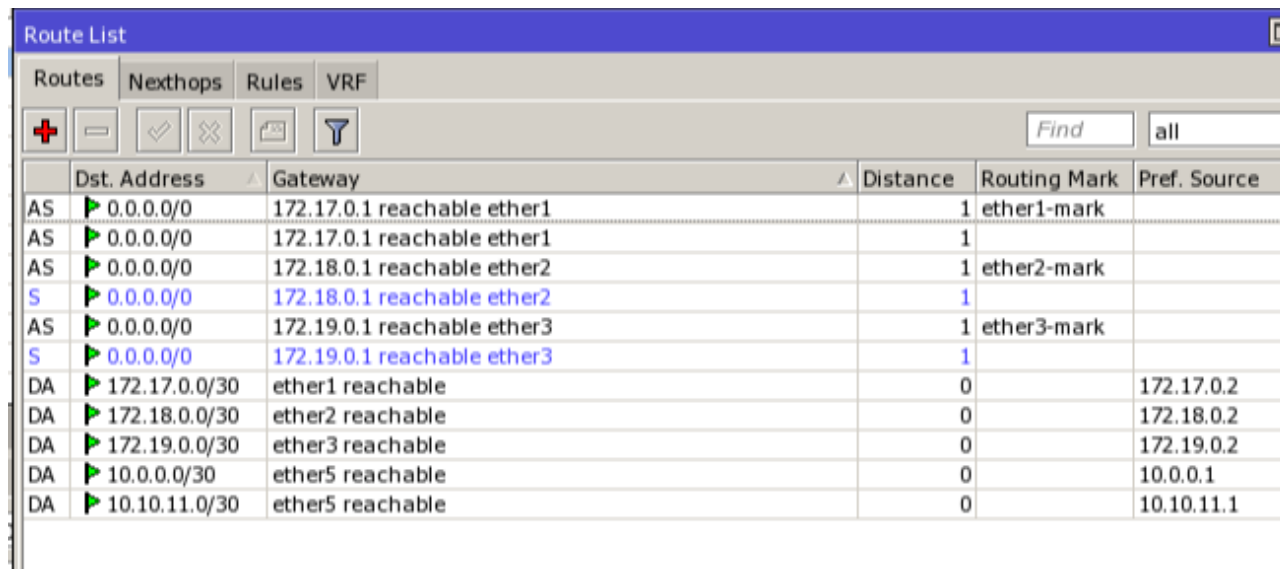
At the bottom of the window, there are three checkboxes: "enabled" (checked), "active" (checked), and "static" (checked). On the right side of the window, there are several buttons: "OK", "Cancel", "Apply", "Disable", "Comment", "Copy", and "Remove".

Use “check-gateway” to ensure gateway is alive.

Only need to use “check-gateway” on marked routes because any routes with that gateway become inactive if it fails thereby affecting marked routes too.

Step by Step Configuration

Final result - Routing table



The screenshot shows the Mikrotik WinBox 'Route List' window. The window has tabs for 'Routes', 'Nexthops', 'Rules', and 'VRF'. Below the tabs is a toolbar with icons for adding, deleting, and filtering routes, along with a search box containing 'Find' and 'all'. The main area displays a table of routes with columns for 'Dst. Address', 'Gateway', 'Distance', 'Routing Mark', and 'Pref. Source'. The routes are as follows:

| | Dst. Address | Gateway | Distance | Routing Mark | Pref. Source |
|----|---------------|-----------------------------|----------|--------------|--------------|
| AS | 0.0.0.0/0 | 172.17.0.1 reachable ether1 | 1 | ether1-mark | |
| AS | 0.0.0.0/0 | 172.17.0.1 reachable ether1 | 1 | | |
| AS | 0.0.0.0/0 | 172.18.0.1 reachable ether2 | 1 | ether2-mark | |
| S | 0.0.0.0/0 | 172.18.0.1 reachable ether2 | 1 | | |
| AS | 0.0.0.0/0 | 172.19.0.1 reachable ether3 | 1 | ether3-mark | |
| S | 0.0.0.0/0 | 172.19.0.1 reachable ether3 | 1 | | |
| DA | 172.17.0.0/30 | ether1 reachable | 0 | | 172.17.0.2 |
| DA | 172.18.0.0/30 | ether2 reachable | 0 | | 172.18.0.2 |
| DA | 172.19.0.0/30 | ether3 reachable | 0 | | 172.19.0.2 |
| DA | 10.0.0.0/30 | ether5 reachable | 0 | | 10.0.0.1 |
| DA | 10.10.11.0/30 | ether5 reachable | 0 | | 10.10.11.1 |

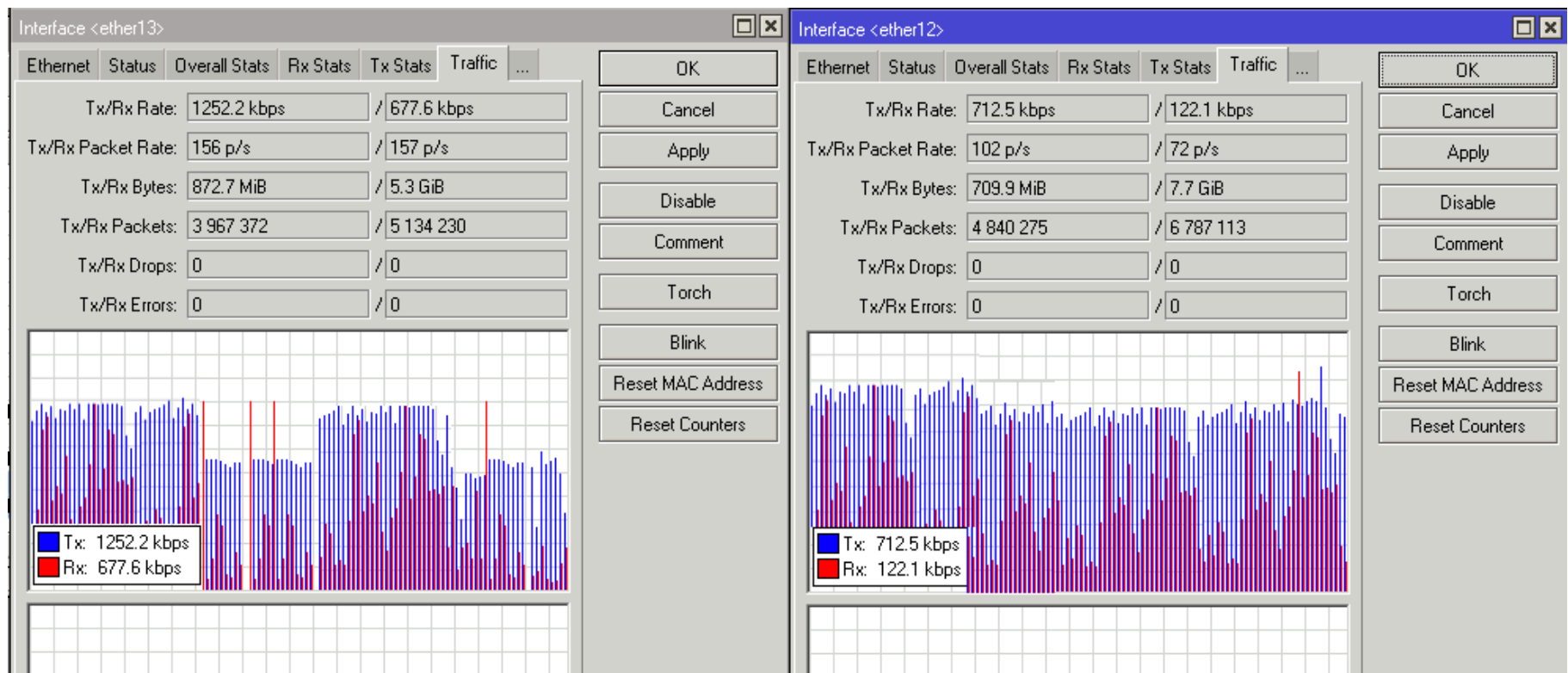
One marked default for each WAN connection, and one unmarked default route for each WAN connection

Completed routing table

Step by Step Configuration

Final result!

Actual screen shots from a load balance configuration in production with 2 WAN connections.



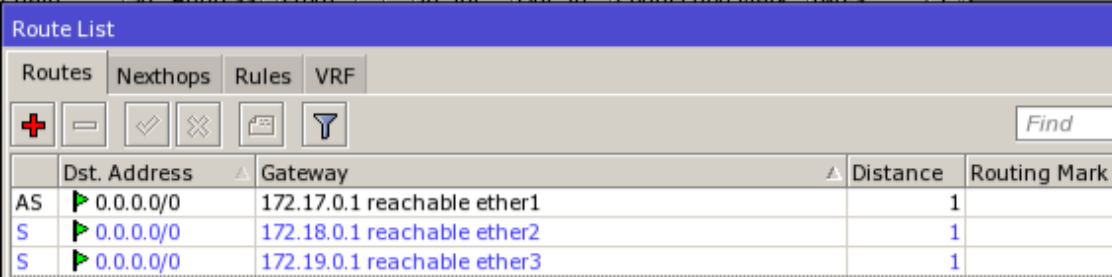
Common Problems

I use DHCP for my WAN addressing, how can I get the marked routes created properly?

```
/system script
add name=ConfigureDHCPRoutes policy=\
ftp,reboot,read,write,policy,test,winbox,password,sniff,sensitive,api source=":local cli\
entcounter\r\
\n:local routecounter\r\
\n:local duplicatecounter\r\
\n:local routeupdated "no\r\
\n:foreach clientcounter in=[/ip dhcp-client find] do={\r\
\n:local routingmarkname ([/ip dhcp-client get \$clientcounter interface] . \"-mark\r\
\n:local newroutinggateway [ip dhcp-client get \$clientcounter gateway]\r\
\n:foreach routecounter in=[/ip route find where routing-mark=\$routingmarkname] do={\r\
\n :local routinggateway [/ip route get [find routing-mark=\$routingmarkname] gateway]\
\r\
\n\t:if ([:len \$newroutinggateway] > 0) do={\r\
\n\t :if (\$\"routinggateway\" != \$\"newroutinggateway\") do={ \r\
\n\t /ip route set \$routecounter gateway=\$newroutinggateway \r\
\n\t\t:set routeupdated \"yes\r\
\n\t } \r\
\n\t} \r\
\n } \r\
\n :if ([:len \$newroutinggateway] > 0) do={\r\
\n :if (\$routeupdated = \"no\") do={\r\
\n /ip route add routing-mark=\$routingmarkname gateway=\$newroutinggateway dst-add\
ress=0.0.0.0/0\r\
\n } \r\
\n } \r\
\n} \r\
\n"
```

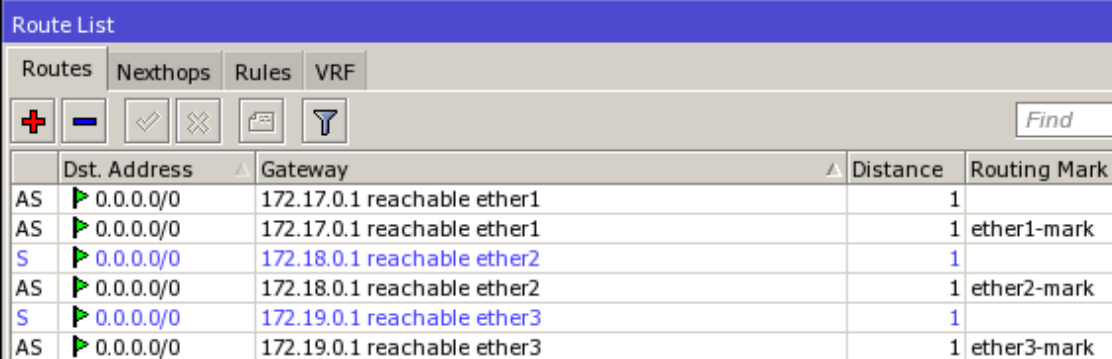
Common Problems

Before Running Script



| | Dst. Address | Gateway | Distance | Routing Mark |
|----|--------------|-----------------------------|----------|--------------|
| AS | 0.0.0.0/0 | 172.17.0.1 reachable ether1 | 1 | |
| S | 0.0.0.0/0 | 172.18.0.1 reachable ether2 | 1 | |
| S | 0.0.0.0/0 | 172.19.0.1 reachable ether3 | 1 | |

After Running Script



| | Dst. Address | Gateway | Distance | Routing Mark |
|----|--------------|-----------------------------|----------|--------------|
| AS | 0.0.0.0/0 | 172.17.0.1 reachable ether1 | 1 | |
| AS | 0.0.0.0/0 | 172.17.0.1 reachable ether1 | 1 | ether1-mark |
| S | 0.0.0.0/0 | 172.18.0.1 reachable ether2 | 1 | |
| AS | 0.0.0.0/0 | 172.18.0.1 reachable ether2 | 1 | ether2-mark |
| S | 0.0.0.0/0 | 172.19.0.1 reachable ether3 | 1 | |
| AS | 0.0.0.0/0 | 172.19.0.1 reachable ether3 | 1 | ether3-mark |

Common Problems

PCC doesn't seem to work properly with HotSpot or IP Webproxy

- It is possible to make it work but the rules get very detailed and complicated.

Solution: Use two routers, one for load balancing, one for HotSpot or IP Webproxy.

Solution: Use metarouter with host router doing main routing functions, virtual router doing the load balancing.

Common Problems

DNS resolves from some clients, not others

- If you are using two different ISP's and their respective name servers, possibly some clients are accessing ISP1's DNS server through ISP2's connection and ISP1 is blocking DNS requests from outside their IP space.

Solution: Consider OpenDNS, destination NAT with redirect to DNS cache, etc.

Common Problems

Strange http issues, some images load, other don't, problems with some secure sites

Solution: Try using “both addresses” or “source address “ for PCC classifier. While “both addresses and ports” gives the greatest chance for randomization and better possibility for even distribution, it can create these types of issues.

Common Problems

I can only get asymmetrical connections, one DSL and one cable modem.

Solution: You can “weight” one interface higher and force more traffic through it by repeating the connection marking PCC rule more than once for that connection.

Example for added weight to WAN3.

```
/ip firewall mangle
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=\
    no dst-address-type=!local in-interface=ether5 new-connection-mark=WAN1 \
    passthrough=yes per-connection-classifier=both-addresses:3/0
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=\
    no dst-address-type=!local in-interface=ether5 new-connection-mark=WAN2 \
    passthrough=yes per-connection-classifier=both-addresses:3/1
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=\
    no dst-address-type=!local in-interface=ether5 new-connection-mark=WAN3 \
    passthrough=yes per-connection-classifier=both-addresses:3/2
add action=mark-connection chain=prerouting connection-mark=no-mark disabled=\
    no dst-address-type=!local in-interface=ether5 new-connection-mark=WAN3 \
    passthrough=yes per-connection-classifier=both-addresses:3/3
```

Thank You!

- MyWISPTraining.com
- LearnMikroTik.com
- ISPSupplies.com
- “RouterOS by Example” available for many distributors or Amazon.com, iTunes

