Monitoring the Internet Connections of WAN Links with Only Routing Configuration

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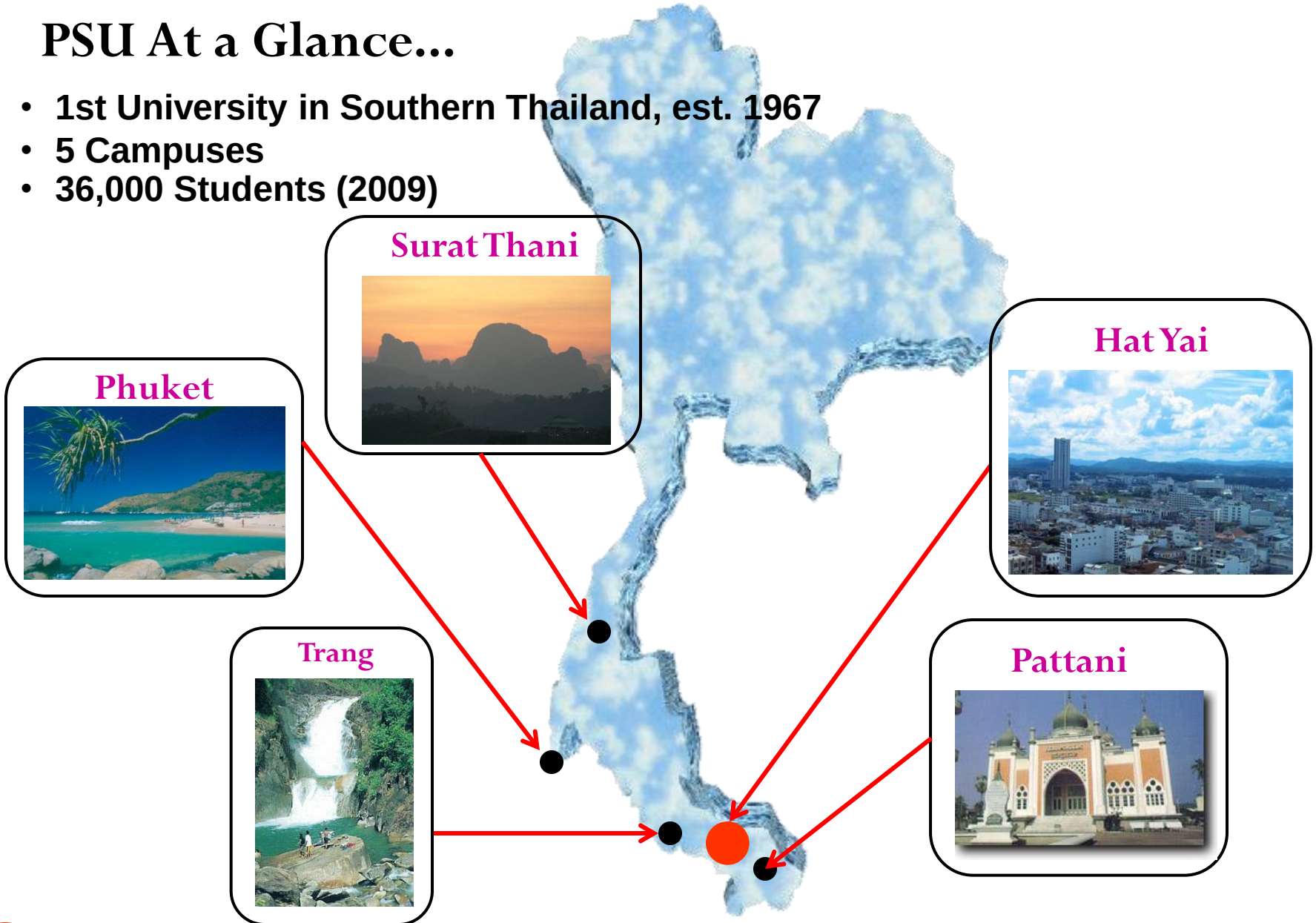
PSU At a Glance...

- 1st University in Southern Thailand, est. 1967
- 5 Campuses
- 36,000 Students (2009)



About Me

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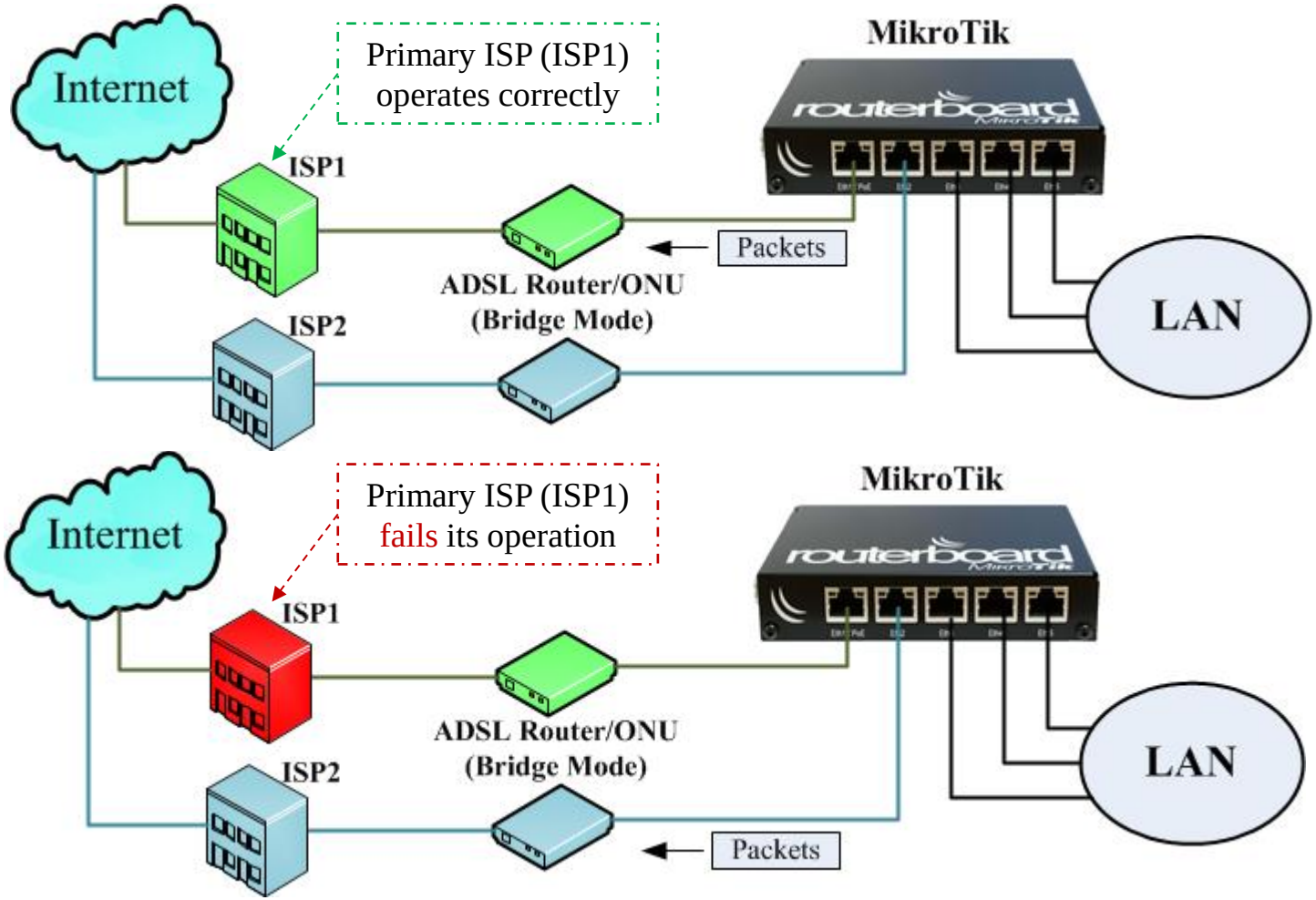
What is ISP Failover?

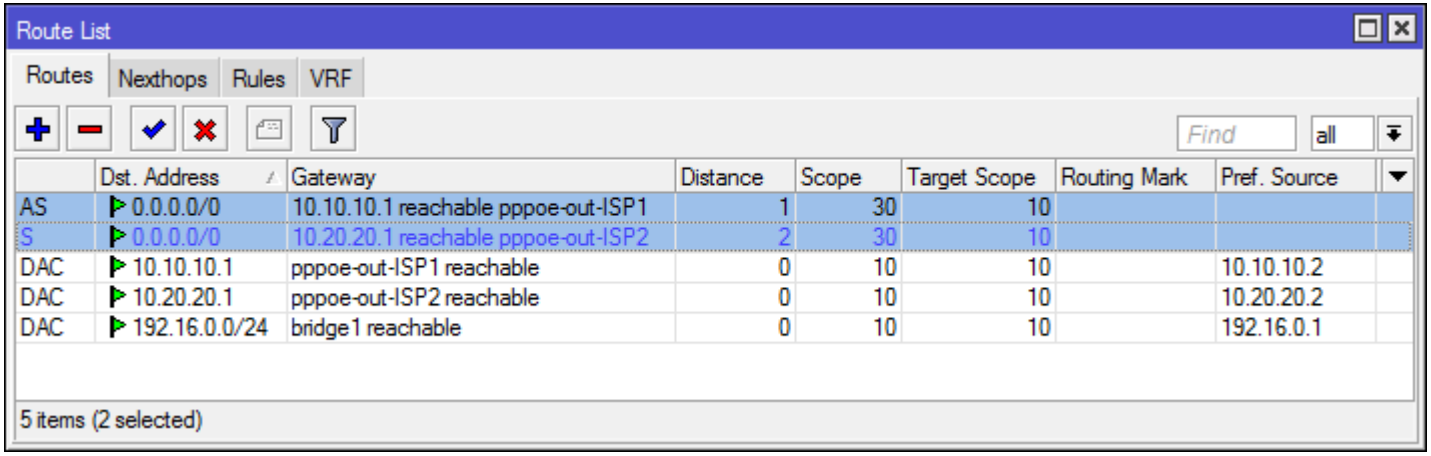
- **ISP Failover** is an operation to automatically switch over to the **standby ISP** when a primary ISP fails, i.e. it cannot provide its Internet service to the clients.



ISP Failover in MikroTik Routers

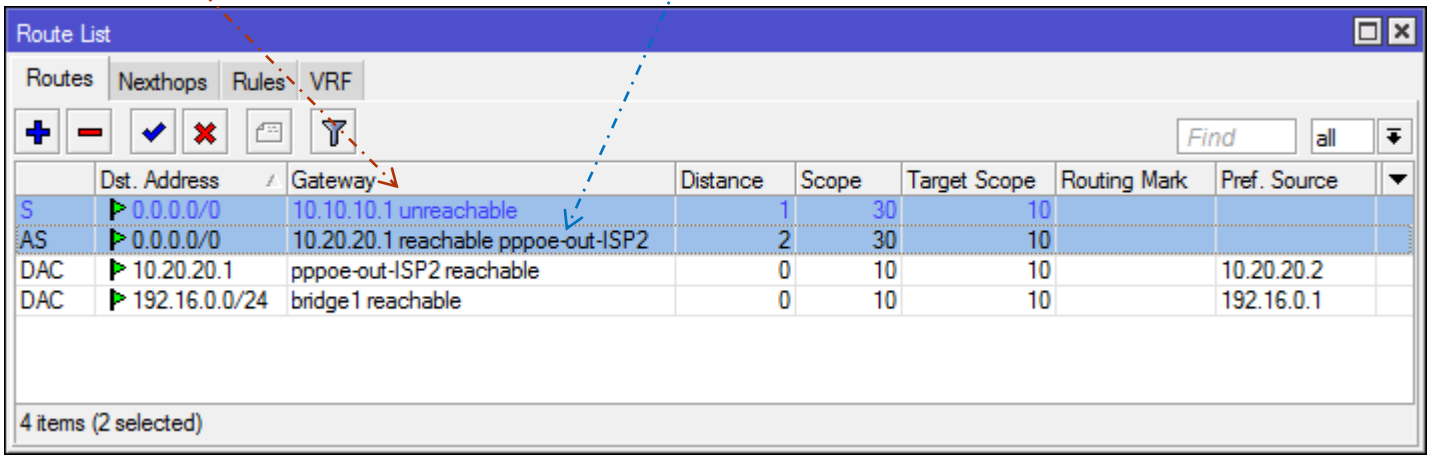
- Failover to the standby ISP in MikroTik routers can be simply configured by adding an default route with a **higher value** of the **distance** parameter in the routing table. This implies that the default route with a lower distance takes precedence over another one.

```
/ip route add gateway="IP Address of ISP1 Gateway" check-gateway=ping distance=1
/ip route add gateway="IP Address of ISP2 Gateway" check-gateway=ping distance=2
```



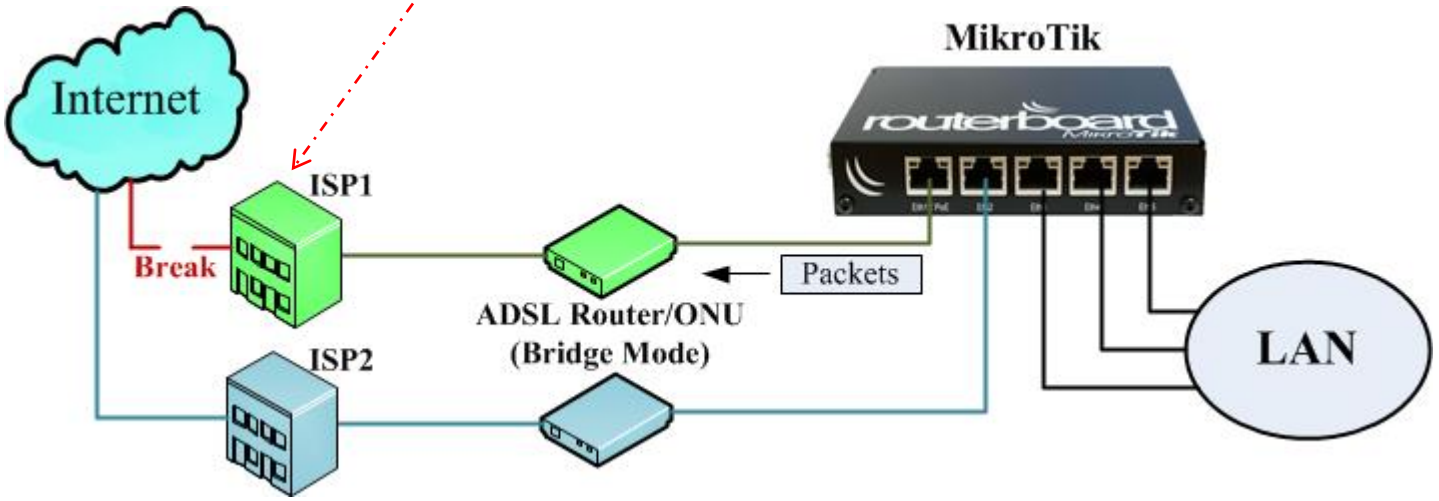
ISP Failover in MikroTik Routers

- Typically, monitoring the down state of an ISP is to periodically check the operation of the ISP gateway, i.e. an ICMP request packet is transmitted to the IP addresses of the ISP gateway every period of time (10 seconds).
- If the router does not get any ICMP response packet within the two timeouts (i.e. 20 seconds), it determines the ISP fails. It will then indicate the ISP gateway is unreachable and switch over the default route of another ISP gateway.



Typical Problems in ISP Failover

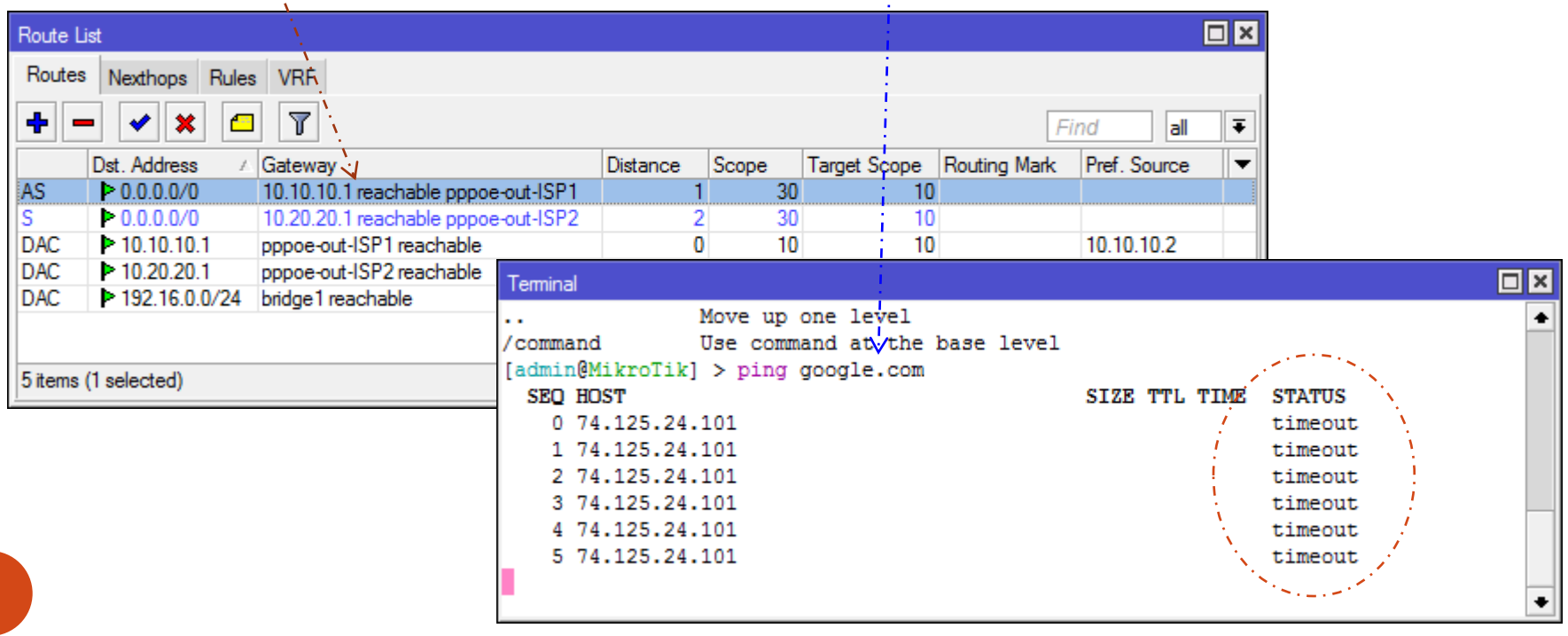
- The **typical problem** is that the router still get the ICMP responses from the gateway of the primary ISP but the Internet cannot be accessible due to any possible problem behind the primary ISP.
- In this way, all packets that are forwarded to the Internet are still transmitted to the gateway of the primary ISP.



The Internet cannot be accessible via ISP1 but the gateway of ISP1 responses ICMP packets correctly

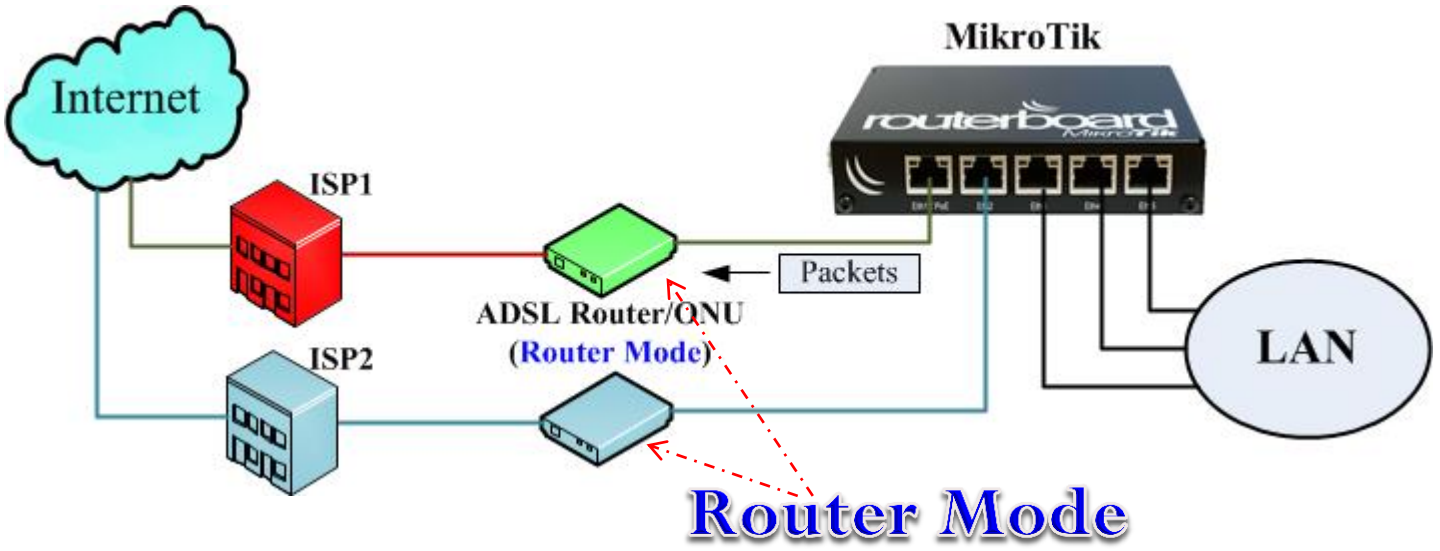
Typical Problems in ISP Failover

- The typical problem is that the router still get the ICMP responses from the gateway of the primary ISP but the Internet cannot be accessible due to any possible problem behind the primary ISP.
- In this way, all packets that are forwarded to the Internet are still transmitted to the gateway of the primary ISP.



Typical Problems in ISP Failover

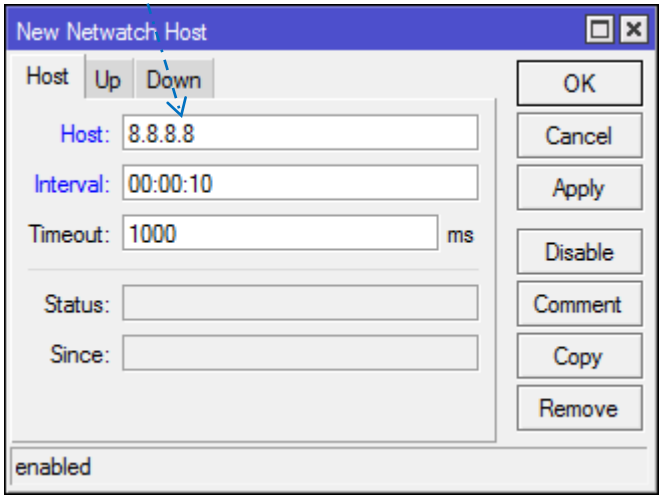
- This is even worse in a case where some ASDL routers or ONU routers are not allowed to configure to be in a bridge mode.
- The default root's gateway is not the ISP gateway anymore.



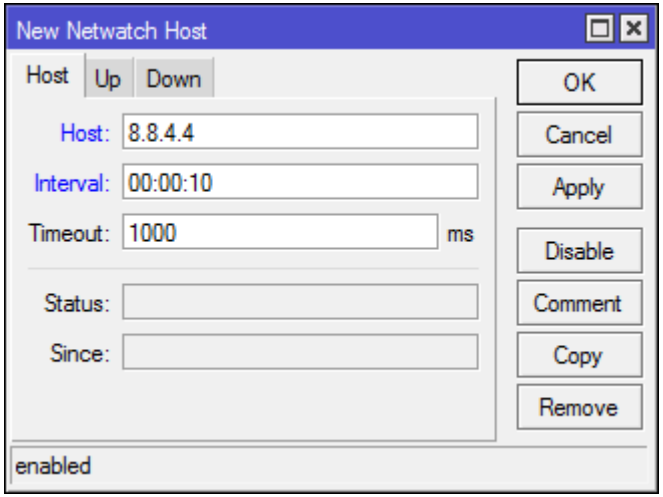
The default root's gateway is not an ISP gateway

Current Solution With Netwatch

- Currently the **Netwatch** tool is widely used in Thailand to monitor the Internet connections of WAN links by checking a remote host instead of the nearby gateway.
- It works like the traditional way by periodically sending an ICMP request packet but to a specified remote host in the Internet.



Host (8.8.8.8) via the ISP1 gateway

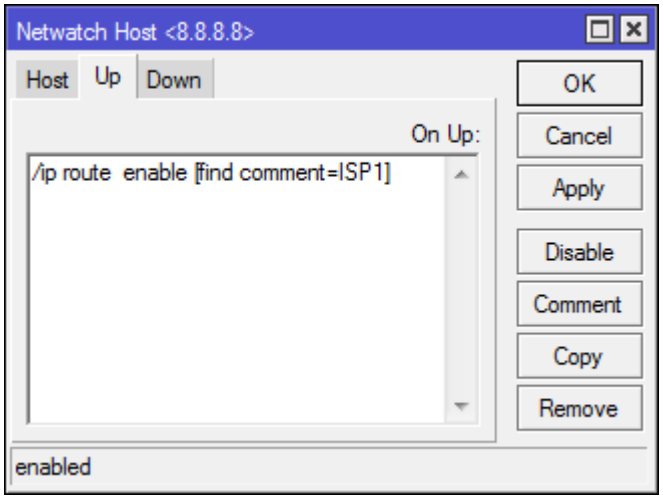


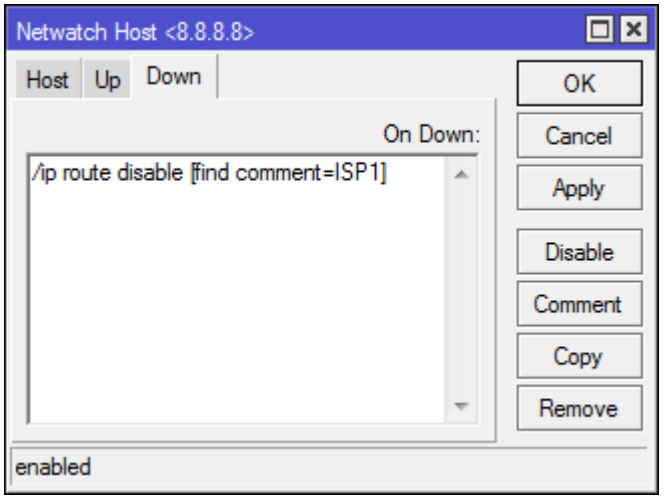
Host (8.8.4.4) via the ISP2 gateway

Current Solution With Netwatch

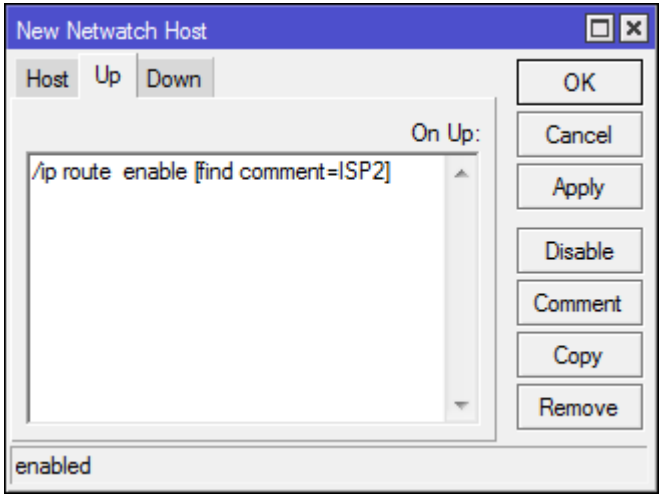
- However **scripting** is needed to disable and enable default routes (by finding their comments) in case where the up and down events of the remote hosts occur.

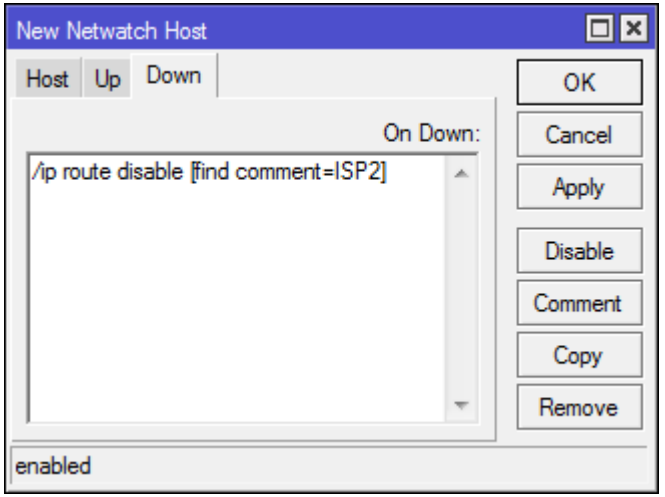
Host (8.8.8.8) for ISP1





Host (8.8.4.4) for ISP2





Current Solution With Netwatch

- However **scripting in the Netwatch tool** is needed to disable and enable default routes (by finding their comments) in case where the up and down events of the remote host occur.

```
/tool netwatch
add down-script="/ip route disable [find comment=ISP1]" host=8.8.8.8 \
    interval=10s up-script="/ip route  enable [find comment=ISP1]"
add down-script="/ip route disable [find comment=ISP2]" host=8.8.4.4 \
    interval=10s up-script="/ip route  enable [find comment=ISP2]"
```

- Each default root will be disabled and enabled by referring its comment parameter.

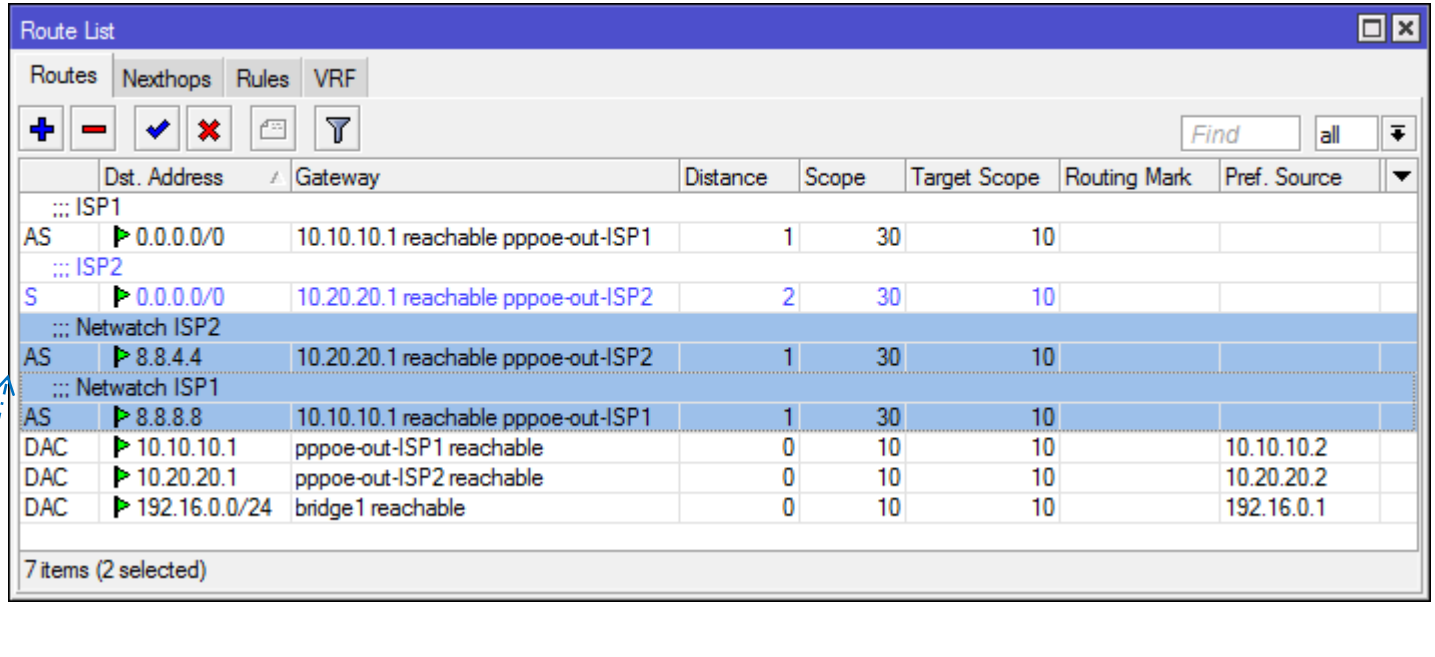
```
/ip route
add check-gateway=ping comment=ISP1 distance=1 gateway=10.10.10.1
add check-gateway=ping comment=ISP2 distance=2 gateway=10.20.20.1
```

- The Netwatch tasks will ping each remote hosts via a different route (or gateway).

```
/ip route
add check-gateway=ping comment="Netwatch ISP2" distance=1 dst-address=\
    8.8.4.4/32 gateway=10.20.20.1
add check-gateway=ping comment="Netwatch ISP1" distance=1 dst-address=\
    8.8.8.8/32 gateway=10.10.10.1
```

Scripting in Netwatch

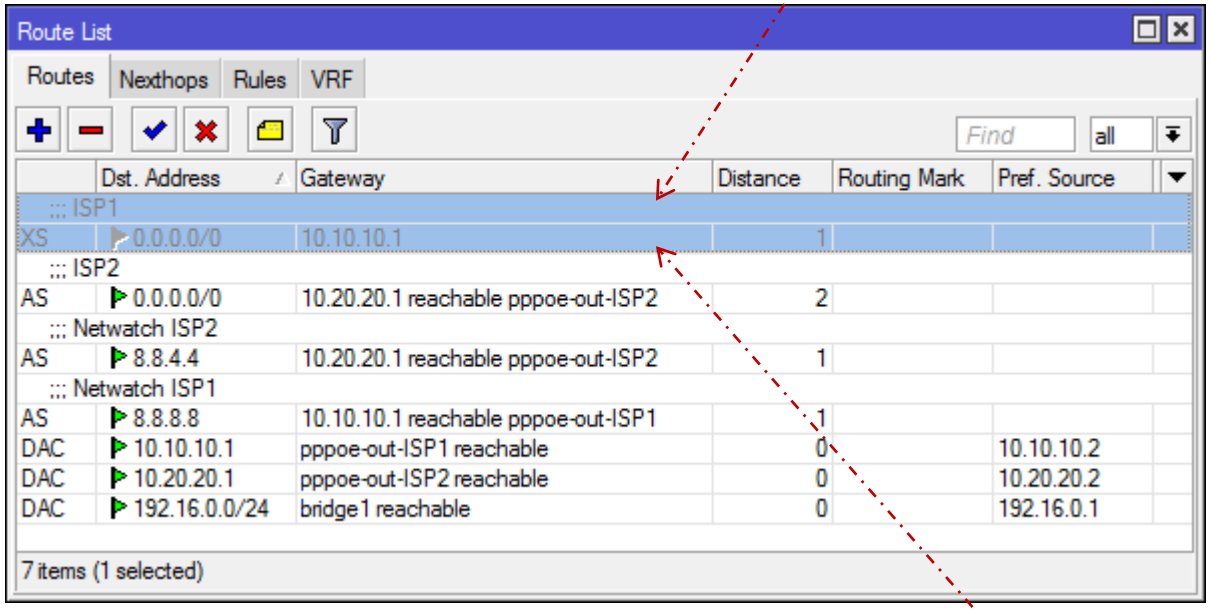
- It can be said that such scripting is not easy to accomplish for technicians who want to implement network solutions with failover for their customers but they do not know much about scripting. They prefer to simply configure via WinBox with GUI.

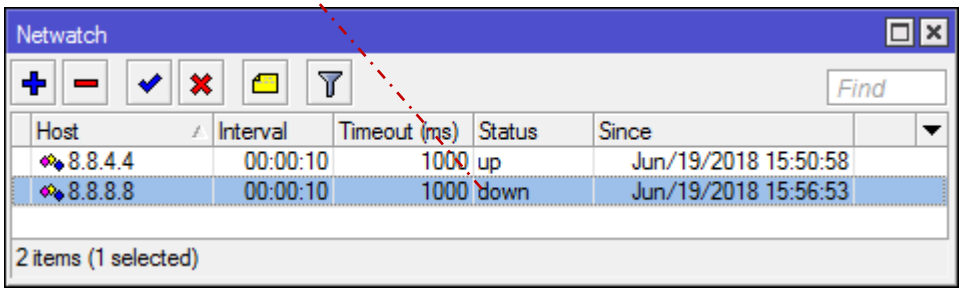


- Routes for remote hosts (i.e. 8.8.8.8 via the ISP1 gateway and 8.8.4.4 via the ISP2 gateway) must be added and always available for the Netwatch tool's tasks.

Scripting in Netwatch

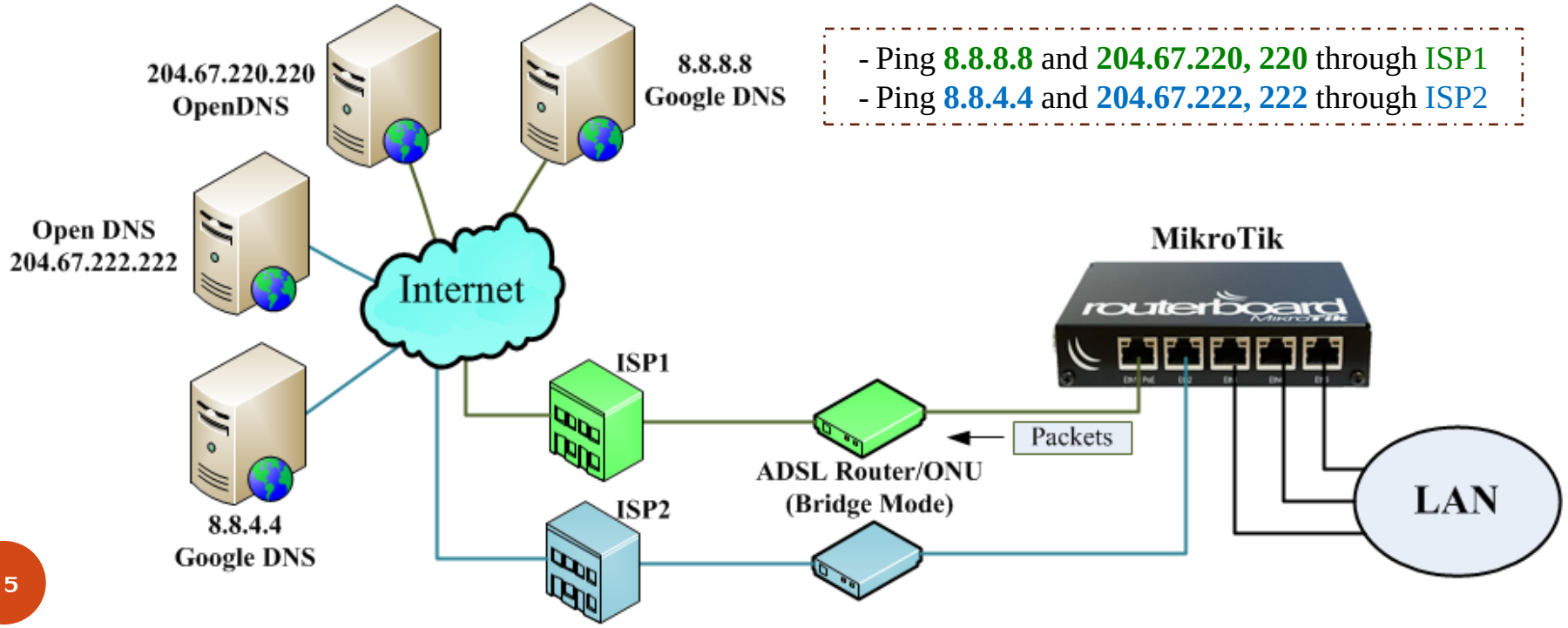
- The default root with the ISP1 comment is disabled when the Netwatch does not get an ICMP response packet for a specified timeout (1 second) after sending an ICMP request packet via the ISP1 gateway (10.10.10.1).





Multiple Remote Hosts with Netwatch

- It is possible that a single remote host might be down, checking multiple remote hosts per WAN link (such as Google DNS and OpenDNS) is required to **confirm** whether the Internet connection is **really** available per WAN link.
- In this regard, using the Netwatch tool seems to be **unable to cope with** because it supports only a single remote host.



Solution with Only Routing Configuration

- An **alternative solution** that can figure out the previously mentioned problems is done by **configuring only routes** in the routing table **(/ip routes)** without scripting and using the Netwatch tool at all.
- This solution can be broken down into **two scenarios**:
  1) Failover with **checking a single remote host** per WAN link
  2) Failover with **checking multiple remote hosts** per WAN link

No Scripting & Netwatch

Only Routing Configuration

Being Able to Check Multiple Remote Hosts per WAN Link

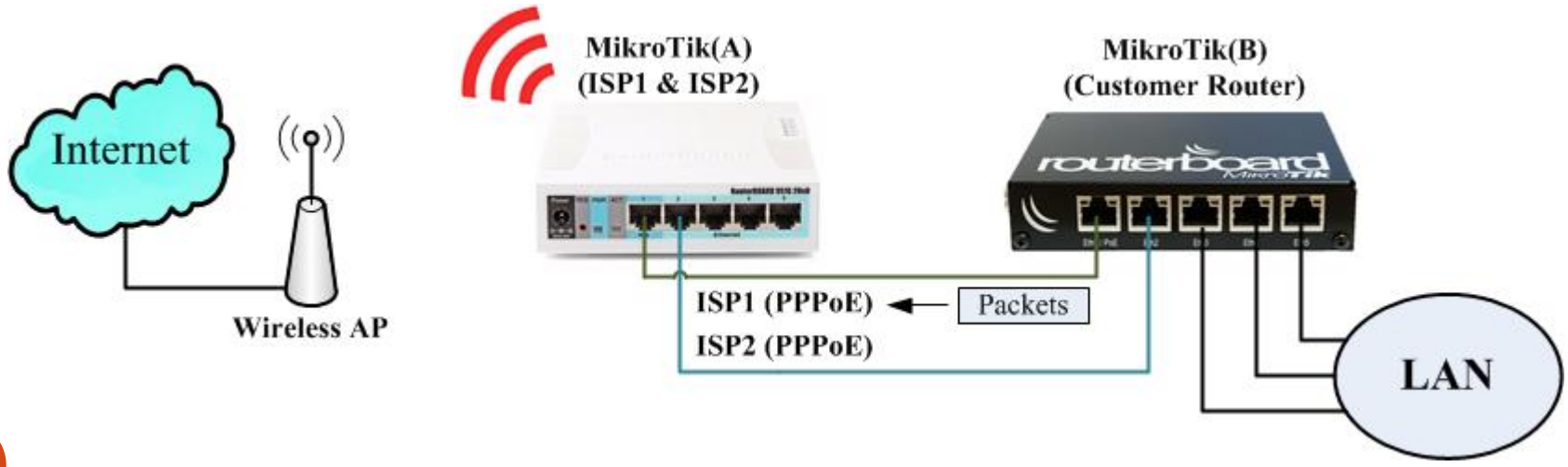
Reference

[1] https://wiki.mikrotik.com/wiki/Manual:IP/Route

[2] https://wiki.mikrotik.com/wiki/Advanced_Routing_Failover_without_Scripting

Basic Configuration with Two ISPs

- For **demonstration**, two (MikroTik) routers are used.
  - ✓MikroTik(A) emulates ISP1 and ISP2 via Ether1 and Ether2, respectively.
  - ✓MikroTik(B) emulates a router in a customer house.
- Both ISP1 and ISP2 provide IP addresses to the customer's router via PPPoE
  - ✓At the ISP1, Local Address = 10.10.10.1, Remote Address = 10.10.10.2
  - ✓At the ISP2, Local Address = 10.20.20.1, Remote Address = 10.20.20.2



Basic Configuration with Two ISPs

- At the customer router, the basic configuration is described by the following scripts.
- PPPoE Clients for ISP1 and ISP2

```
/interface pppoe-client
add disabled=no interface=ether1 name=pppoe-out-ISP1 password=12345 \
    use-peer-dns=yes user=user1
add disabled=no interface=ether2 name=pppoe-out-ISP2 password=12345 \
    use-peer-dns=yes user=user2
```

- Bridge with ether3, ether4, ether5

```
/interface bridge
add name=bridge1

/interface bridge port
add bridge=bridge1 interface=ether3
add bridge=bridge1 interface=ether4
add bridge=bridge1 interface=ether5
```

- Bridge's IP Address as 192.168.0.1/24

```
/ip address
add address=192.16.0.1/24 interface=bridge1 network=192.16.0.0
```

Basic Configuration with Two ISPs

- At the customer router, the basic configuration is described by the following scripts.
- DHCP Server with a pool of 192.168.0.2-192.168.0.254

```
/ip pool
add name=dhcp_pool1 ranges=192.16.0.2-192.16.0.254

/ip dhcp-server
add address-pool=dhcp_pool1 disabled=no interface=bridge1 name=dhcp1

/ip dhcp-server network
add address=192.16.0.0/24 gateway=192.16.0.1
```

- DNS Server in the customer router

```
/ip dns
set allow-remote-requests=yes
```

- NAT for the PPPoE Clients of ISP1 and ISP2

```
/ip firewall nat
add action=masquerade chain=srcnat out-interface=pppoe-out-ISP1
add action=masquerade chain=srcnat out-interface=pppoe-out-ISP2
```

Failover with Checking a Single Remote Host

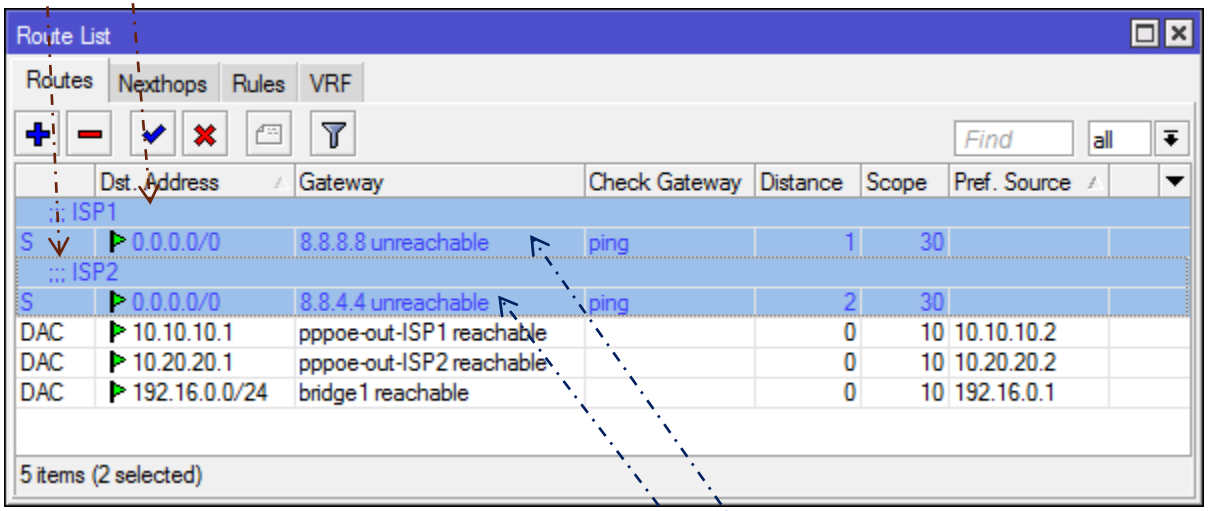
- Failover with checking a single remote host per WAN link

1) Create default routes using remote hosts as gateways with different distances

   - /ip route

     add distance=1 gateway=8.8.8.8 check-gateway=ping

     add distance=2 gateway=8.8.4.4 check-gateway=ping



Remote hosts are unreachable

Failover with Checking a Single Remote Host

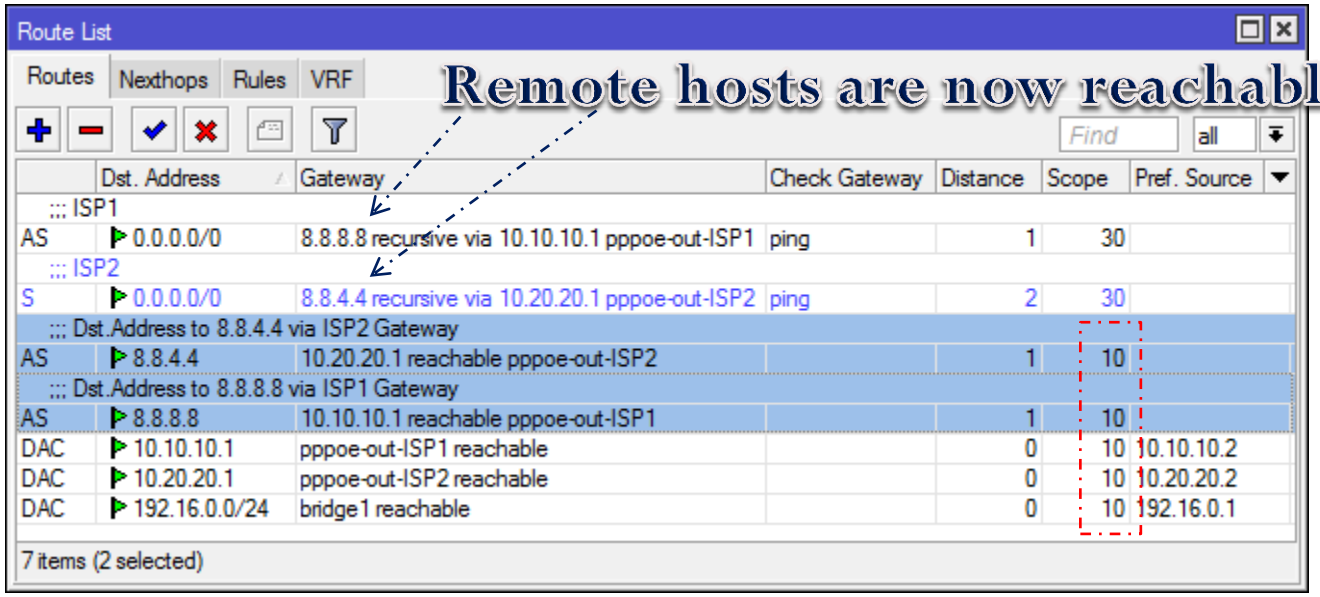
- Failover with checking a single remote host per WAN link

2) Create routes to the remote hosts using corresponding ISP gateways with scope=10 (the scope parameter must be less or equal to the target score parameter)

  - /ip route

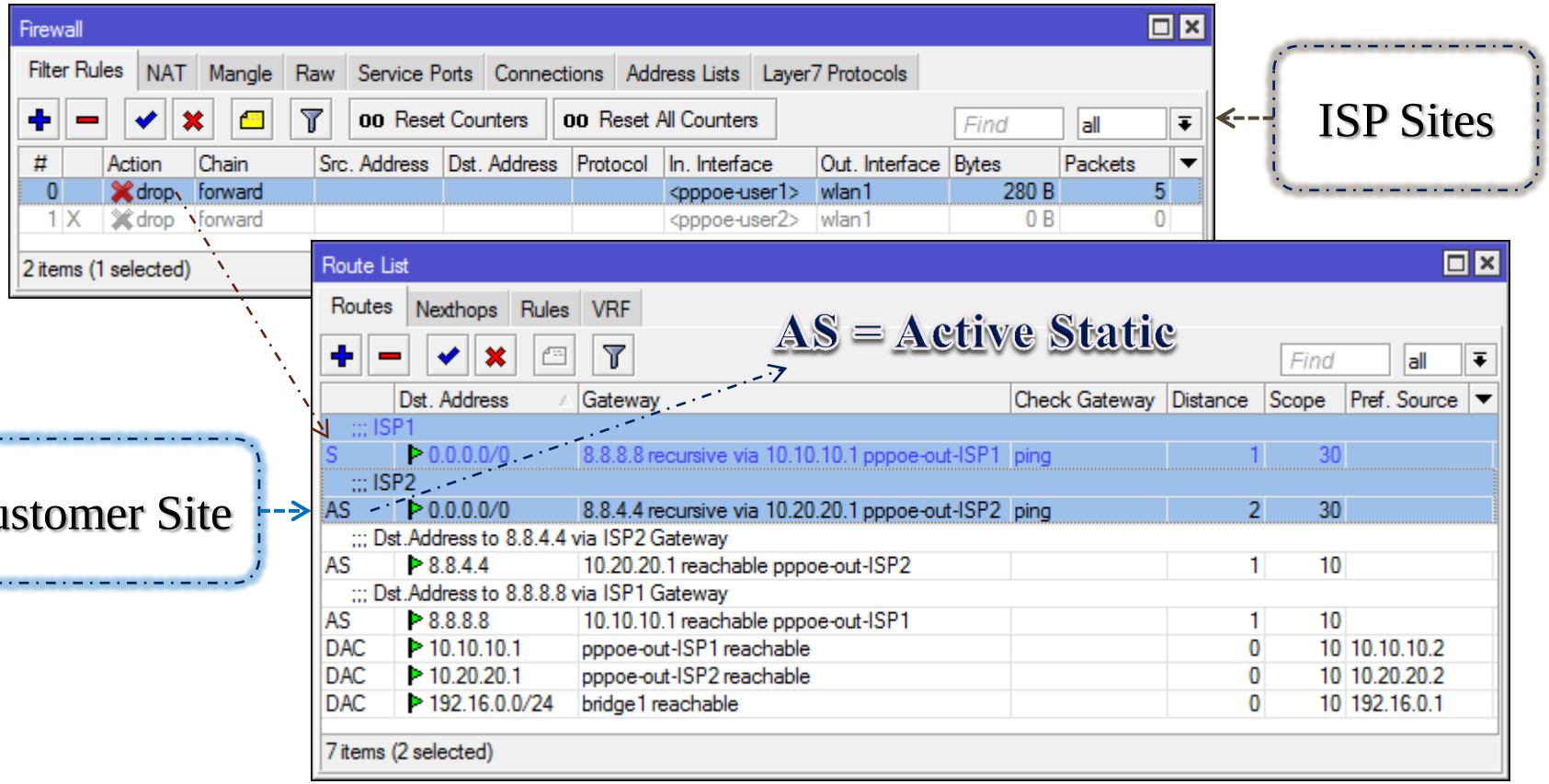
add dst-address=8.8.8.8 gateway=10.10.10.1 scope=10

add dst-address=8.8.4.4 gateway=10.20.20.1 scope=10



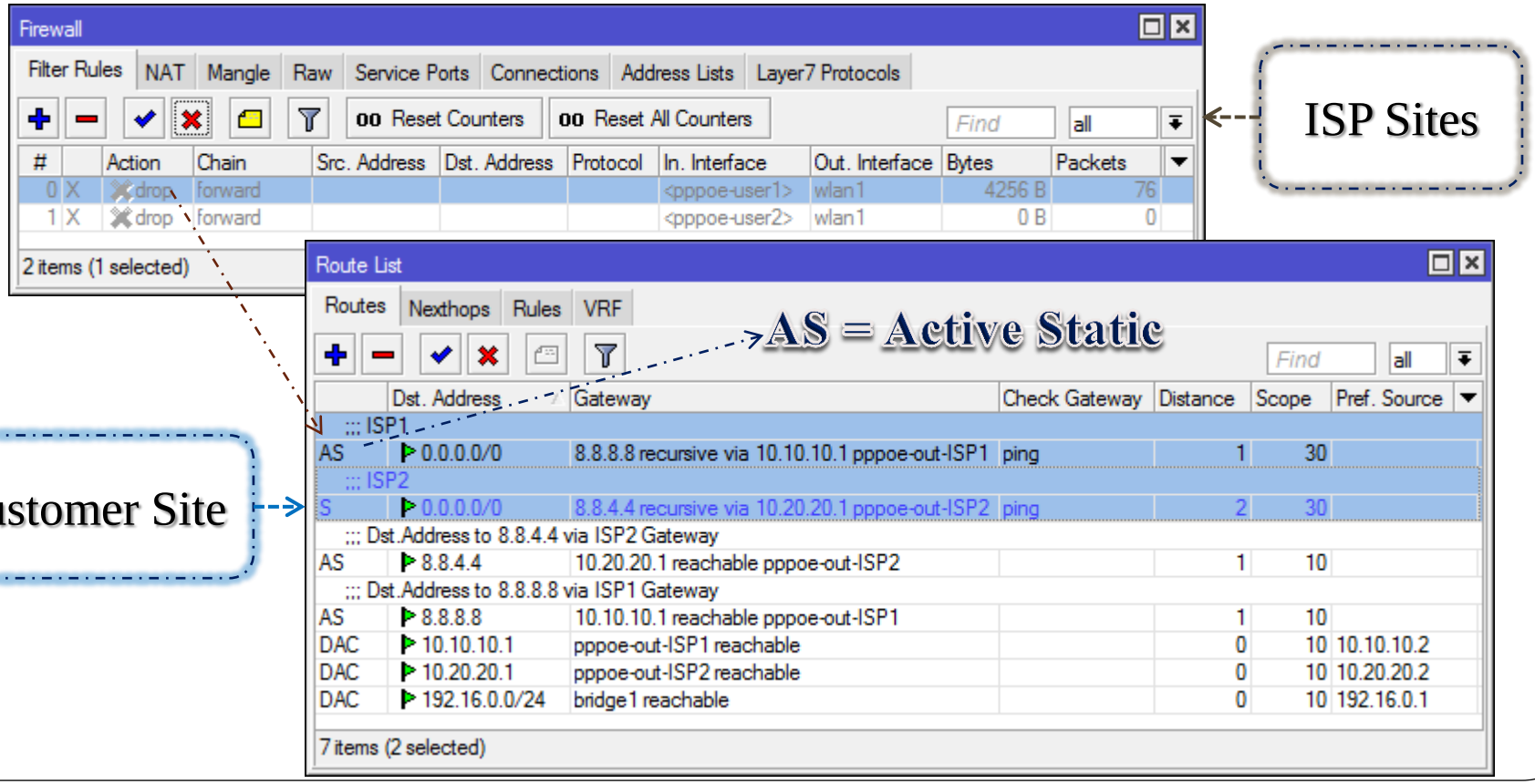
Failover with Checking Single Remote Hosts

- **Testing**: failover with checking a single remote host per WAN link
- Scenario#1: The ISP1 fails to access the Internet, the firewall rule in the MikroTik(A) drops all packets from the ISP1 PPPoE to the Internet. The backup WAN link (to ISP2) should take over all packets to the Internet.



Failover with Checking Single Remote Hosts

- **Testing:** failover with checking a single remote host per WAN link
- Scenario#2: The primary ISP1 has been recovered to be accessible to the Internet, the firewall rule in the MikroTik(A) that drops all packets from the ISP1 is disabled. The WAN link (ISP1) should return to take over all packets to the Internet.



Failover with Checking a Single Remote Host

- Failover with checking a single remote host per WAN link
- In case of **load balancing**, you have corresponding routing masks (toISP1, toISP2)
- The first step 1) is revised (adding default routes and changing distances) as follow.
  - /ip route

    add distance=1 gateway=8.8.8.8 routing-mask=toISP1 check-gateway=ping

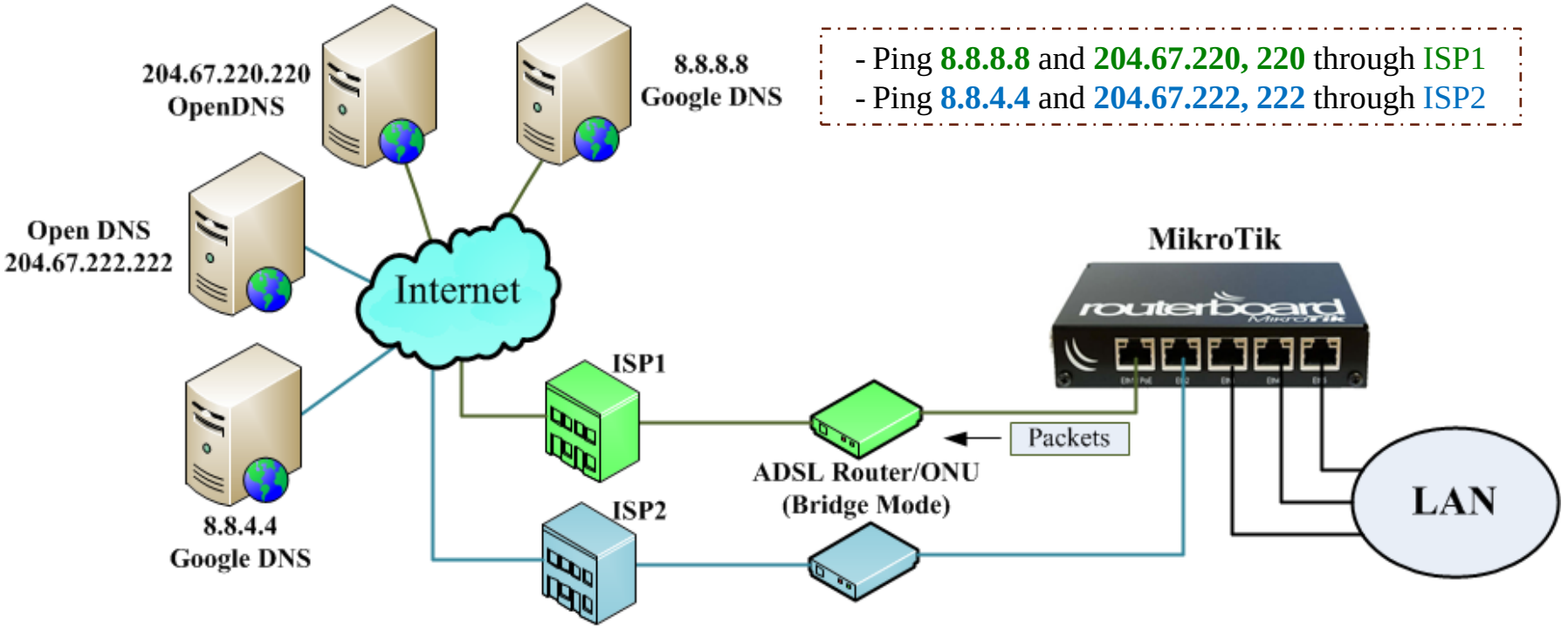
    add distance=2 gateway=8.8.4.4 routing-mask=toISP1 check-gateway=ping
  - /ip route

    add distance=1 gateway=8.8.4.4 routing-mask=toISP2 check-gateway=ping

    add distance=2 gateway=8.8.8.8 routing-mask=toISP2 check-gateway=ping

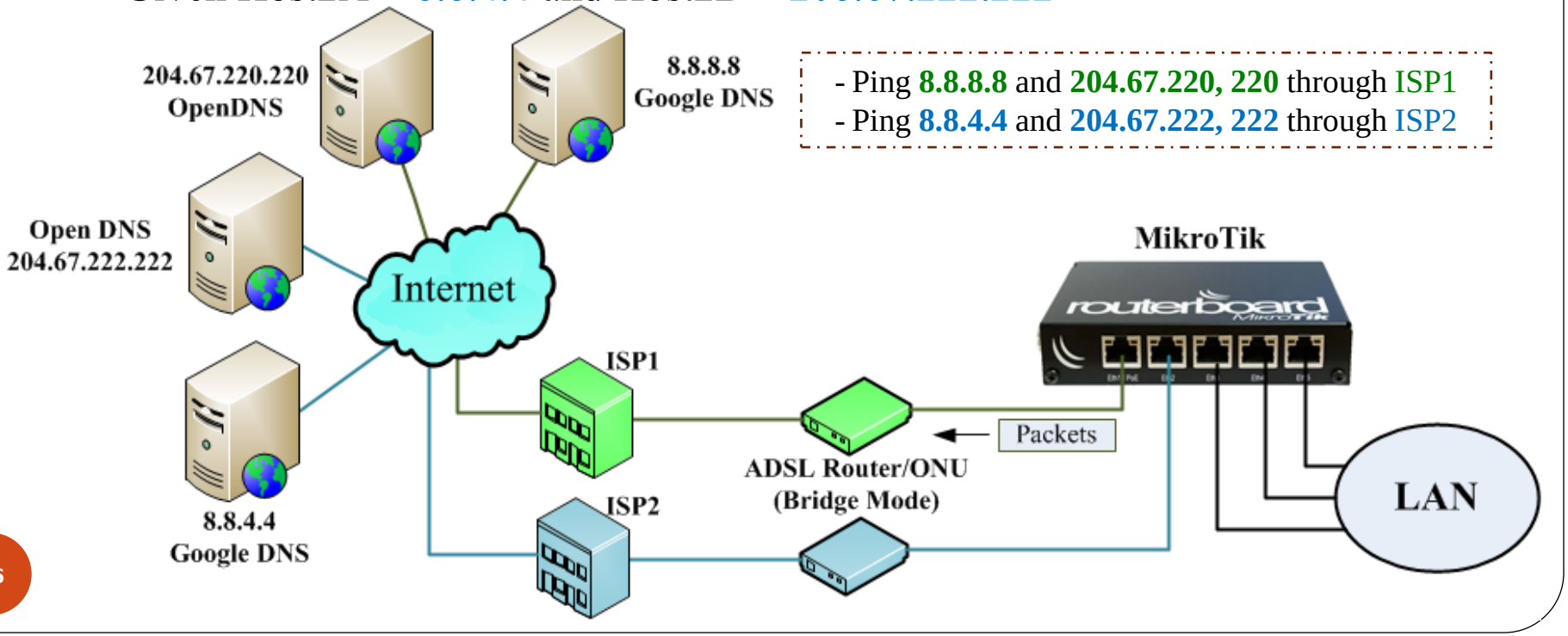
Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link
- **Google DNS** (8.8.8.8, 8.8.4.4) and **OpenDNS** (208.67.220.220, 208.67.222.222) are well known as trustable and stable DNS servers.



Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link
- Monitoring the primary WAN link's state by checking Host1A, Host1B via GW1
  - Given Host1A = 8.8.8.8 and Host1B = 208.67.220.220
- Monitoring the backup WAN link's state by checking Host2A, Host2B via GW2
  - Given Host2A = 8.8.4.4 and Host2B = 208.67.222.222



Failover with Checking Multiple Remote Hosts

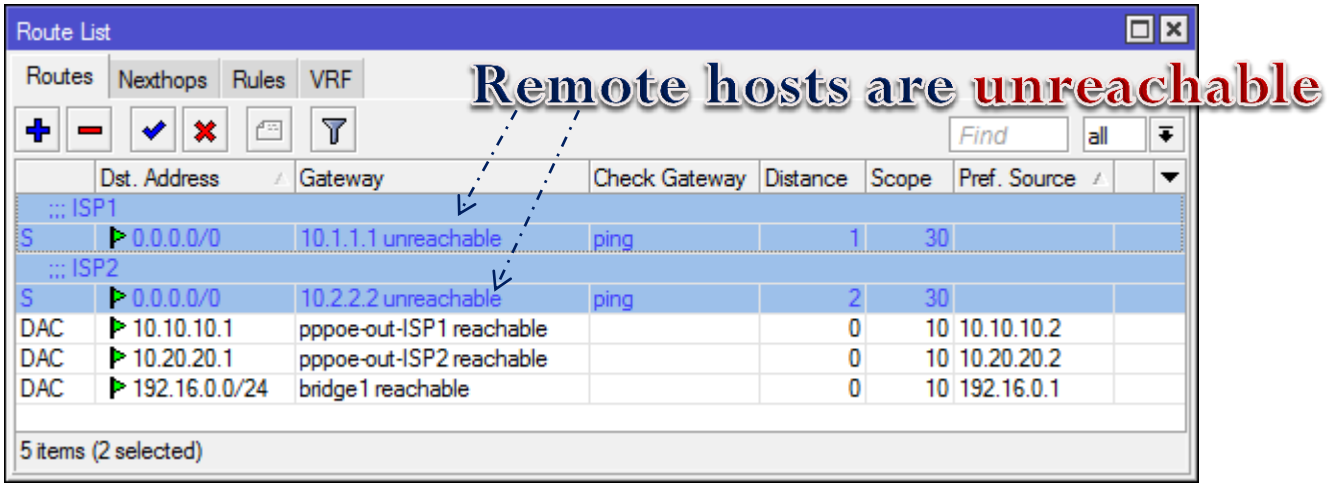
- Failover with checking multiple remote hosts per WAN link

1) Create default routes using remote hosts as gateways with different distances, but instead of using remote hosts, **two virtual hops** (10.1.1.1 for GW1 and 10.2.2.2 for GW2) has been setup as corresponding gateways to simplify the default routes.

   - /ip route

     add distance=1 gateway=10.1.1.1

     add distance=2 gateway=10.2.2.2



Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link

2) Create routes to the virtual hops using corresponding multiple remote hosts with scope=10

  - /ip route

    add dst-address=10.1.1.1 gateway=8.8.8.8 scope=10 check-gateway=ping

    add dst-address=10.1.1.1 gateway=208.67.220.220 scope=10 check-gateway=ping

  - /ip route

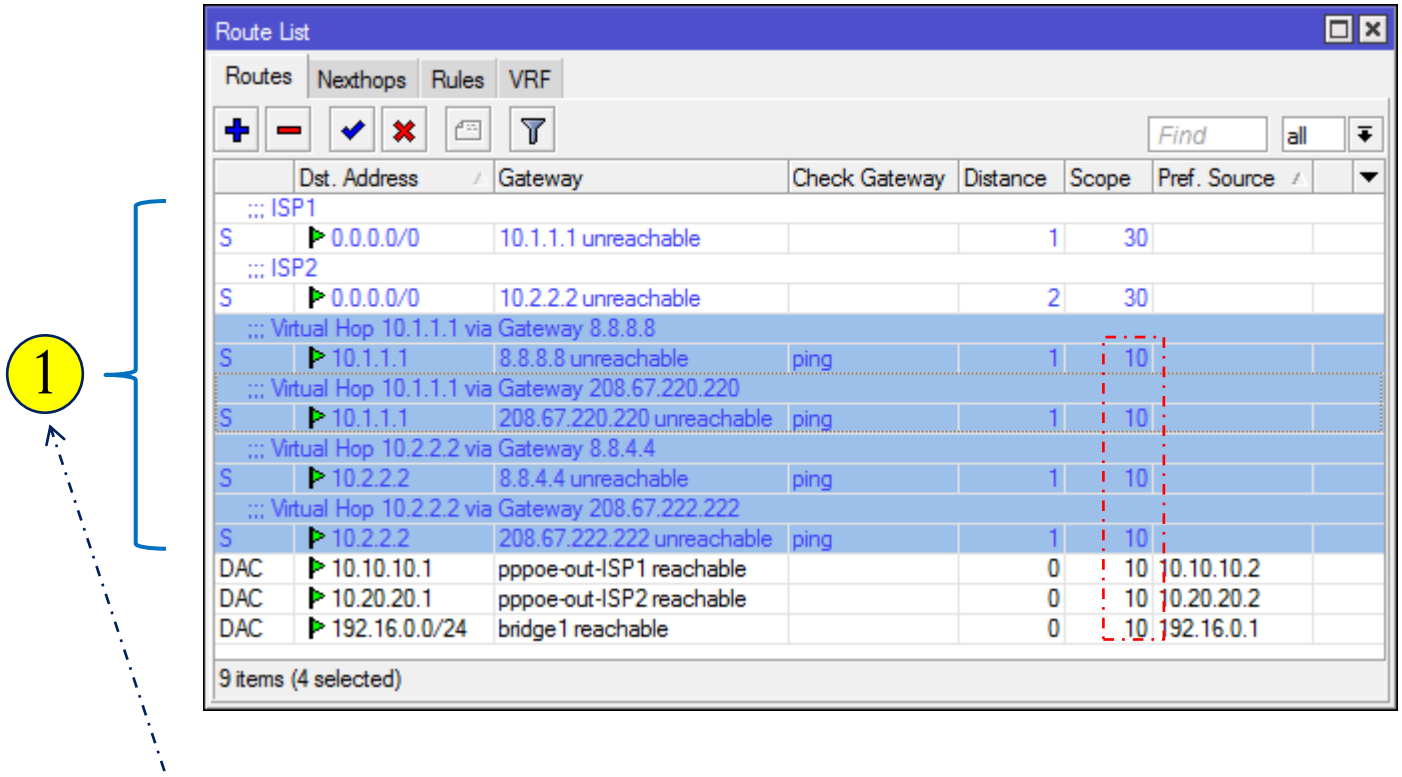
    add dst-address=10.2.2.2 gateway=8.8.4.4 scope=10 check-gateway=ping

    add dst-address=10.2.2.2 gateway=208.67.222.222 scope=10 check-gateway=ping

Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link

2) Create routes to the virtual hops using corresponding multiple remote hosts with scope=10



Remote hosts are unreachable. No routes with the scope 10

Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link

3) Create routes to the remote hosts using corresponding ISP gateways with **scope=10** (the scope parameter must be less or equal to the target score parameter)

- /ip route

  add dst-address=8.8.8.8 gateway=10.10.10.1 scope=10

  add dst-address=208.67.220.220 gateway=10.10.10.1 scope=10

- /ip route

  add dst-address=8.8.4.4 gateway=10.20.20.1 scope=10

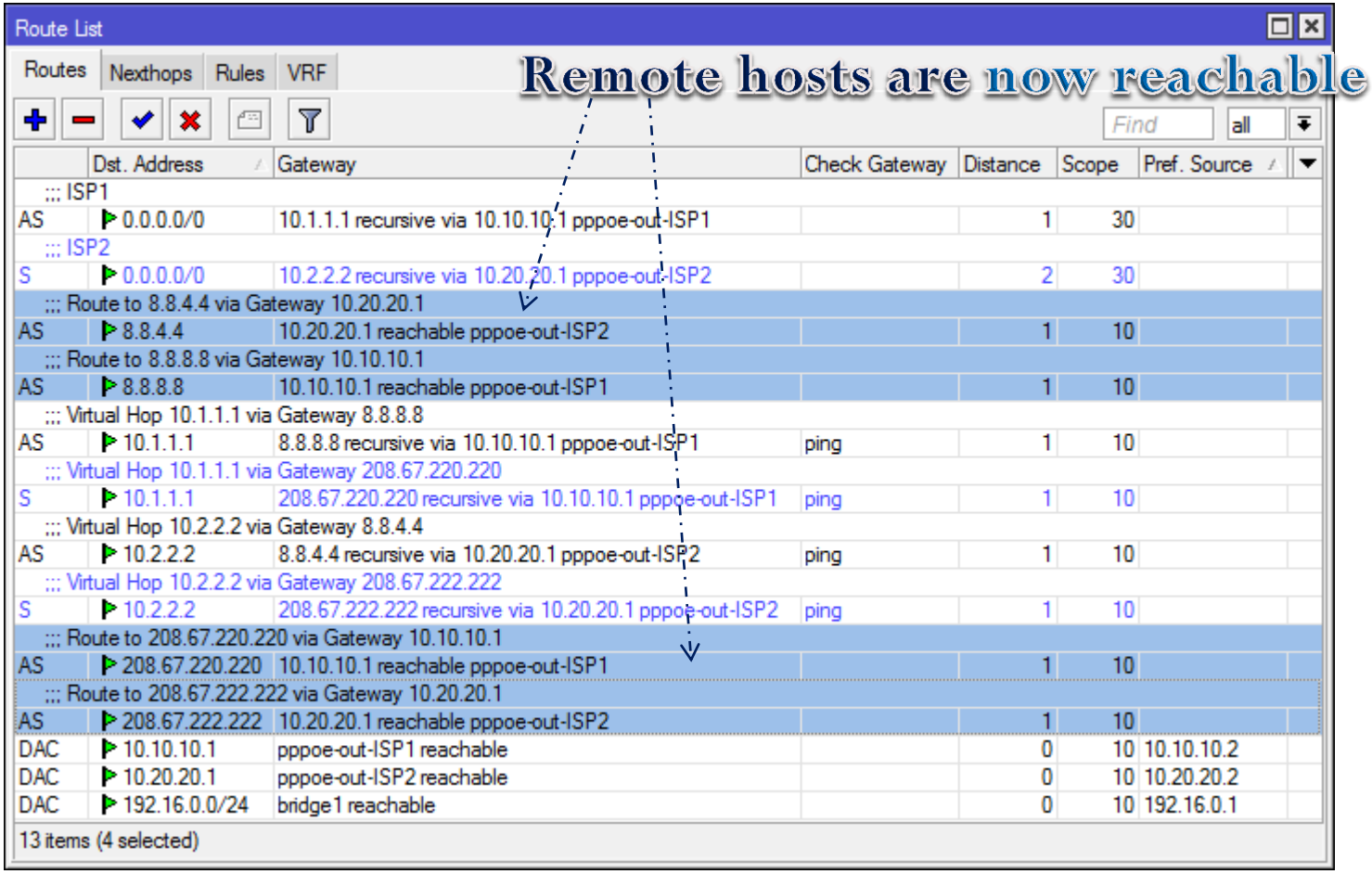
  add dst-address=208.67.222.222 gateway=10.20.20.1 scope=10

Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link

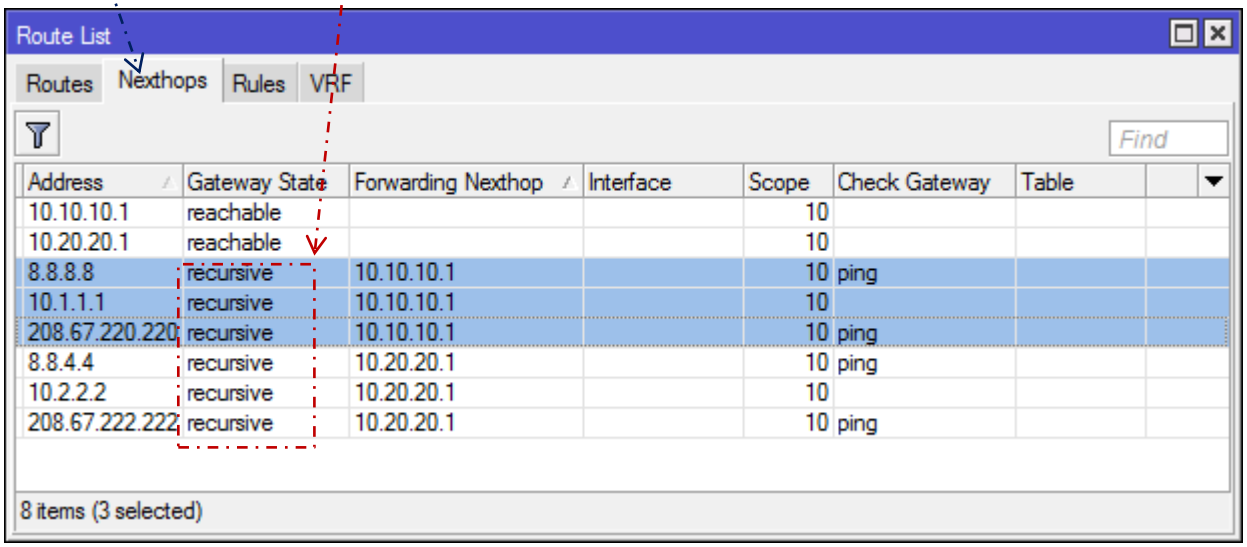
3) Create routes to the remote hosts using corresponding ISP gateways with **scope=10**

(the scope parameter must be less or equal to the target score parameter)



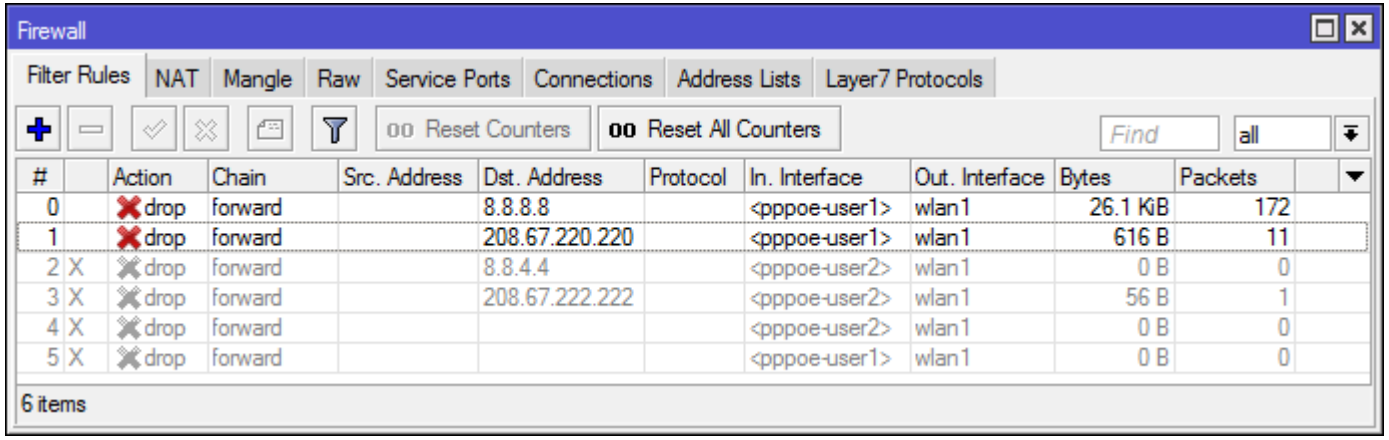
Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link
- The result of manually adding such routes with the scope 10 can be checked in term of **next hop** (/ip route nexthop print). Note that such routes are not connected routes.
- The **gateway** state "recursive" denotes that the gateway is used as the destination address for the next round in finding the next appropriate route (with the scope 10) in the route list.



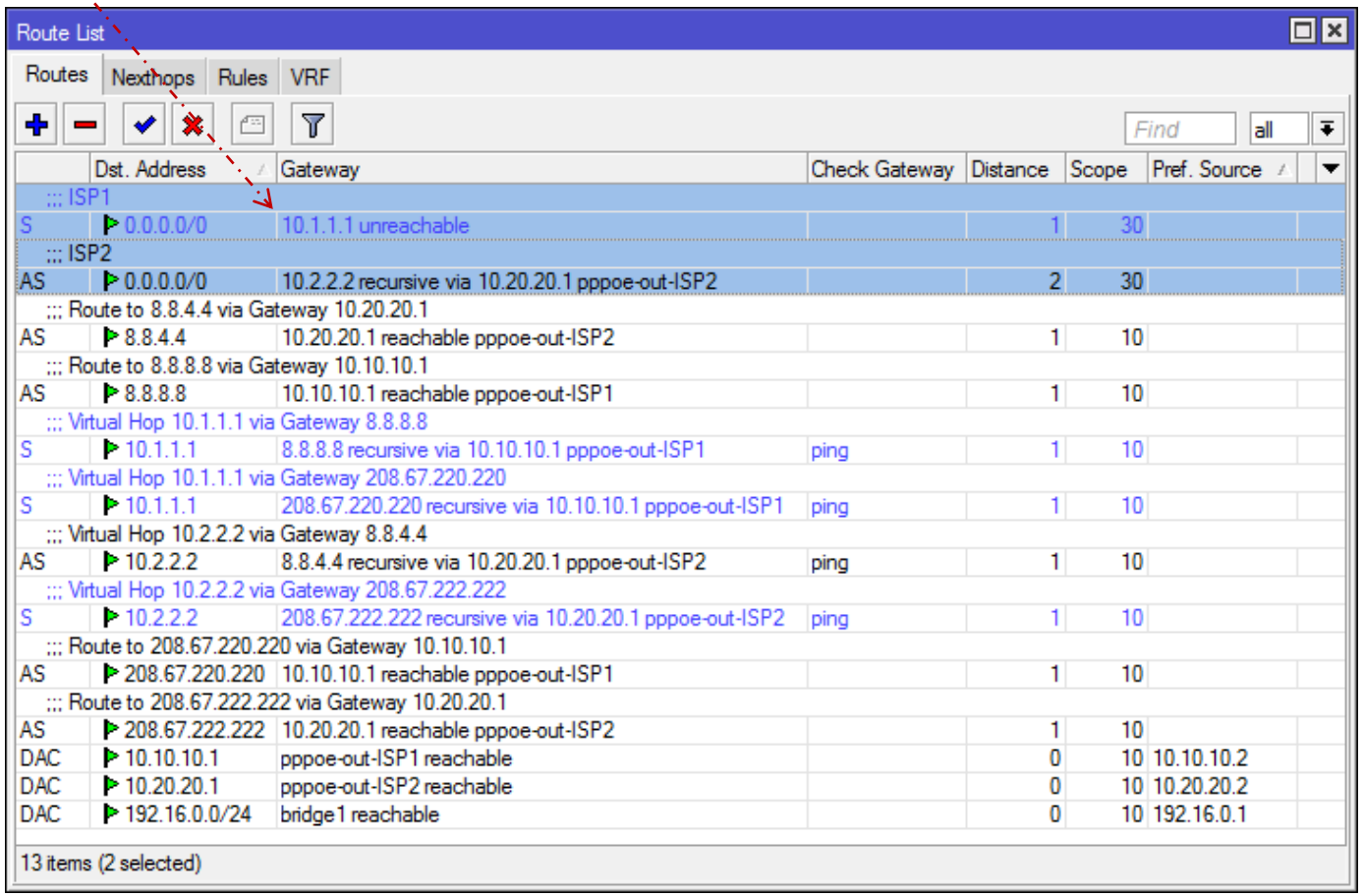
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#1: The ISP1 fails to access the Internet, the firewall rule in the MikroTik(A) drops all packets from the WAN link of ISP1 to the hosts (8.8.8.8 and 204.67.220.220).
- The backup WAN link (to ISP2) should take over all packets to the Internet.



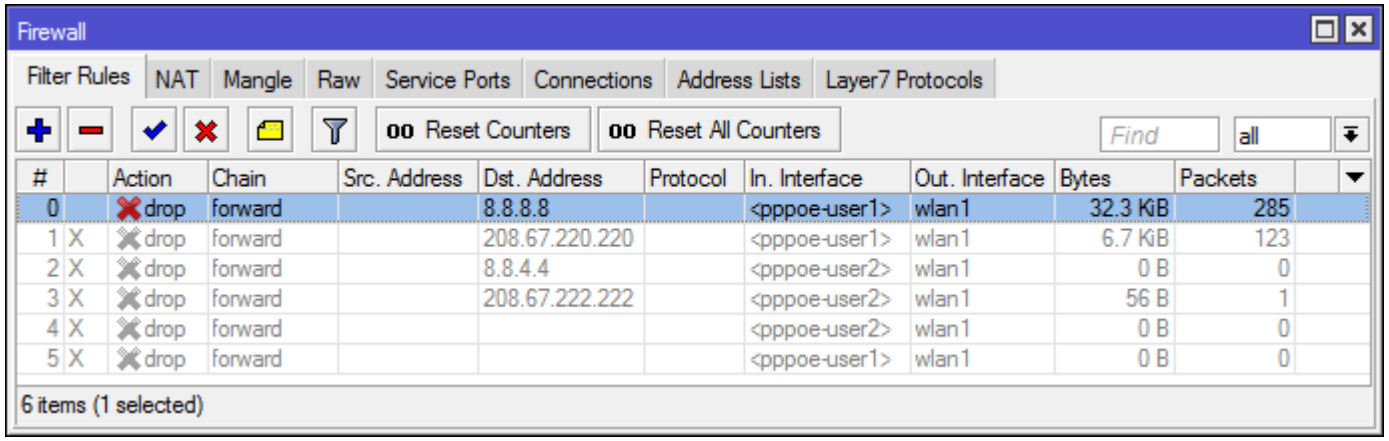
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#1: The **result** in the route list shows that the default route through the ISP1 is unreachable, and the default route through the ISP2 has taken over.



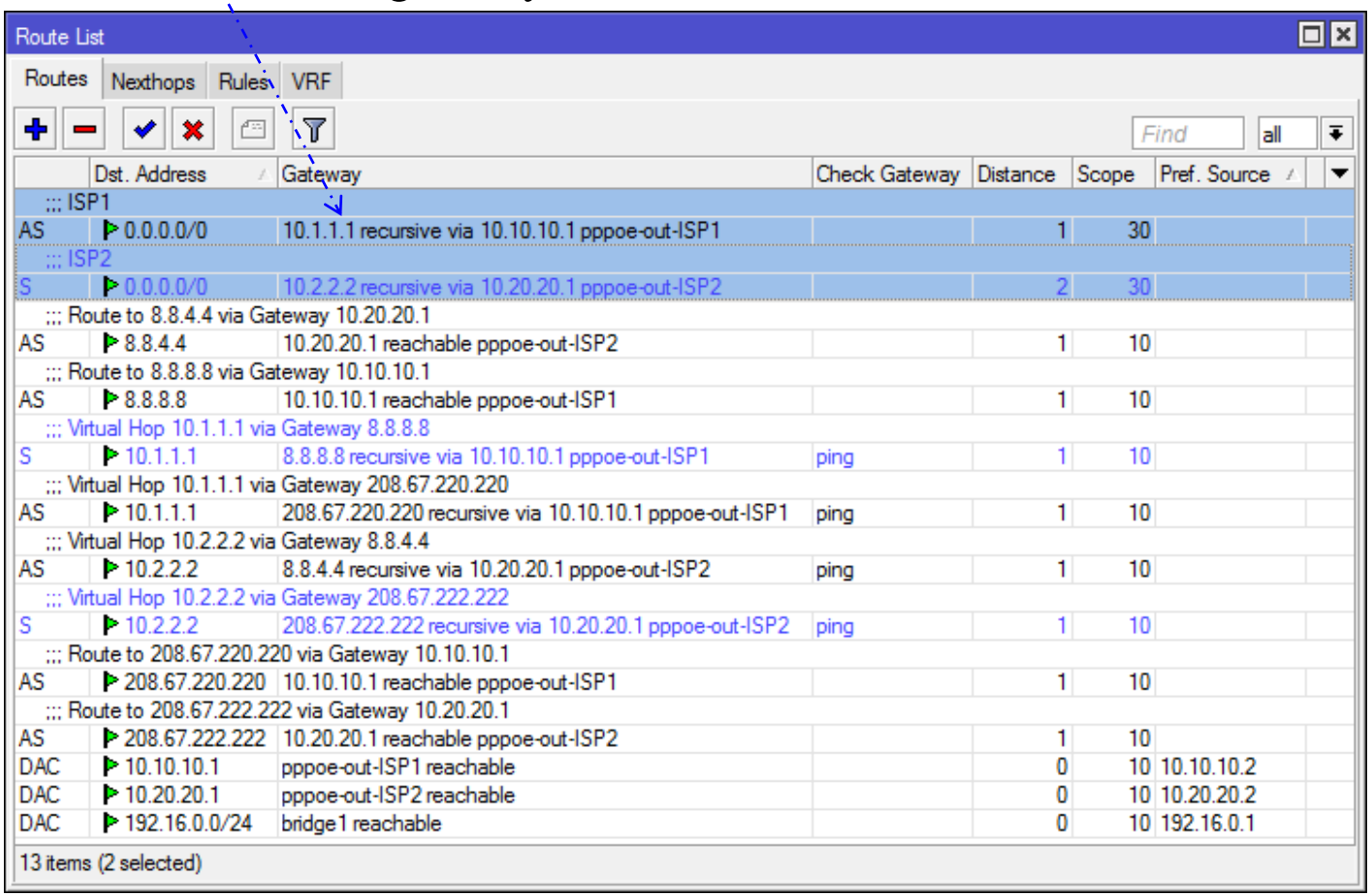
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#2: The ISP1 must be able to access the Internet, even if the host (8.8.8.8) fails. The firewall rule in the MikroTik(A) drops all packets from the WAN link of ISP1 to only the hosts (8.8.8.8).
- The primary WAN link (to ISP1) should still take over all packets to the Internet.



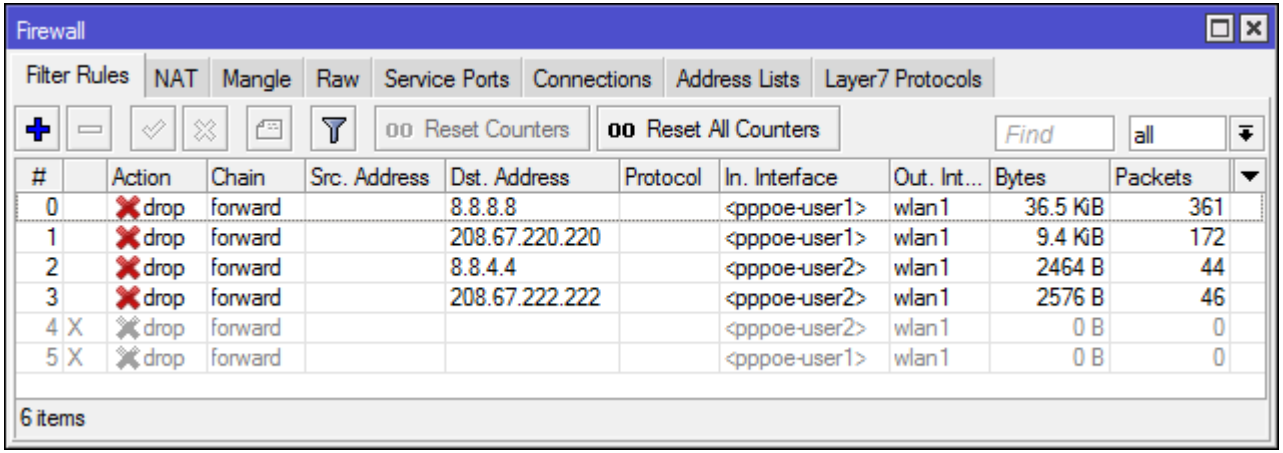
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#2: The **result** in the route list shows that the default route through the ISP1 is reachable via the ISP1 gateway (10.10.10.1).



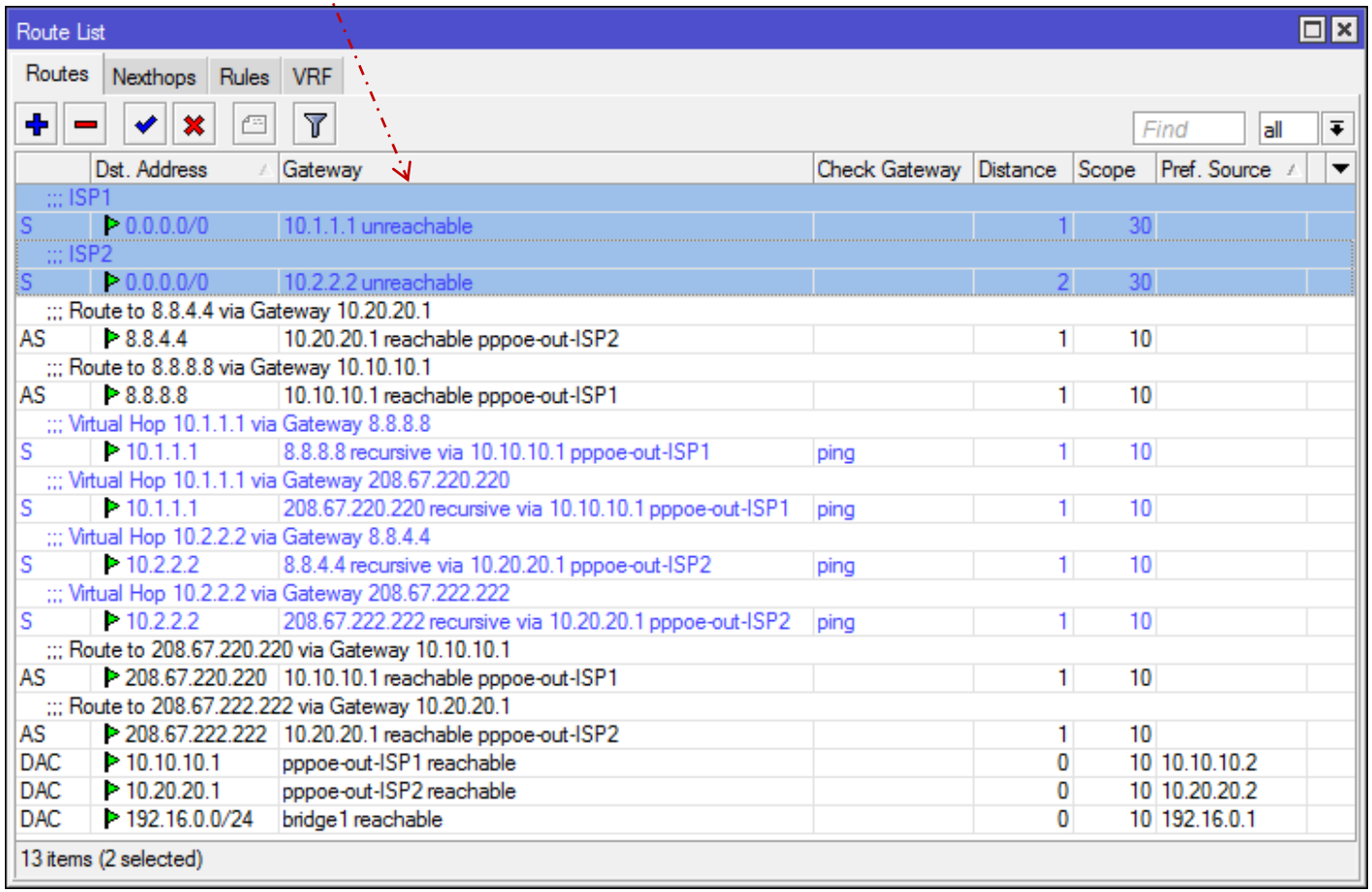
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#3: All hosts (8.8.8.8, 208.67.220.220, 8.8.4.4, and 208.67.222.222) fails.
- The firewall rule in the MikroTik(A) drops all packets as follows.
  - ✓ From the WAN link of ISP1 to the hosts (8.8.8.8, 208.67.220.220)
  - ✓ From the WAN link of ISP2 to the hosts (8.8.4.4, 208.67.222.222)



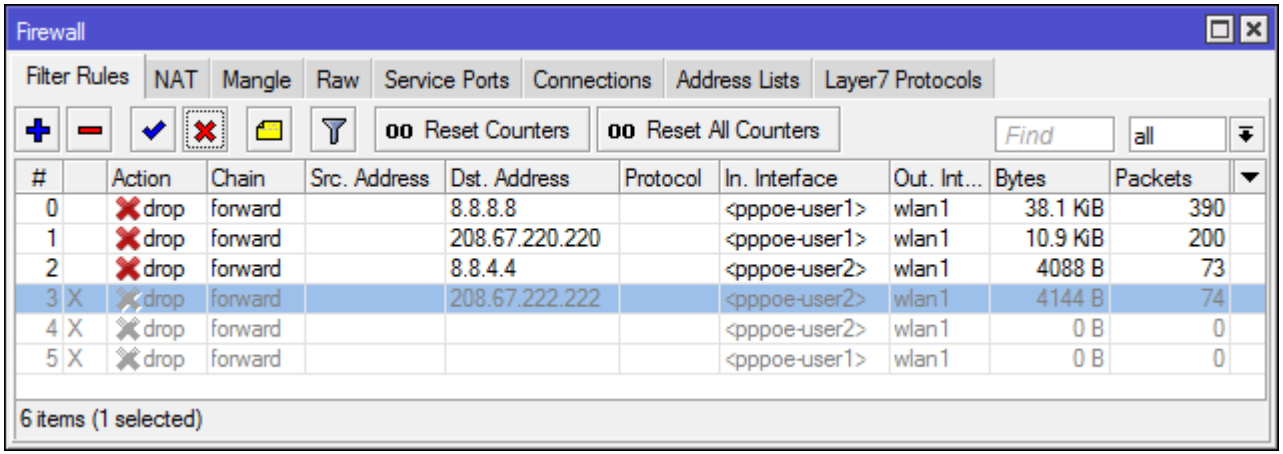
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#3: The **result** in the route list shows that the default route through both ISP1 and ISP2 are unreachable.



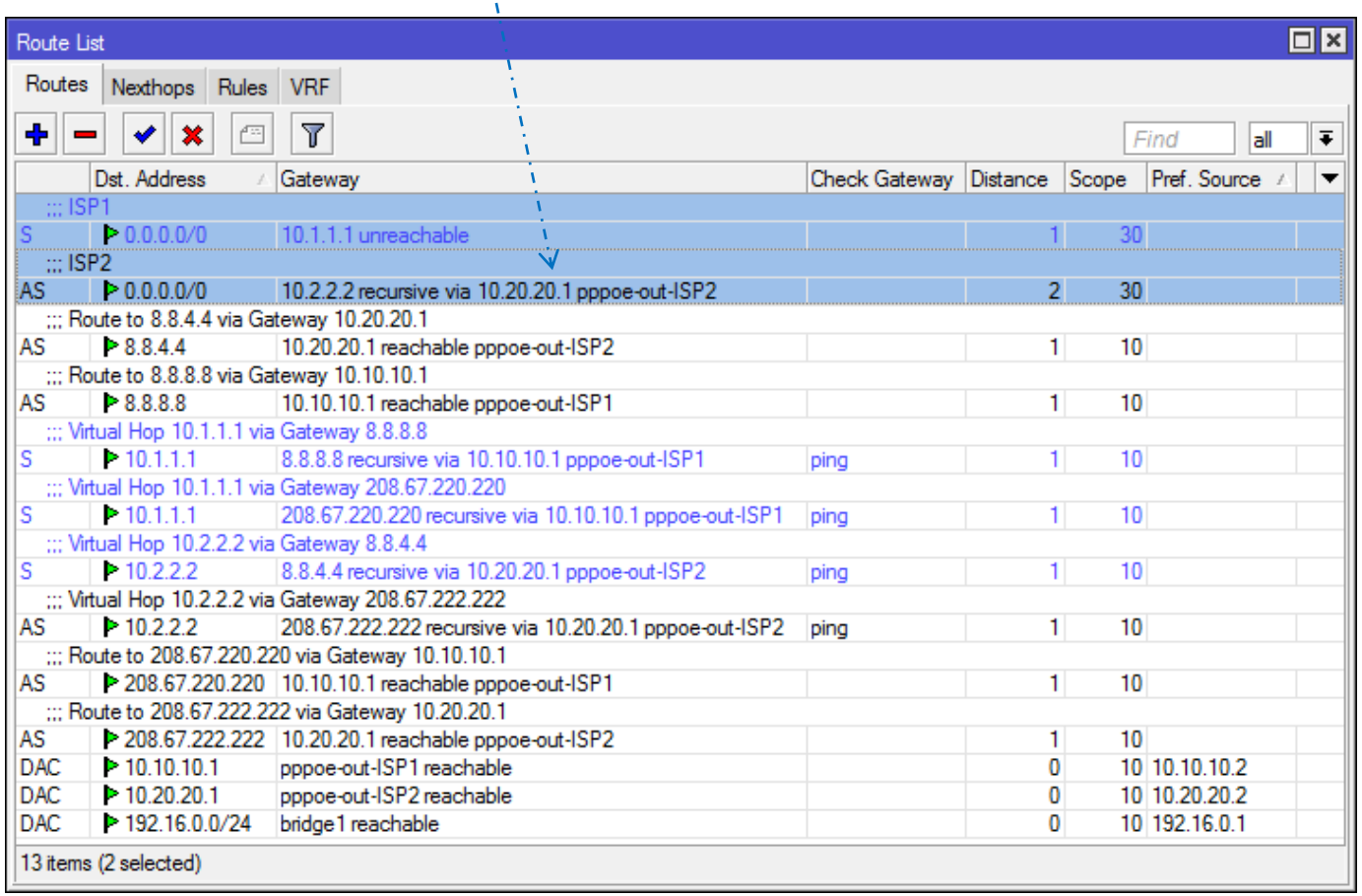
Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#4: All hosts (8.8.8.8, 208.67.220.220, and 8.8.4.4) fails but only the host (208.67.222.222) is fine.
- The firewall rule in the MikroTik(A) drops all packets as follows.
  - ✓ From the WAN link of ISP1 to the hosts (8.8.8.8, 208.67.220.220)
  - ✓ From the WAN link of ISP2 to the hosts (8.8.4.4)



Failover with Checking Multiple Remote Hosts

- **Testing:** failover with checking multiple remote hosts per WAN link
- Scenario#4: The **result** in the route list shows that the default route through the ISP1 is unreachable but the default route of ISP2 has taken over all traffic to the Internet.



Failover with Checking Multiple Remote Hosts

- Failover with checking multiple remote hosts per WAN link
- In case of **load balancing**, you have corresponding **routing masks** (toISP1, toISP2)
- The first step 1) is revised (adding default routes and changing distances) as follow
  - /ip route

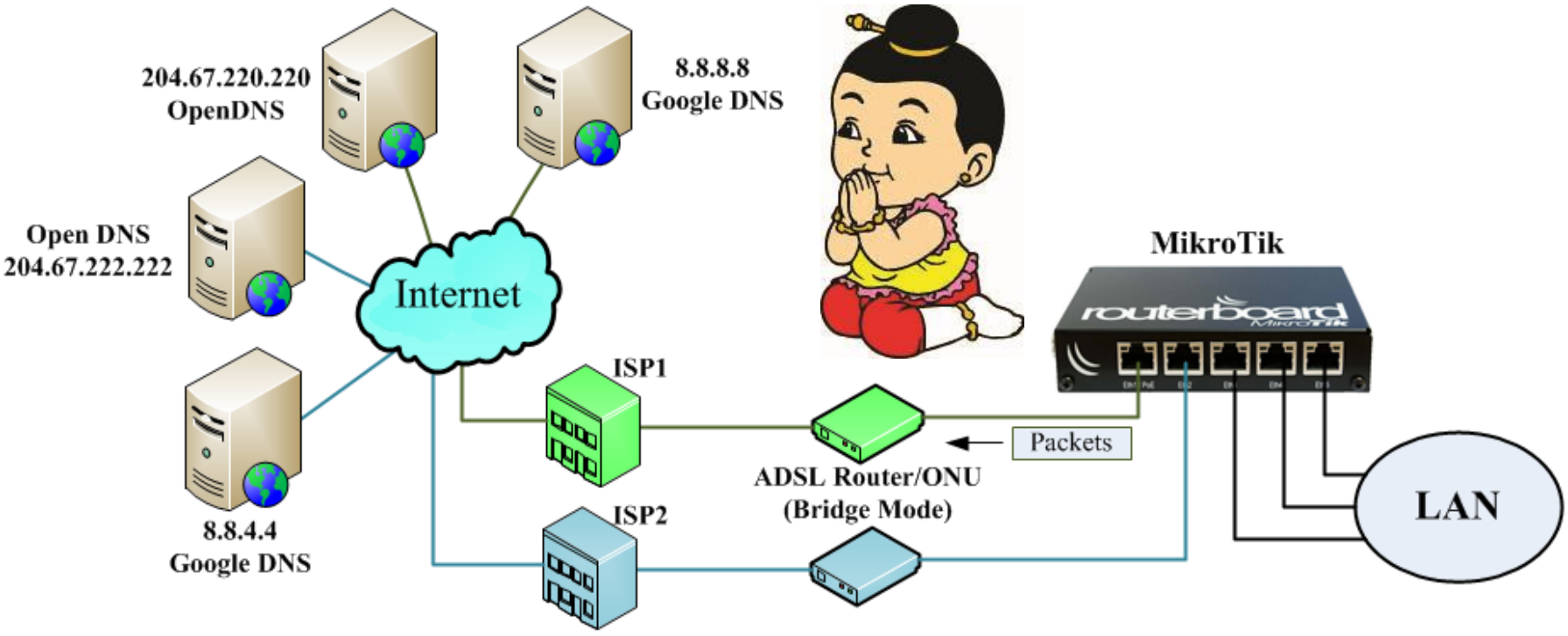
    add distance=1 gateway=10.1.1.1 routing-mask=toISP1

    add distance=2 gateway=10.2.2.2 routing-mask=toISP1
  - /ip route

    add distance=1 gateway=10.2.2.2 routing-mask=toISP2

    add distance=2 gateway=10.1.1.1 routing-mask=toISP2

Thank You for Your Attention



Reference

[1] https://wiki.mikrotik.com/wiki/Manual:IP/Route

[2] https://wiki.mikrotik.com/wiki/Advanced_Routing_Failover_without_Scripting