Troubleshooting load balancing

Mikrotik User Meeting
Malaysia, 12 june 2019

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GLC Networks

Agenda

- Introduction
- The basics: packets, connection and routing
- Load Balancing (LB) techniques
- Some issues and recommendations
- Q & A

What is GLC?

- Garda Lintas Cakrawala (www.glcnetworks.com)
- Based in Bandung, Indonesia
- Areas: Training, IT Consulting
- Certified partner for: Mikrotik, Ubiquity, Linux foundation
- Product: GLC radius manager
- Regular event: webinar (every 2 weeks, see our schedule on website)

About me

- Name: Achmad Mardiansyah
- Base: bandung, Indonesia
- Linux user since 1999, mikrotik user since 2007,
- Mikrotik Certified Trainer (MTCNA/RE/WE/UME/INE/TCE/IPv6)
- Mikrotik Certified Consultant
- Teacher at Telkom University (Bandung, Indonesia)
- Website contributor: achmadjournal.com, mikrotik.tips, asysadmin.tips
- More info: http://au.linkedin.com/in/achmadmardiansyah

Past experiences

- 2019, **Congo (DRC)**: build a wireless ISP from ground-up
- 2018, **Malaysia**: network revamp, develop billing solution and integration, setup dynamic routing
- 2017, **Libya (north africa)**: remote wireless migration for a new Wireless ISP
- 2016, **United Kingdom**: facilitates workshop for a wireless ISP, migrating a bridged to routed network
- 2015, **West Borneo**: supporting wireless infrastructure project
- 2014, **Senegal (west africa)**: TAC2 engineer for HLR migration from NOKIA to ERICSSON

About Telkom University

- Located in Bandung, Indonesia
- 7 Faculties, 27 schools
- Areas: Engineering, Communications, Computing, Bussiness and management, Arts
- 650+ Academic staff, 400+ Administration staff, 20000+ students
- An exchange program
- Runs mikrotik academy program

Mikrotik academy @ TEL-U

- Started in 2013
- Embedded into schools curriculum
- 100% hands-on
- Get MTCNA certification

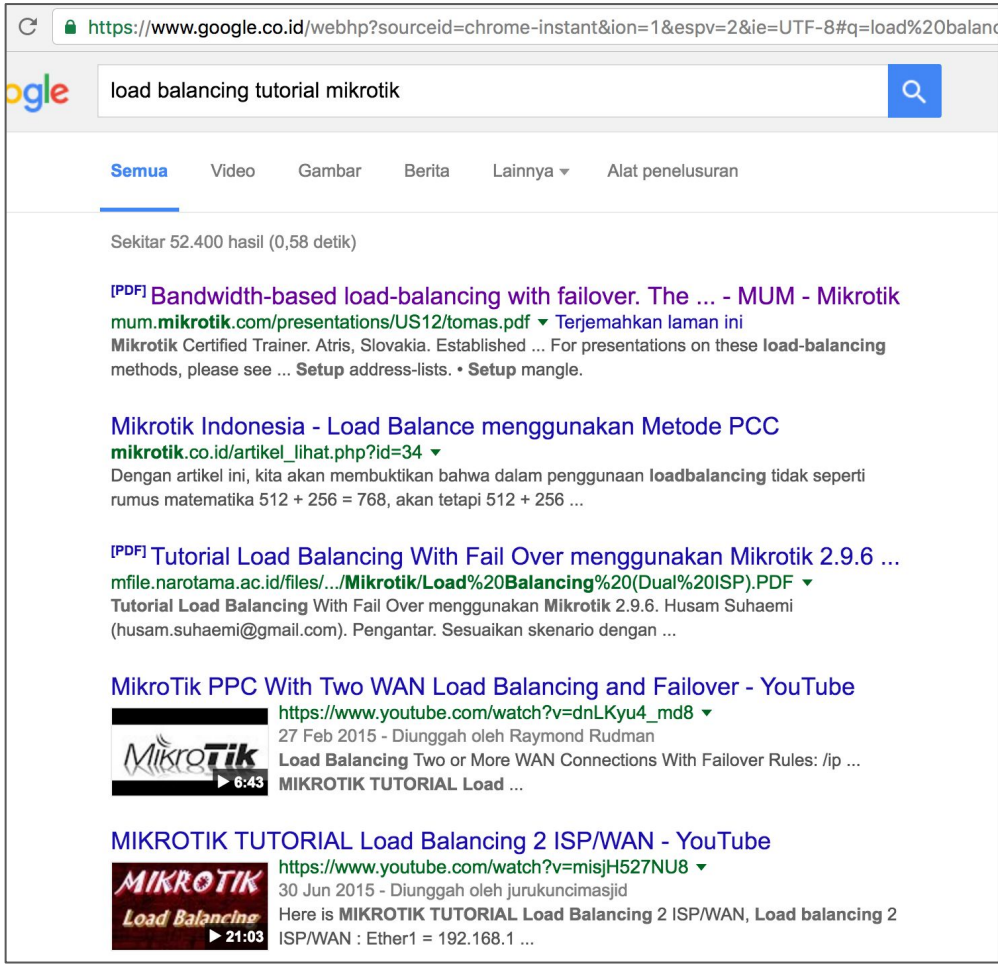
About load balancing

Why should i care?

- Lots of tutorials in internet!!!
- Tons of pages, tutorial, videos

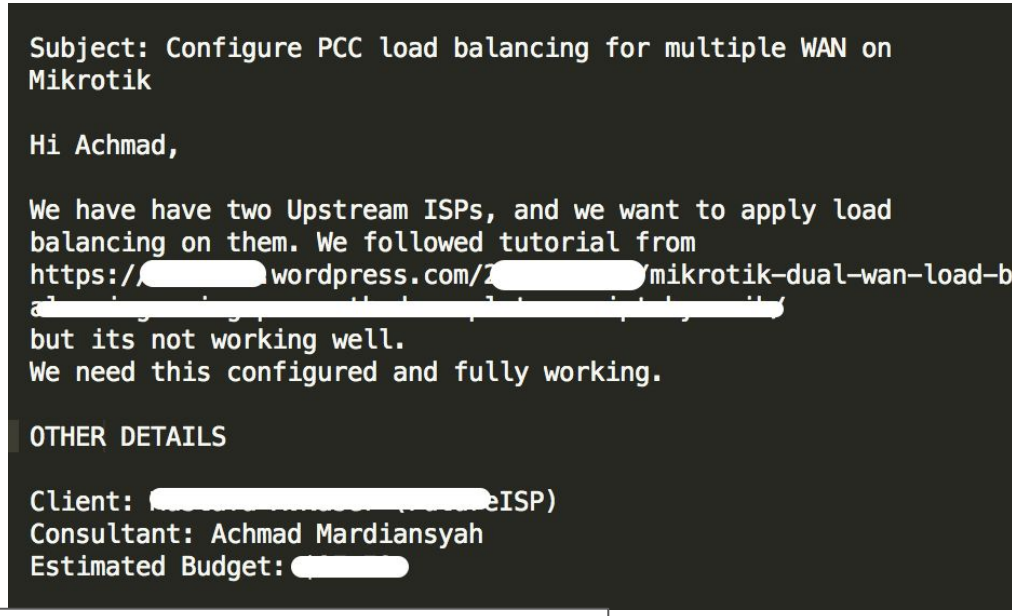
Questions for reader:

- Do you really understand that?
- Did the writer understand that?
- Is it really works as expected?



Are those webpages really work on you?

- Information overloaded… which one suits you?
- Perhaps their network environment is different than yours
- You need to understand how it works...



Subject: Configure PCC load balancing for multiple WAN on Mikrotik

Hi Achmad,

We have have two Upstream ISPs, and we want to apply load balancing on them. We followed tutorial from https:/[redacted]wordpress.com/[redacted]/mikrotik-dual-wan-load-b[redacted]
but its not working well.
We need this configured and fully working.

OTHER DETAILS

Client: [redacted]eISP)
Consultant: Achmad Mardiansyah
Estimated Budget: [redacted]

> 3. Saya mau coba Load Balance Ethernet+Bolt LTE ZTE MF90
> http://mikrotik[redacted]?id=76
> http://[redacted]isp-load-balancing-pcc-dengan-failover-tanpa-script
> tapi belum berhasil
> Apa trainernya dah pernah coba

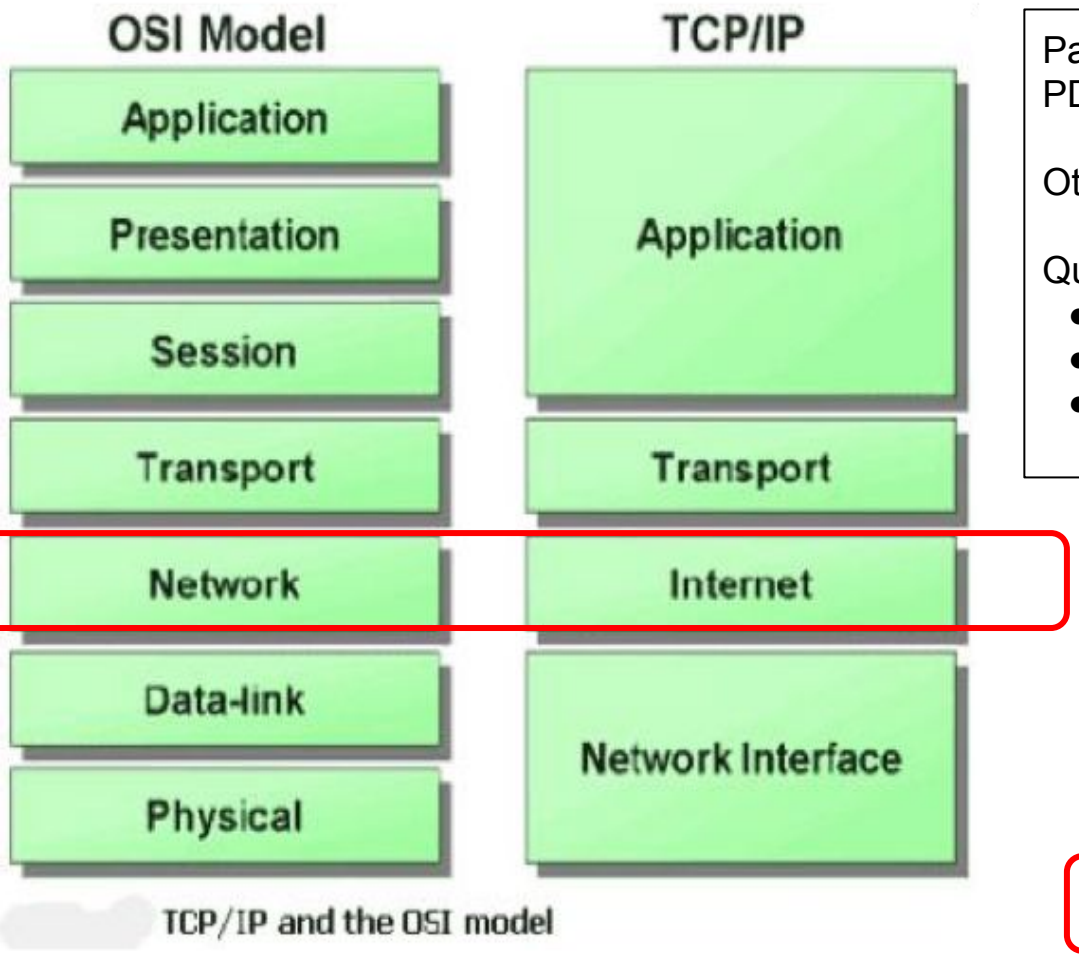
—

dulu pernah diimplementasikan disini:
http://www.glcnetworks.com/main/maret-2014-optimasi-jaringan-pada-sebuah-kantor-di-jakarta/

mudah2an membantu ya

The basics: packet, connection, routing

What is packets?

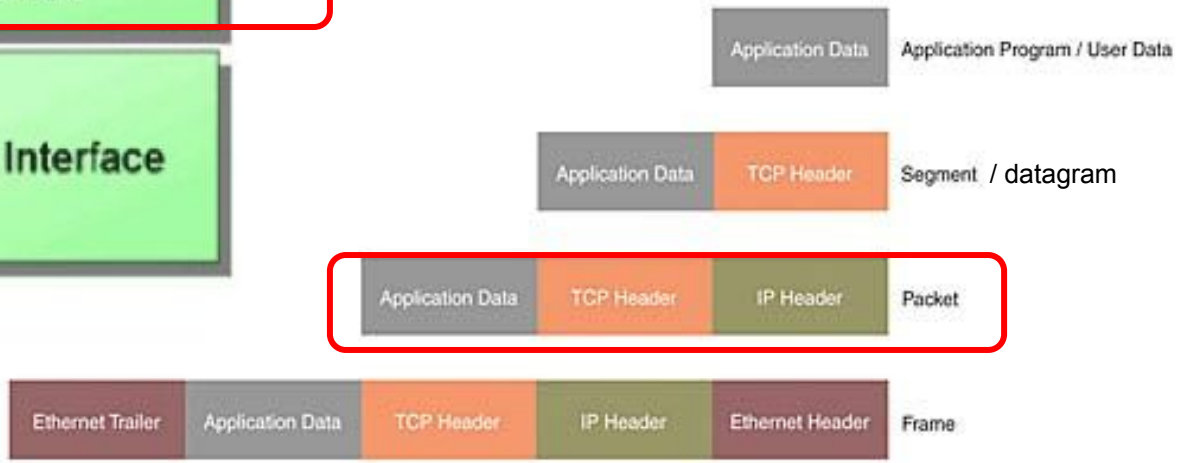


Packet is a unit of data transmission (layer 3 PDU)

Other units: segment, datagram, frame

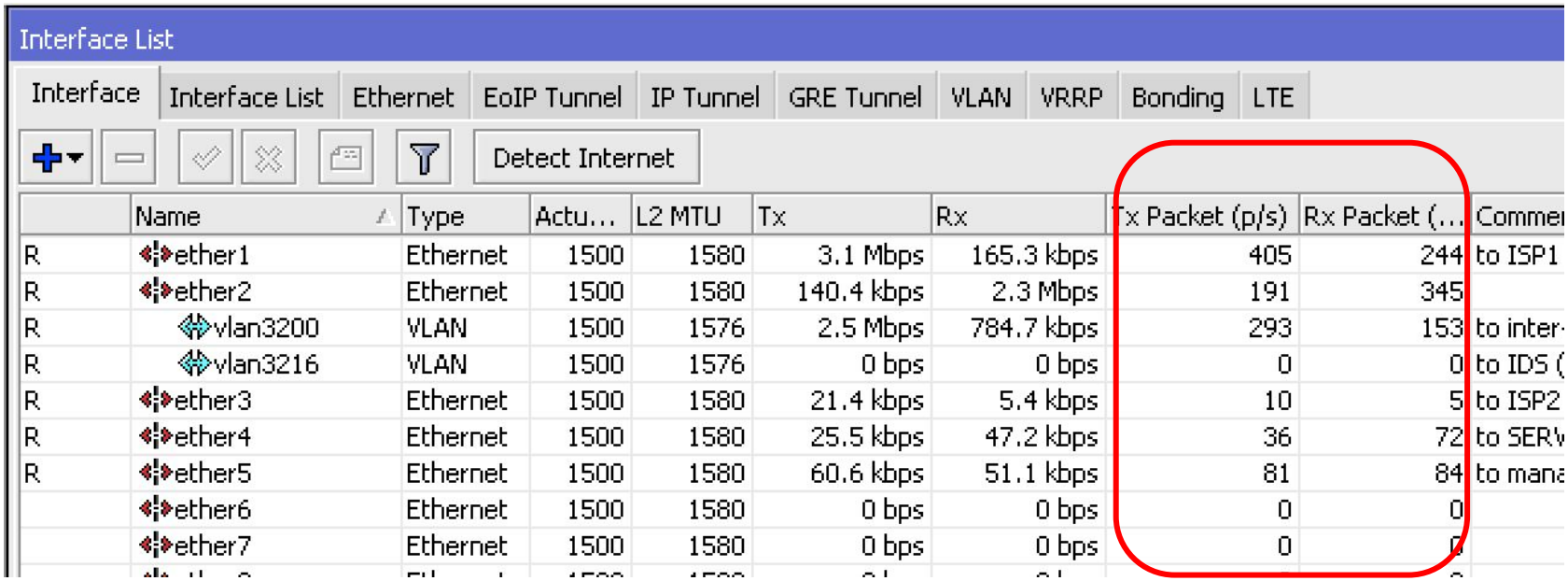
Questions:

- Is there any packet in a frame?
- Is there any packet in a segment?
- How to measure mbps of packets



How do you know packet's statistics?

Measured in pps (packet per second) -> part of router performance



Layer 3 header (which one is IPv4?)

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Version				IHL				DSCP						ECN		Total Length															
4	32	Identification																Flags				Fragment Offset											
8	64	Time To Live								Protocol								Header Checksum															
12	96	Source IP Address																															
16	128	Destination IP Address																															
20	160	Options (if IHL > 5)																															

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	*Version*				*Traffic Class*												*Flow Label*															
4	32	*Payload Length*																*Next Header*								*Hop Limit*							
8	64	*Source Address*																															
12	96																																
16	128																																
20	160																																
24	192	*Destination Address*																															
28	224																																
32	256																																
36	288																																

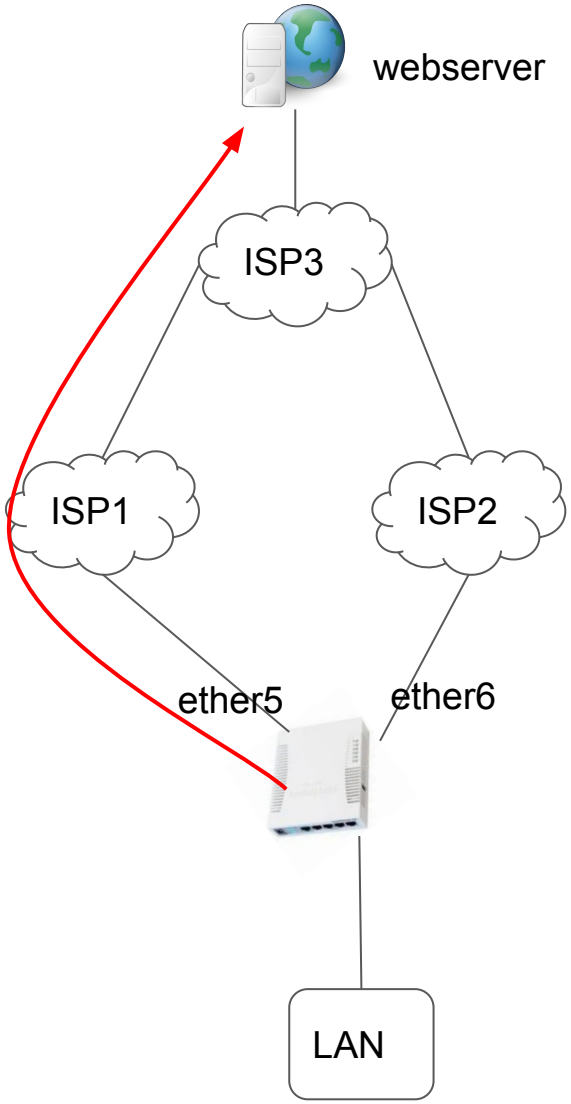
Layer 4 header (which one is TCP?)

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Source port																Destination port															
4	32	Sequence number																															
8	64	Acknowledgment number (if ACK set)																															
12	96	Data offset				Reserved 0 0 0				NS	CWR	ECE	URG	ACK	PSH	RST	SYN	FIN	Window Size														
16	128	Checksum																	Urgent pointer (if URG set)														
20	160	Options (if *data offset* > 5. Padded at the end with "0" bytes if necessary.)																															
...	...	...																															

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Source port																Destination port															
4	32	Length																Checksum															

What is connection?

- **A Connection** is identified by a set of IP addresses (source and destination) and ports (if necessary. E.g. source and destination port)
- When you access a remote computer, you will create a connection

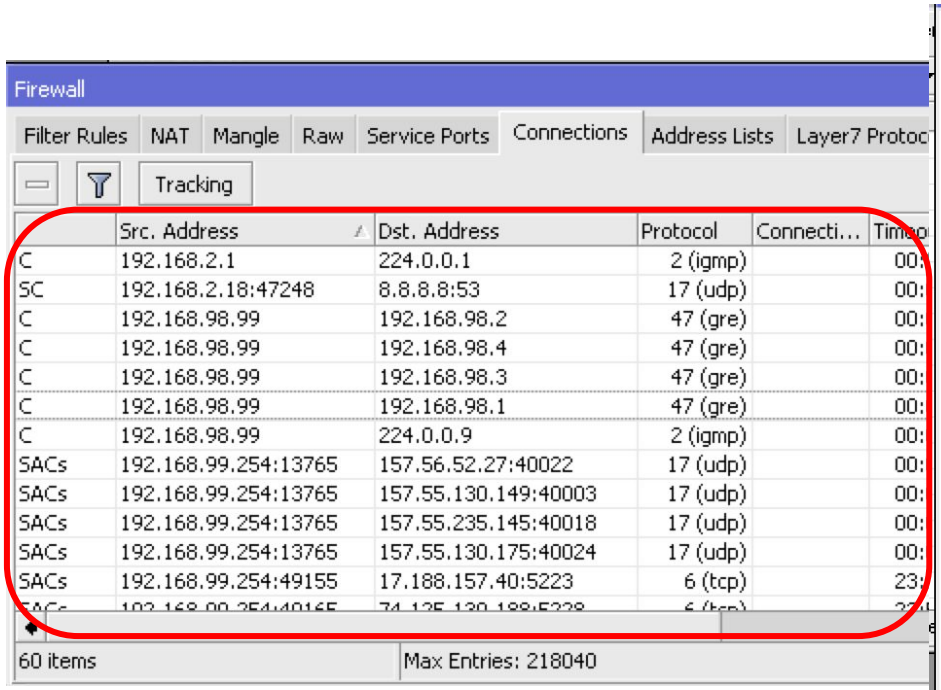


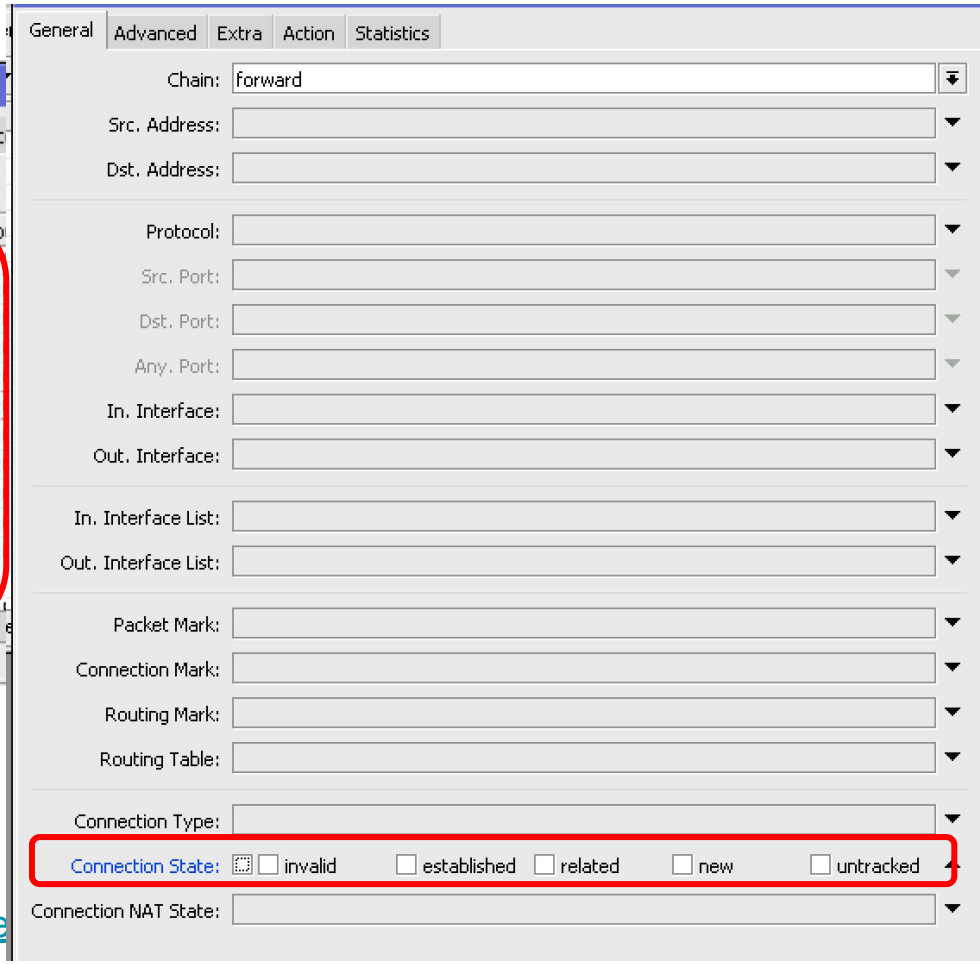
Questions:

- Is packet part of connection?
- Is connection part of packet?
- Can 1 connection have more than one packets?
- Do packets have mechanism between them so that they know their arrangement or connection between them?
- Can router identify relation between packet? E.g. keep track the relations between packet?

Mikrotik supports connection tracking

Mikrotik conn-track supports protocol: TCP, UDP, ICMP and others



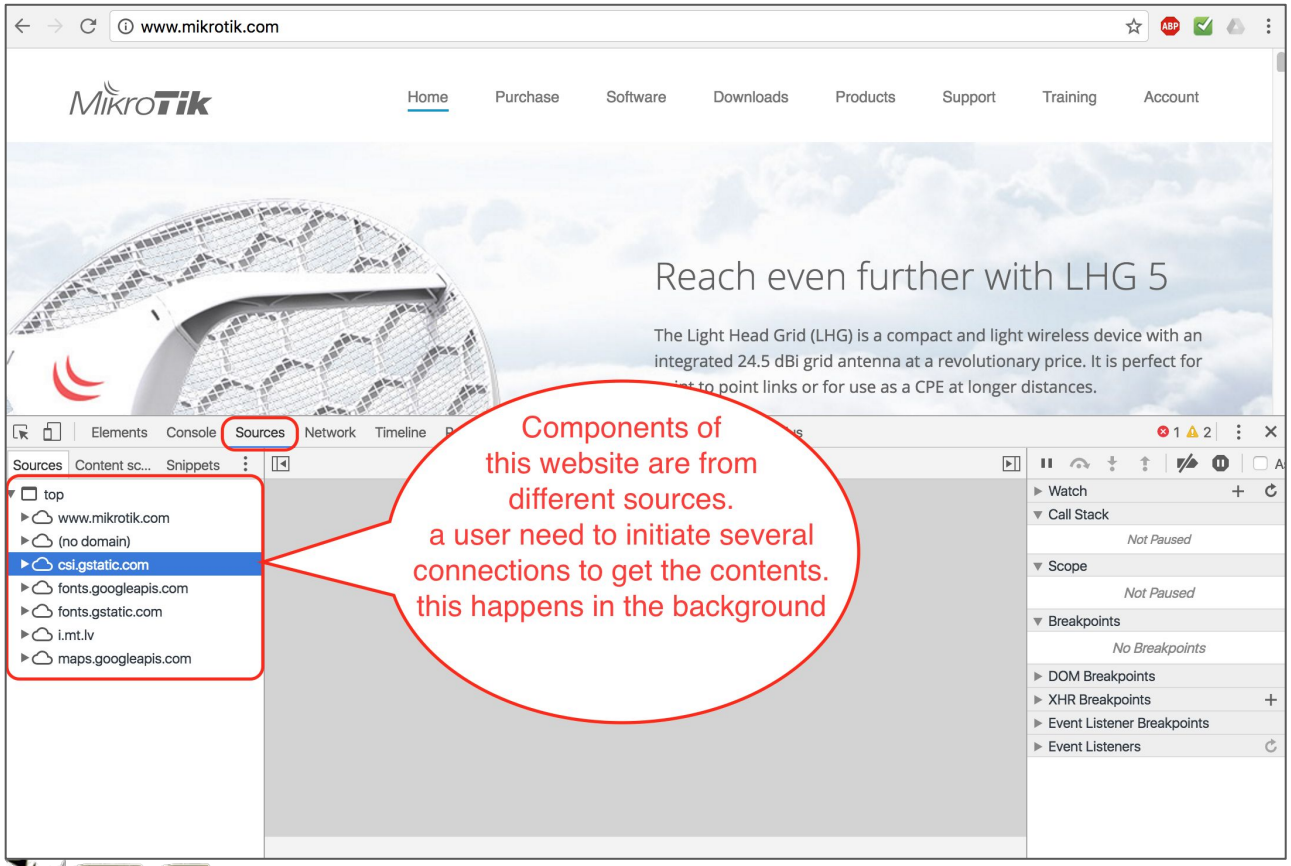


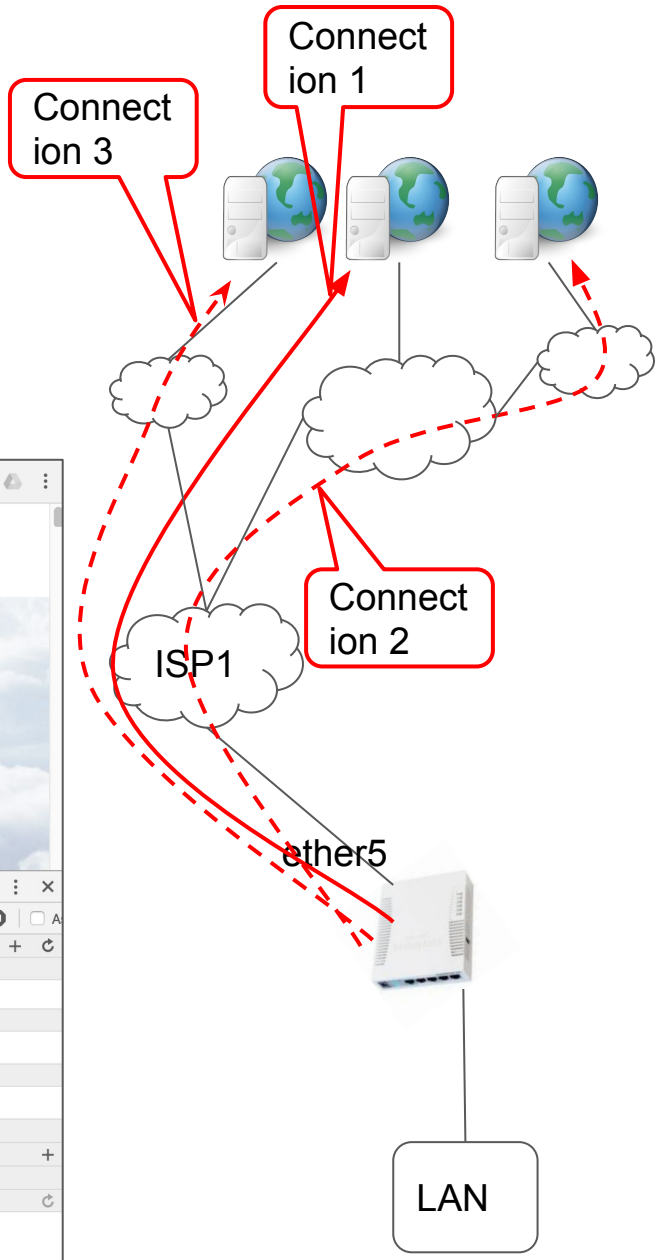
QUESTION

HOW MANY CONNECTION(S) YOUR BROWSER CREATE WHEN YOU OPEN A WEBSITE?

Answer: inspect the web elements

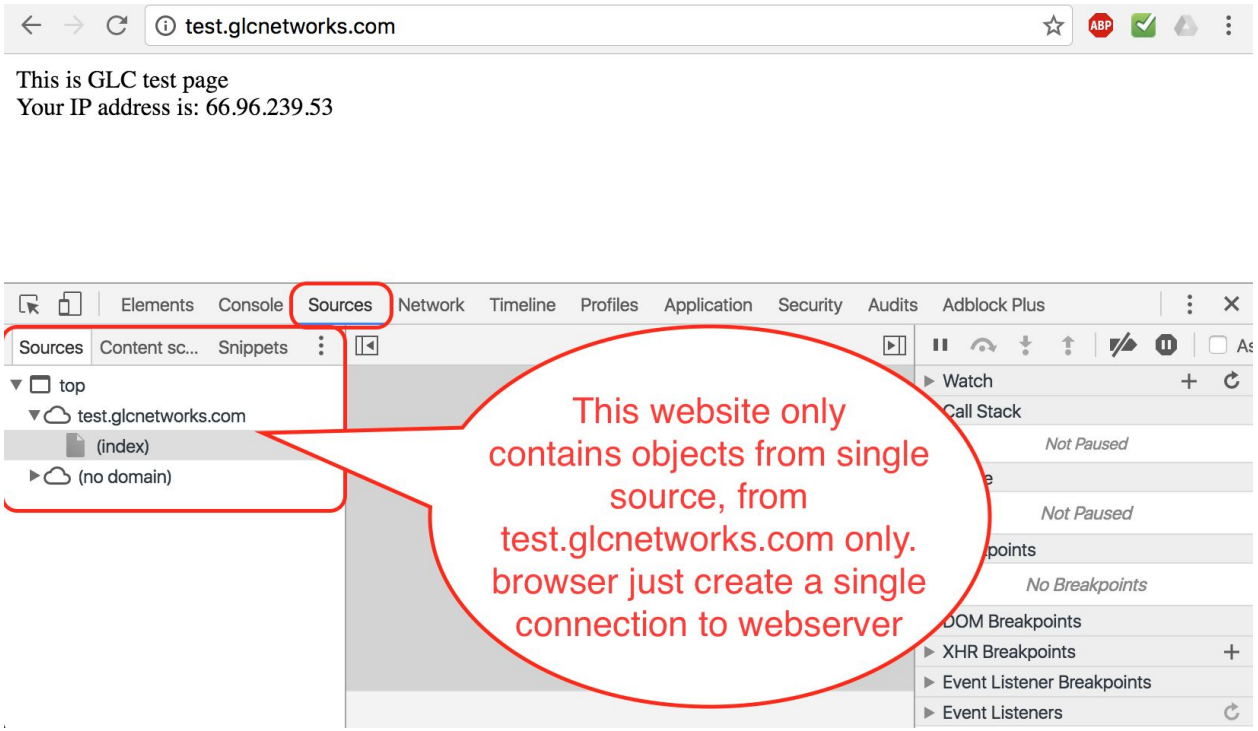
- Client can open **multiple connections** to get website components

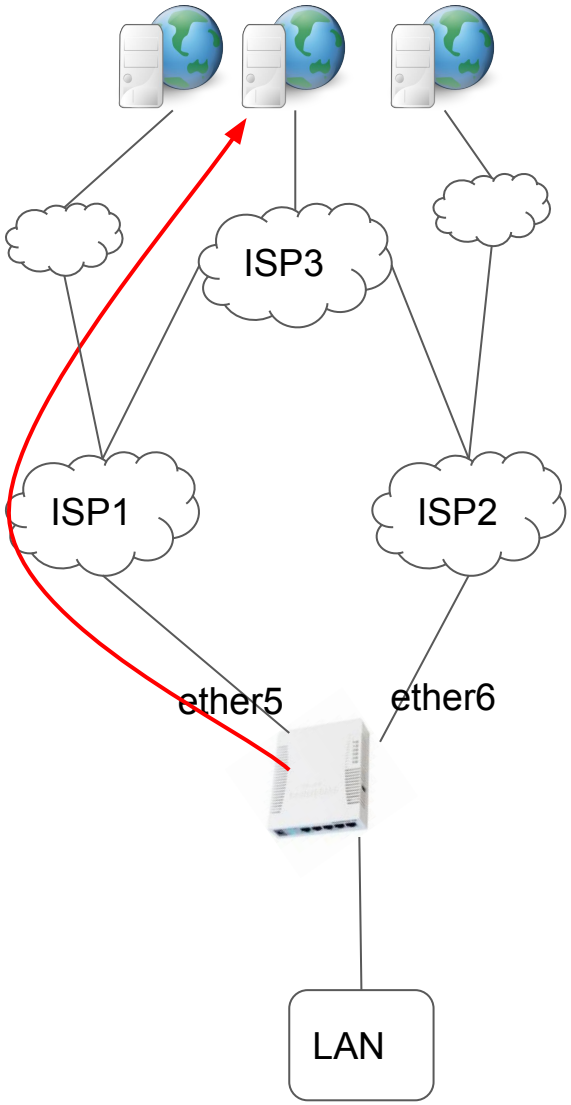




Example: Single connection to a website

Website with single connection:
http://test.glcnetworks.com

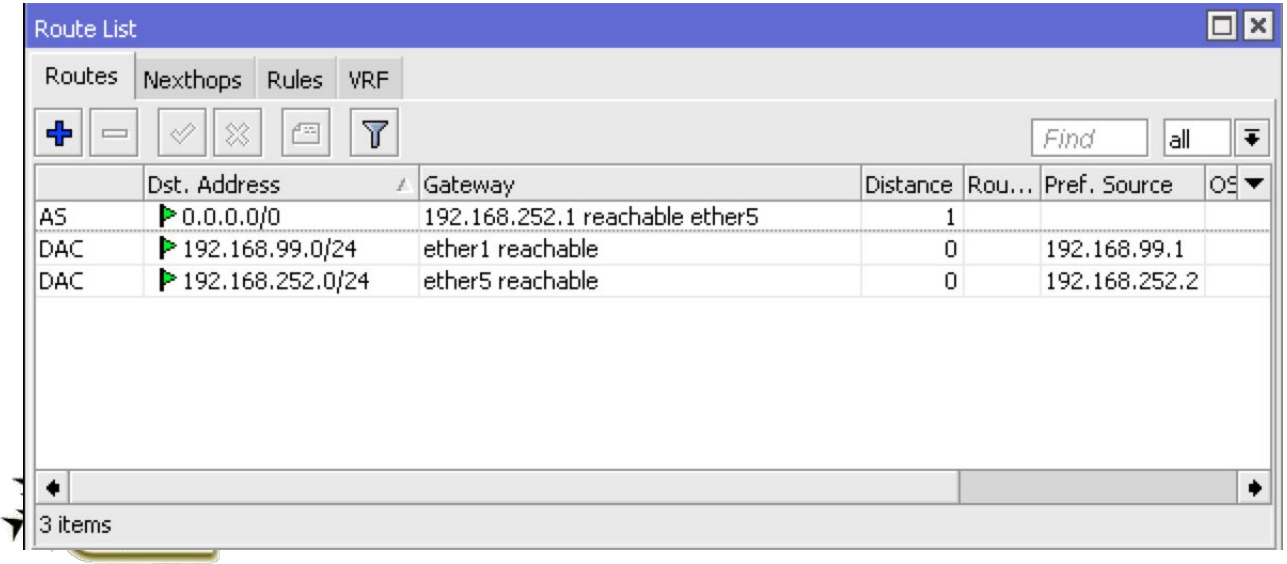


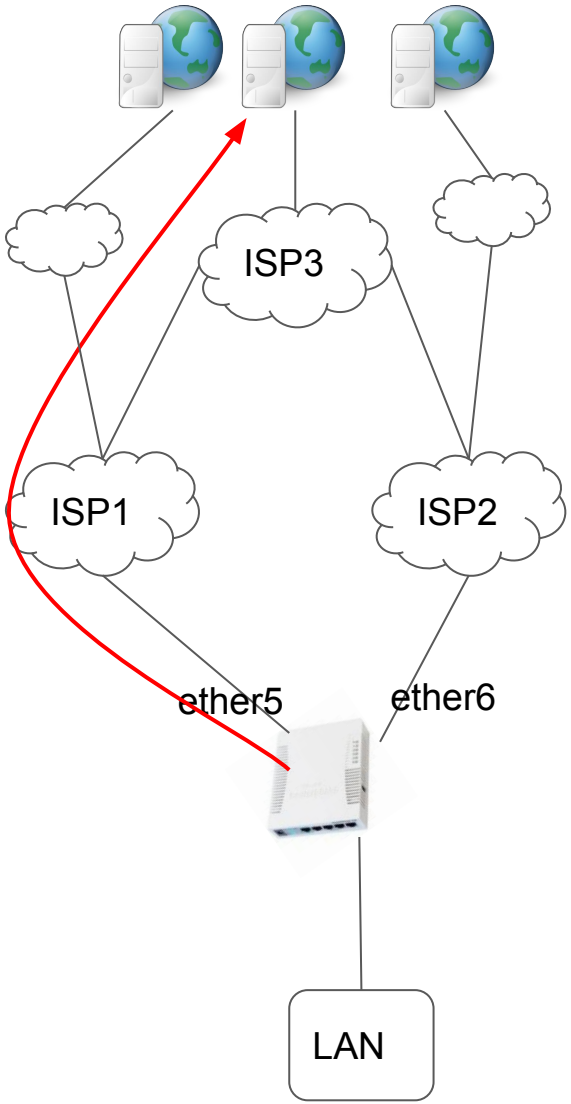


Routing and forwarding

Routing and Forwarding

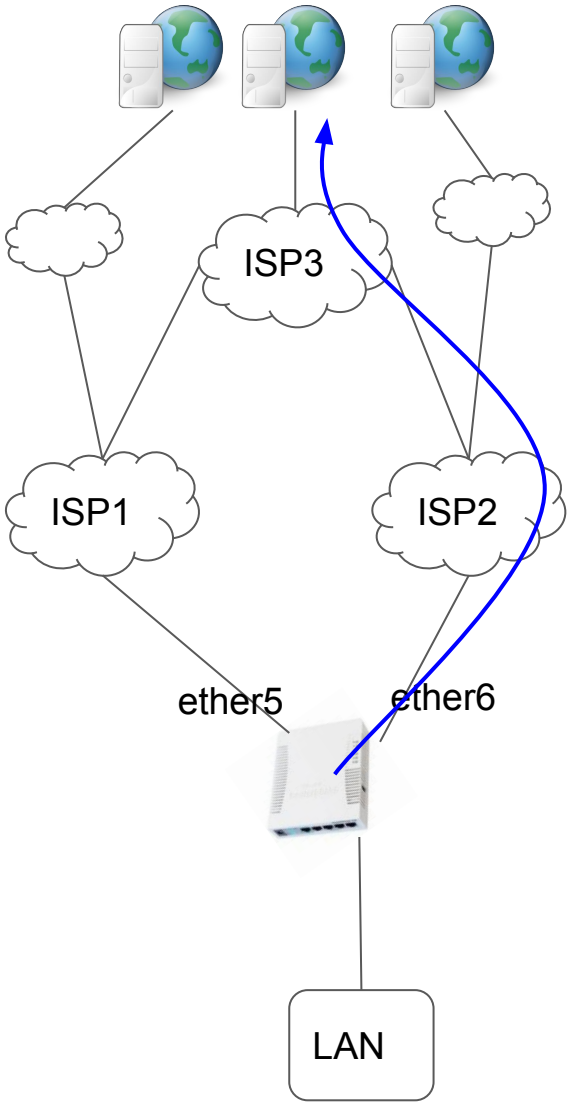
- A process to forward a packet from input interface to output interface, based on information on routing table.
- As we use private IP address, there will be a NAT process before sending out to exit interface
- To check your public IP address, go to http://test.glcnetworks.com





Adjust routing (mangle: mark-routing)

- Process to mark a packet to for routing purpose
- Steps:
  - Create firewall mangle with action mark-routing
  - Create routing entry with defined-mark
  - Create NAT rule if we use private IP address
- To check our public IP address, go to http://test.glcnetworks.com



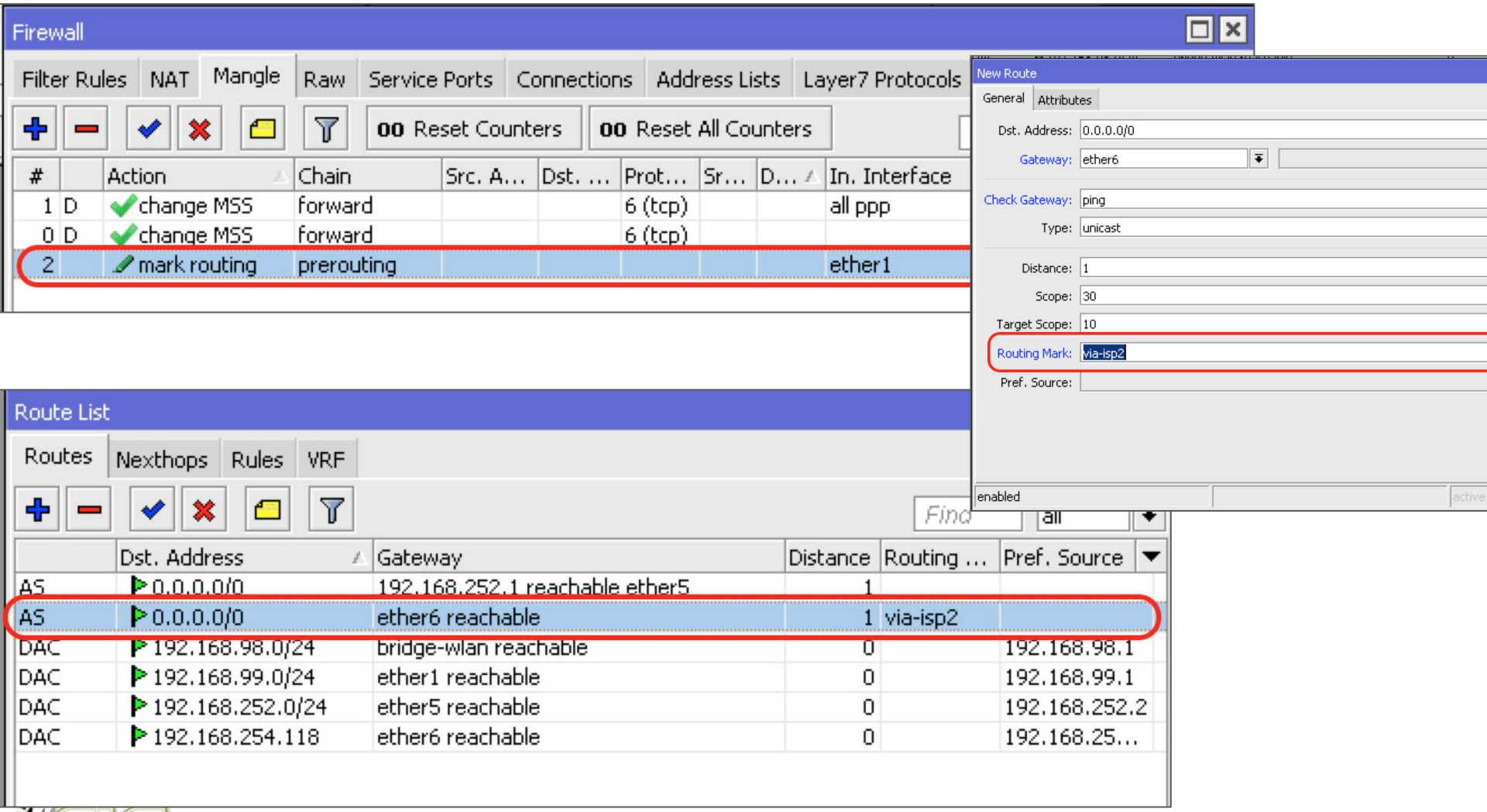
Route List

Routes | Nexthops | Rules | VRF

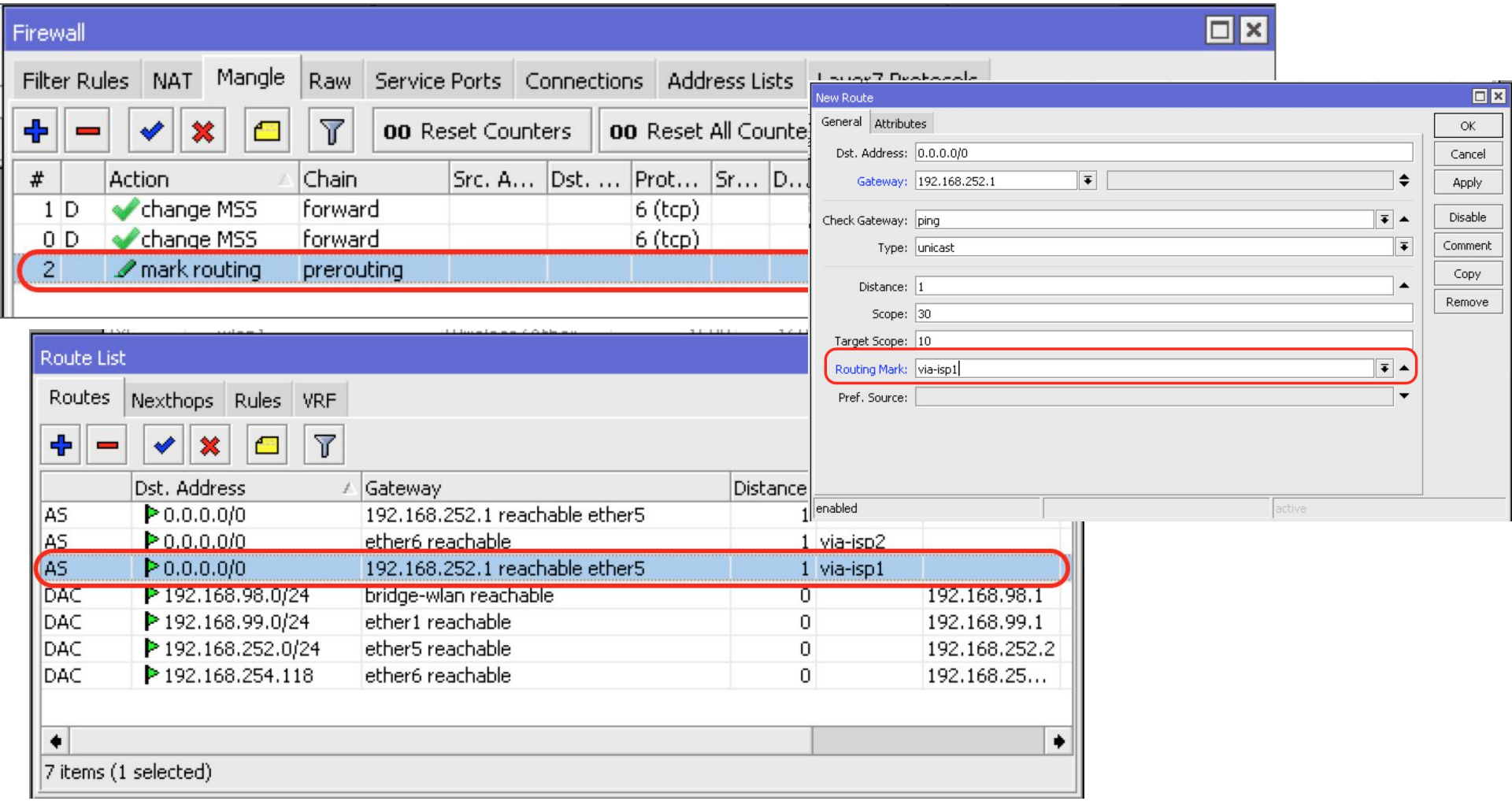
Find | all

	Dst. Address	Gateway	Distance	Routing ...	Pref. Source
AS	0.0.0.0/0	192.168.252.1 reachable ether5	1		
AS	0.0.0.0/0	ether6 reachable	1	via-isp2	
DAC	192.168.98.0/24	bridge-wlan reachable	0		192.168.98.1
DAC	192.168.99.0/24	ether1 reachable	0		192.168.99.1
DAC	192.168.252.0/24	ether5 reachable	0		192.168.252.2
DAC	192.168.254.118	ether6 reachable	0		192.168.25...

Forward traffic via ISP2 using mangle



Forward traffic via ISP1 using mangle



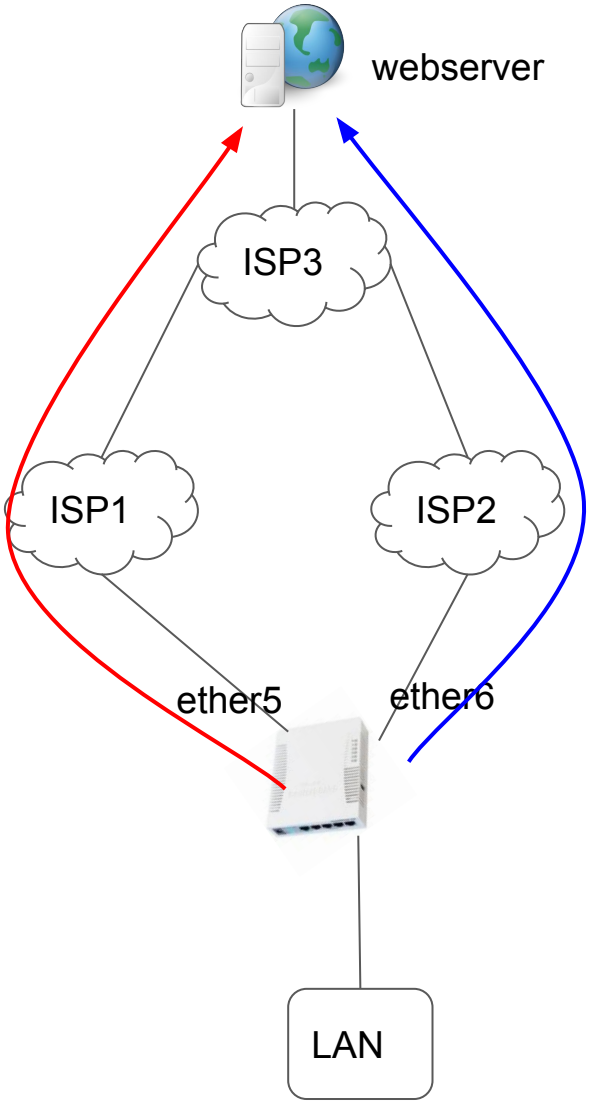
Load Balancing

What is (traffic) load balancing?

- Is a process to forward traffic on several links
- Applied on router
- != failover

Benefits:

- Increase utilisation of upstream links

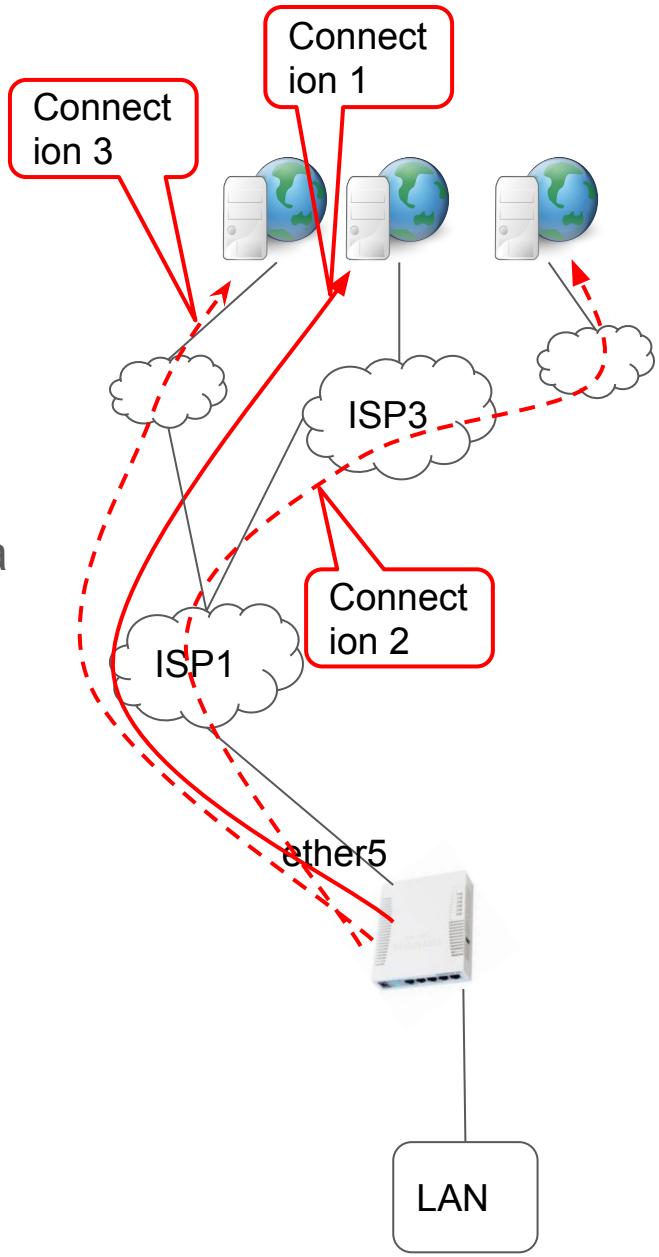


Load balancing techniques

Method	Per-connection	per-packet
Firewall marking	YES	YES
ECMP	YES	NO
PCC	YES	NO
Nth	YES	YES
Bonding	NO	YES
OSPF	YES	NO
BGP	YES	NO

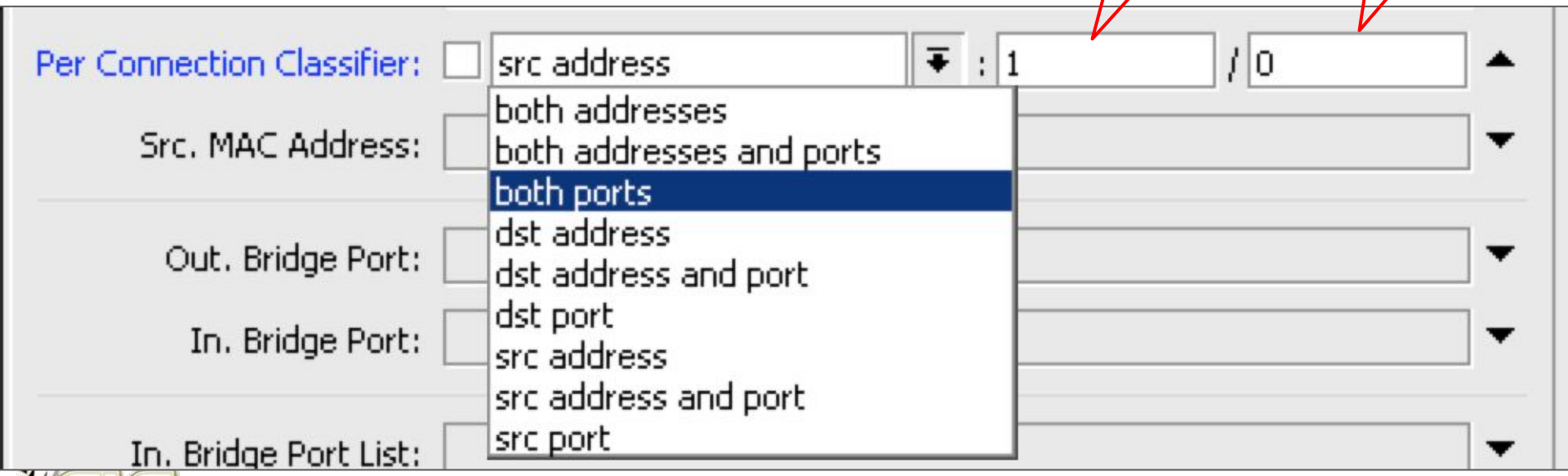
How PCC works?

- PCC = Per Connection Classifier
- PCC can identify the connection and mark them for further processing
- Example: a client opens a multi-object website via single ISP. both addresses (src-address and dst-address) are used to identify connection
- PCC can identify each connection made from client

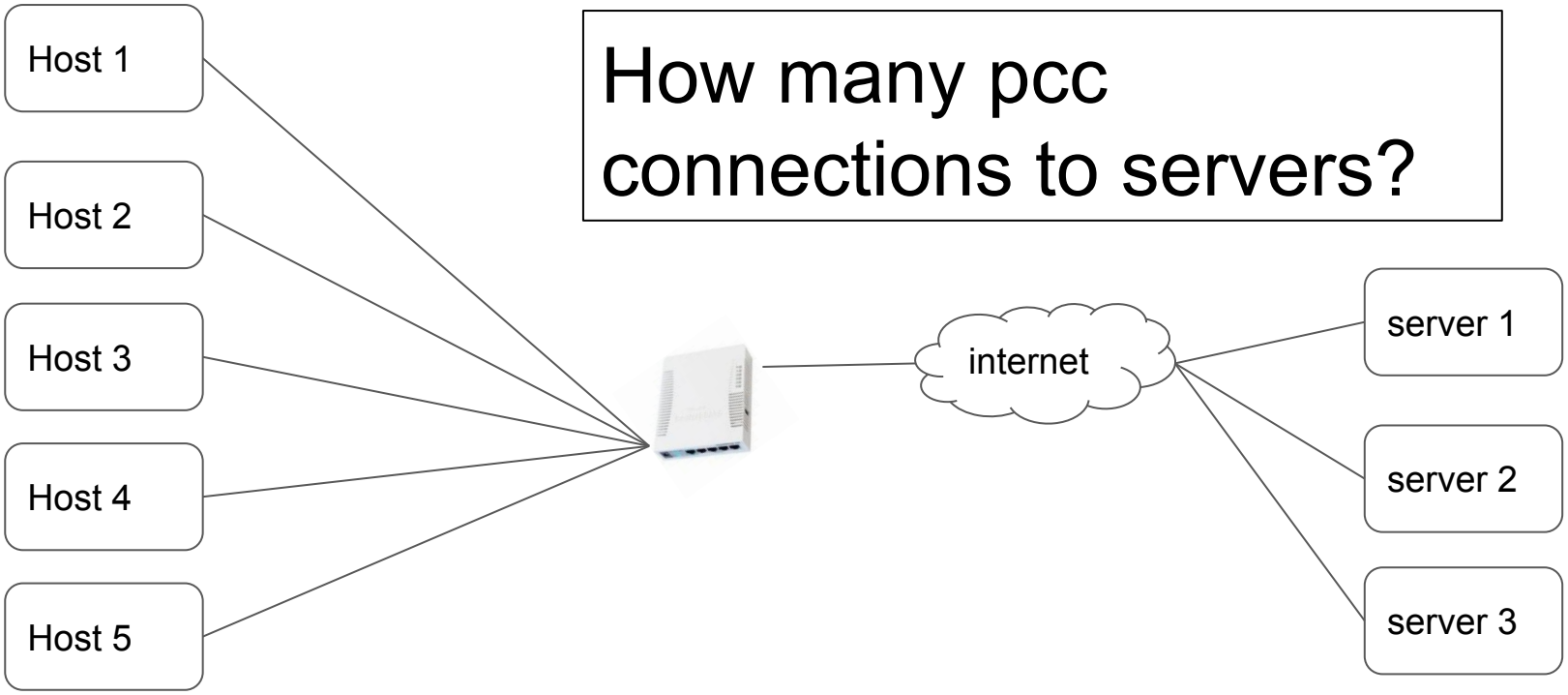


Applying PCC

- You need to understand the concept of connection (conn-track=active)
- Applied on firewall mangle
- Need to define classifier. Can be based on:
  - Source or destination address only
  - Both addresses
  - Etc
- Define connection number and total connection

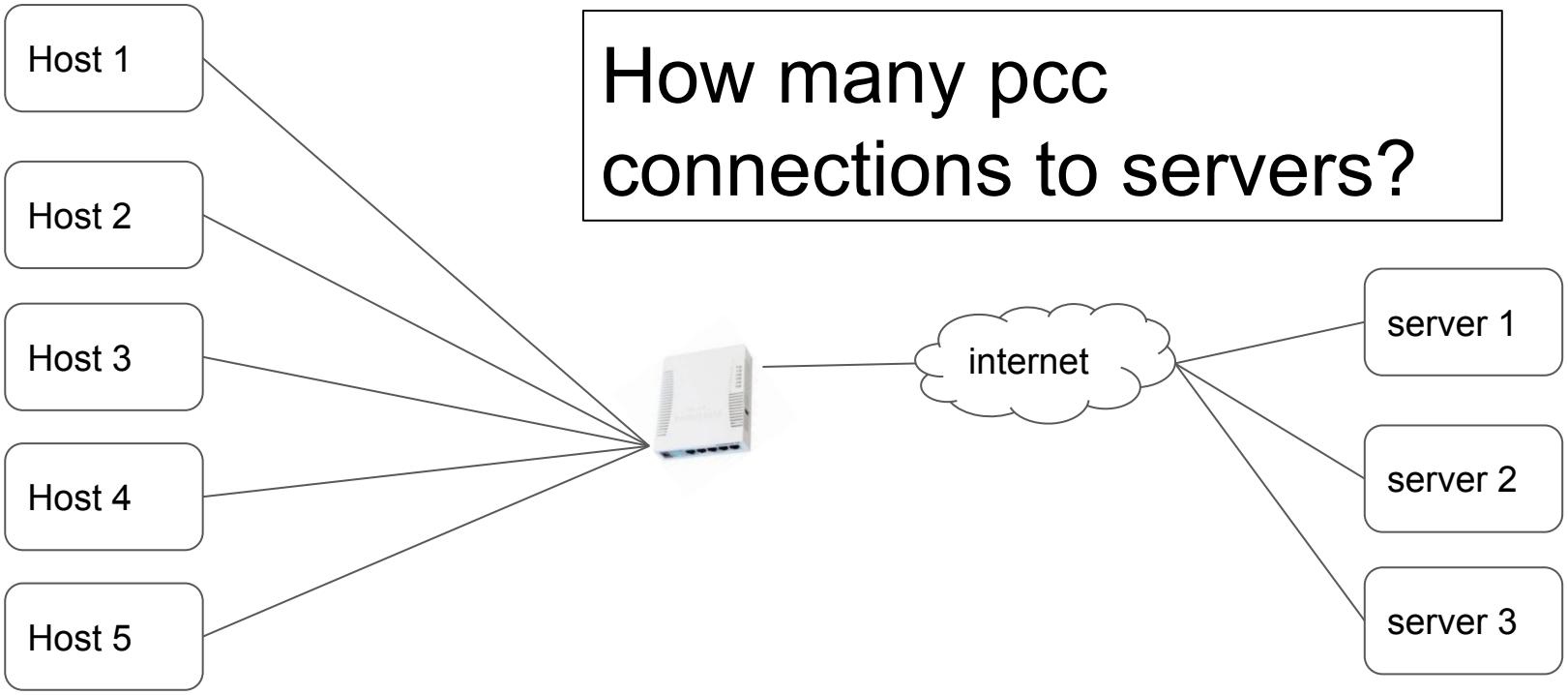


Exercise: Classifier=src-addr



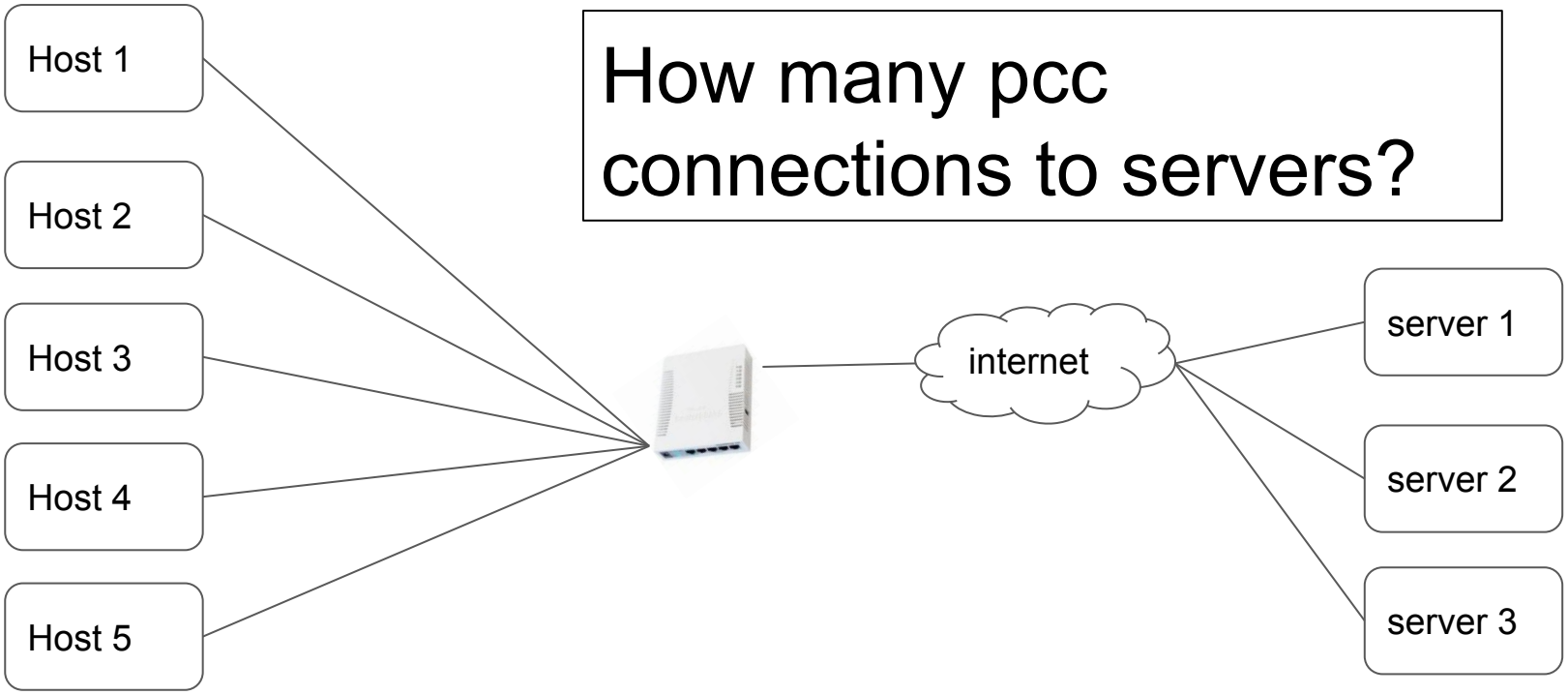
Each host connects to 3 servers

Exercise: Classifier=dst-addr



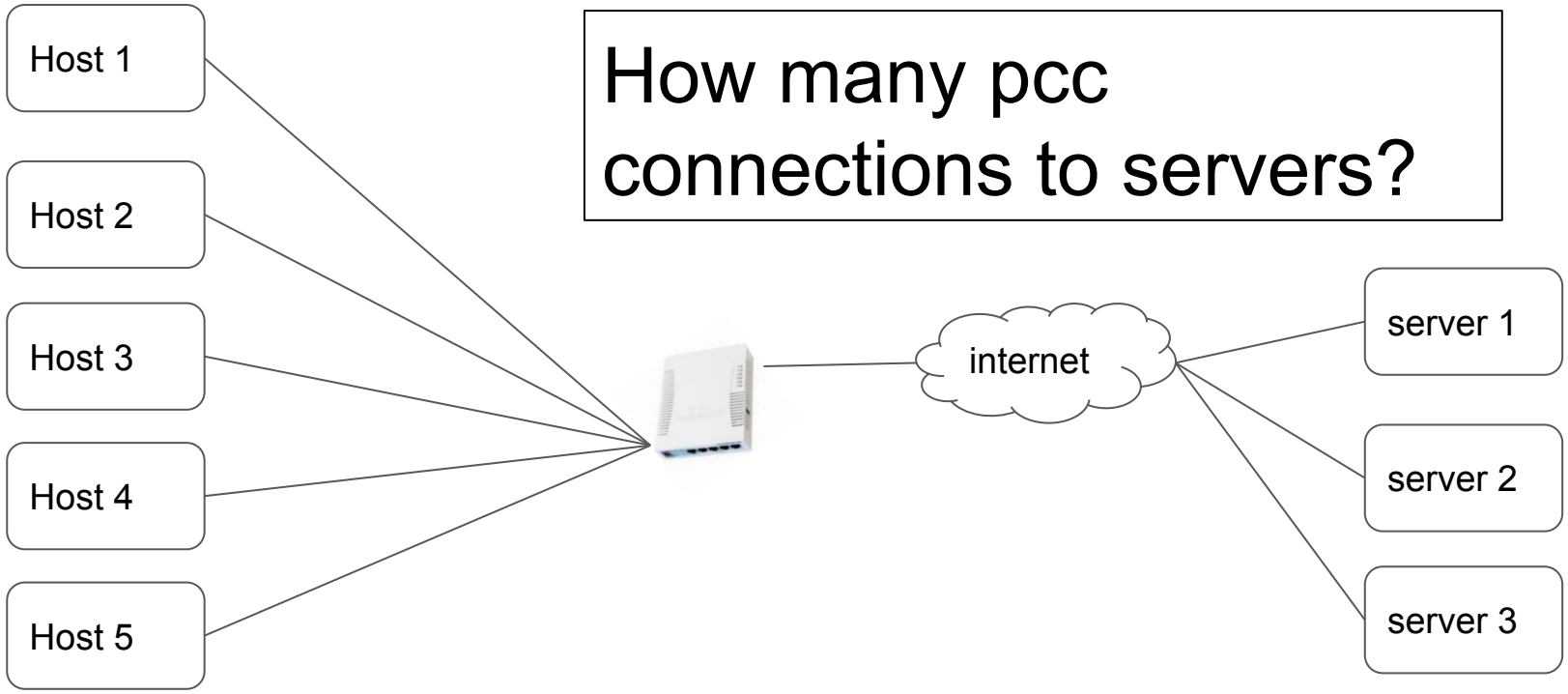
Each host connects to 3 servers

Exercise: Classifier=both-address



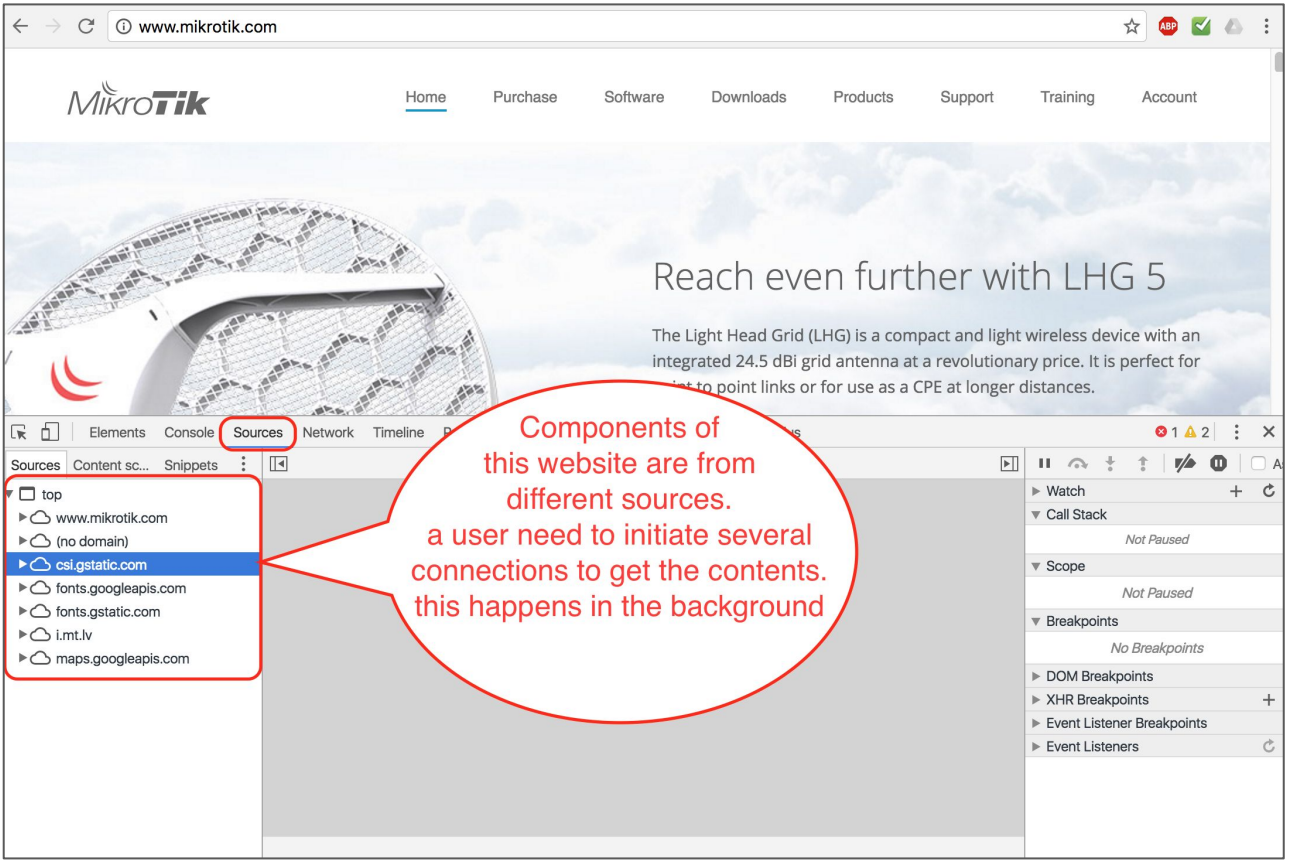
Each host connects to 3 servers

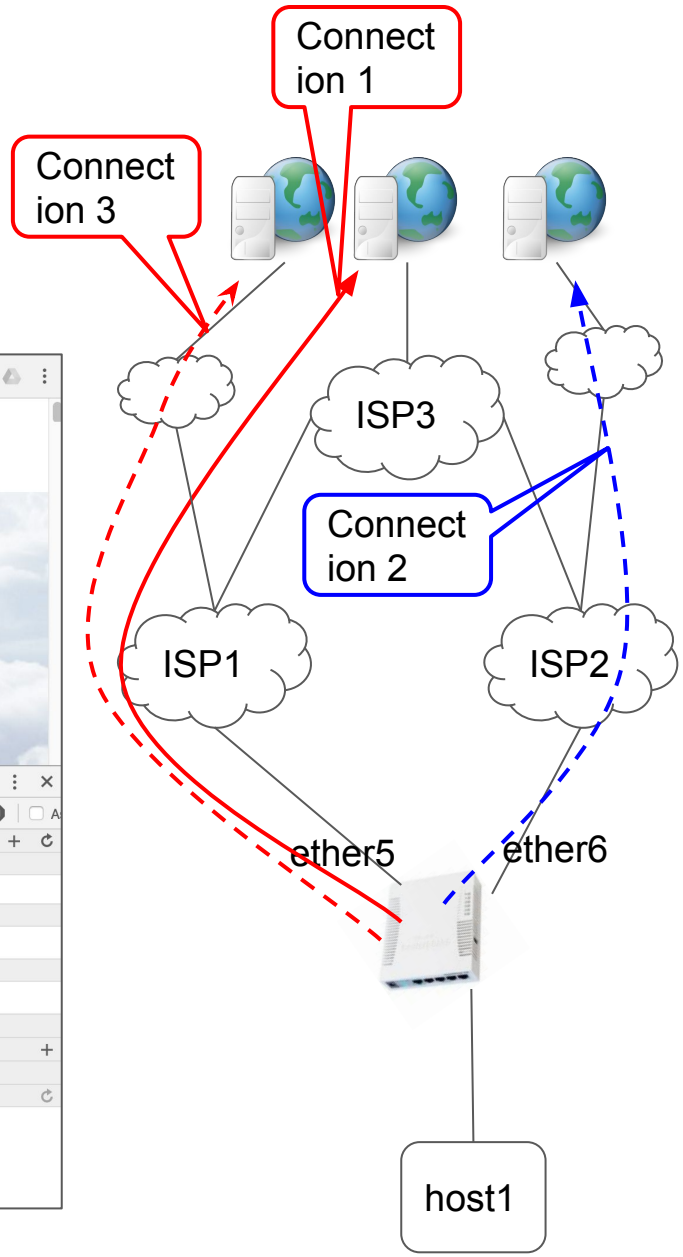
Exercise: Classifier=both-address-and-ports



Each host connects to 3 servers

Example: LB with classifier: both address





Some issues & recommendations

Some issues & recommendations

Issues:

- **Beware of NATed connection** -> webserver will see inbound connection from 2 ip public addresses
  - page will not displayed correctly (as it is considered illegal session)
  - banking / https pages will not allow you to access their website

Recommendations

- **If you use NAT**, Better to use classifier based on **source IP address** only -> will give client consistent path to the destination
- **Avoid NAT if possible** -> using public IP address end-to-end -> use BGP -> better performance

QA

Some info

- Hope you are more curious now
- These materials are part of Mikrotik Certified Traffic Control Engineer (MTCTCE) course
- If you are interested, you can sign up to our website

End of slides

- Thank you for your attention
- Please submit your feedback: http://bit.ly/glcfeedback
- Like our facebook page: “GLC networks”
- Stay tune with our schedule