

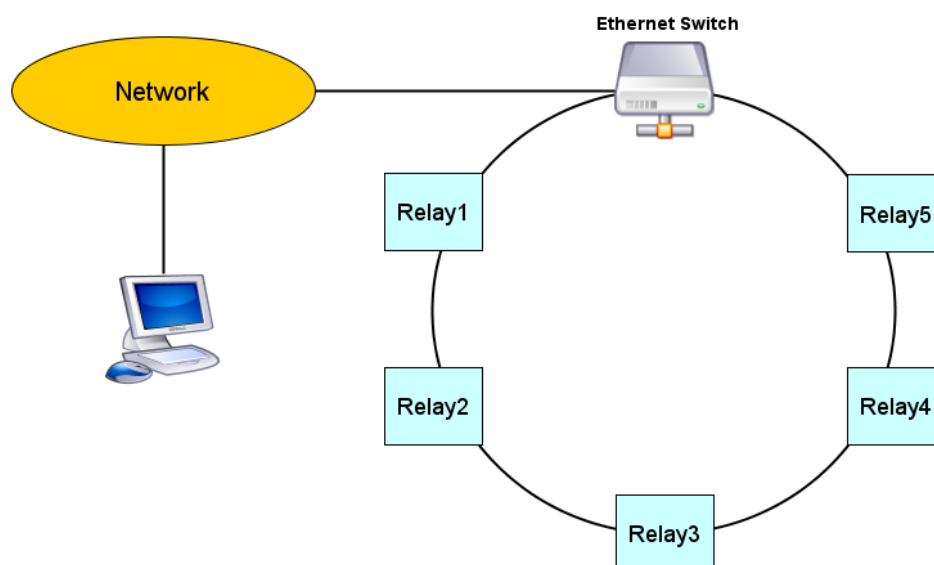
# Rapid Spanning Tree Protocol (RSTP) for dual port 100Mbps Ethernet interface in VAMP 2xx and VAMP 5x relay series

## Introduction

Spanning Tree Protocol (STP) is a link layer network protocol that prevents bridge loops and flooding in local networks with redundant connections. To ensure a loop-free topology RSTP disables some connections leaving single active path between any two devices. Each of these disabled connections can be used as a backup path in case of active connection failure. The former STP protocol has been superseded by RSTP – Rapid Spanning Tree Protocol, which is able to respond to topology changes faster than STP.

## Network topologies

Ring topology can be a cost effective solution for networks that are required to tolerate a single cable failure. To create a ring topology only one Ethernet Switch (with RSTP support) and n cables are needed, where n is the total number of devices in the ring (including Ethernet Switch).

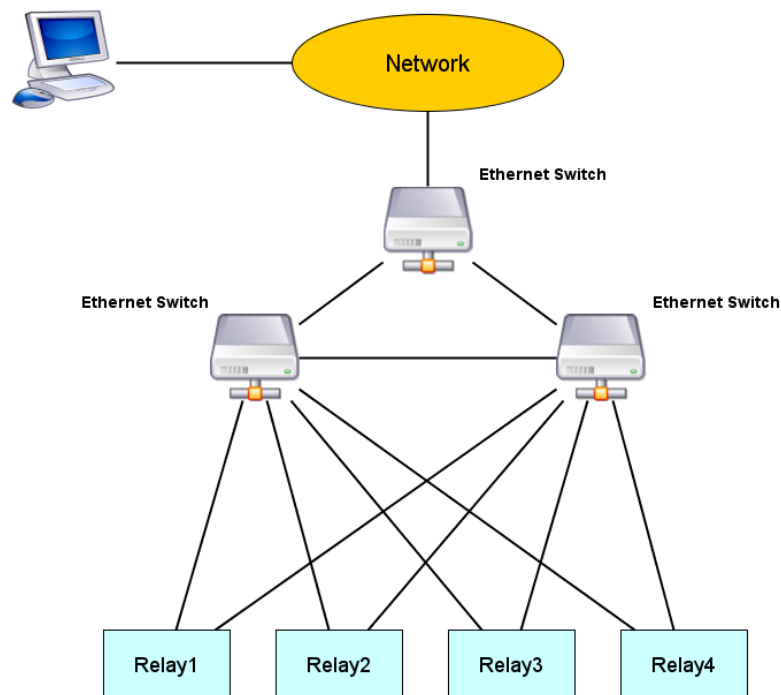


Remember that this topology has some drawbacks:

- increased delay for relays that are not connected directly to Ethernet Switch, this delay depends on device number between Ethernet Switch and chosen relay,
- increased network traffic through almost all relays,
- damage of two cables always creates an isolated subnetwork with at least one relay.

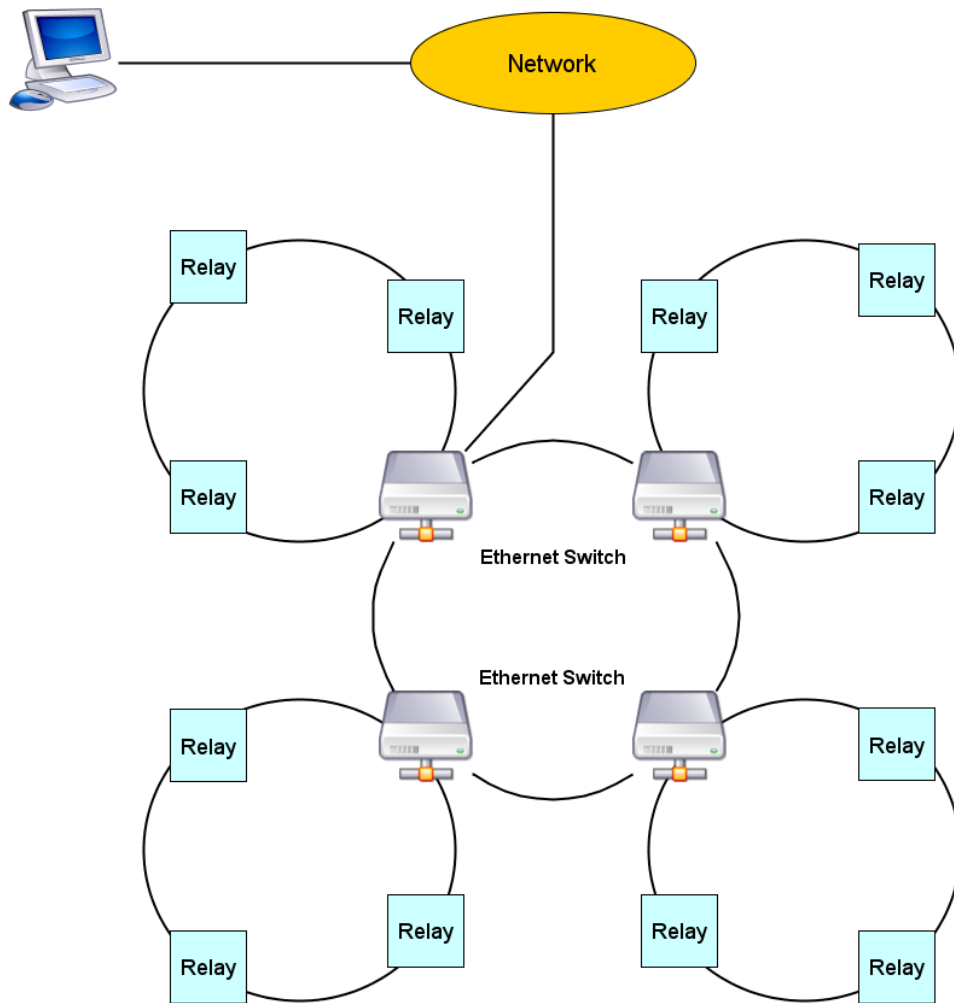
Because of the mentioned drawbacks, the number of relays that can be connected in this topology shall be limited.

Multiple star topology can be used instead of the ring topology to overcome these drawbacks. This configuration is more expensive than a ring topology - at least two or three Ethernet switches (all with RSTP support) and  $2*n+3$  cables are needed, where n is number of relays.



Note that in this topology a damage of two cables creates an isolated subnetwork only if both damaged cables are connected to the same relay and in this case only that relay is not accessible.

Because of ring topology limitations, another type of topology can be used instead if there is a large number of relays that need to be connected. This topology can be called "ring of rings" (see the diagram below). A set of Ethernet switches creates an inner ring. Each of Ethernet switches is also a part of an outer ring, which is created by relays.



There are some differences compared to a single ring topology:

- if a damage of two cables occurs in a single ring topology, in worst case all of the relays can be isolated; because in the "ring of rings" topology the outer rings are created by subsets of relays, it's not possible to loose connection to all devices in whole network – in worst case only the relays in one outer ring can become isolated (to loose connection to all devices 2 cables need to be damaged inside every outer ring),
- because outer rings are smaller than one single ring (with the same total number of relays in whole network), the delays are smaller and network traffic through relays is also smaller than in a single ring topology.

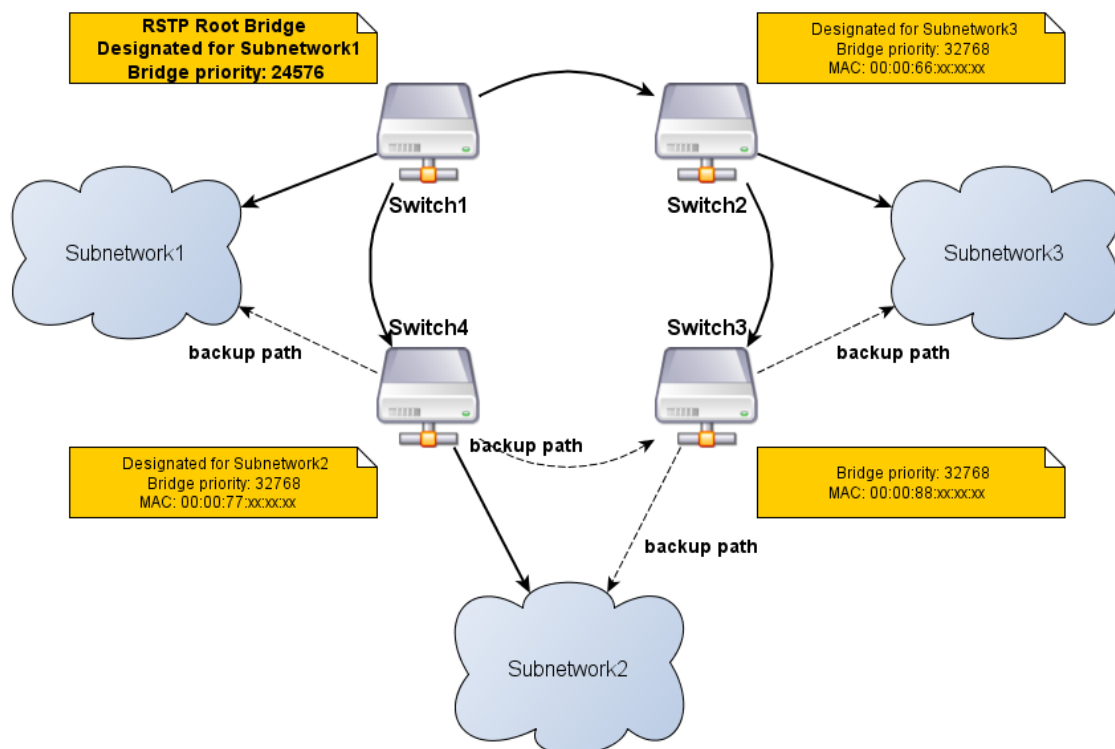
## RSTP parameters in Vampset

RSTP protocol can be enabled and configured under **RSTP PROTOCOL FOR ETHERNET** group on **PROTOCOL CONFIGURATION** tab in Vampset. This group is visible only for relays with dual port Ethernet interface.

RSTP PROTOCOL FOR ETHERNET		
Enable for RSTP	<input checked="" type="checkbox"/>	
Bridge priority	32768	
Hello time	2 s	
Forward delay	15 s	
Max Age	20 s	
Migrate time	3 s	
Protocol version	2	
	Port 1	Port 2
Port priority	128	128
Admin edge	No	No
Auto edge	No	No
Current state	Forwarding	Blocked

**Bridge priority** is taken into account during building and adjusting the spanning tree structure inside the network. The device with best Bridge priority (lowest value) becomes an **RSTP root device** for that network. If priorities of two or more devices are equal then the device with lowest MAC address is chosen as a root.

For each network segment, from all devices connecting this segment to the rest of the network, the device with best Bridge priority becomes a **designated device** for that network segment. It means that the whole network traffic between the Root and this segment of the network is being forwarded by this designated device. A simple topology explaining this matter is shown below.



**Hello time** setting defines how often RSTP frames (Hello BPDU) are sent. These frames are used for monitoring and announcing current status of connections, priority and MAC address of Root in the whole RSTP network, and parameters of that RSTP network (Hello time, Forward delay, Max Age).

**Forward delay** defines the time needed for the port to change its state from blocking to forwarding. Max Age is the time that every RSTP device should wait before starting to change the topology in case of not receiving Hello BPDU.

**Protocol version** set to 2 means that Vamp uses RSTP. It is a read only parameter – Vamp relays do not support the old STP protocol (version 1).

**Port priority** is important when both Ethernet ports are connected to the same network segment – in such a case the port with worse priority (higher value) is disabled as a backup path for that segment.

Setting **Admin edge** parameter to Yes informs the relay that on the given Ethernet port there is a device with single connection to the network and without RSTP protocol support. Setting **Auto edge** to Yes enables automatic discovering of edge device. Edge device is a device that has only one connection to the network and does not support RSTP protocol (if the whole network is considered as a graph, an edge device is a leaf element of that graph). Note that an edge port in the relay can change its state from blocking to forwarding immediately by skipping listening and learning states.

**Current state** of the port is a read-only parameter and can be set to one of following values: Blocked, Learning, Listening, Forwarding. Ethernet frames with user data can be sent or received by a port only if it is in Forwarding state. In all other states only sending and receiving of RSTP frames is possible on that port.

Note that three of the described parameters: Hello time, Forward delay and Max Age should have the same values set on every device inside the RSTP network.

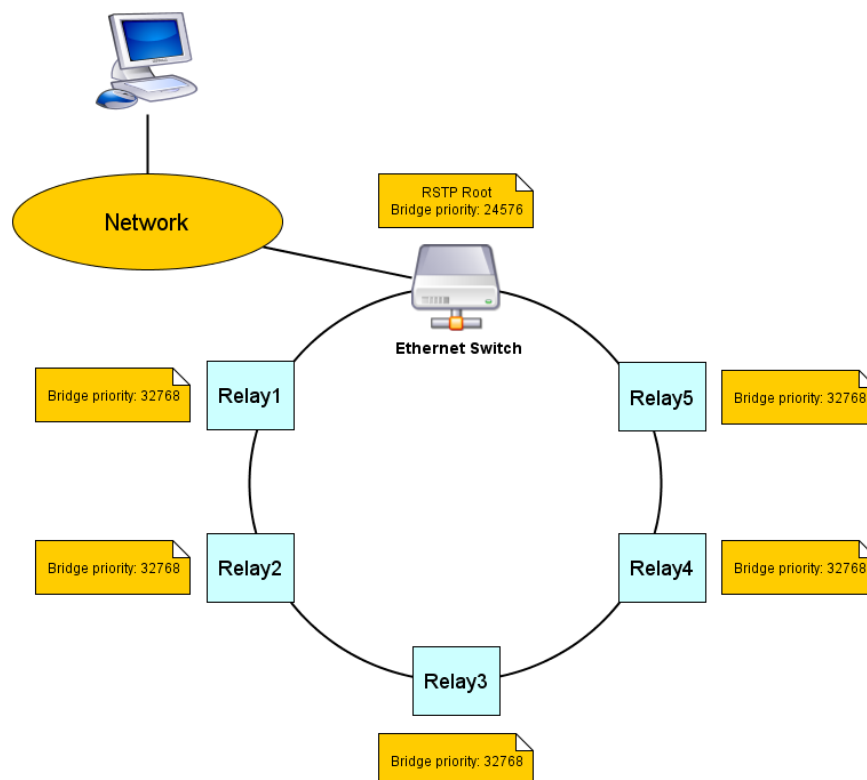
## Appendix: Topology configuration examples

Because the spanning tree is designed to ensure that all devices have single active connection to RSTP root and the distance between each device and the root (cost of the path to the bridge) is best possible, it is important to configure RSTP parameters correctly to achieve good results.

One device in RSTP network should have best bridge priority set to become the RSTP root. The best results could be obtained the best bridge priority is set to the device that works as an external traffic router for the RSTP network.

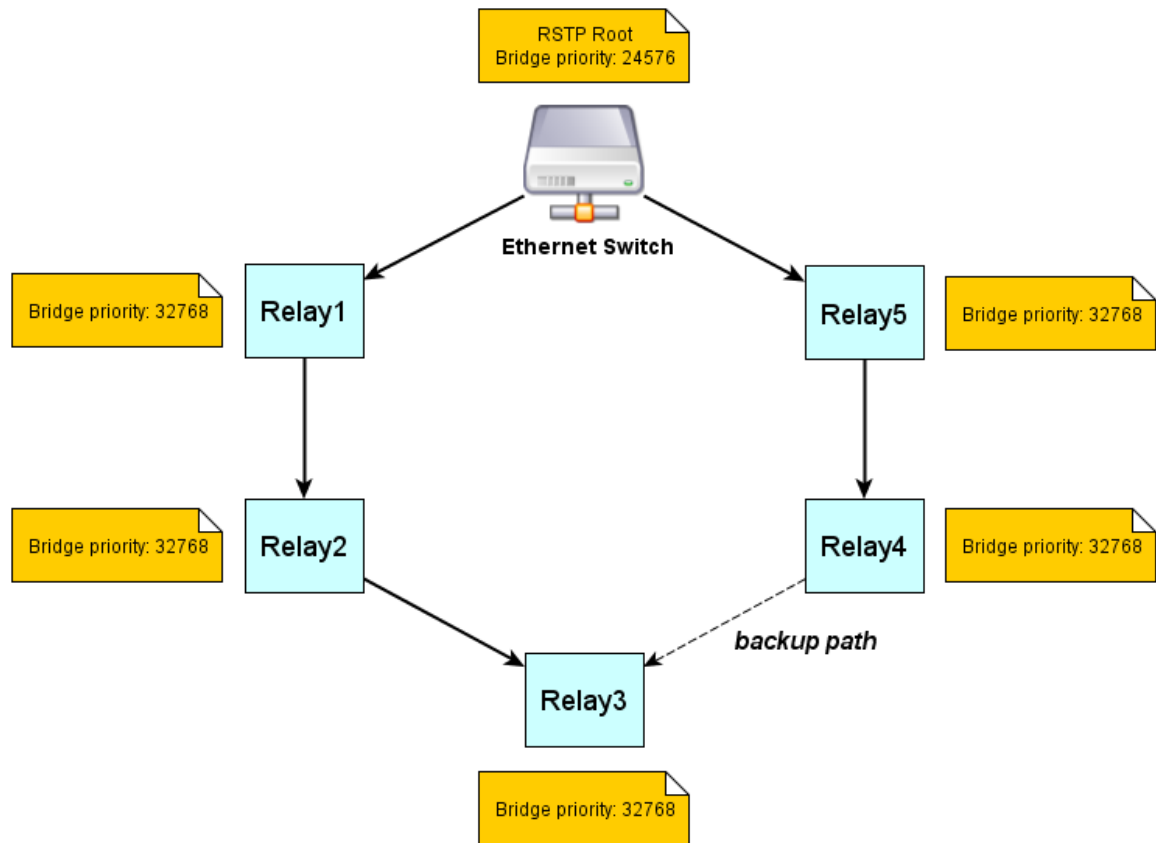
### Configuring ring topology

Consider a simple ring topology shown below.

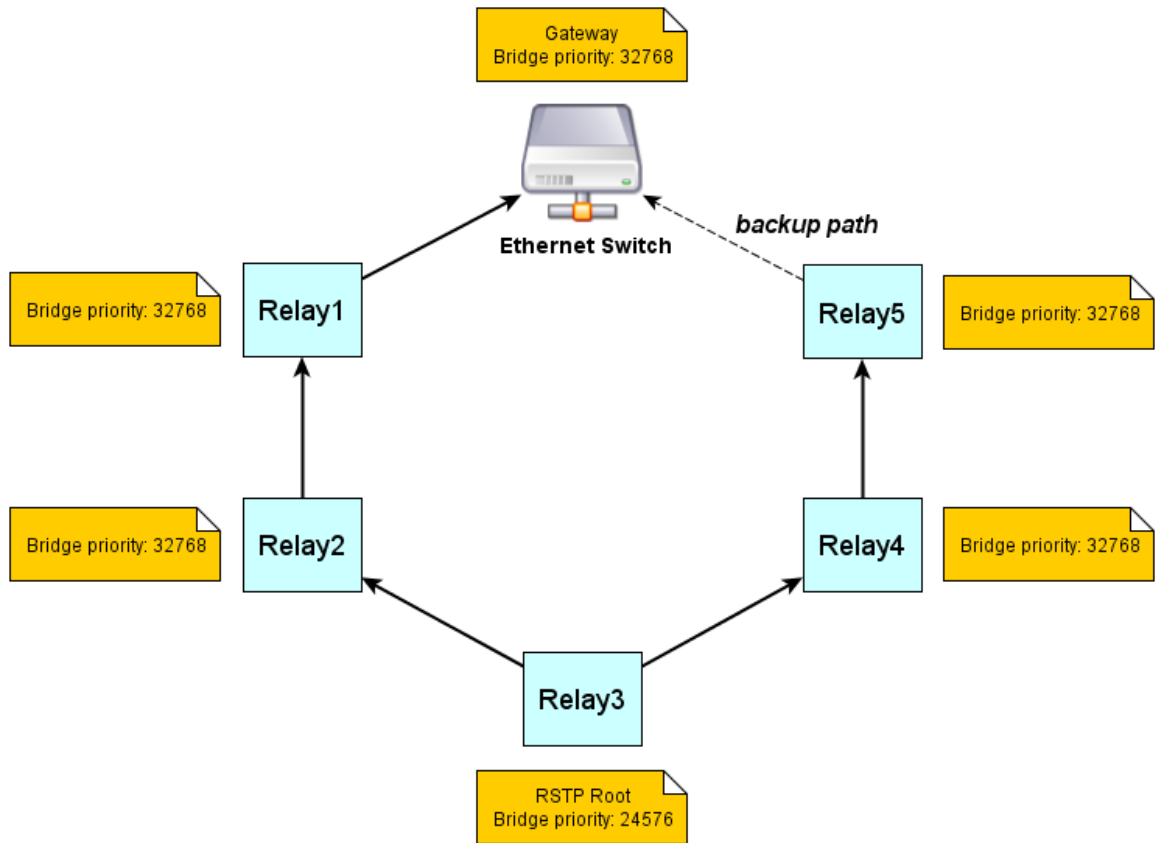


In the above example to obtain the best spanning tree topology (from an external PC point of view) the Ethernet Switch should be the root device, because it works as a router for that part of the network. This results in the spanning tree topology shown below (assuming that Relay2 has lower MAC address than Relay4). Relay3 has the longest path to the root – 3 connections. Because the root device also operates as an external traffic router, for Relay 3 we obtain also the

longest path to a device in that network. The connection marked as “backup path” is disabled by RSTP algorithm to avoid loop and flooding, so there is no network traffic (except RSTP Hello BPDU frames) between Relay3 and Relay4.

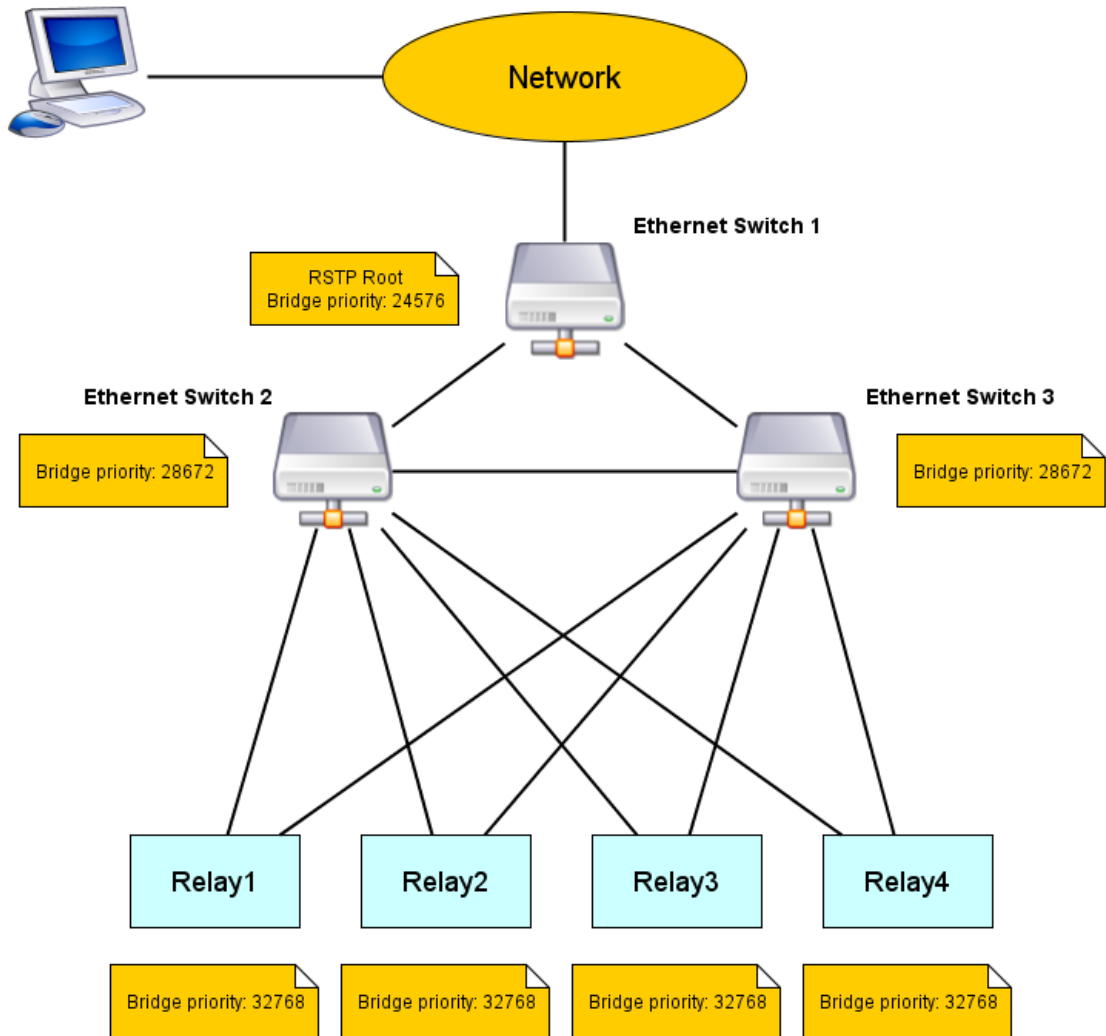


The worst case of the spanning tree topology will be when Relay3 is configured to be the root (has best bridge priority). The spanning tree topology for that configuration is shown below. In this case the longest path to the root is also 3 connections, but the longest path to device in that network is 5 connections, because an access to any device is possible only via the router. This results in an increased delay when the packet transmission occurs set between Relay5 or Relay4 and any device (PC) placed outside the RSTP network.

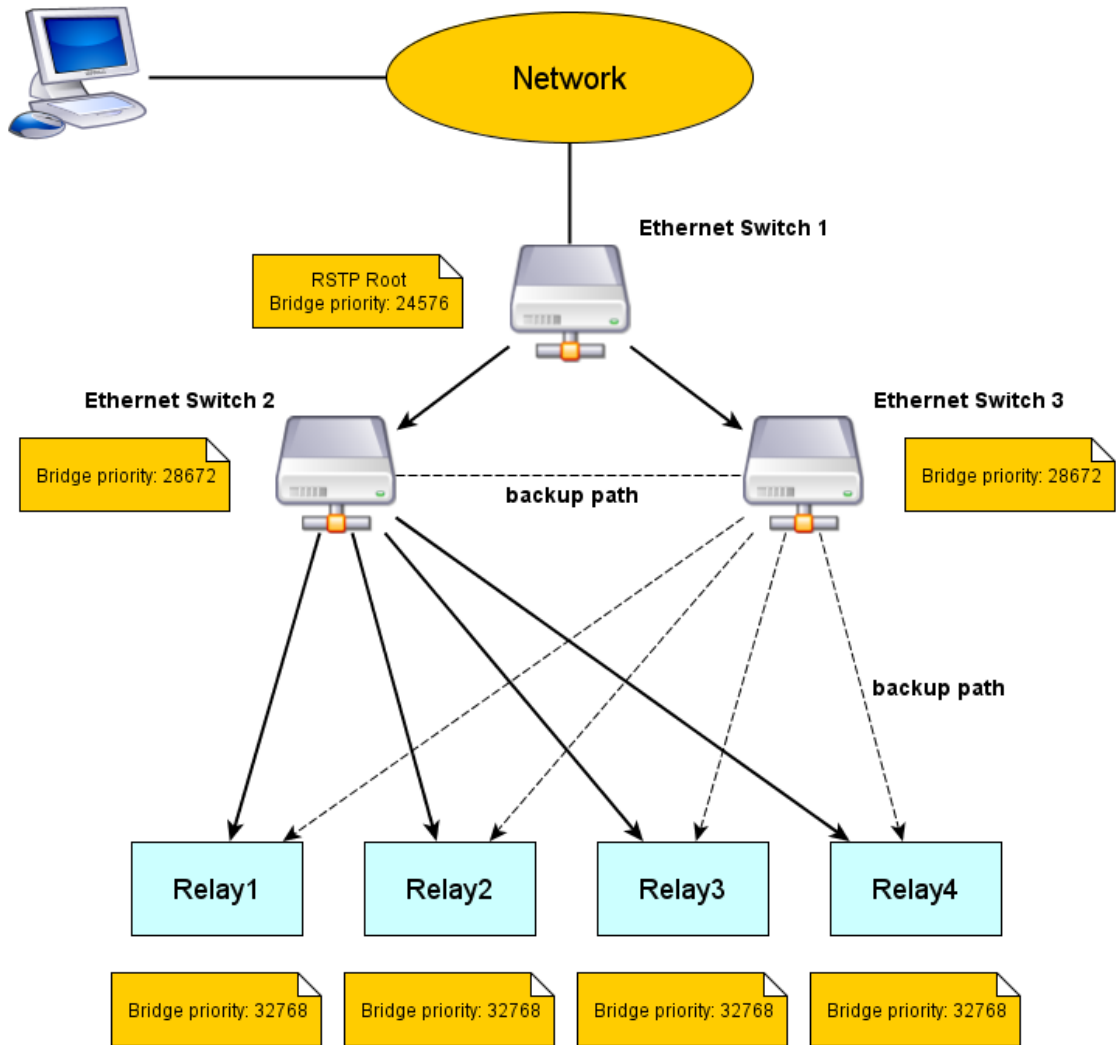


## Configuring multiple star topology

Consider a simple multiple star topology shown below.



In the above example, to obtain the best spanning tree topology (from an external PC point of view) the Ethernet Switch 1 should be the root device, because it works as a router for that part of the network. This results in the spanning tree topology shown below (assuming that Ethernet Switch 2 has lower MAC address than Ethernet Switch 3). All Relays have the same path cost to the root: 2 connections. The connections marked with dotted lines as “backup path” are disabled by RSTP algorithm to avoid loop and flooding, so there is no network traffic (except RSTP Hello BPDU frames) on those connections.



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