Load Balance with Masquerade Network on RouterOS

Prepared by:

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About Me

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in Wroclaw, Poland
March 1-2, 2010

- Jānis Meģis, MikroTik
- Jānis (Tehnical, Trainer, NOT Sales)
  - Support & Training Engineer for almost 6 years
  - Specialization: QoS, PPP, Firewall, Routing
  - Teaching MikroTik RouterOS classes since 2005

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About Me

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- Valens Riyadi - valens@mikrotik.co.id
- Company: Citraweb Nusa Infomedia
  - Mikrotik Distributor (2002), Training Partner (2005) - www.mikrotik.co.id
  - Wireless ISP - www.citra.net.id
  - Web Developer - www.citra.web.id
- Head of National Internet Resources of Indonesian ISP Association / IDNIC
- Founder and Volunteer of Airputih Foundation, an IT Emergency Task Force on Disaster Area

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Basic Concept

- Load Balance
  - How to share traffic into 2 or more gateways
- Fail Over
  - How to choose one link as primary link, and automatically swing to another link if the primary link fail

Load Balance

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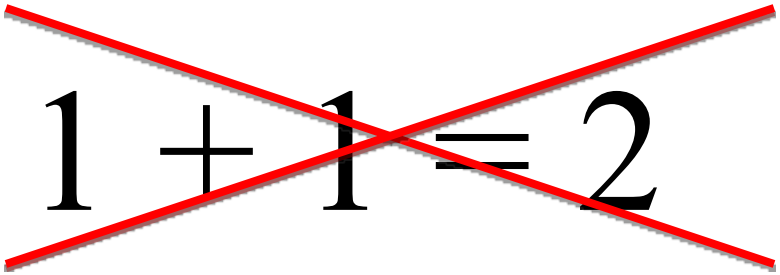
- Load Balancing is a technique to distribute workload across two or more network links in order to maximize throughput, minimize response time, and avoid overload
- Using multiple network links with load balancing, instead of a single network links, may increase reliability through redundancy

Load Balance



$$1 + 1 = 1 + 1$$

$$1 + 1 = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$$

$$1 + 1 = \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$$

The more users, more connections, the load balance will be more balance

Load Balance

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- The traffic distributed base on probability.
- We have to know how big is each link, and distributed traffic accordingly
- If we have 2 gateways… A & B
  - A has 1 mbps, and B has 2 mbps
  - We will divide traffic to 3 flow, and send 1 flow to A, and 2 flows to B

RouterOS Features

- We need to use:
  - Static route and policy route
  - Firewall Mangle
  - Firewall src-nat
- For more advanced setting, we can use also OSPF and BGP

Key of Load Balance

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- UPLINK
  - In simple network, we can choose which gateway we want to use for each uplink flow, using static route/policy route

Key of Load Balance

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- DOWNLINK
  - In natted network, we choose downlink gateway using src-nat/masq. Traffic will return from internet according to IP Address we use in NAT for each flow.
  - In non natted network, we have to use BGP advertisement to control the routing from internet to our network.

Key Load Balance

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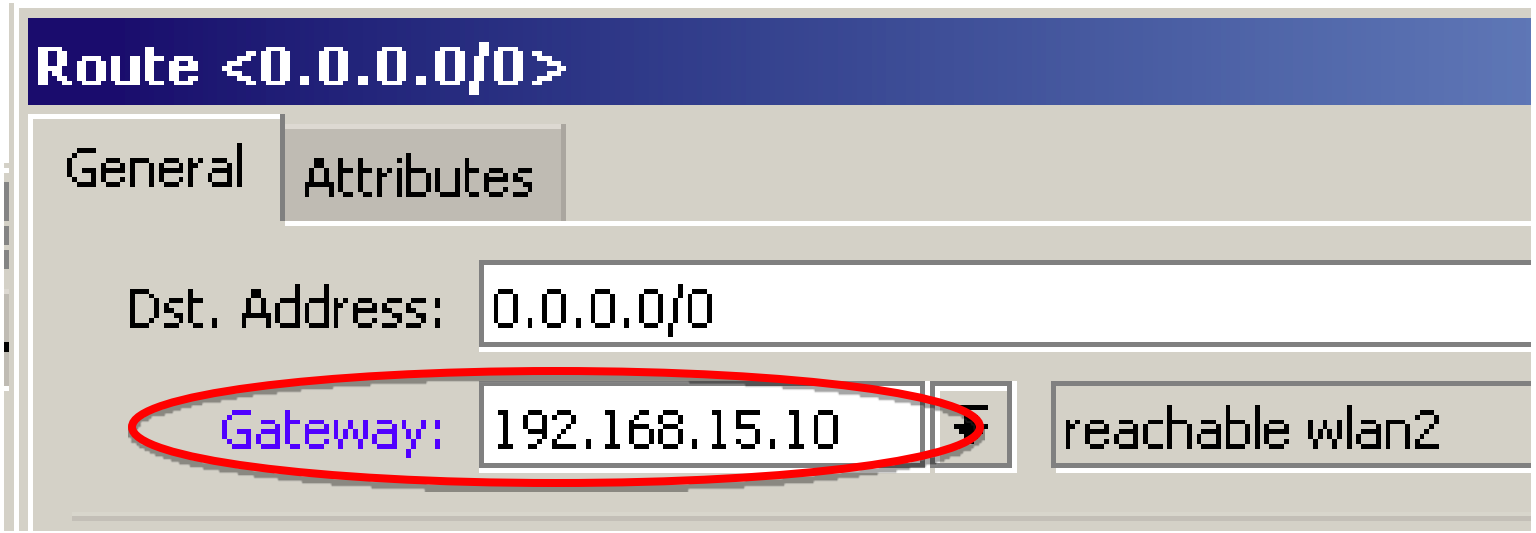
- Traffic src-natted to IP Address located on gateway A, will return from internet through gateway A.
- If we use plain masquerade for each flow on all gateways, traffic will return from internet on the same gateway when leaving the network.

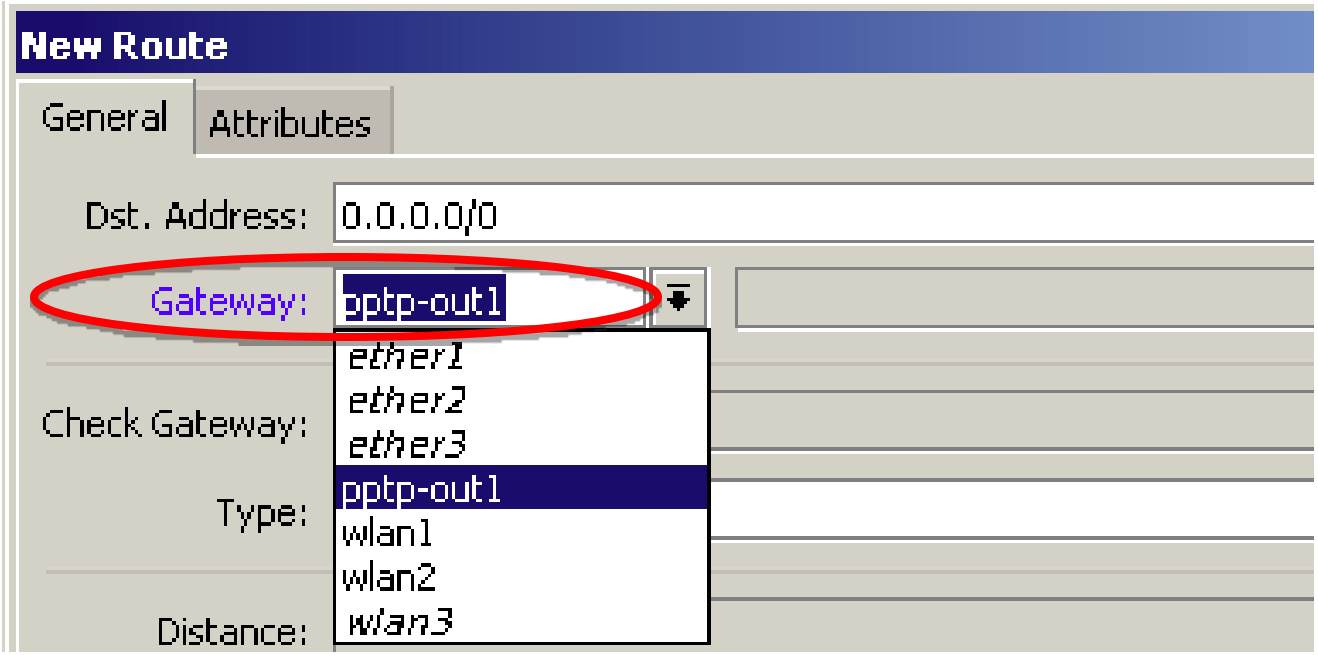
Static Route

- You can specify IP Address for the gateway in static route, if the interface is a static interface and has a static IP config.



Static Route

- For dynamic interface (ex: PPTP, PPPoE) you can choose interface as the gateway



Load Balance Method

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- Static Route with Address List
- ECMP (equal cost multi path)
- NTH
- PCC
- BGP

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Static Route

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- Base on destination address
  - Gateway A for internasional
  - Gateway B for local/domestic traffic
    - Using address-list of IP Address on domestic network/local internet exchange

Static Route

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- Base on source address
  - Client IP Address: 192.168.0.0/24
    - 192.168.0.0-127 → gateway A
    - 192.168.0.128-255 → gateway B

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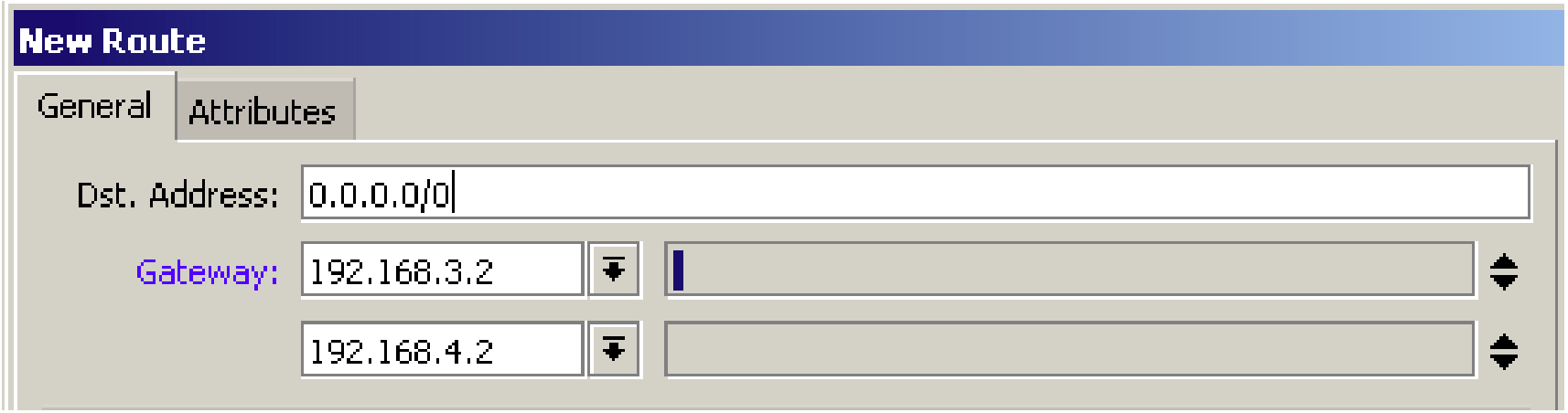
ECMP

- Equal Cost Multi Path
- The easiest way to do load balance for several gateways is using ECMP.
- ECMP will balance traffic to several gateways randomly

ECMP

- With 2 gateways with same capacity.



ECMP

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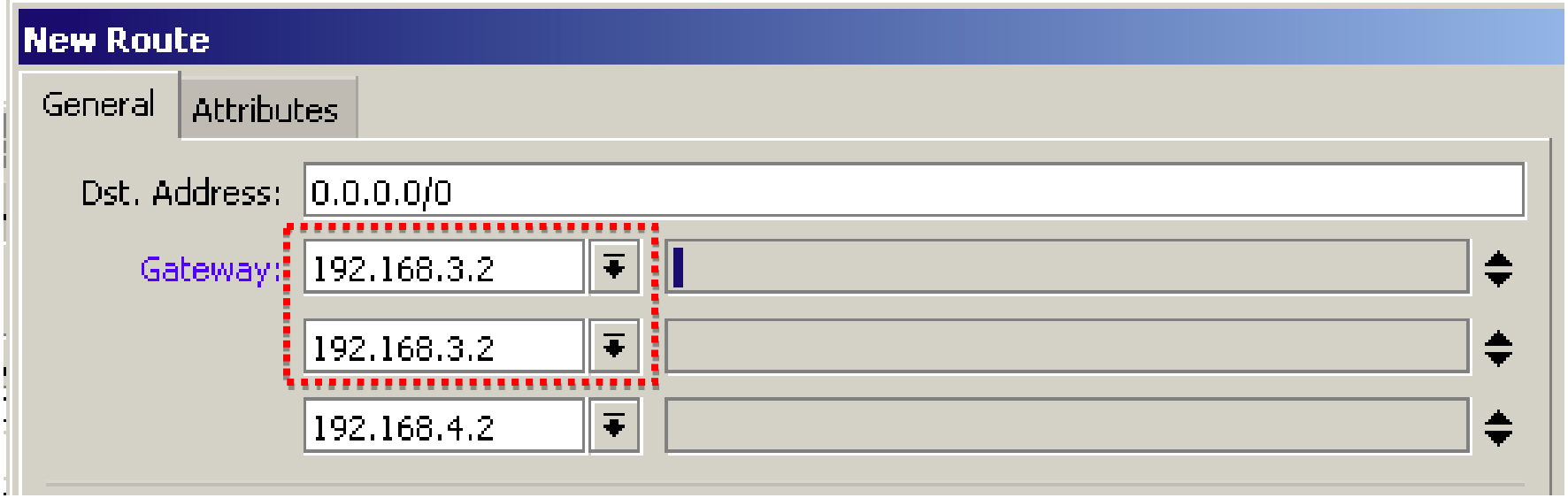
- 2 gateway, capacity of gateway A is twice than gateway B



ECMP

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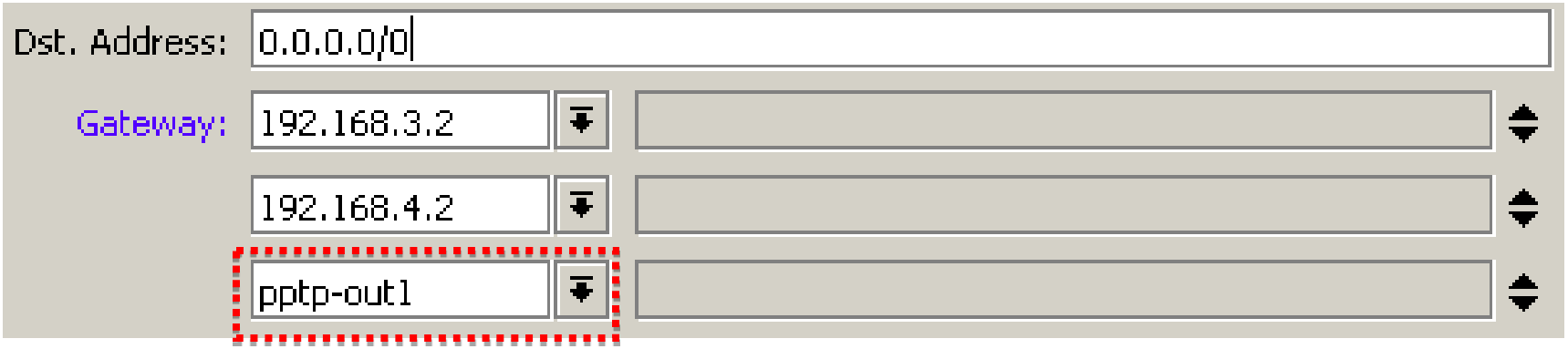
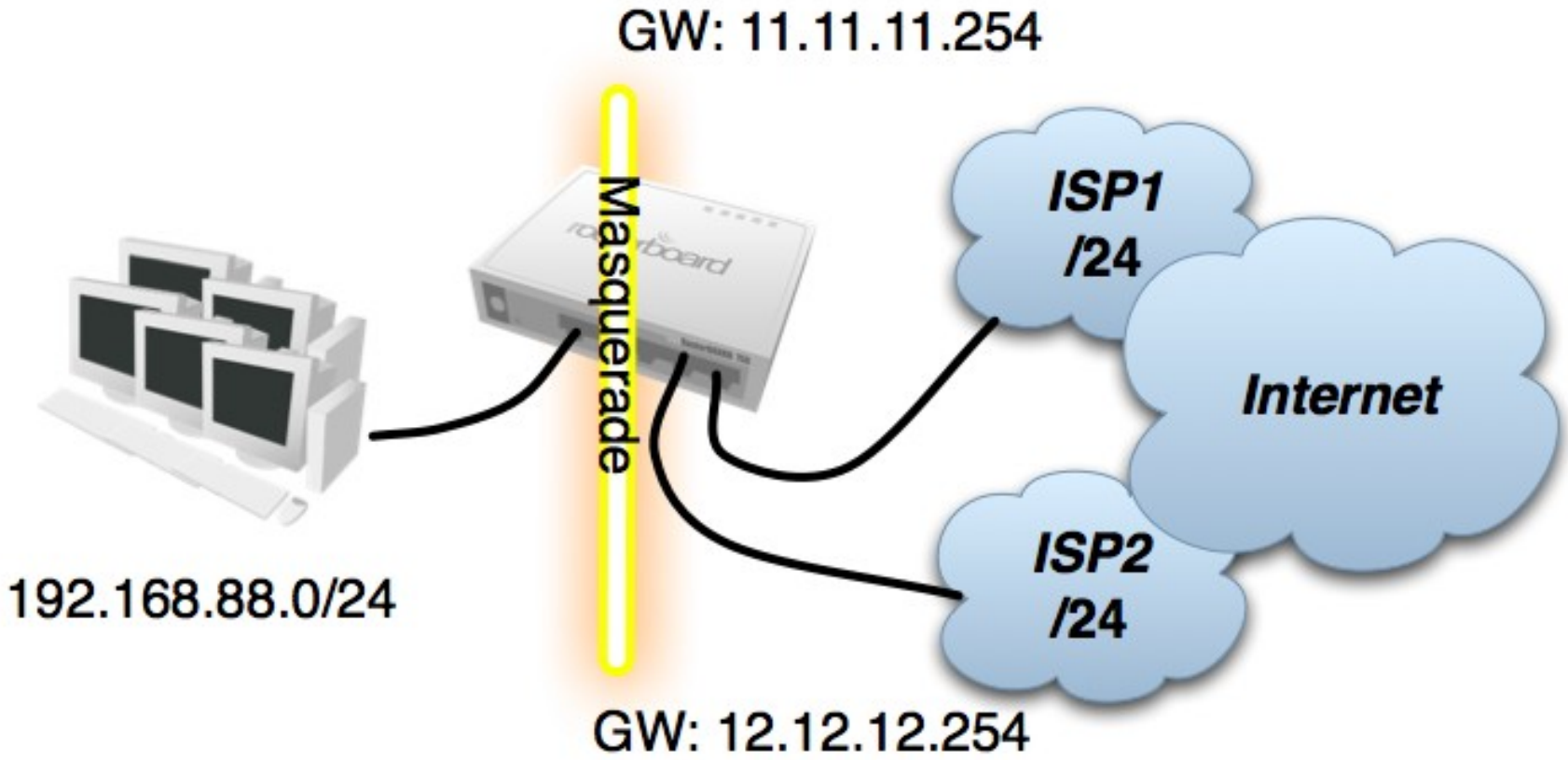
- 3 gateway, gateway C is using gateway interface



ECMP Drawback

- As forwarding database is rebuilt every 10min in Linux Kernel, there is a chance that connection will jump to other gateway
- In case of masquerade this jump results in change of source address and in eventual disconnect
- More info at:
  - http://www.enyo.de/fw/security/notes/linux-dst-cache-dos.html
  - http://marc.info/?m=105217616607144
  - http://lkml.indiana.edu/hypermail/linux/net/0305.2/index.html#19

Configuration Setup



Basic Configuration

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```
[admin@MikroTik] > /interface set 1 name=to_ISP1
[admin@MikroTik] > /interface set 2 name=to_ISP2
[admin@MikroTik] > /interface set 3 name=Local
```

```
[admin@MikroTik] /ip address> add address=192.168.88.254/24 interface=Local
[admin@MikroTik] /ip address> add address=11.11.11.1/24 interface=to_ISP1
[admin@MikroTik] /ip address> add address=12.12.12.1/24 interface=to_ISP2
```

```
[admin@MikroTik] /ip route> add gateway=11.11.11.254 distance=2
[admin@MikroTik] /ip route> add gateway=12.12.12.254 distance=3
```

```
[admin@MikroTik] /ip firewall nat> add chain=srcnat out-interface=to_ISP1 action=masquerade
[admin@MikroTik] /ip firewall nat> add chain=srcnat out-interface=to_ISP2 action=masquerade
```

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Policy Routing

- Policy routing is a method that allow to create separate routing polices for different traffic by creating custom routing tables
- In RouterOS these routing tables are created:
  - For every table specified in /ip route rule
  - For every routing-mark in mangle facility
- Marked traffic is automatically assigned to the proper routing table (no need for lookup rules)

Routing-mark

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- RouterOS attribute assigned to each packet
- Routing-mark can be changed in firewall mangle facility just before any routing decision:
  - chain Prerouting – for all incoming traffic
  - chain Output – for outgoing traffic from router
- Every new routing mark have its own routing table with the same name
- By default all packets have “main” routing mark

Traffic to Connected Networks

- As connected routes are available only in “main” routing table, it is necessary that traffic to connected networks will stay in “main” routing table
- This will also allow proper communication between locally and remotely connected

```
/ip firewall mangle> add chain=prerouting src-address=192.168.88.0/24
                       dst-address=11.11.11.0/24 action=accept

/ip firewall mangle> add chain=prerouting src-address=192.168.88.0/24
                       dst-address=12.12.12.0/24 action=accept

/ip firewall mangle> add chain=prerouting src-address=192.168.88.0/24
                       dst-address=192.168.88.0/24 action=accept
```

Remote Connections

- In case when connection is initiated from public interface it is necessary to ensure that these connections will be replied via the same interface (from the same public IP)
- First we need to capture these connections (you can ether use default connection mark “no-mark” or connection state “new” here)

```
/ip firewall mangle> add chain=prerouting connection-mark=no-mark in-interface=to ISP1
                                          action=mark-connection new-connection-mark=ISP1_conn
/ip firewall mangle> add chain=prerouting connection-mark=no-mark in-interface=to_ISP2
                                          action=mark-connection new-connection-mark=ISP2_conn
```

Custom Policy Routing

- Now we need to create a default route for every routing table (or else it will be resolved by main routing table)

```
/ip route> add gateway=11.11.11.254 routing-mark=ISP1_traffic
/ip route> add gateway=12.12.12.254 routing-mark=ISP2_traffic
```

- Lets create a jump rule to your custom policy routing here

```
/ip firewall mangle> add chain=prerouting in-interface=Local connection-mark=no-mark
                                          action=jump jump-target=policy_routing
```

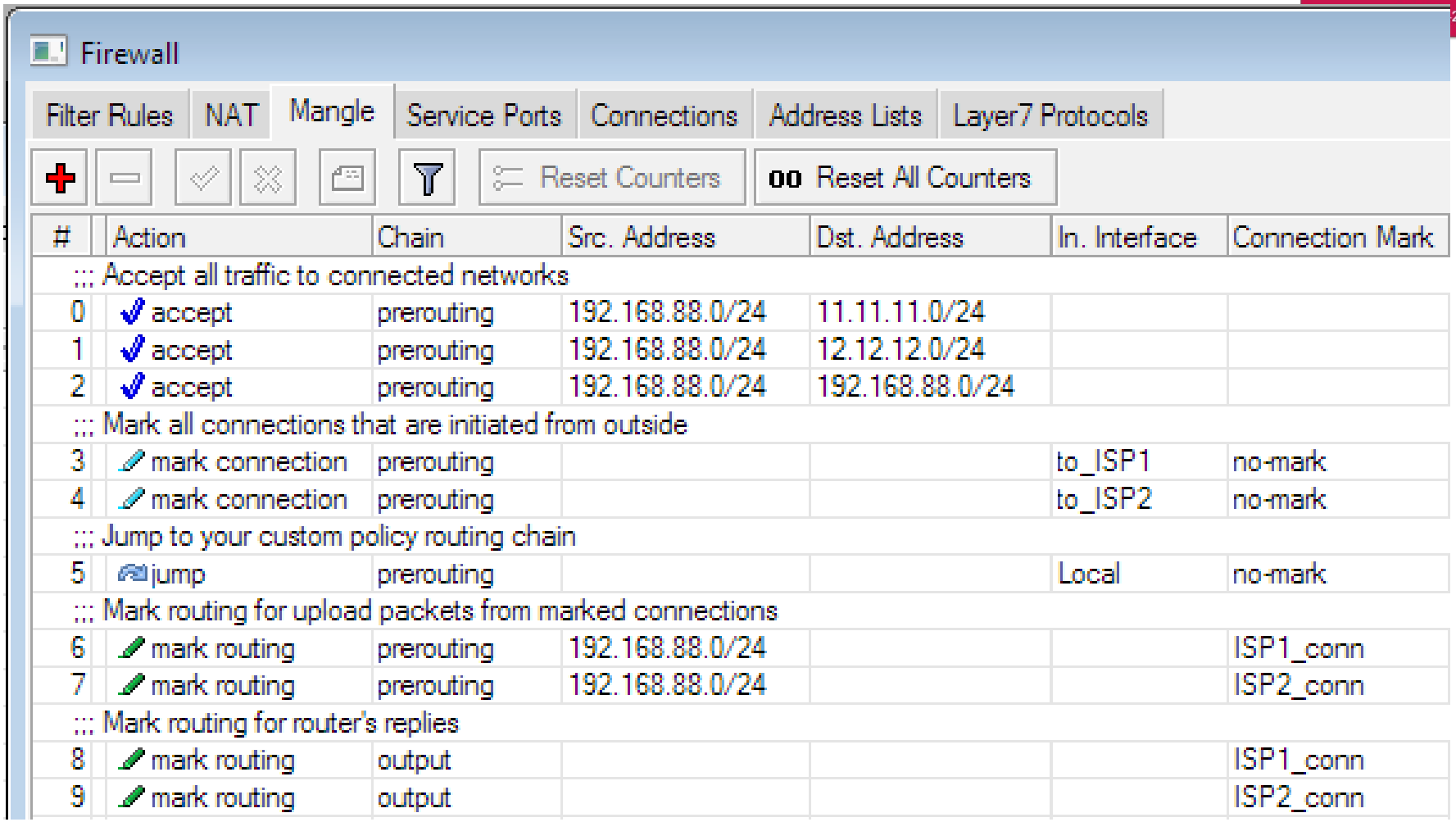
Mark Routing

- Mark routing rules in mangle chain “output” will ensure that router itself is reachable via both public IP addresses
- Mark routing rules in mangle chain “prerouting” will ensure your desired load balancing

```
/ip firewall mangle> add chain=prerouting connection-mark=ISP1_conn src-address=192.168.88.0/24
                                          action=mark-routing new-routing-mark=ISP1_traffic
/ip firewall mangle> add chain=prerouting connection-mark=ISP2_conn src-address=192.168.88.0/24
                                          action=mark-routing new-routing-mark=ISP2_traffic

/ip firewall mangle> add chain=output connection-mark=ISP1_conn
                                          action=mark-routing new-routing-mark=ISP1_traffic
/ip firewall mangle> add chain=output connection-mark=ISP2_conn
                                          action=mark-routing new-routing-mark=ISP2_traffic
```

Mangle configuration



#	Action	Chain	Src. Address	Dst. Address	In. Interface	Connection Mark
;;; Accept all traffic to connected networks						
0	accept	prerouting	192.168.88.0/24	11.11.11.0/24		
1	accept	prerouting	192.168.88.0/24	12.12.12.0/24		
2	accept	prerouting	192.168.88.0/24	192.168.88.0/24		
;;; Mark all connections that are initiated from outside						
3	mark connection	prerouting			to_ISP1	no-mark
4	mark connection	prerouting			to_ISP2	no-mark
;;; Jump to your custom policy routing chain						
5	jump	prerouting			Local	no-mark
;;; Mark routing for upload packets from marked connections						
6	mark routing	prerouting	192.168.88.0/24			ISP1_conn
7	mark routing	prerouting	192.168.88.0/24			ISP2_conn
;;; Mark routing for router's replies						
8	mark routing	output				ISP1_conn
9	mark routing	output				ISP2_conn

Custom Policy Routing

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- There are no best way that we can suggest for load balancing you can either:
  - Balance based on client IP address (address list)
  - Balance based on traffic type (p2p, layer-7, protocol, port)
  - Use automatic balancing (PCC)
- We do not suggest to use “nth” for policy routing of typical user traffic.

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Per-address-pair Load Balancing

- In many situations communication between two hosts consist of more than one simultaneous connection.
- If those connections are taking different routing path they might have different latency, drop rate, fragmentation or source address (NAT) – this way making multi-connection communications impossible.
- That is why instead of per-connection load balancing we should think about per-address-pair load balancing

Per Connection Classifier

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- PCC is a firewall matcher that allows you to divide traffic into equal streams with ability to keep packets with specific set of options in one particular stream
- You can specify set of options from src-address, src-port, dst-address, dst-port
- More info at: http://wiki.mikrotik.com/wiki/PCC

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PCC Configuration

- We just need to add 2 rules to our “policy_routing” chain to ensure automatic per-address-pair load balancing

```
/ip firewall mangle> add chain=policy_routing dst-address-type=!local
                       per-connection-classifier=both-addresses:2/0
                       action=mark-connection new-connection-mark=ISP1_conn

/ip firewall mangle> add chain=policy_routing dst-address-type=!local
                       per-connection-classifier=both-addresses:2/1
                       action=mark-connection new-connection-mark=ISP2_conn
```

Usual Problems

- Be careful about using “no-mark” connection mark if you have other mangle configuration in different chain
- ISP specified DNS servers might block request from non-ISP public IPs, so we suggest to use public (ISP independent) DNS servers.
- If you would like to ensure fail-over – enable “check-gateway” option in all default routes.

Thank you!

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- Q&A……
- Or email to:
  - support@mikrotik.com
  - valens@mikrotik.co.id

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