

# Fully redundant networks

**EU MUM 2016**

# Hello!

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MikroTik Trainer



# Consulting & Training



**A long time ago in a galaxy far,  
far away....**



# X-Wing Fighter



# How can we make it work?



A decorative header featuring a network diagram of interconnected nodes and lines. A central node is highlighted with a dashed circle and contains a blue double quote icon.

“

*What is network redundancy?*

*Is redundant network redundancy  
**redundant?***

A background network diagram consisting of various nodes (circles) and connecting lines (edges). Some nodes are solid grey, while others are hollow white with a grey border. The connections are a mix of solid and dashed lines, creating a complex web-like structure. The diagram is positioned on the left and right sides of the slide, framing the central text.

1.

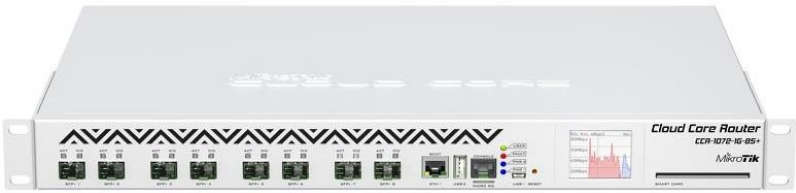
# Network redundancy

Equipment redundancy

Path redundancy



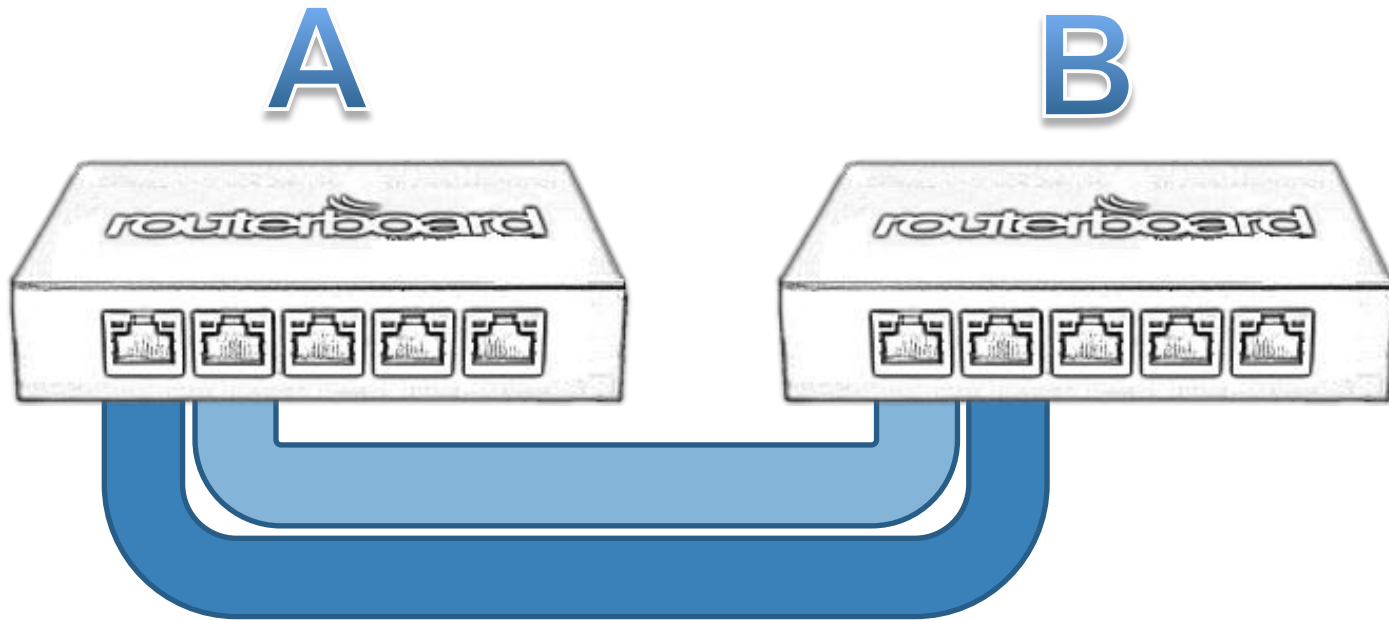
# Equipment redundancy



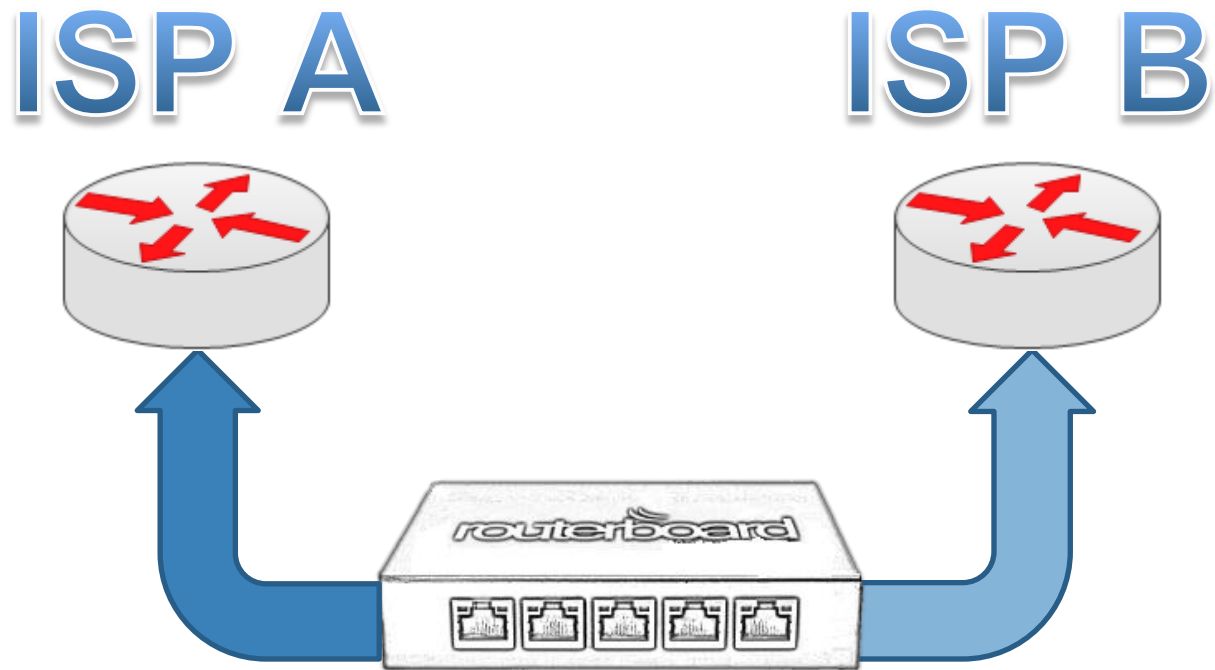
# Path redundancy



# Path redundancy



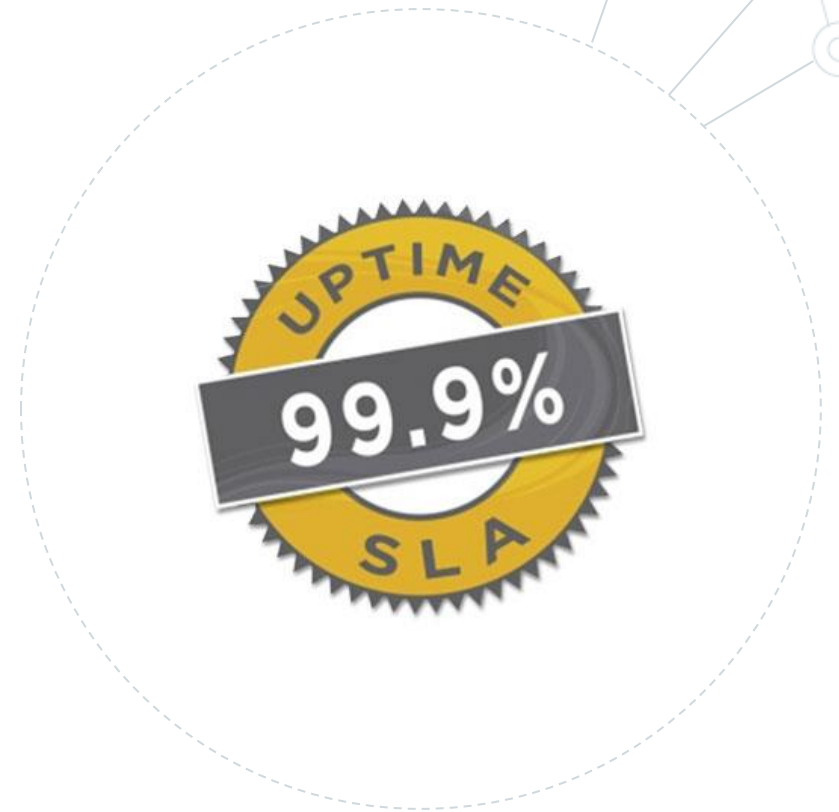
# Upstream path redundancy



# SLAs are based on calculations

Network uptime SLA:

This is not TIER based, as in case of data centers, but mathematically calculated.



# Calculation based on 1%



For every single point of failure  
in the network we take 1%  
(thumb rule) of monthly  
downtime into account



2.

# **Non redundant networks**

No equipment redundancy

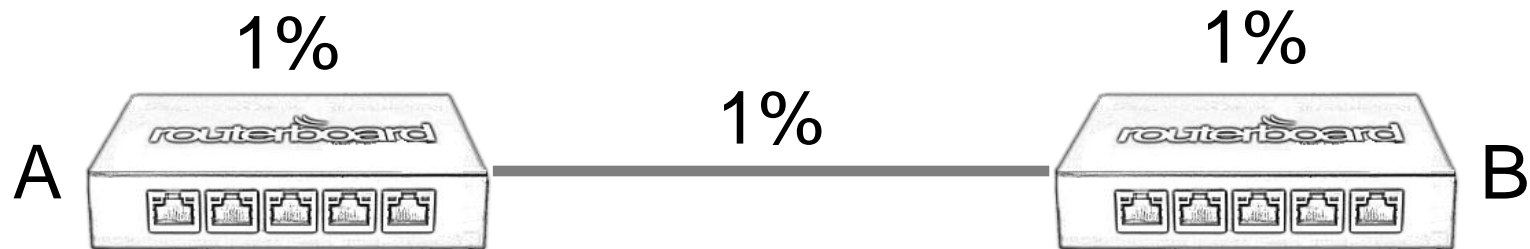
No path redundancy





# EXAMPLE

- ◎ 1% means:  $30,5 \text{ days} \times 24\text{h} / 100 = \mathbf{7,32\text{h}}$
- ◎ 1% of downtime for device A
- ◎ 1% of downtime for device B
- ◎ 1% of downtime for the link



Max network downtime = 3%  
(SLA = 97% guaranteed uptime)





3.

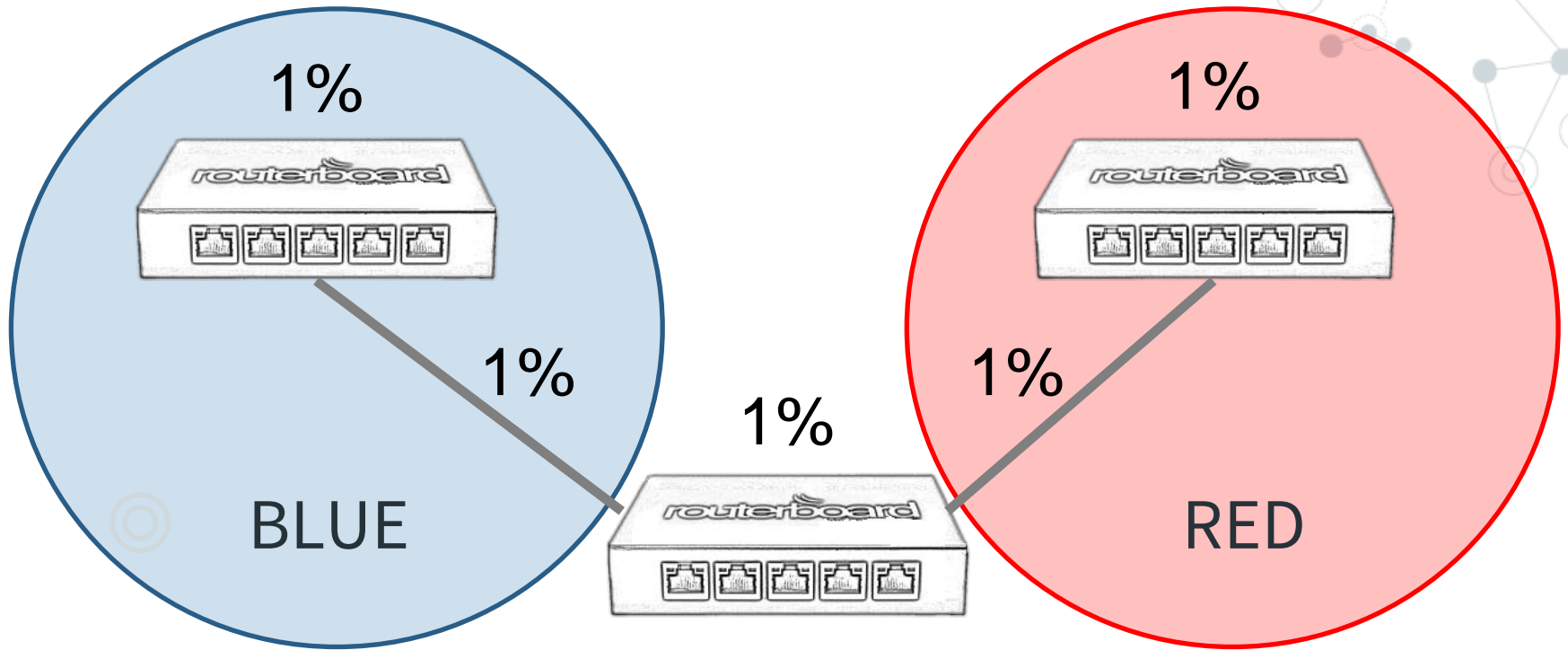
# Multiple upstream networks

No equipment redundancy

Partial upstream path redundancy



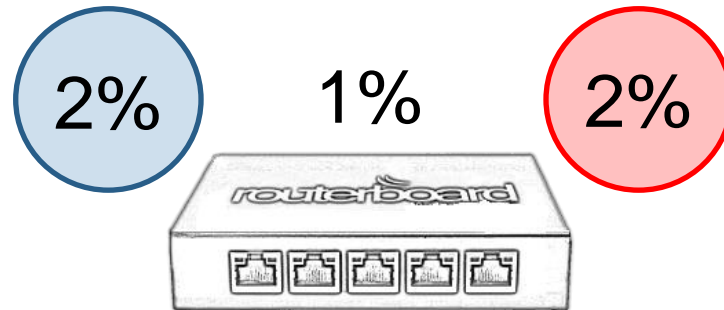
# WHAT IF WE DO IT LIKE THIS?



◎ BLUE max downtime = 2%

◎ RED max downtime = 2%

# CALCULATION



- ◎ The chance BLUE and RED will both be down is:  $2\% \times 2\% = 0,04\%$
- ◎ The worst case that RB and both ISPs will be down is:  $1\% + 0,04\% = 1,04\%$
- ◎ SLA for the current network: 98,96%



4.

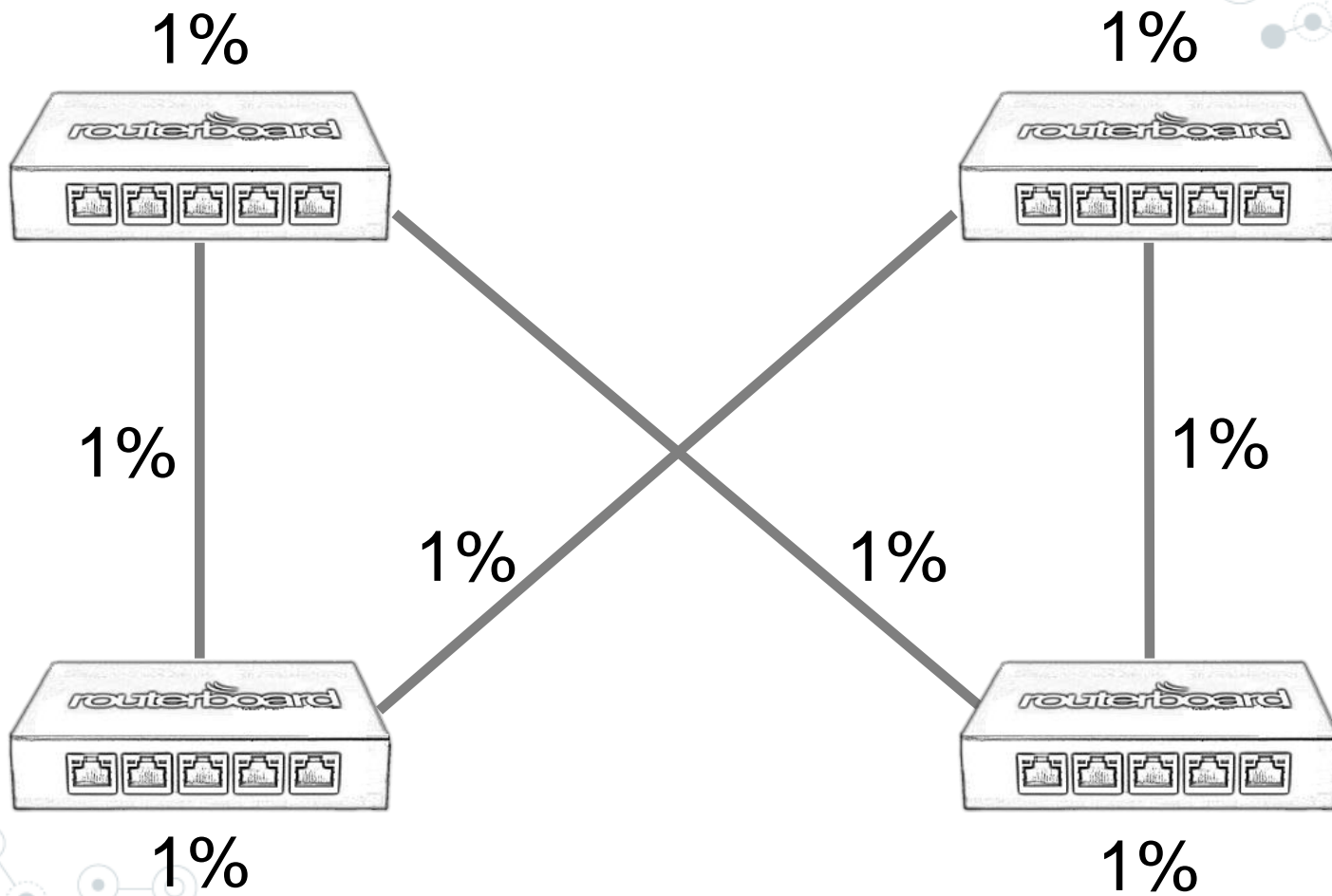
# Partial mesh networks

Equipment redundancy

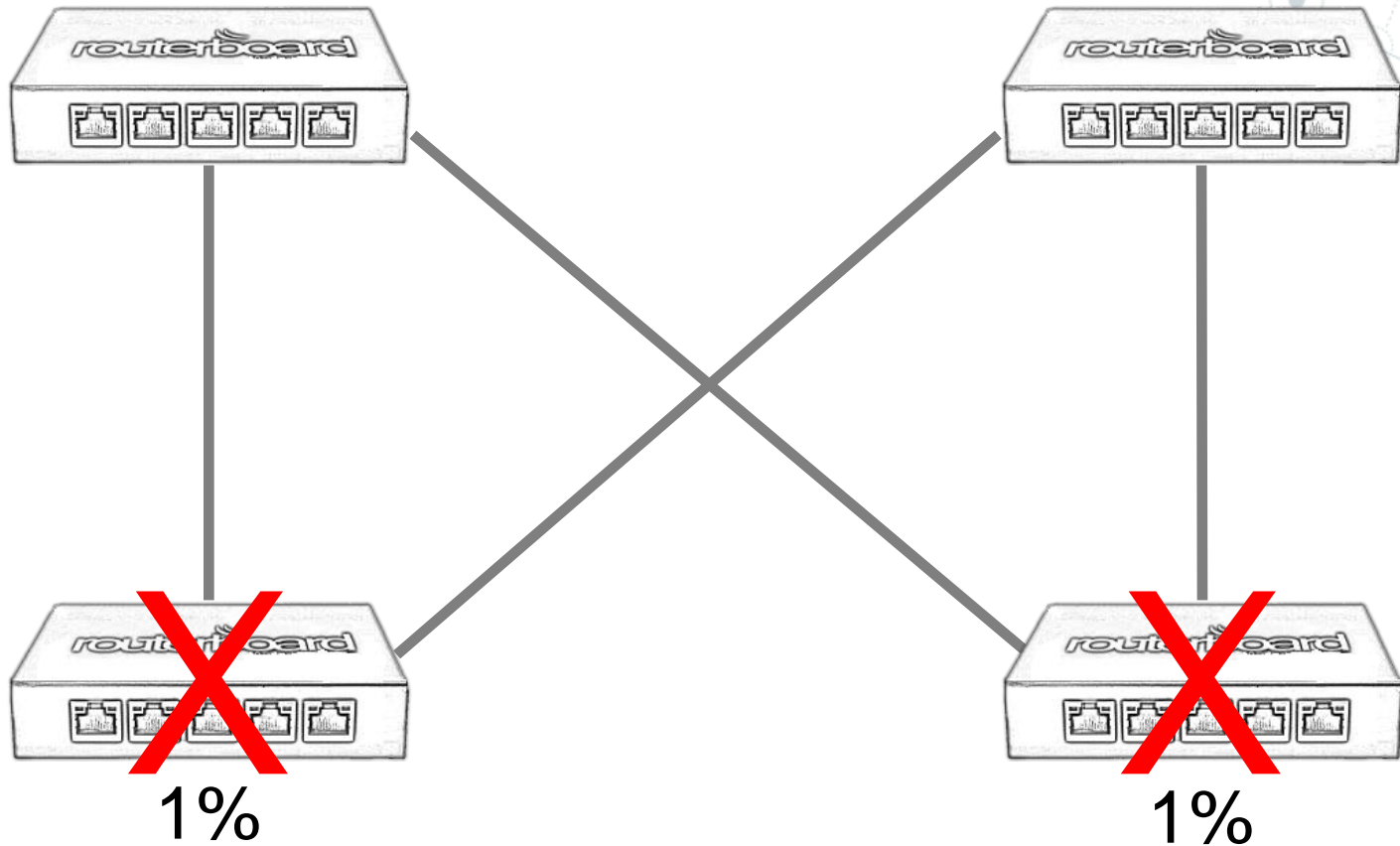
Multiple upstream path  
redundancy



# WITH UP TO 3 POINTS OF FAILURE THIS NETWORK CAN FAIL IN 6 WAYS



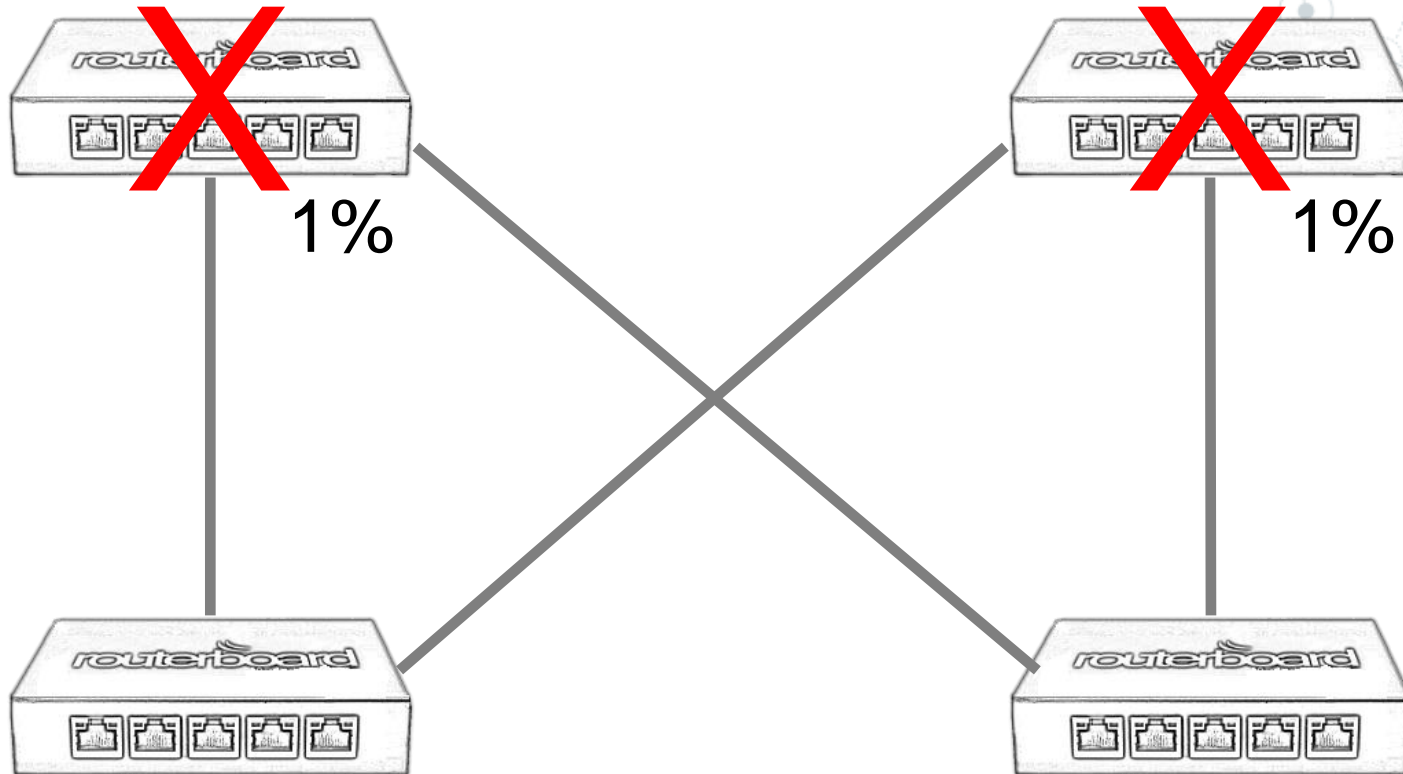
# FAIL NO. 1



The chance for this to happen:

$$1\% \times 1\% = 0,01\%$$

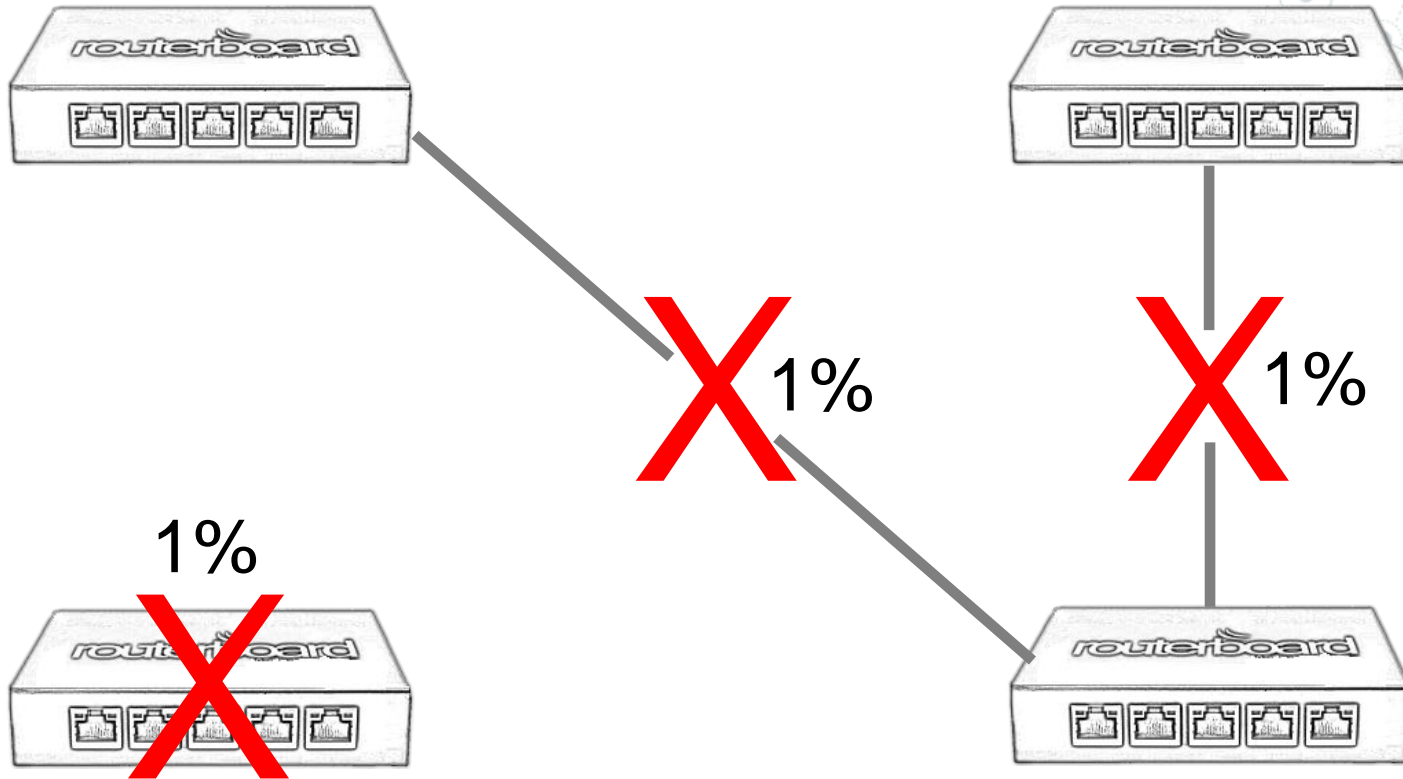
## FAIL NO. 2



The chance for this to happen:

$$1\% \times 1\% = 0,01\%$$

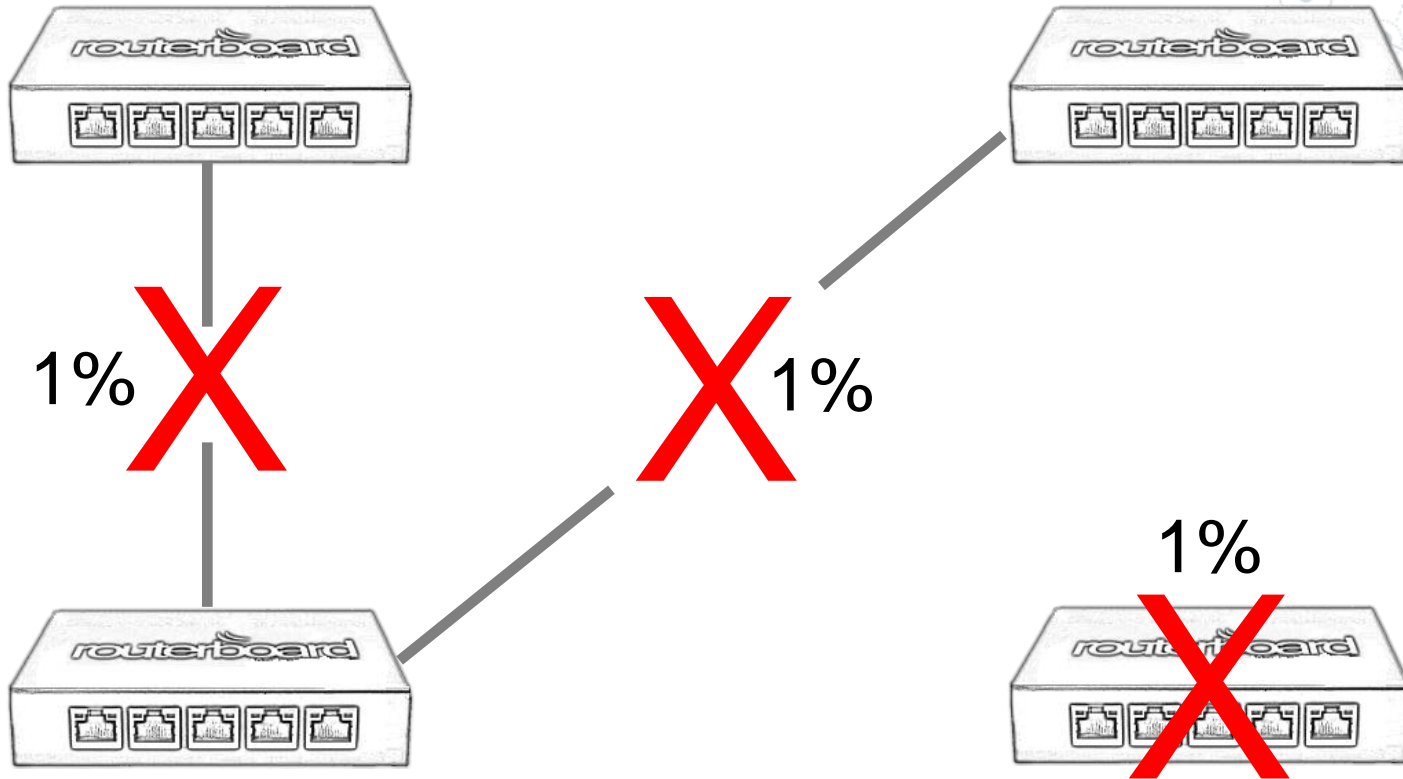
# FAIL NO. 3



🎯 The chance for this to happen:  
 $1\% \times 1\% \times 1\% = 0,0001\%$

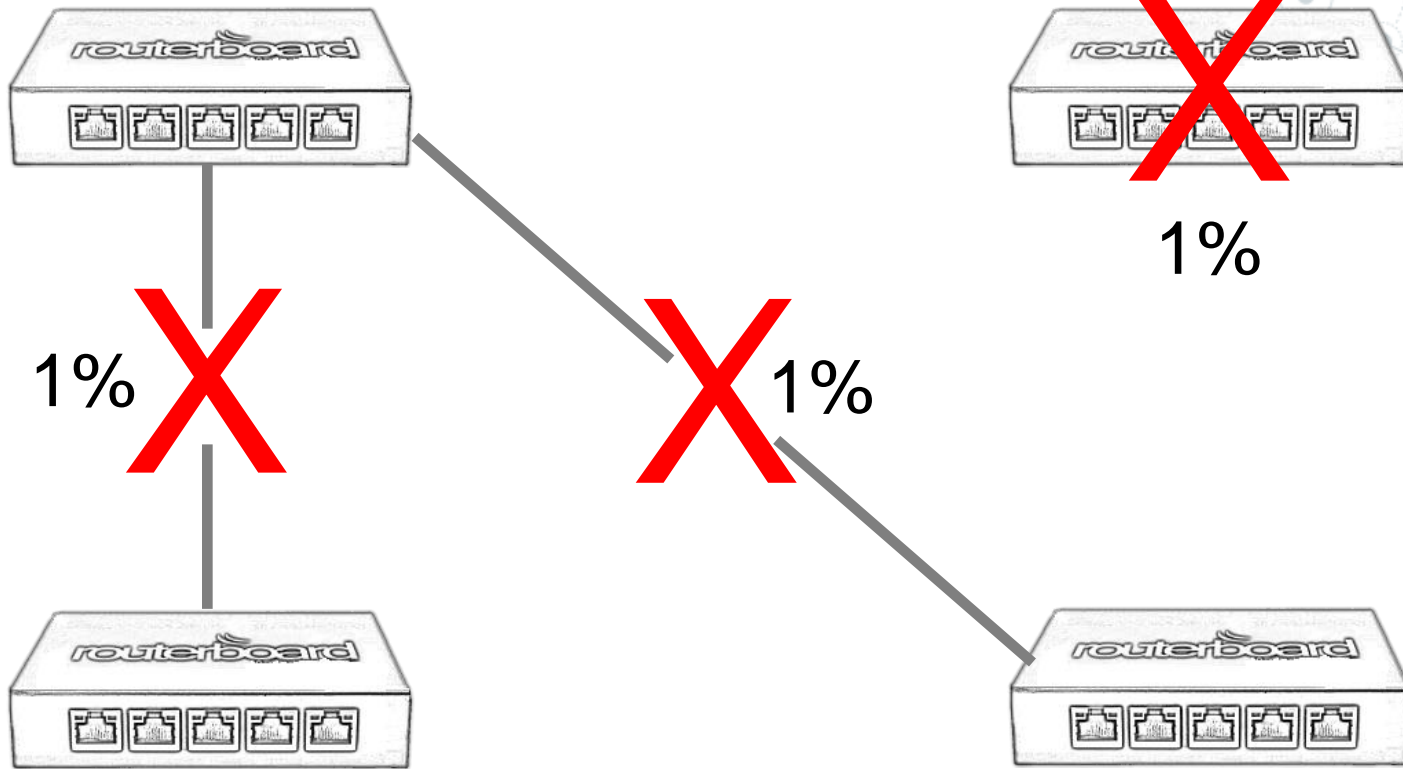


# FAIL NO. 4



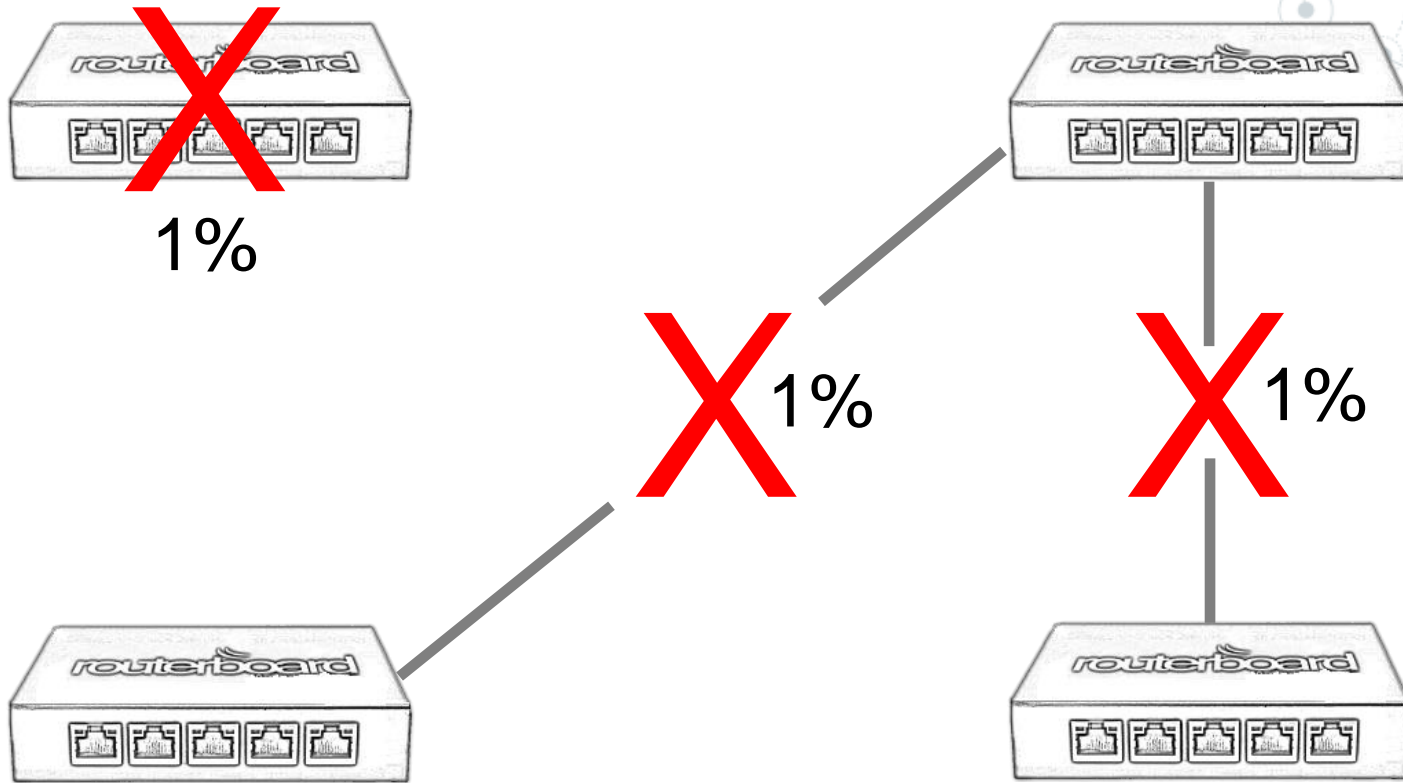
🎯 The chance for this to happen:  
 $1\% \times 1\% \times 1\% = 0,0001\%$

# FAIL NO. 5



🎯 The chance for this to happen:  
 $1\% \times 1\% \times 1\% = 0,0001\%$

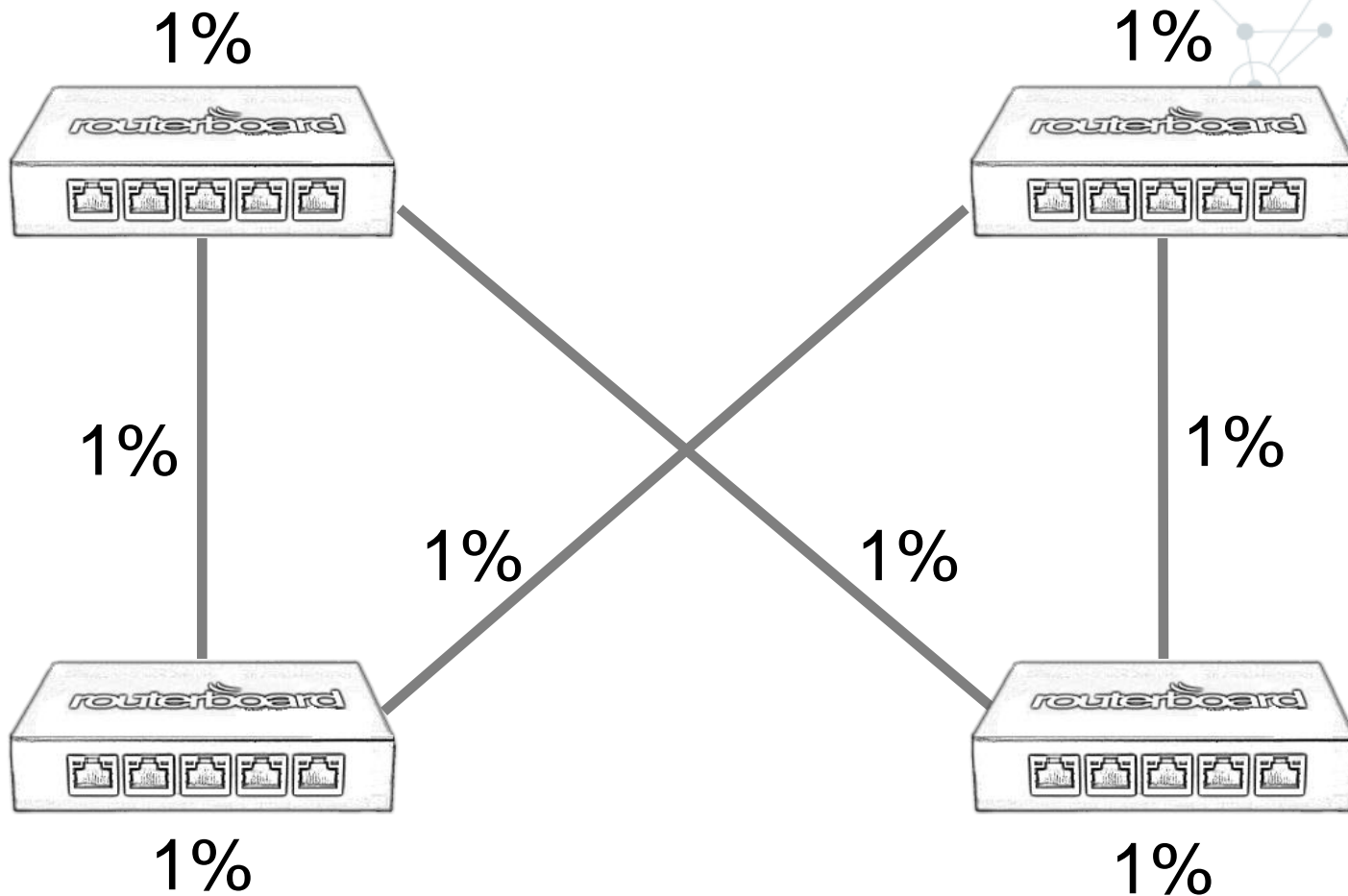
# FAIL NO. 6



🎯 The chance for this to happen:

$$1\% \times 1\% \times 1\% = 0,0001\%$$

# TOTAL FAILURE RATE



$$4 \times 0,0001\% + 2 \times 0,01\% = 0,0204\%$$

SLA: 99,9796% (**99,9%**)




5.

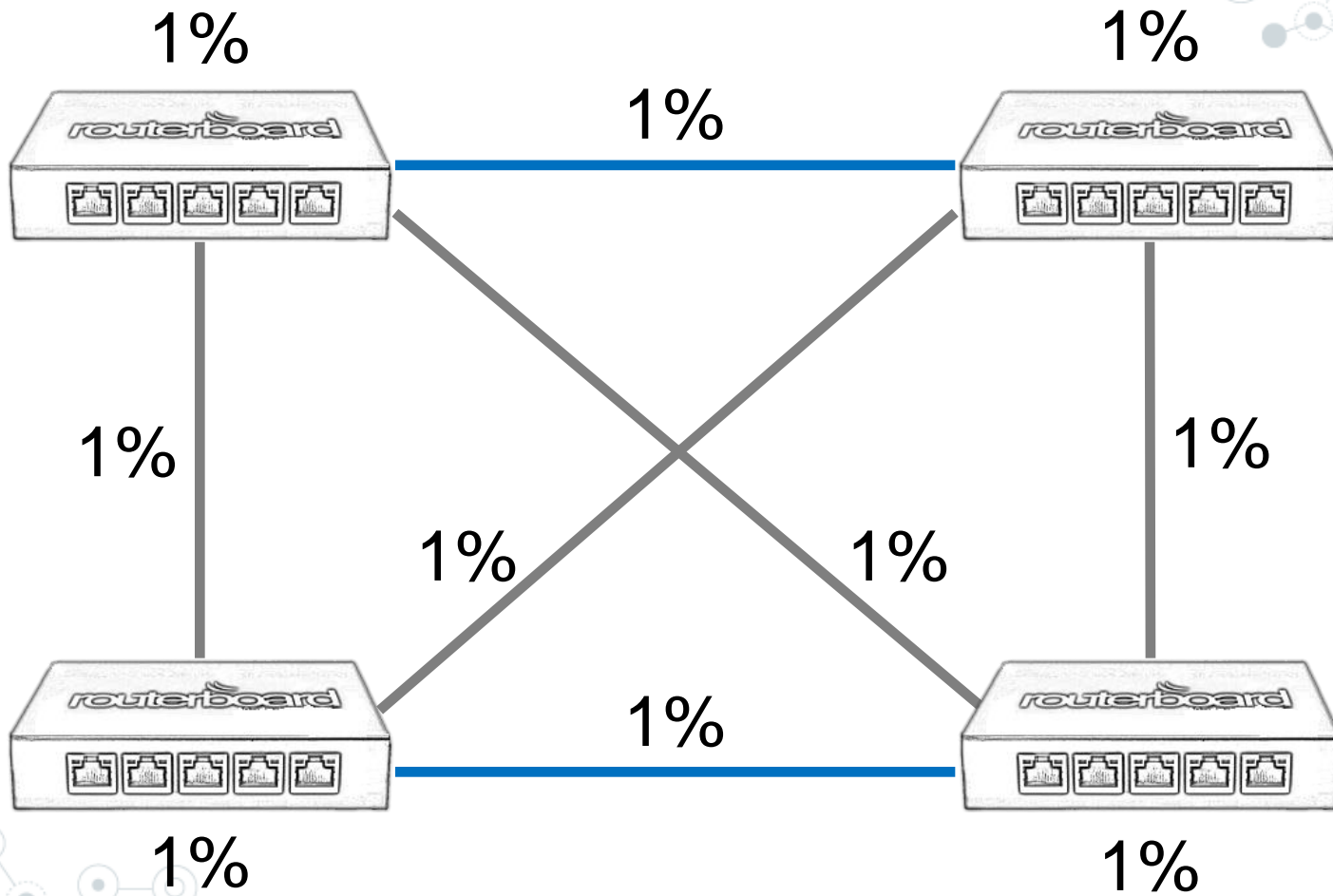
# Mesh networks

Equipment redundancy

Multiple path redundancy and  
upstream path redundancy



# 99,9% MESH NETWORK





6.

# Fully redundant networks

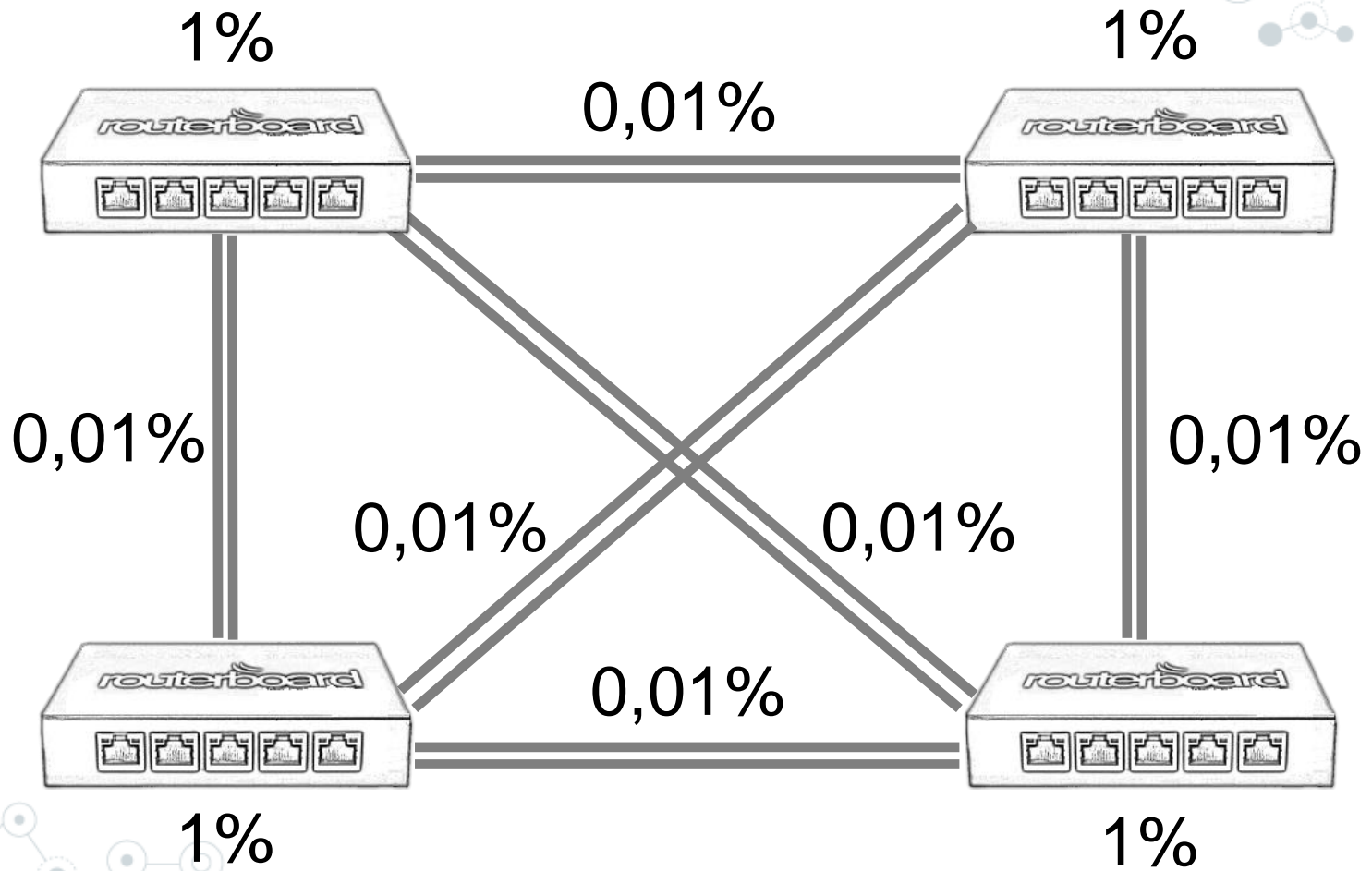
Equipment redundancy

Double path redundancy with double upstream path redundancy



# 99,98%

## FULLY REDUNDANT NETWORK





A background network diagram consisting of various nodes (circles) connected by lines, some solid and some dashed, representing a network topology. The nodes vary in size and some have concentric circles, suggesting different levels or types of nodes in the network.

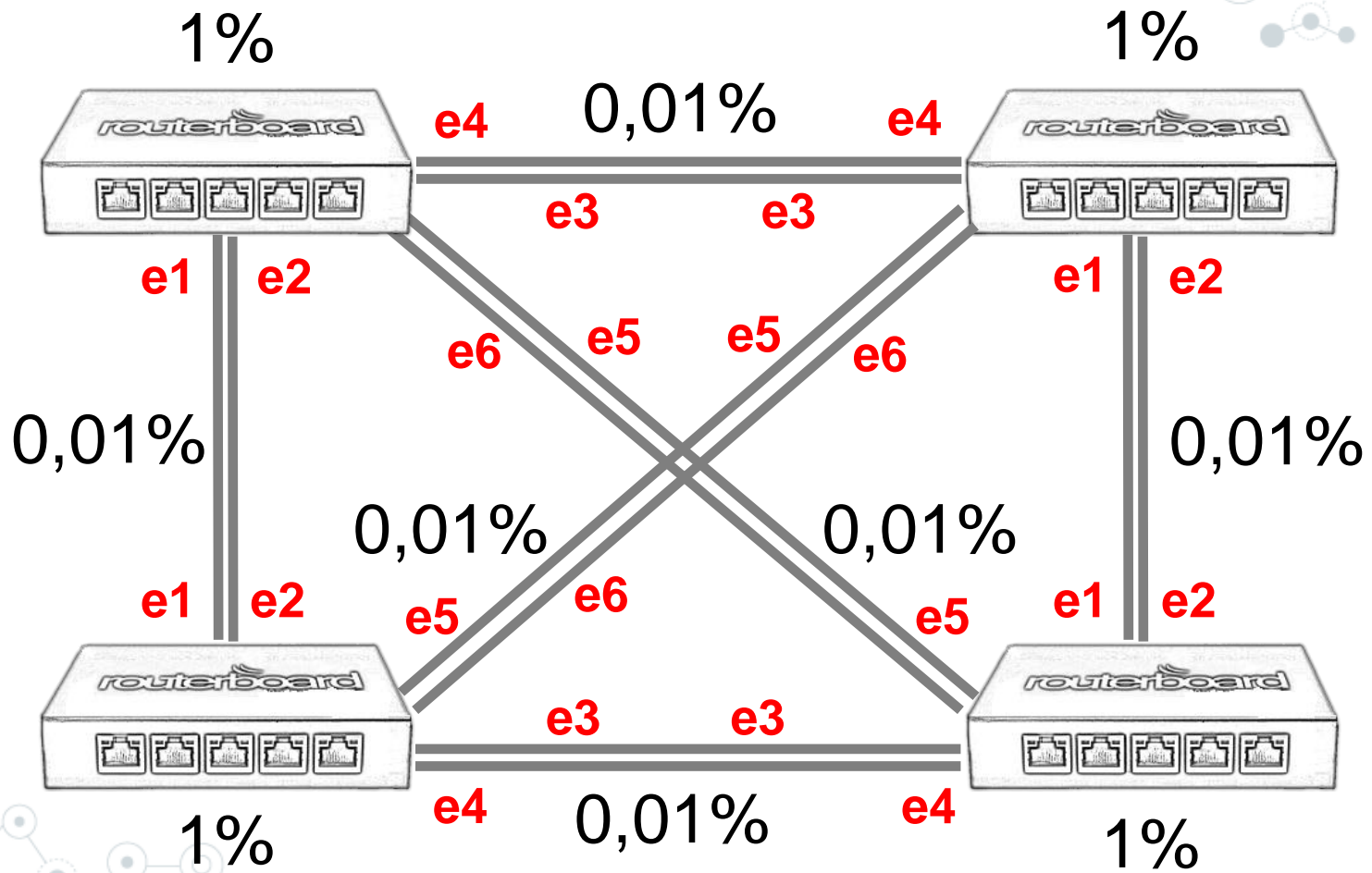
7.

# Let's do it on MikroTik

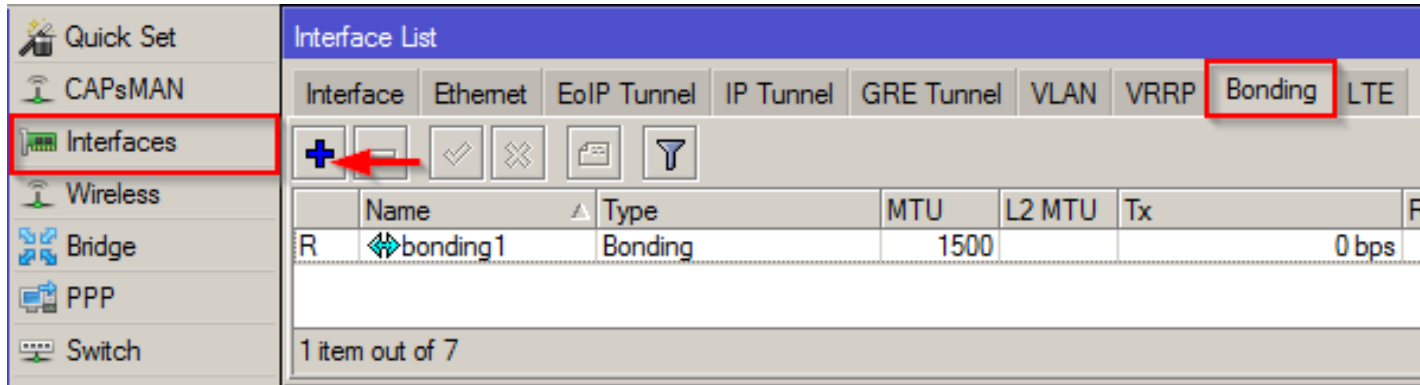
There are different ways to do it

We will use multiple protocols and  
layers to prove the concept

# Use bonding active-backup



# Create the bonding interfaces

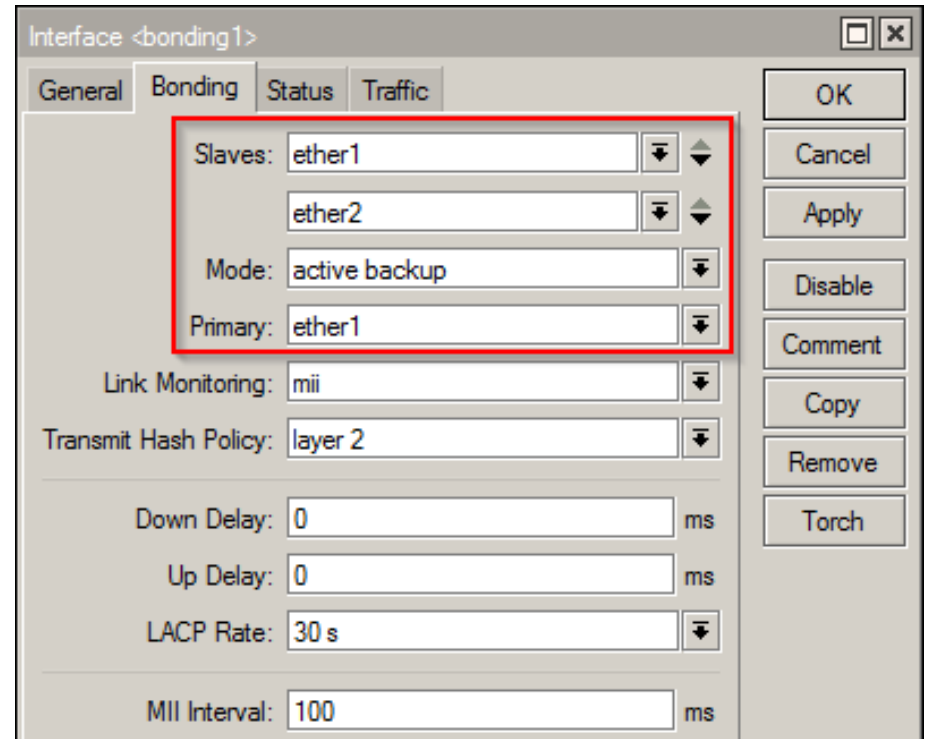


The screenshot shows the Mikrotik WinBox 'Interface List' window. The 'Bonding' tab is selected and highlighted with a red box. A red arrow points to the '+' icon in the toolbar, indicating the action to create a new interface. The table below shows one bonding interface:

Interface	Ethernet	EoIP Tunnel	IP Tunnel	GRE Tunnel	VLAN	VRRP	Bonding	LTE
R							↔ bonding1	
Name	Type		MTU	L2 MTU	Tx		Rb	
	bonding1		Bonding	1500			0 bps	

1 item out of 7

Repeat this process for every bonding link on every router until you get all 3 bonding interfaces on each router

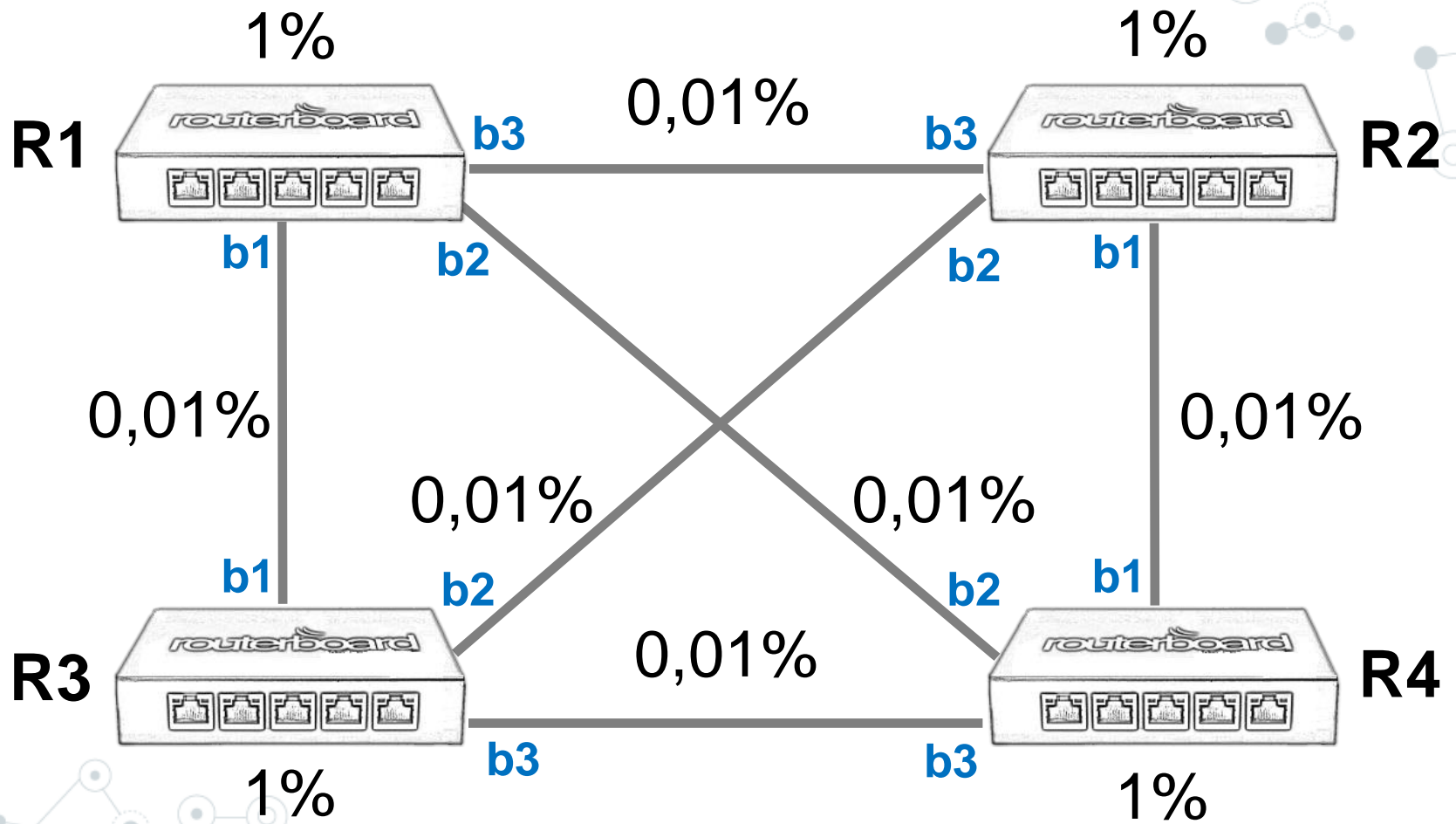


The screenshot shows the configuration window for the 'bonding1' interface. The 'Bonding' tab is selected. The configuration is as follows:

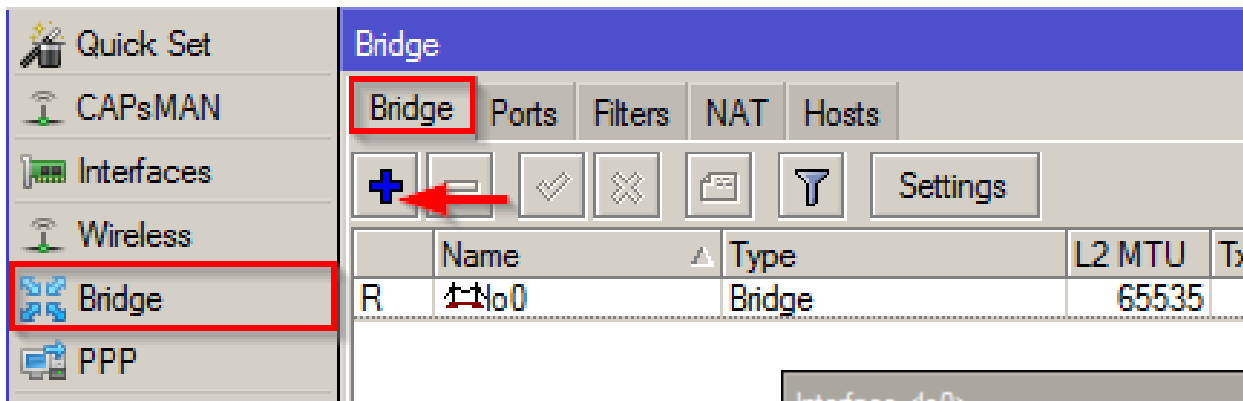
- Slaves: ether1, ether2
- Mode: active backup
- Primary: ether1
- Link Monitoring: mii
- Transmit Hash Policy: layer 2
- Down Delay: 0 ms
- Up Delay: 0 ms
- LACP Rate: 30 s
- MII Interval: 100 ms

Buttons on the right include OK, Cancel, Apply, Disable, Comment, Copy, Remove, and Torch.

# Resulting network



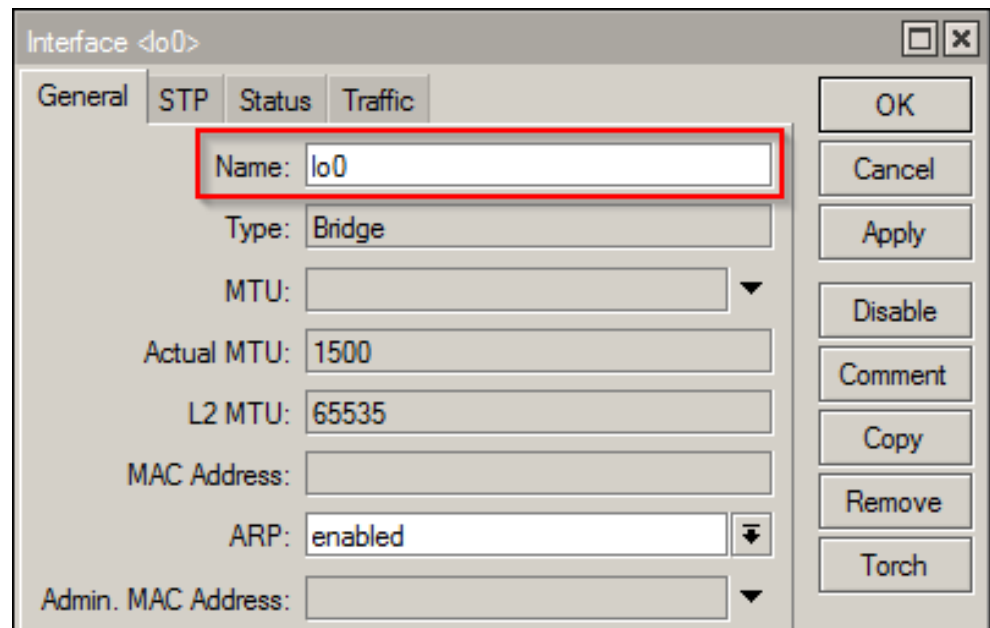
# Loopback setup



The screenshot shows the Mikrotik WinBox interface for configuring a bridge. On the left sidebar, the 'Bridge' option is highlighted with a red box. In the main window, the 'Bridge' tab is selected and also highlighted with a red box. A red arrow points to the '+' icon in the toolbar. Below the toolbar, a table lists the bridge configuration:

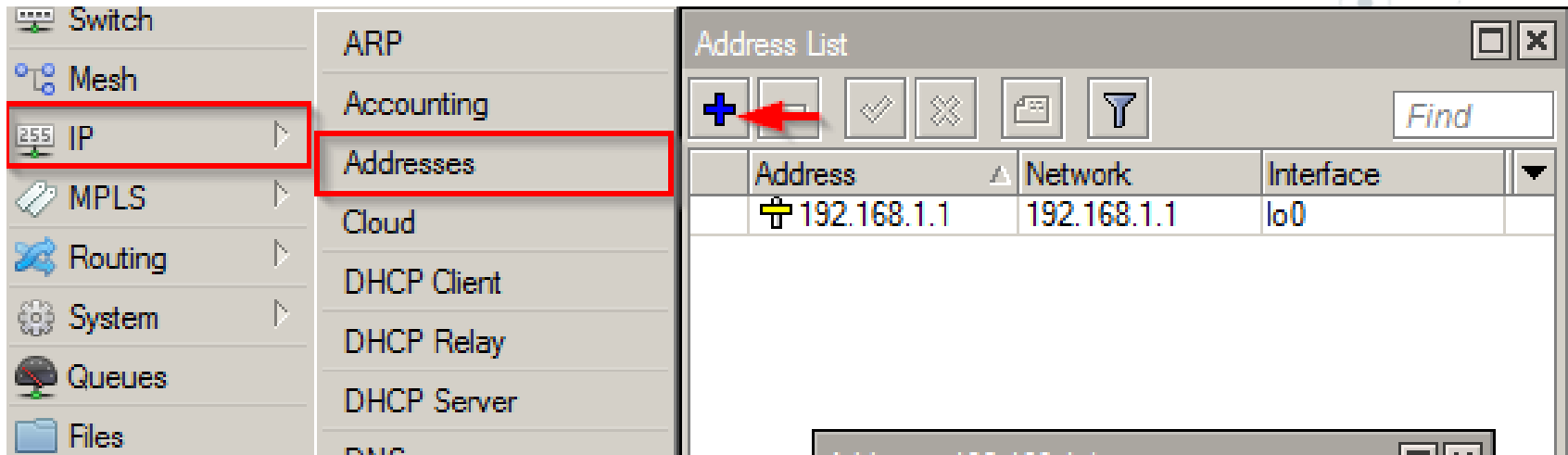
	Name	Type	L2 MTU	T...
R	lo0	Bridge	65535	

On every router add a loopback device (a bridge with no ports attached)



The screenshot shows the 'Interface <lo0>' configuration window in Mikrotik WinBox. The 'General' tab is selected. The 'Name' field is highlighted with a red box and contains the value 'lo0'. Other fields include 'Type' set to 'Bridge', 'MTU' set to 1500, 'Actual MTU' set to 1500, 'L2 MTU' set to 65535, 'MAC Address' set to an empty field, 'ARP' set to 'enabled', and 'Admin. MAC Address' set to an empty field. On the right side, there are buttons for 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', 'Remove', and 'Torch'.

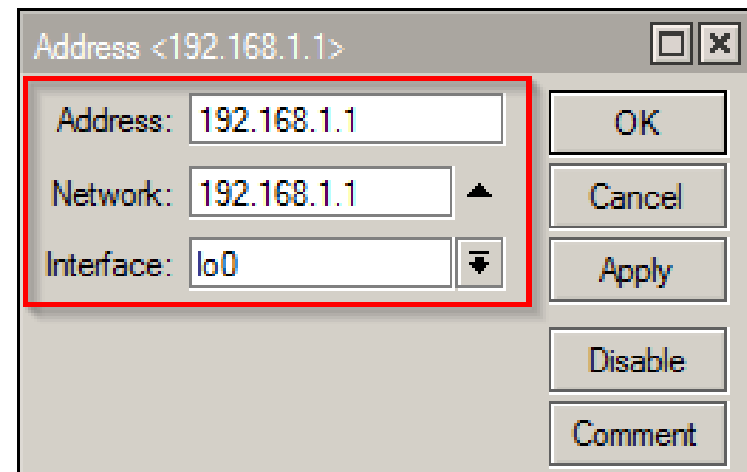
# Adding loopback IPs



The screenshot shows the Mikrotik WinBox interface. On the left, the 'IP' menu item is highlighted with a red box. In the center, the 'Addresses' menu item is also highlighted with a red box. On the right, the 'Address List' window is open, displaying a table with one entry: 192.168.1.1 on the lo0 interface. A red arrow points to the '+' icon in the Address List toolbar.

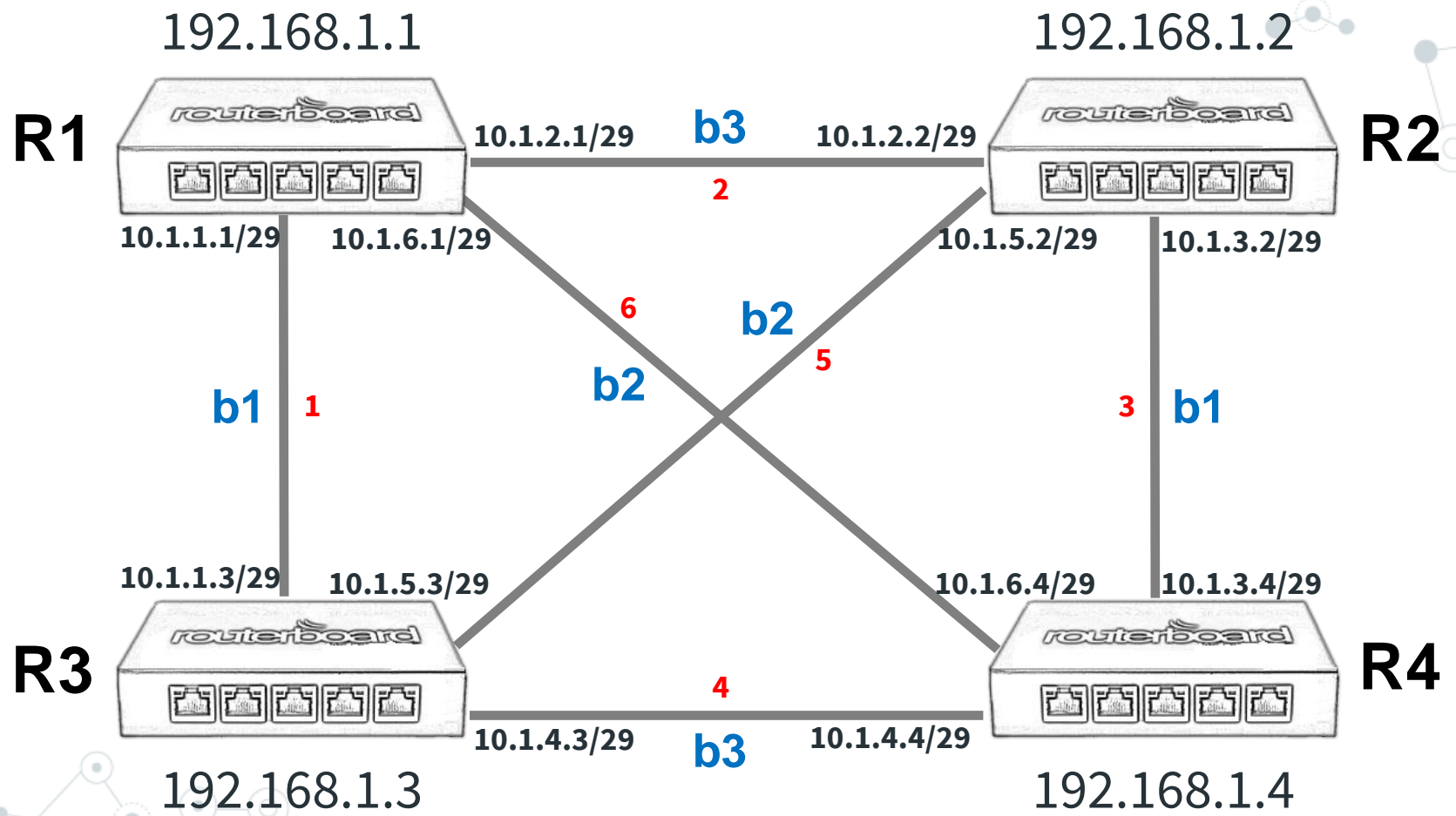
Address	Network	Interface
192.168.1.1	192.168.1.1	lo0

On every router add  
a loopback IP  
(/32 netmask)



The screenshot shows the 'Address <192.168.1.1>' configuration dialog box. The 'Address', 'Network', and 'Interface' fields are highlighted with a red box. The 'Address' field contains '192.168.1.1', the 'Network' field contains '192.168.1.1', and the 'Interface' field contains 'lo0'. The dialog box also includes buttons for 'OK', 'Cancel', 'Apply', 'Disable', and 'Comment'.

# Interconnections



# Adding the interconnect networks

Link number

Router number

R1

Address	Network	Interface
10.1.1.1/29	10.1.1.0	bonding1
10.1.6.1/29	10.1.6.0	bonding2
10.1.2.1/29	10.1.2.0	bonding3
192.168.1.1	192.168.1.1	lo0

R2

Address	Network	Interface
10.1.3.2/29	10.1.3.0	bonding1
10.1.5.2/29	10.1.5.0	bonding2
10.1.2.2/29	10.1.2.0	bonding3
192.168.1.2	192.168.1.2	lo0

R3

Address	Network	Interface
10.1.1.3/29	10.1.1.0	bonding1
10.1.5.3/29	10.1.5.0	bonding2
10.1.4.3/29	10.1.4.0	bonding3
192.168.1.3	192.168.1.3	lo0

R4

Address	Network	Interface
10.1.3.4/29	10.1.3.0	bonding1
10.1.6.4/29	10.1.6.0	bonding2
10.1.4.4/29	10.1.4.0	bonding3
192.168.1.4	192.168.1.4	lo0



# OSPF setup

The screenshot displays a network configuration interface. On the left, a sidebar menu has 'Routing' and 'OSPF' highlighted with red boxes. The main window shows the 'OSPF' configuration page with the 'Instances' tab selected. A table lists the OSPF instances:

Name	Router ID	Running
default	192.168.1.1	no

An 'OSPF Instance <default>' dialog box is open, showing the 'General' tab. The 'Router ID' field is highlighted with a red box and contains the value '192.168.1.1'. Other fields include 'Name: default', 'Redistribute Default Route: never', 'Redistribute Connected Routes: no', 'Redistribute Static Routes: no', and 'Redistribute RIP Routes: no'. Buttons for 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', and 'Remove' are visible on the right.

Set the OSPF router ID to the loopback address

# OSPF setup

The screenshot displays the OSPF configuration interface. The 'Networks' tab is active, showing a table of networks. A red box highlights the toolbar and the network table. A red arrow points to the '+' icon in the toolbar. Below the network table, an 'Address List' window is open, showing a table of IP addresses and their associated interfaces.

Network	Area
10.1.1.0/29	backbone
10.1.2.0/29	backbone
10.1.6.0/29	backbone
192.168.1.1	backbone

Address	Network	Interface
10.1.1.1/29	10.1.1.0	bonding1
10.1.2.1/29	10.1.2.0	bonding3
10.1.6.1/29	10.1.6.0	bonding2
192.168.1.1	192.168.1.1	lo0

Add all connected networks to OSPF

# Adding the interconnect networks

## R1

OSPF

Instances Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors Sham Links LS

Network	Area
10.1.1.0/29	backbone
10.1.2.0/29	backbone
10.1.6.0/29	backbone
192.168.1.1	backbone

Address List

Address	Network	Interface
10.1.1.1/29	10.1.1.0	bonding1
10.1.2.1/29	10.1.2.0	bonding3
10.1.6.1/29	10.1.6.0	bonding2
192.168.1.1	192.168.1.1	lo0

## R2

OSPF

Instances Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors Sham Links LS

Network	Area
10.1.2.0/29	backbone
10.1.3.0/29	backbone
10.1.5.0/29	backbone
192.168.1.2	backbone

Address List

Address	Network	Interface
10.1.2.2/29	10.1.2.0	bonding3
10.1.3.2/29	10.1.3.0	bonding1
10.1.5.2/29	10.1.5.0	bonding2
192.168.1.2	192.168.1.2	lo0

## R3

OSPF

Instances Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors Sham Links LS

Network	Area
10.1.1.0/29	backbone
10.1.4.0/29	backbone
10.1.5.0/29	backbone
192.168.1.3	backbone

Address List

Address	Network	Interface
10.1.1.3/29	10.1.1.0	bonding1
10.1.4.3/29	10.1.4.0	bonding3
10.1.5.3/29	10.1.5.0	bonding2
192.168.1.3	192.168.1.3	lo0

## R4

OSPF

Instances Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors Sham Links LS

Network	Area
10.1.3.0/24	backbone
10.1.4.0/29	backbone
10.1.6.0/29	backbone
192.168.1.4	backbone

Address List

Address	Network	Interface
10.1.3.4/29	10.1.3.0	bonding1
10.1.4.4/29	10.1.4.0	bonding3
10.1.6.4/29	10.1.6.0	bonding2
192.168.1.4	192.168.1.4	lo0



## R4 - Routing table result

OSPF

Instances Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors Sham Links LSA Routes

+ - ✓ ✗ 📄 🔍

Network	Area
10.1.3.0/24	backbone
10.1.4.0/29	backbone
10.1.6.0/29	backbone
192.168.1.4	backbone

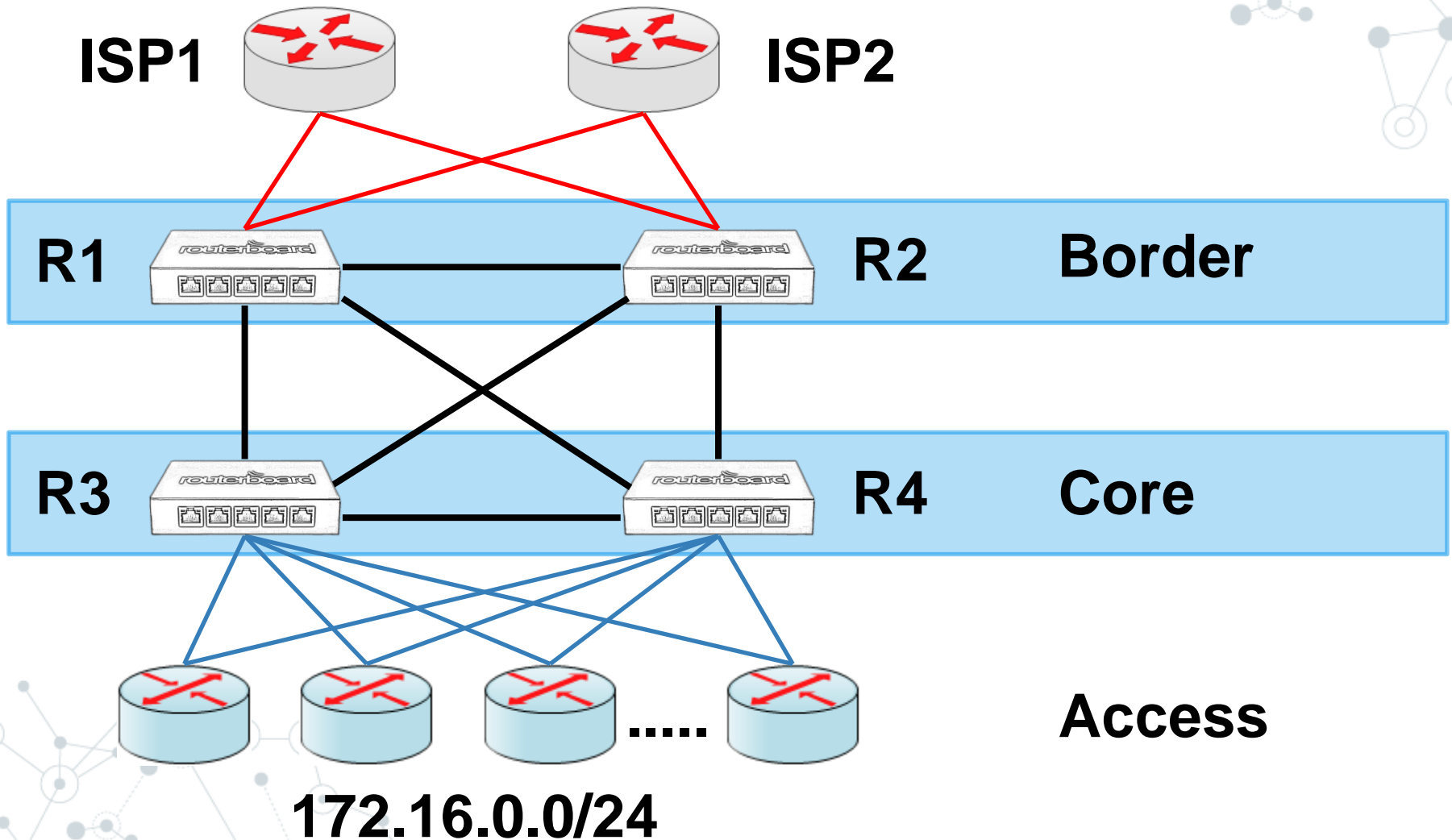
Route List

Routes Nexthops Rules VRF

+ - ✓ ✗ 📄 🔍 Find all

	Dst. Address	Gateway	Distance	Pref. Source
DAo	▶ 10.1.1.0/29	10.1.4.3 reachable bonding3, 10.1.6.1 reachable bonding2	110	
DAo	▶ 10.1.2.0/29	10.1.3.2 reachable bonding1, 10.1.6.1 reachable bonding2	110	
DAC	▶ 10.1.3.0/29	bonding1 reachable	0	10.1.3.4
DAC	▶ 10.1.4.0/29	bonding3 reachable	0	10.1.4.4
DAo	▶ 10.1.5.0/29	10.1.3.2 reachable bonding1, 10.1.4.3 reachable bonding3	110	
DAC	▶ 10.1.6.0/29	bonding2 reachable	0	10.1.6.4
DAo	▶ 192.168.1.1	10.1.6.1 reachable bonding2	110	
DAo	▶ 192.168.1.2	10.1.3.2 reachable bonding1	110	
DAo	▶ 192.168.1.3	10.1.4.3 reachable bonding3	110	
DAC	▶ 192.168.1.4	lo0 reachable	0	192.168.1.4

# Providers and customers



# OSPF specifics

The network is now fully redundant but it depends on OSPF for path selection and convergence

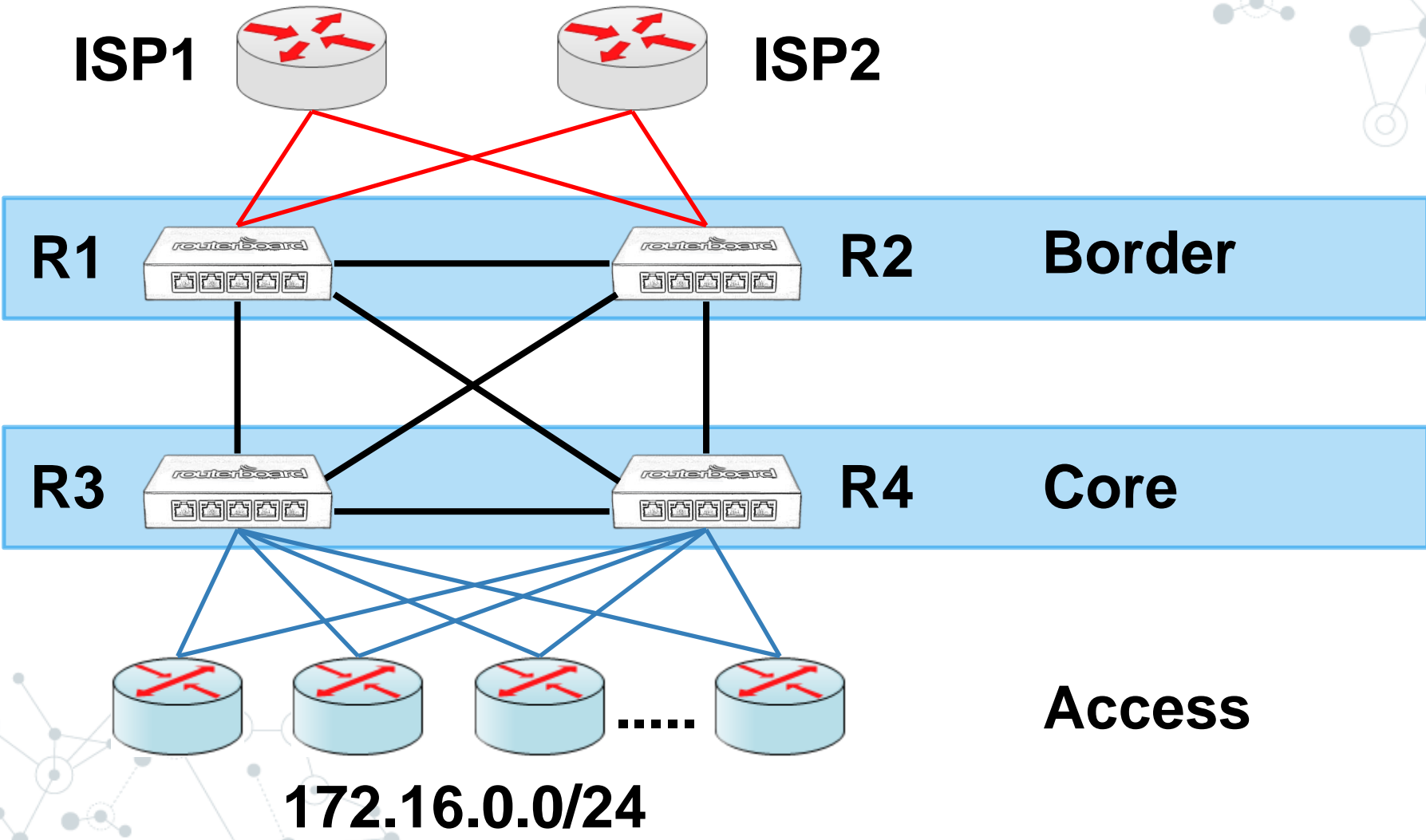


# MPLS TE to the rescue

Deploy MPLS TE for  
faster and better  
path control

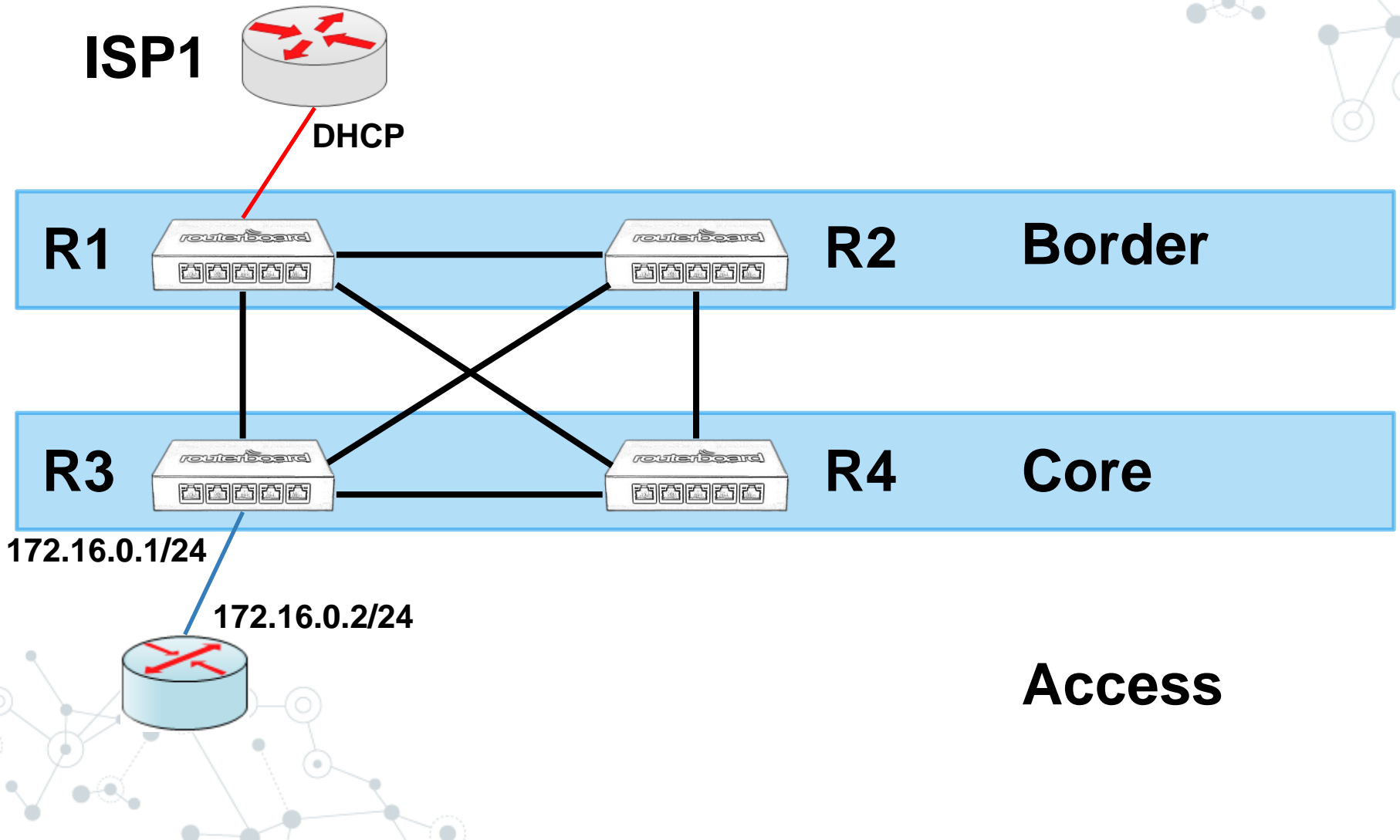


For demo purposes we will turn this network...

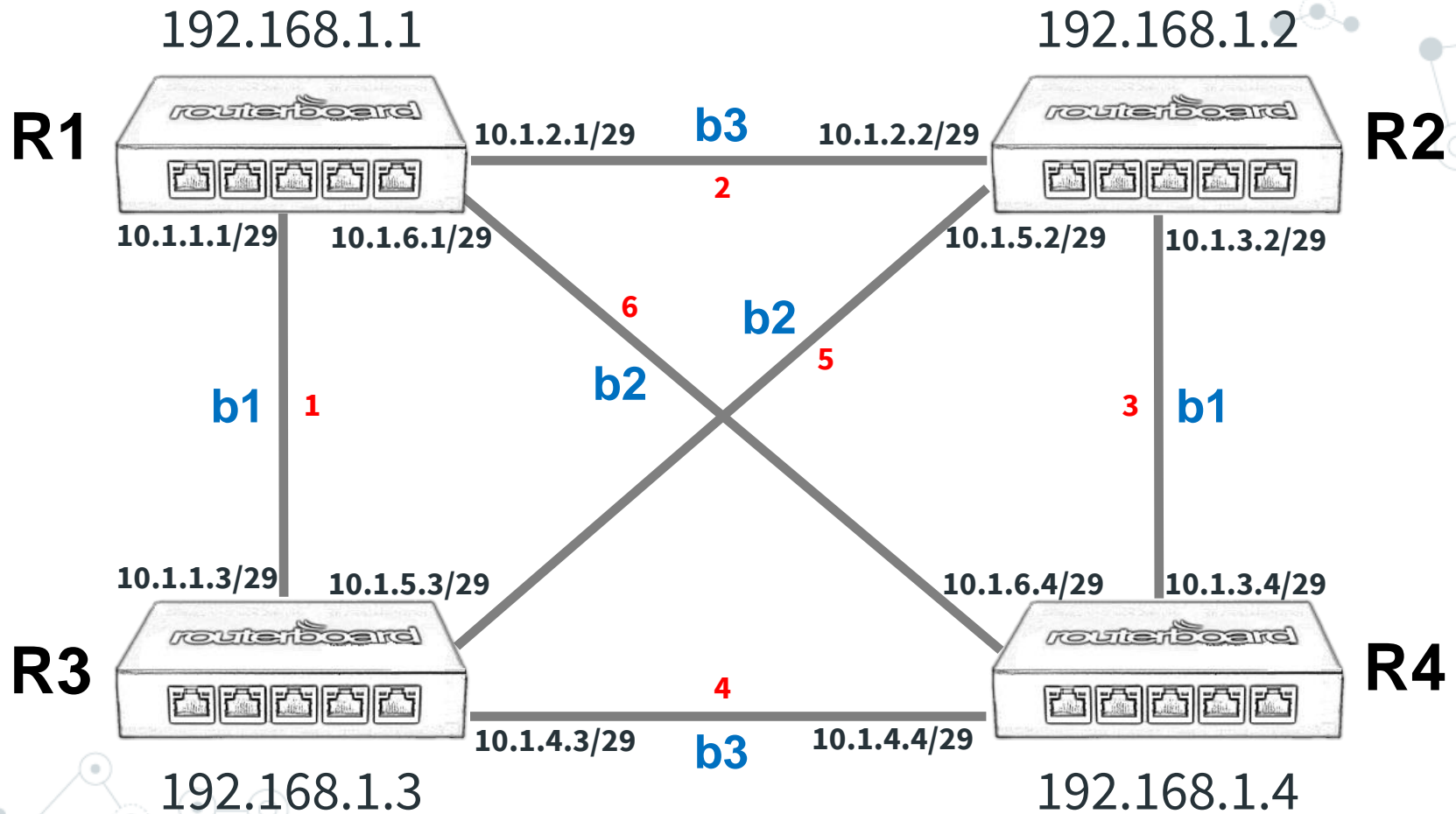




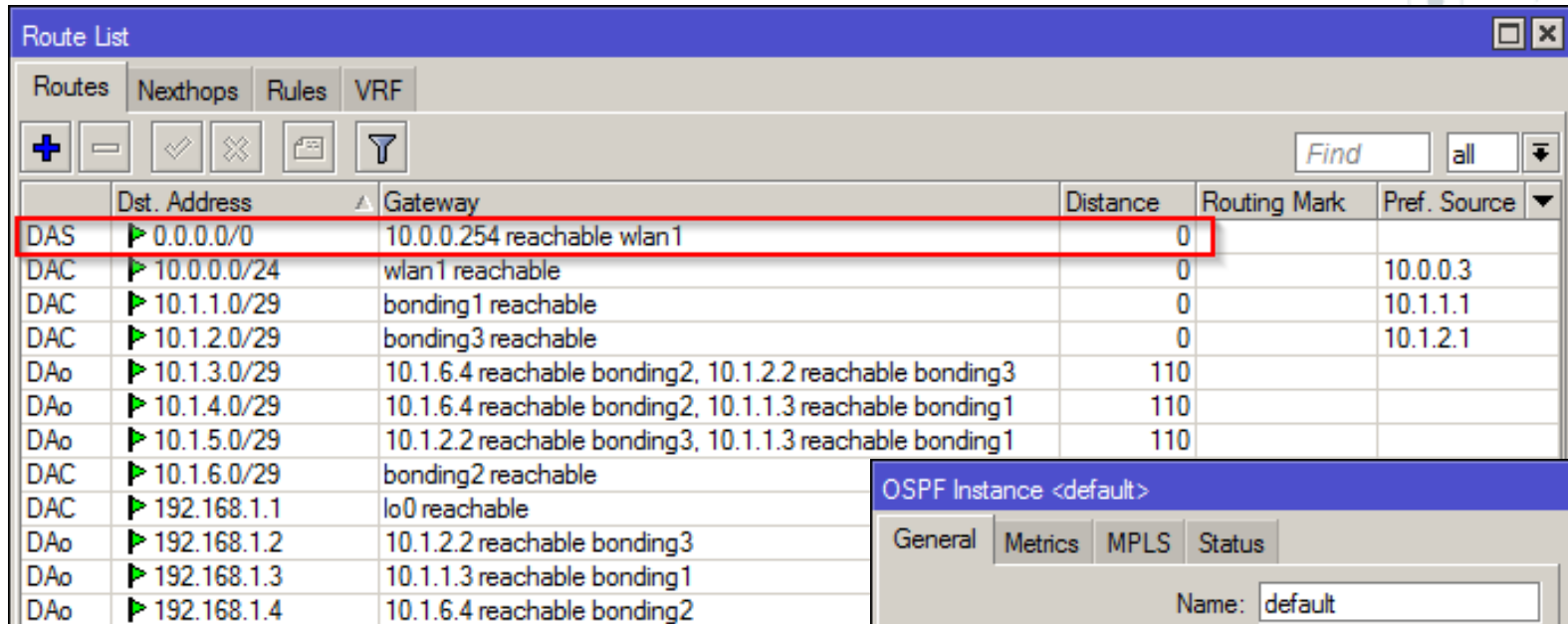
# Into this simplified network



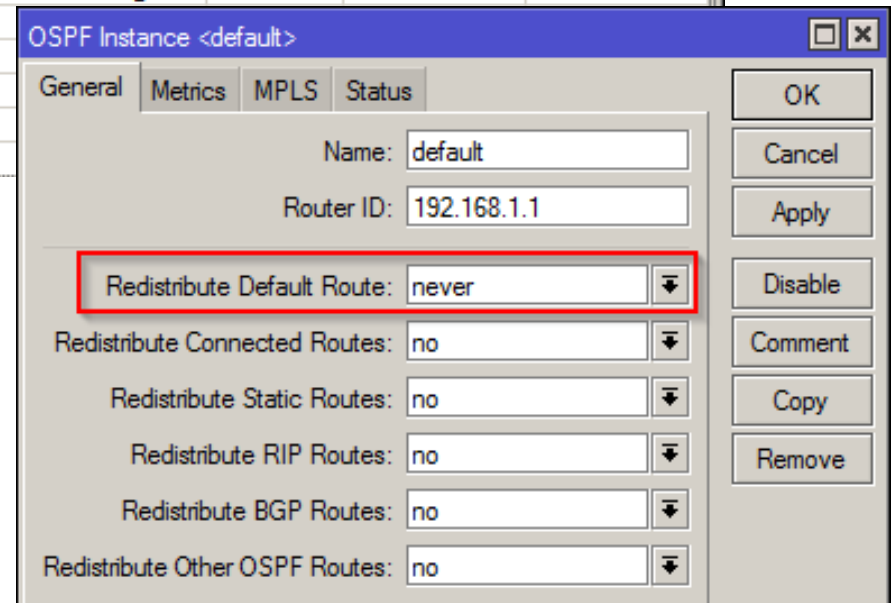
# The rest remains the same



# First things first (R1 default route)



	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
DAS	0.0.0.0/0	10.0.0.254 reachable wlan1	0		
DAC	10.0.0.0/24	wlan1 reachable	0		10.0.0.3
DAC	10.1.1.0/29	bonding1 reachable	0		10.1.1.1
DAC	10.1.2.0/29	bonding3 reachable	0		10.1.2.1
DAo	10.1.3.0/29	10.1.6.4 reachable bonding2, 10.1.2.2 reachable bonding3	110		
DAo	10.1.4.0/29	10.1.6.4 reachable bonding2, 10.1.1.3 reachable bonding1	110		
DAo	10.1.5.0/29	10.1.2.2 reachable bonding3, 10.1.1.3 reachable bonding1	110		
DAC	10.1.6.0/29	bonding2 reachable			
DAC	192.168.1.1	lo0 reachable			
DAo	192.168.1.2	10.1.2.2 reachable bonding3			
DAo	192.168.1.3	10.1.1.3 reachable bonding1			
DAo	192.168.1.4	10.1.6.4 reachable bonding2			



OSPF Instance <default>

General Metrics MPLS Status

Name: default

Router ID: 192.168.1.1

Redistribute Default Route: never

Redistribute Connected Routes: no

Redistribute Static Routes: no

Redistribute RIP Routes: no

Redistribute BGP Routes: no

Redistribute Other OSPF Routes: no

OK Cancel Apply Disable Comment Copy Remove

Do the same for **R2**  
on non-simplified  
setups

# R3 & Customer setup

**Route List**

	Dst. Address	Gateway
DAo	192.168.1.4	10.1.4.4 reachable bonding3
DAC	192.168.1.3	lo0 reachable
DAo	192.168.1.2	10.1.5.2 reachable bonding2
DAo	192.168.1.1	10.1.1.1 reachable bonding1
<b>DAC</b>	<b>172.16.0.0/24</b>	<b>ether5 reachable</b>
DAo	10.1.6.0/29	10.1.4.4 reachable bonding3, 10.1.1.1
DAC	10.1.5.0/29	bonding2 reachable
DAC	10.1.4.0/29	bonding3 reachable
DAo	10.1.3.0/29	10.1.5.2 reachable bonding2, 10.1.4.4
DAo	10.1.2.0/29	10.1.5.2 reachable bonding2, 10.1.1.1
DAC	10.1.1.0/29	bonding1 reachable

**Address List**

Address	Network	Interface
10.1.1.3/29	10.1.1.0	bonding1
10.1.5.3/29	10.1.5.0	bonding2
10.1.4.3/29	10.1.4.0	bonding3
<b>172.16.0.1/24</b>	<b>172.16.0.0</b>	<b>ether5</b>
192.168.1.3	192.168.1.3	lo0

**R3**

## Customer equipment towards R3

**Route List**

	Dst. Address	Gateway
AS	0.0.0.0/0	172.16.0.1 reachable ether1
<b>DAC</b>	<b>172.16.0.0/24</b>	<b>ether1 reachable</b>
DAC	192.168.90.0/24	ether2 reachable

**Address List**

Address	Network	Interface	Pref. Source
172.16.0.2/24	172.16.0.0	ether1	172.16.0.2
192.168.90.1/24	192.168.90.0	ether2	192.168.90.1

# Preliminary MPLS TE over OSPF

The screenshot shows the OSPF configuration interface. The 'Instances' tab is selected, and the 'default' instance is highlighted in the table below. The 'MPLS' sub-tab is selected in the 'OSPF Instance <default>' dialog, and the 'MPLS TE Area' and 'MPLS TE Router ID' fields are highlighted with a red box.

Name	Router ID	Running
default	192.168.1.1	yes

OSPF Instance <default>

General Metrics **MPLS** Status

MPLS TE Area: backbone

MPLS TE Router ID: lo0

Routing Table:

OK  
Cancel  
Apply  
Disable

Do this for all 4 routers

# Setting up MPLS TE interfaces

The screenshot shows the configuration interface for MPLS Traffic Engineering. The left sidebar contains a navigation menu with 'MPLS' selected, and 'Traffic Eng' highlighted in red. The main window displays the 'Traffic Eng' configuration area, which includes a table of configured interfaces. A red arrow points to the '+' button used to add interfaces.

Interface	Bandwidth (bps)	TE Metric	Remaining Bw.
bonding1	1G	1	1000.0 Mbps
bonding2	1G	1	1000.0 Mbps
bonding3	1G	1	1000.0 Mbps

The 'TE Interface <bonding1>' dialog box is open, showing the following configuration:

- Interface: bonding1
- Bandwidth: 1G bps
- K Factor: 3
- Resource Class: 0 Hex
- Refresh Time: 30.000
- Use UDP

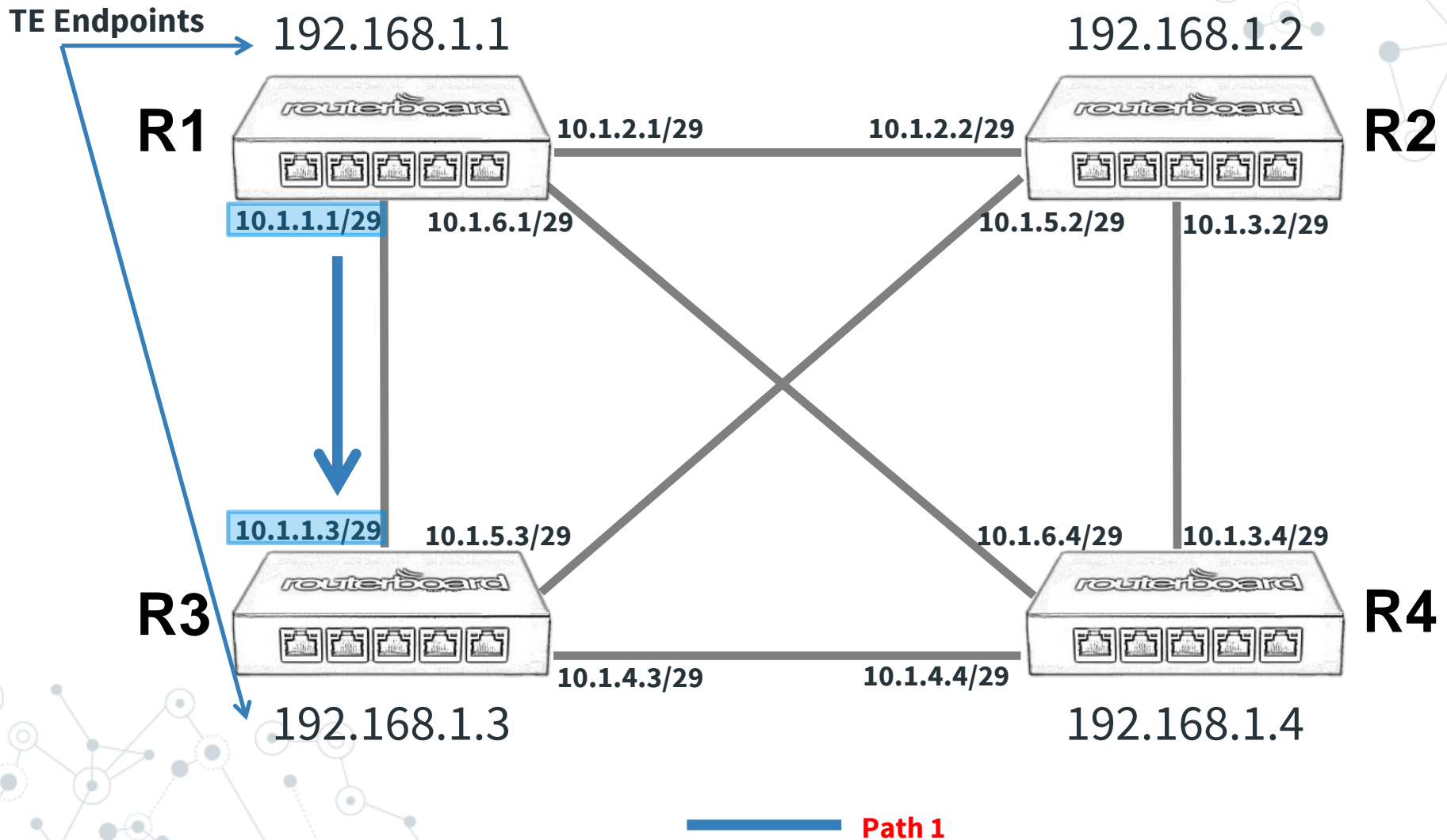
Add each bonding interface to TE on all 4 routers

# TE tunnels are unidirectional

We need to set up paths in both directions

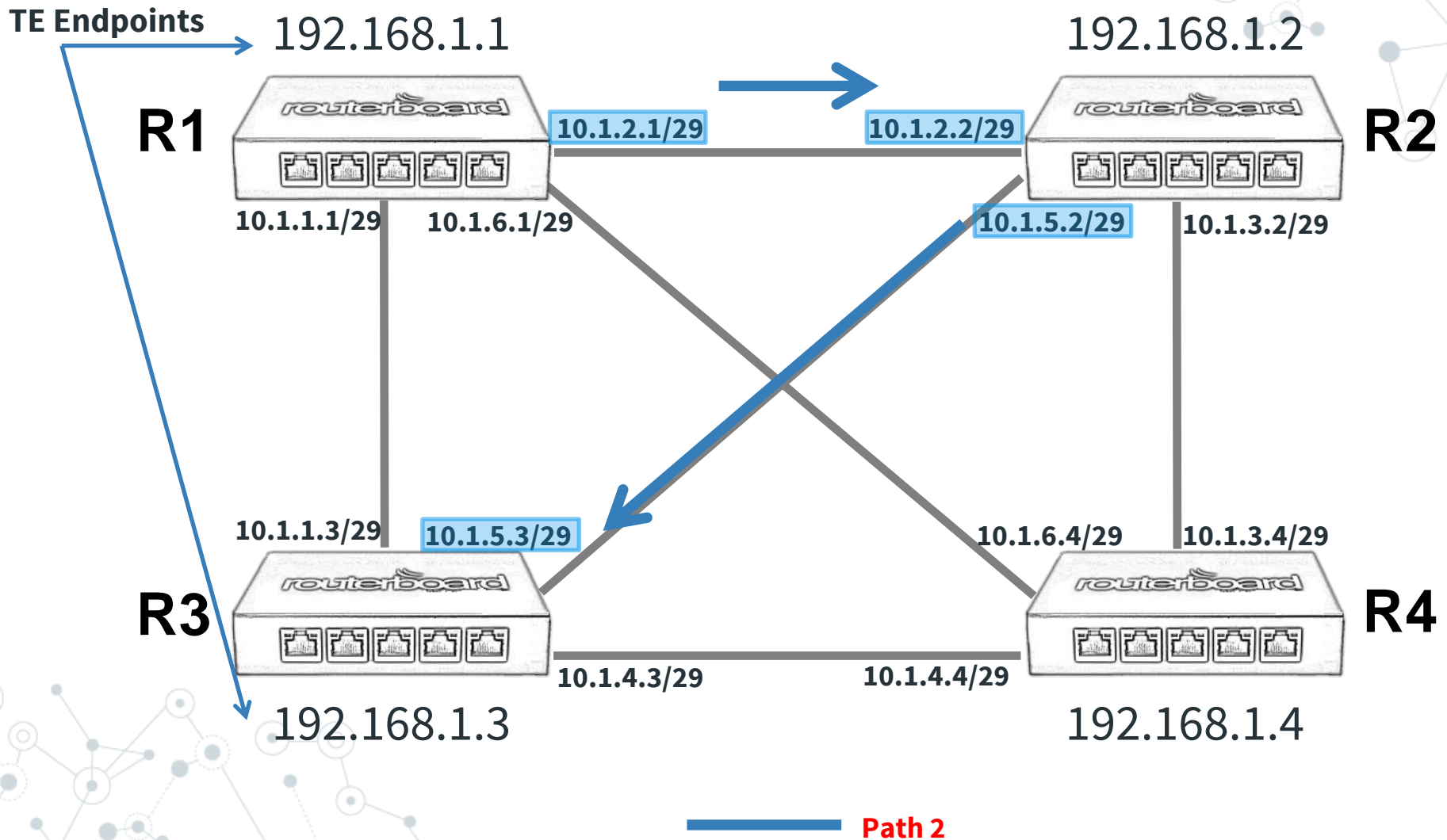


# Possible paths from R1 to R3

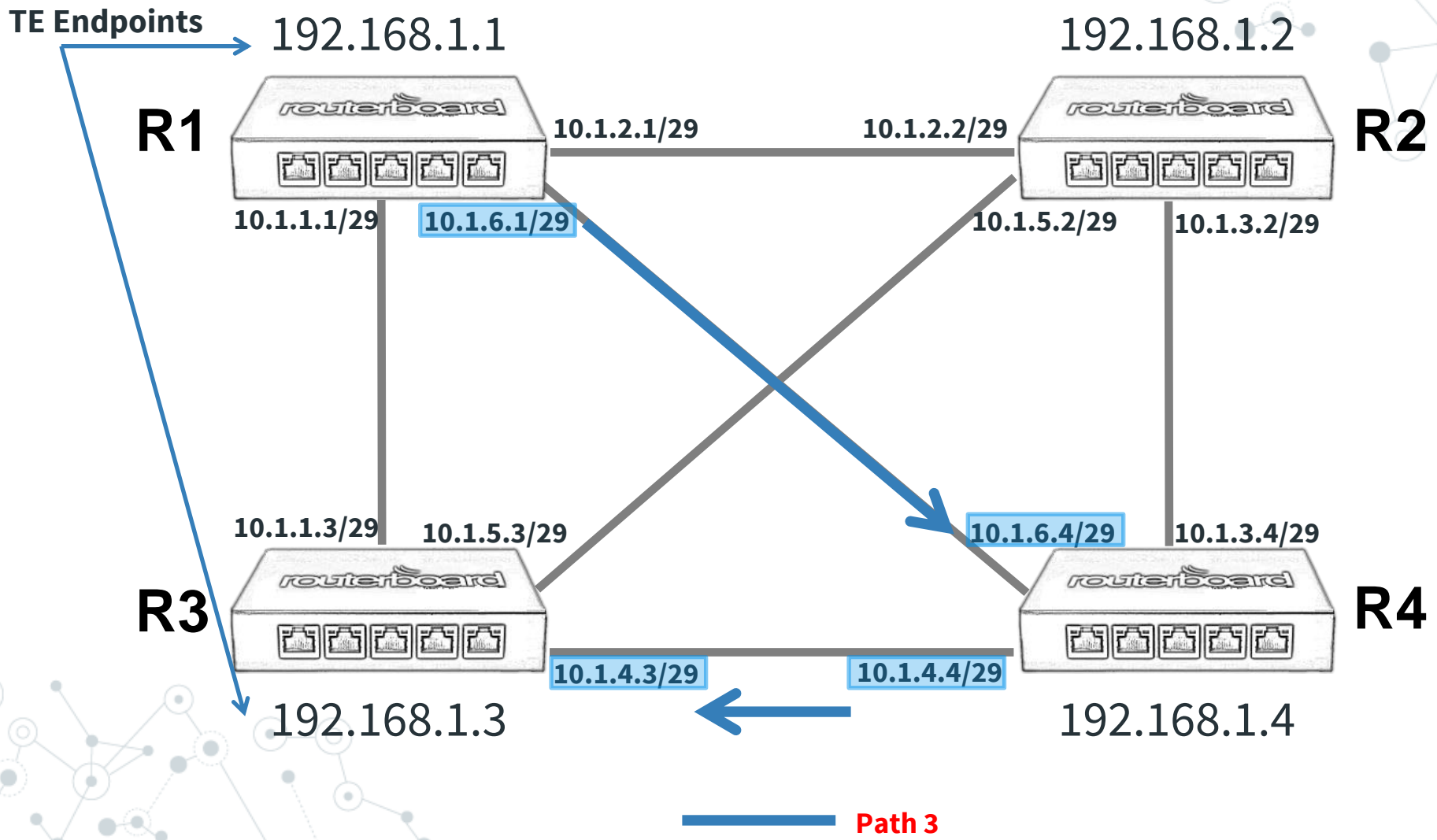




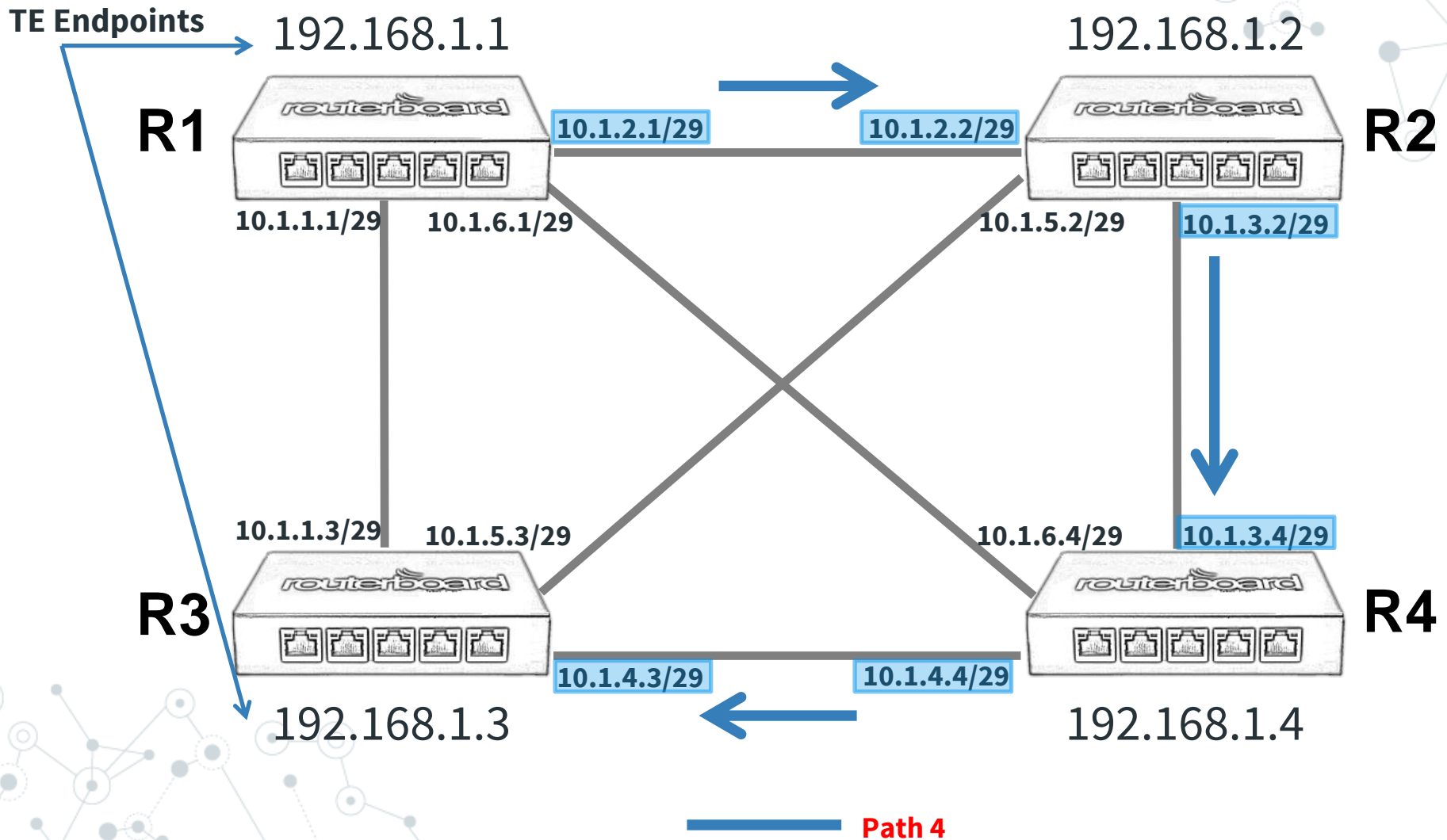
# Possible paths from R1 to R3



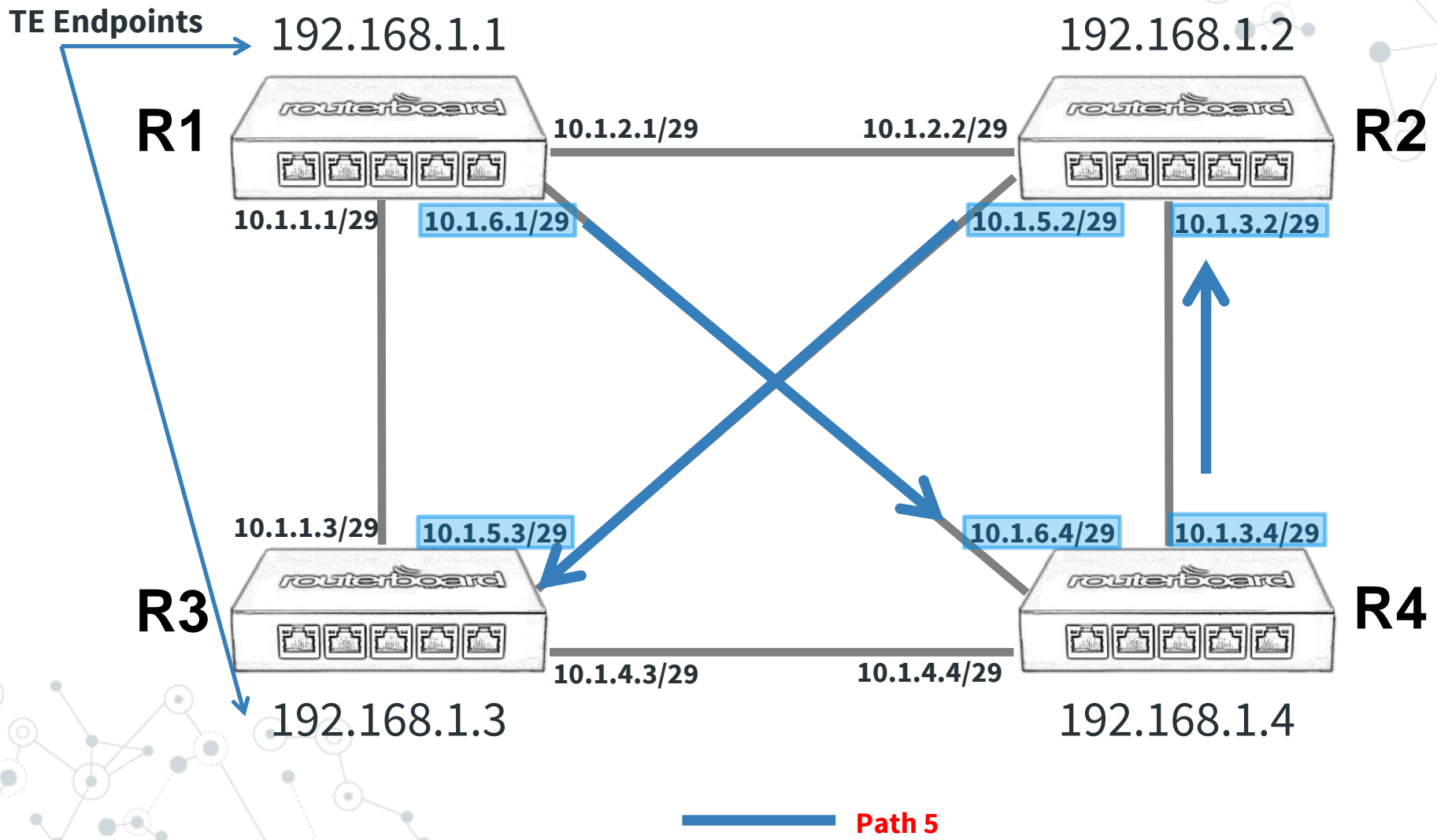
# Possible paths from R1 to R3



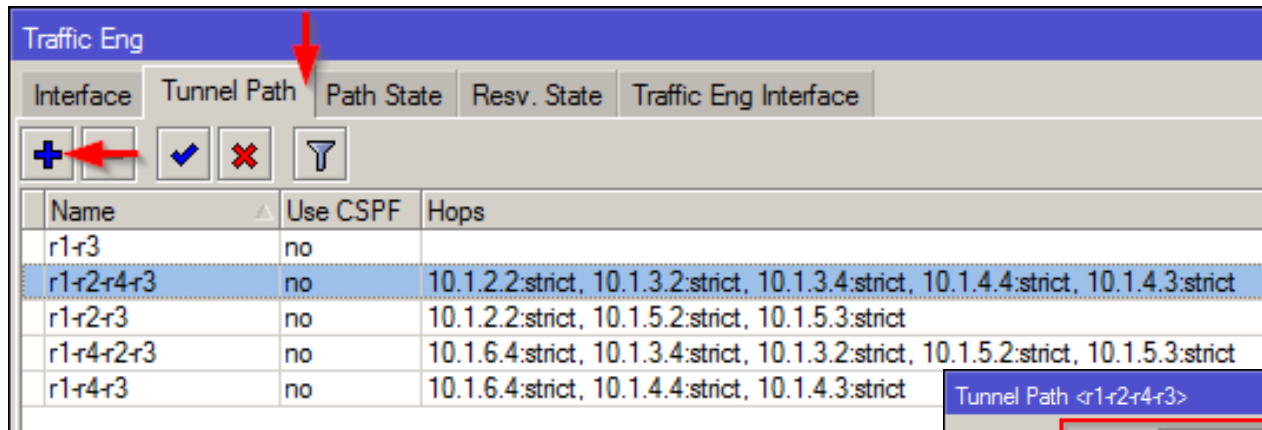
# Possible paths from R1 to R3







# Possible paths from R1 to R3



# Set up TE unidirectional paths on R1

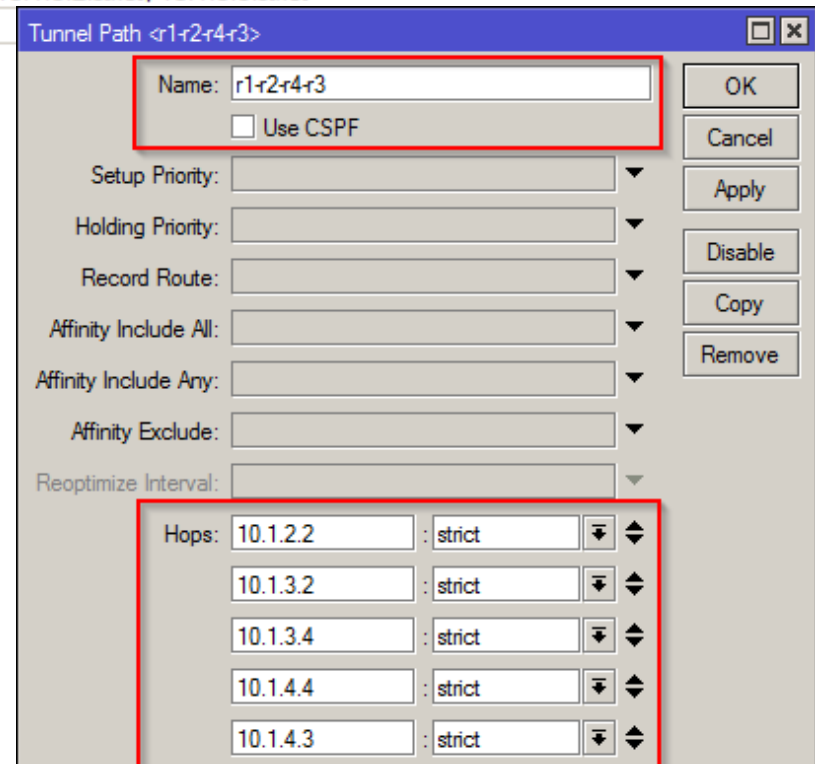


Interface	Tunnel Path	Path State	Resv. State	Traffic Eng Interface
				
Name	Use CSPF	Hops		
r1-r3	no			
r1-r2-r4-r3	no	10.1.2.2:strict, 10.1.3.2:strict, 10.1.3.4:strict, 10.1.4.4:strict, 10.1.4.3:strict		
r1-r2-r3	no	10.1.2.2:strict, 10.1.5.2:strict, 10.1.5.3:strict		
r1-r4-r2-r3	no	10.1.6.4:strict, 10.1.3.4:strict, 10.1.3.2:strict, 10.1.5.2:strict, 10.1.5.3:strict		
r1-r4-r3	no	10.1.6.4:strict, 10.1.4.4:strict, 10.1.4.3:strict		

Add all possible paths

Add *strict next-hops* as well as the *strict* local

Pref-src towards the next *next-hop*



Tunnel Path <r1-r2-r4-r3>

Name: r1-r2-r4-r3

Use CSPF

Setup Priority:

Holding Priority:

Record Route:

Affinity Include All:

Affinity Include Any:

Affinity Exclude:

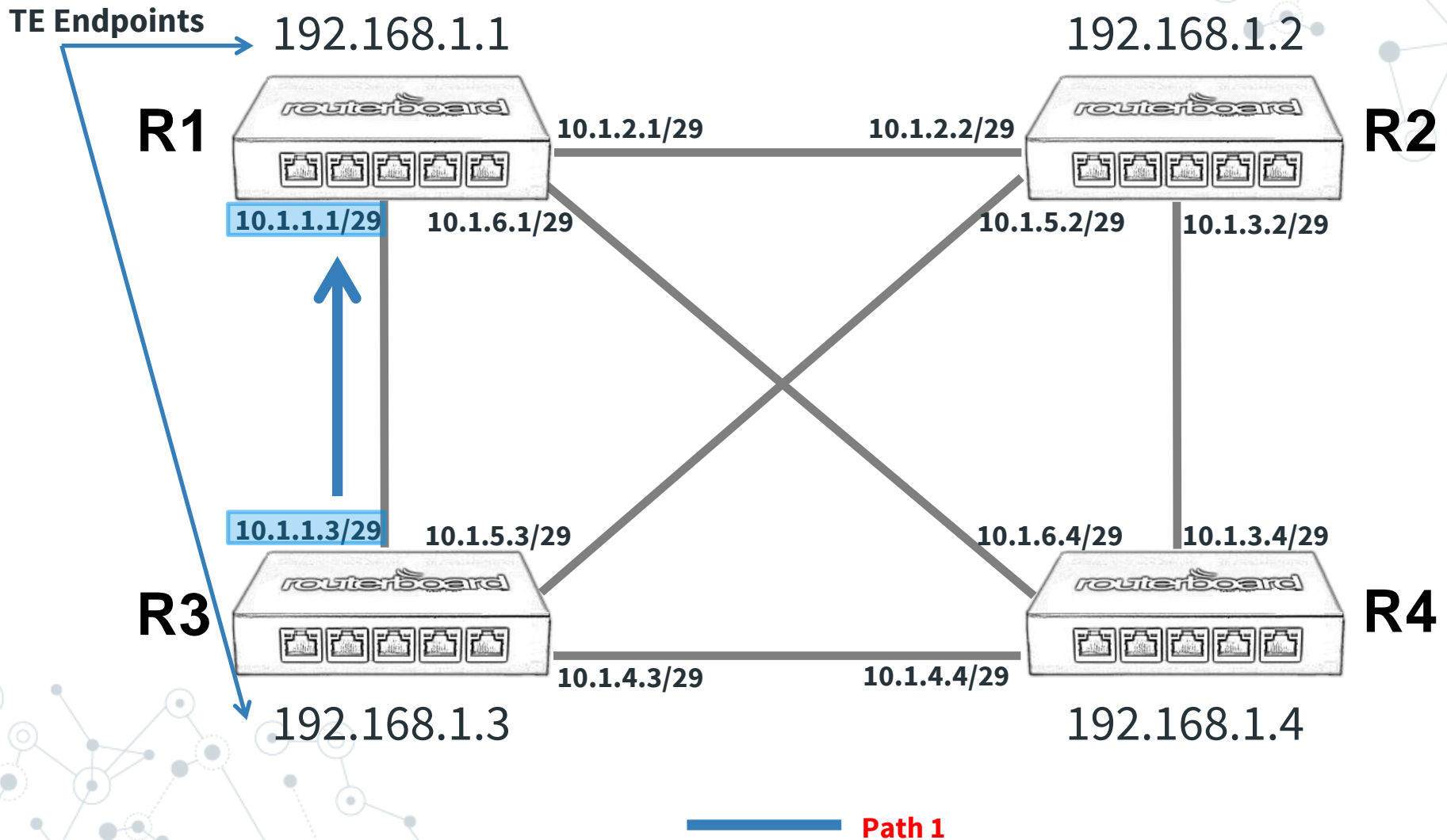
Reoptimize Interval:

Hops:

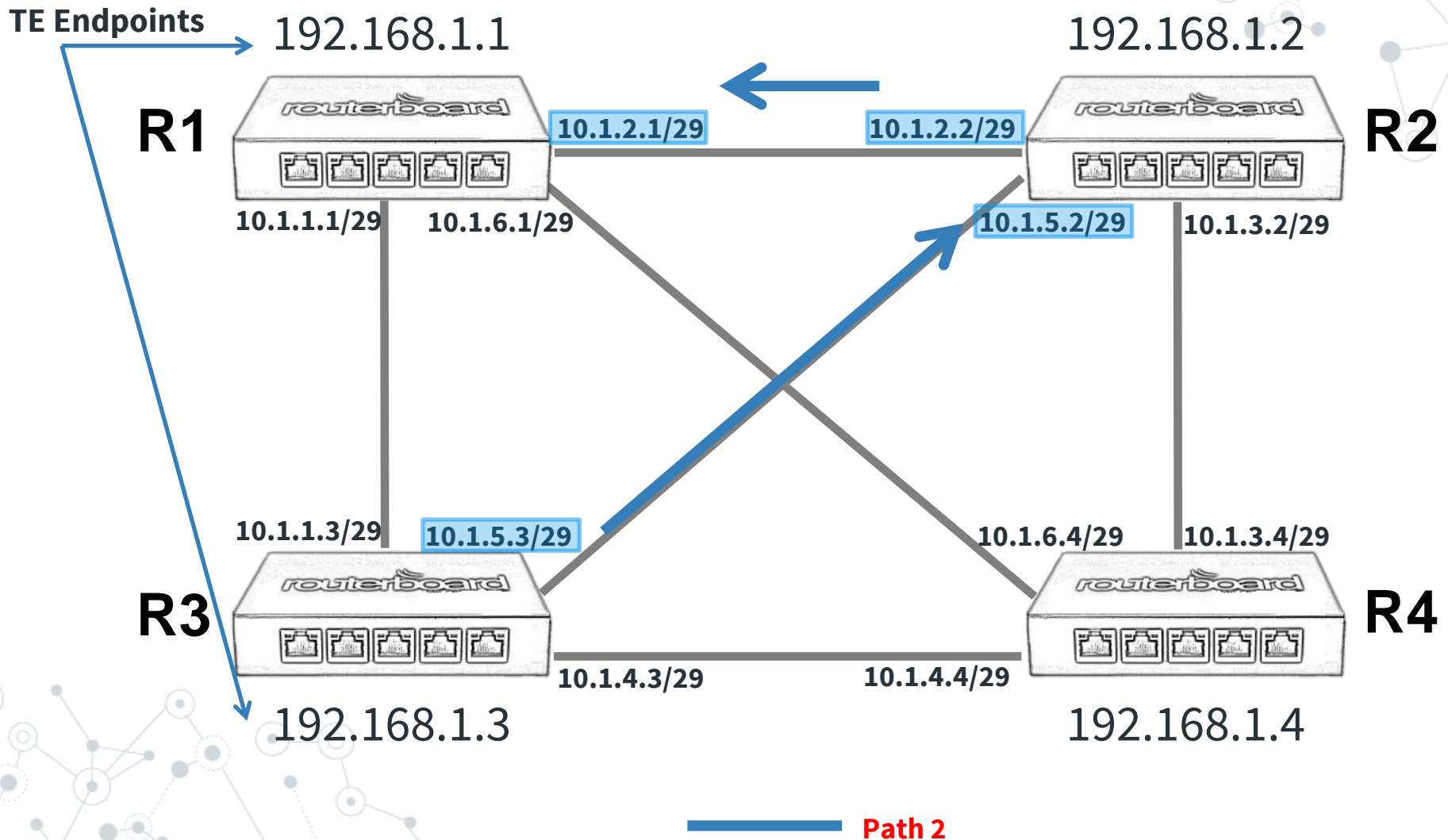
10.1.2.2	: strict	⌵ ⌴
10.1.3.2	: strict	⌵ ⌴
10.1.3.4	: strict	⌵ ⌴
10.1.4.4	: strict	⌵ ⌴
10.1.4.3	: strict	⌵ ⌴

OK Cancel Apply Disable Copy Remove

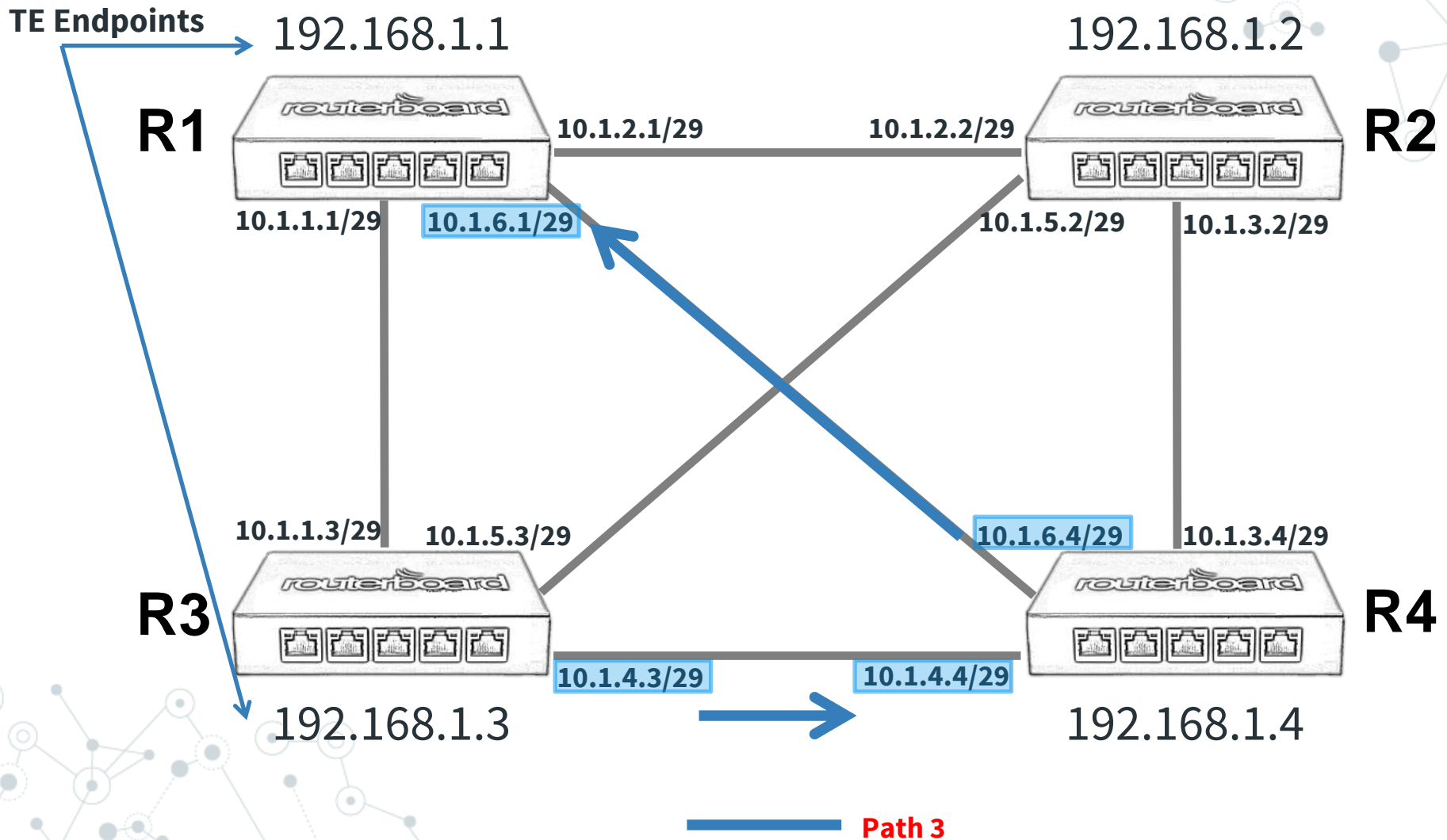
# Possible paths from R3 to R1



# Possible paths from R3 to R1

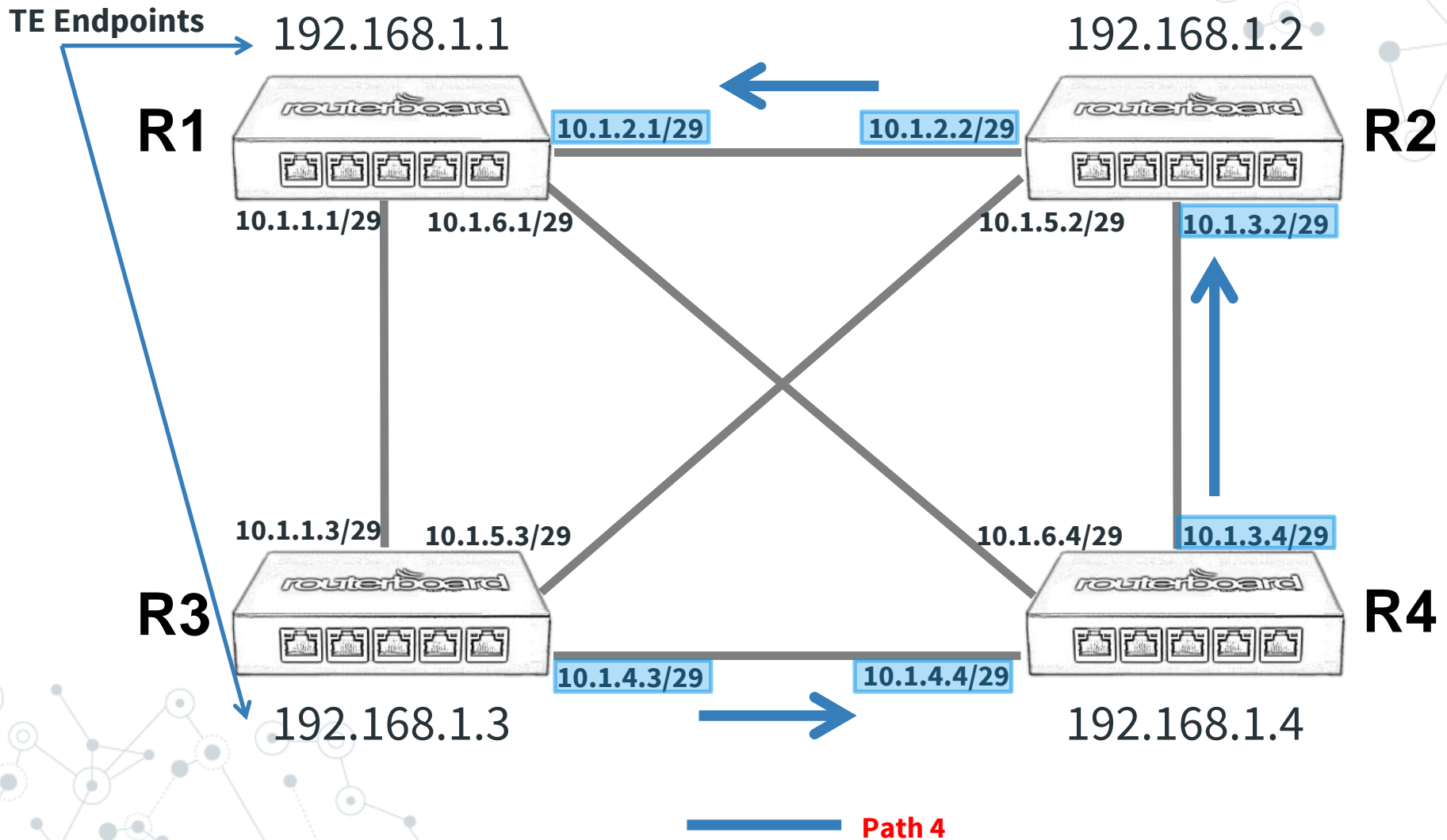


# Possible paths from R3 to R1

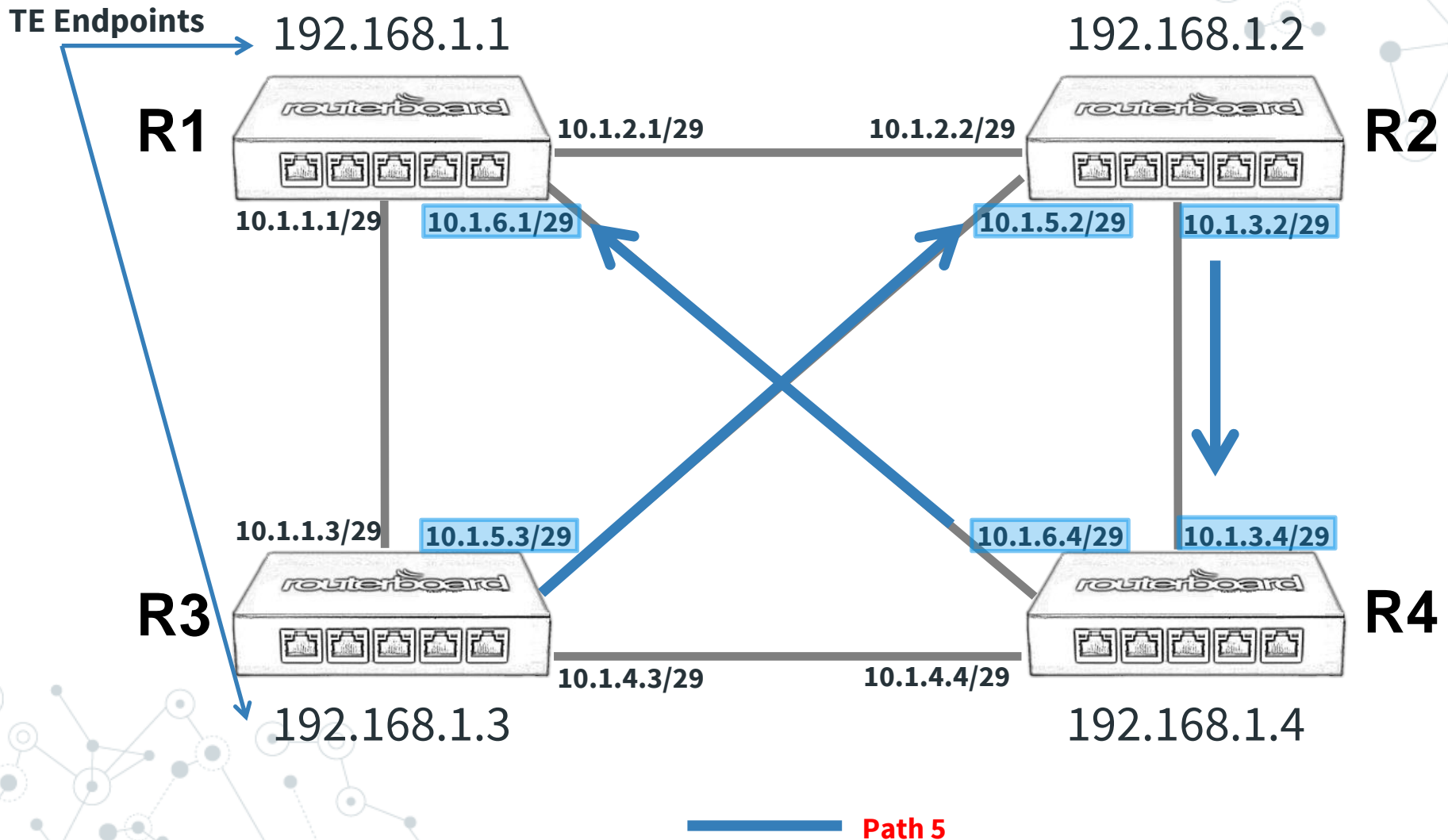




# Possible paths from R3 to R1



# Possible paths from R3 to R1



# Set up TE unidirectional paths on R3

Traffic Eng		
Interface	Tunnel Path	Path State
		Resv. State
		Traffic Eng Interface
+ - ✓ ✗ ⏏		
Name	Use CSPF	Hops
r3-r1	no	
r3-r2-r1	no	10.1.5.2:strict, 10.1.2.2:strict, 10.1.2.1:strict
r3-r2-r4-r1	no	10.1.5.2:strict, 10.1.3.2:strict, 10.1.3.4:strict, 10.1.6.4:strict, 10.1.6.1:strict
r3-r4-r1	no	10.1.4.4:strict, 10.1.6.4:strict, 10.1.6.1:strict
r3-r4-r2-r1	no	10.1.4.4:strict, 10.1.3.4:strict, 10.1.3.2:strict, 10.1.2.2:strict, 10.1.2.1:strict

Repeat the exact setup  
as on **R1**

Tunnel Path <r3-r2-r1>

Name: r3-r2-r1  
 Use CSPF

Setup Priority:

Holding Priority:

Record Route:

Affinity Include All:

Affinity Include Any:

Affinity Exclude:

Reoptimize Interval:

Hops: 10.1.5.2 : strict  
10.1.2.2 : strict  
10.1.2.1 : strict

OK  
Cancel  
Apply  
Disable  
Copy  
Remove

# Set up TE tunnel on R1

Traffic Eng

Interface Tunnel Path Path State Resv. State Traffic Eng Interface

+ - ✓ ✗ 📄 🗑️

	Name	Type	L2 MTU	Tx
R	↔ traffic-eng-downstream-r3	Traffic Eng Interface	65535	

Interface <traffic-eng-downstream-r3>

General TE Bandwidth Status Status Traffic

Name: traffic-eng-downstream-r3

Type: Traffic Eng Interface

MTU: 1500

L2 MTU: 65535

From Address: 192.168.1.1

To Address: 192.168.1.3

Bandwidth: 250M

Primary Path: r1-r3

Secondary Paths: r1-r2-r3

r1-r4-r3

r1-r2-r4-r3

r1-r4-r2-r3

OK Cancel Apply Disable Comment Copy Remove Torch

Interface <traffic-eng-downstream-r3>

General TE Bandwidth Status Status Traffic

Primary Retry Interval: 00:01:00

Setup Priority:

Holding Priority:

Record Route:

Affinity Include All:

Affinity Include Any:

Affinity Exclude:

Reoptimize Interval: 00:00:05

OK Cancel Apply Disable Comment Copy Remove Torch

# Set up TE tunnel on R3

Traffic Eng

Interface	Tunnel Path	Path State	Resv. State	Traffic Eng Interface
R	↔ traffic-eng-upstream-r1			

Table with 5 columns: Interface, Tunnel Path, Path State, Resv. State, Traffic Eng Interface. Row 1: R, ↔ traffic-eng-upstream-r1, Path State, Resv. State, Traffic Eng Interface.

Interface <traffic-eng-upstream-r1>

General | TE | Bandwidth | Status | Status | Traffic

Name: traffic-eng-upstream-r1

Type: Traffic Eng Interface

MTU: 1500

L2 MTU: 65535

From Address: 192.168.1.3

To Address: 192.168.1.1

Bandwidth: 250M

Primary Path: r3-r1

Secondary Paths: r3-r2-r1, r3-r4-r1, r3-r4-r2-r1, r3-r2-r4-r1

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove, Torch

Interface <traffic-eng-upstream-r1>

General | TE | Bandwidth | Status | Status | Traffic

Primary Retry Interval: 00:01:00

Setup Priority: [dropdown]

Holding Priority: [dropdown]

Record Route:

Affinity Include All: [dropdown]

Affinity Include Any: [dropdown]

Affinity Exclude: [dropdown]

Reoptimize Interval: 00:00:05

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove, Torch

# TE effects on R3

Traffic Eng

Interface	Tunnel Path	Path State	Resv. State	Traffic Eng Interface
+	-	✓	✗	⌵
Interface	Bandwidth (bps)	TE Metric	Remaining Bw.	
bonding1	1G	1	750.0 Mbps	
bonding2	1G	1	1000.0 Mbps	
bonding3	1G	1	1000.0 Mbps	

Traffic Eng

Interface	Tunnel Path	Path State	Resv. State	Traffic Eng Interface	
⌵					
	Src.	Dst.	Bandwidth	Out Interface	Out Next Hop
ER	192.168.1.1:1	192.168.1.3:4	250.0 Mbps		
LFP	192.168.1.3:1	192.168.1.1:18	250.0 Mbps	bonding1	10.1.1.1

# R1 routing (download traffic)

The screenshot displays a network configuration interface. The top window, titled "Route List", shows a table of routes. The bottom window, titled "Route <172.16.0.0/24>", shows the configuration for the selected route. A red box highlights the "Dst. Address" and "Gateway" fields in the bottom window.

	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
DAo	192.168.1.4	10.1.6.4 reachable bonding2	110		
DAo	192.168.1.3	10.1.1.3 reachable bonding1	110		
DAo	192.168.1.2	10.1.2.2 reachable bonding3	110		
DAC	192.168.1.1	lo0 reachable	0		192.168.1.1
AS	172.16.0.0/24	traffic-eng-downstream-r3 reachable	1		
DAC	10.1.6.0/29				
DAo	10.1.5.0/29				
DAo	10.1.4.0/29				
DAo	10.1.3.0/29				
DAC	10.1.2.0/29				
DAC	10.1.1.0/29				
DAC	10.0.0.0/24				
DAS	0.0.0.0/0				

Route <172.16.0.0/24>

General Attributes

Dst. Address: 172.16.0.0/24

Gateway: traffic-eng-downstream-r3 reachable

Check Gateway: [ ]

Type: unicast

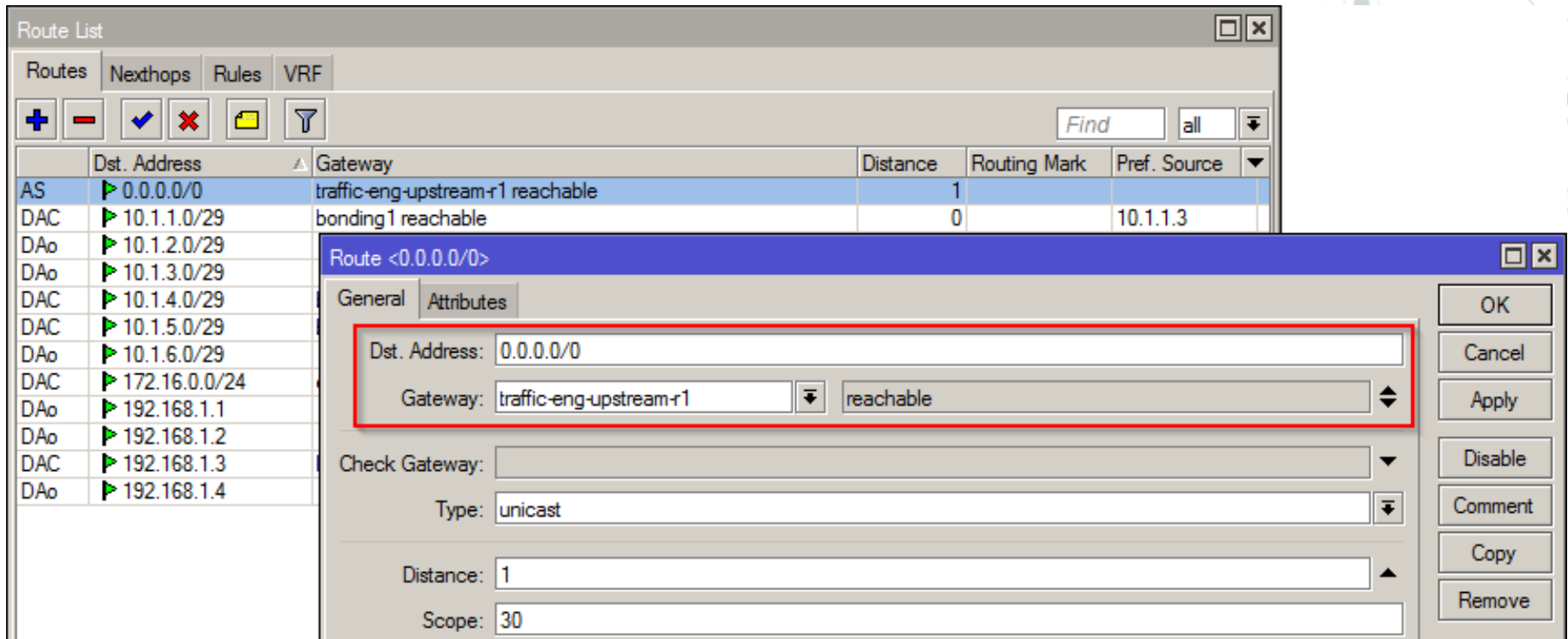
Distance: 1

Scope: 30

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove

From **R1** push the traffic for 172.16.0.0/24 through the TE tunnel

# R3 routing (upload traffic)



The screenshot displays a network configuration interface. The main window is titled "Route List" and contains a table of routes. The table has columns for "Dst. Address", "Gateway", "Distance", "Routing Mark", and "Pref. Source". The first row is highlighted in blue and shows the route for "AS" with a destination address of "0.0.0.0/0" and a gateway of "traffic-eng-upstream-r1 reachable" at a distance of 1. Below the table, a detailed view of the selected route is shown in a separate window titled "Route <0.0.0.0/0>". This window has two tabs: "General" and "Attributes". The "General" tab is active, and a red box highlights the "Dst. Address" field (set to "0.0.0.0/0") and the "Gateway" field (set to "traffic-eng-upstream-r1" with a dropdown arrow and "reachable" with a double-headed arrow). Other fields in the "General" tab include "Check Gateway", "Type" (set to "unicast"), "Distance" (set to "1"), and "Scope" (set to "30"). On the right side of the "Route" window, there are several buttons: "OK", "Cancel", "Apply", "Disable", "Comment", "Copy", and "Remove".

	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
AS	0.0.0.0/0	traffic-eng-upstream-r1 reachable	1		
DAC	10.1.1.0/29	bonding1 reachable	0		10.1.1.3
DAo	10.1.2.0/29				
DAo	10.1.3.0/29				
DAC	10.1.4.0/29				
DAC	10.1.5.0/29				
DAo	10.1.6.0/29				
DAC	172.16.0.0/24				
DAo	192.168.1.1				
DAo	192.168.1.2				
DAC	192.168.1.3				
DAo	192.168.1.4				

From **R3** push all traffic through the TE tunnel



## Final checks and test

- ⦿ Check if DNS is working on all routers
- ⦿ Check that MPLS TE opaque LSAs exist
- ⦿ Check if you need NAT on the border
  
- ⦿ Test if it's working from customer
  
- ⦿ Verify that tunnels are pushing traffic correctly (only TX) and that reservations are met on the bonding interfaces that have the active paths attached

# Customer test

```
Terminal
```

```
[admin@Management] > /tool traceroute mikrotik.com
```

#	ADDRESS	LOSS	SENT	LAST	AVG	BEST	WORST
1	172.16.0.1	0%	15	0.2ms	0.5	0.2	5.1
2	192.168.1.1	0%	15	0.3ms	0.4	0.2	1.5
3	10.0.0.254	0%	15	0.6ms	1.3	0.6	4.4
4	85.204.99.149	0%	15	5.4ms	6.5	5.4	11.1
5	81.183.1.104	0%	15	20.5ms	22	19.1	36.7
6	80.81.194.165	0%	15	68.9ms	71	68.3	75
7	195.13.224.86	0%	15	70.5ms	71.1	70.5	73
8	159.148.147.196	0%	14	68.2ms	69.4	68.2	71.8

```
-- [Q quit|D dump|C-z pause]
```

# R1 & R3 tunnels

Traffic Eng

Interface Tunnel Path Path State Resv. State Traffic Eng Interface

+ - ✓ ✗ [icon] [icon] Find

	Name	Type	L2 MTU	Tx	Tx Packet (p/s)	
R	traffic-eng-downstream-r3	Traffic Eng Interface	65535	3.2 kbps	7	

1 item out of 14

Traffic Eng

Interface Tunnel Path Path State Resv. State Traffic Eng Interface

+ - ✓ ✗ [icon] [icon] Find

	Name	Type	L2 MTU	Tx	Tx Packet (p/s)	
R	traffic-eng-upstream-r1	Traffic Eng Interface	65535	1568 bps	7	

1 item out of 8

A decorative network diagram in the top right corner, consisting of various sized circles (nodes) connected by thin lines (edges). Some nodes are solid grey, while others are white with a grey outline. The connections are a mix of solid and dashed lines.

# Thank you!

**Any questions?**

A decorative network diagram in the bottom left corner, similar to the one in the top right, featuring nodes of different sizes and styles connected by solid and dashed lines.



**Contact me**

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