

A decorative background featuring a network diagram. It consists of numerous nodes, represented by circles of varying sizes and shades of gray, connected by thin, light gray lines. Some nodes are highlighted with a blue outline or a solid blue dot. The network is distributed across the slide, with a denser concentration on the left side and a more sparse arrangement on the right.

Network Layer

Routing within an AS - IGP

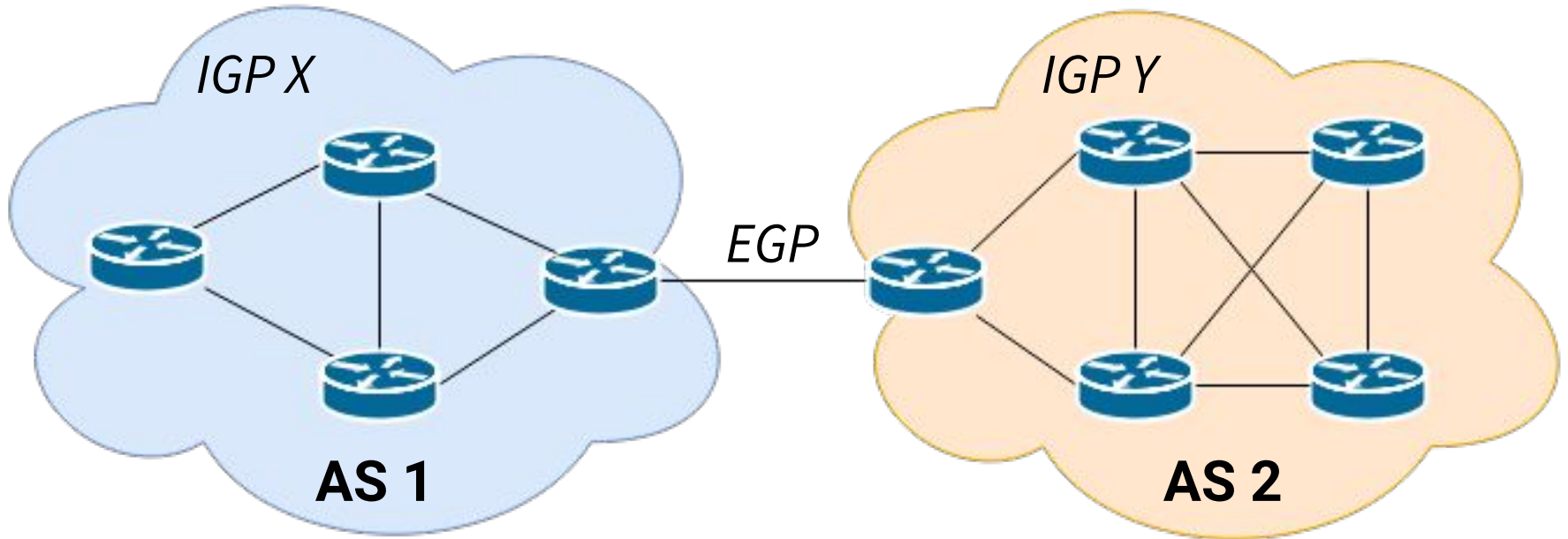
A decorative background featuring a network diagram with nodes and connecting lines, primarily located on the left and bottom right sides of the slide.

Contents !

- Introduction to IGP. How routing decisions are made?
- Dynamic routing. RIP
- Dynamic routing. OSPF
- Lab! OSPF with Docker and Quagga

What is an Autonomous System(AS) ?

One or more IP networks controlled by one or more operators with a **clear policy that governs how routing decisions are made.**

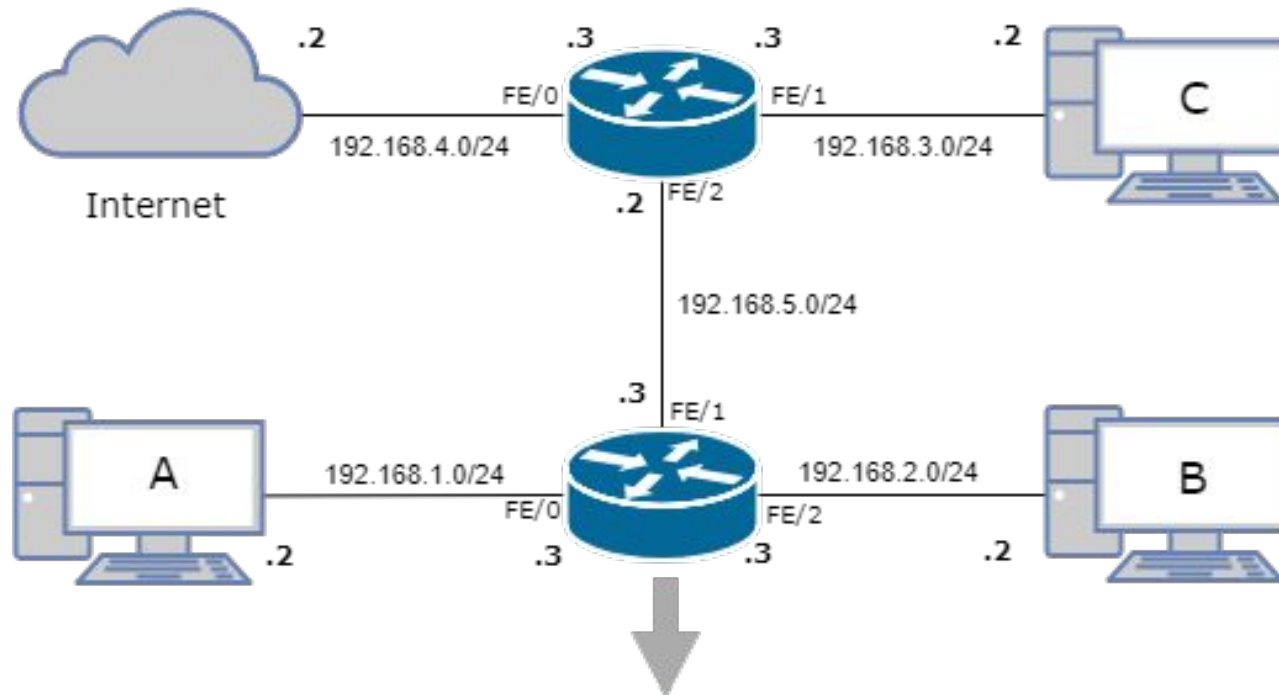


IGP: Interior gateway protocol

EGP: Exterior gateway protocol

How routing decisions are made?

Static Routing



D	192.168.1.0	255.255.255.0	FE/0	--
D	192.168.2.0	255.255.255.0	FE/2	--
D	192.168.5.0	255.255.255.0	FE/1	--
S	192.168.3.0	255.255.255.0	FE/2	192.168.5.2
S	0.0.0.0	0.0.0.0	FE/2	192.168.5.2

Static Routing Quiz! - Which rule is going to match ?

Source 192.168.2.5
Destination 192.168.1.6

1	S	192.168.1.0	/28	255.255.255.240
2	S	192.168.2.0	/29	255.255.255.248
3	S	192.168.1.0	/29	255.255.255.248
4	S	192.168.2.0	/30	255.255.255.252
5	S	192.168.1.0	/30	255.255.255.252

<https://www.menti.com/6a71d791>

Dynamic routing

- Responds faster on link failure
- Does not rely on human intervention

Dynamic routing algorithms



Link State (centralized)

- Each node computes the least cost path using complete knowledge of the network.
- **OSPF, ISIS**

Distance Vector (decentralized)

- Each node maintains a vector with estimates of the costs to all other nodes.
- A node gradually calculates the least-cost path to a destination.
- **RIP, BGP**

RIP - Routing Information Protocol

Behaviour

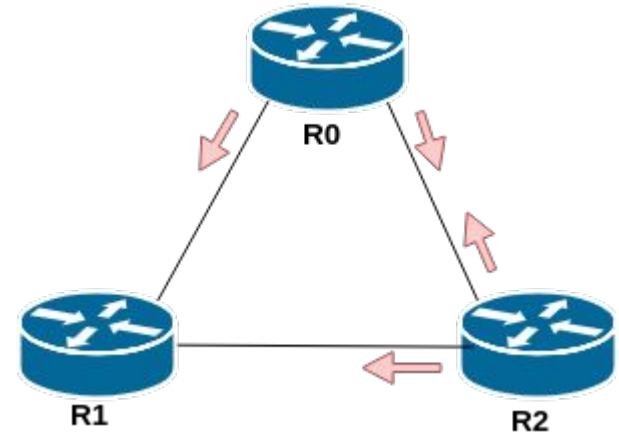
- Route Advertisements are sent periodically (30sec)
- Advertised information is used to discover the best routes

Metrics

- Are used to measure the distance to a given network
- Based on hops, incremented by 1 before advertisement is forwarded
- Hop limit: 15

Versions

- RIPv1: uses broadcast in route updates
- RIPv2: uses multicast in route updates
- RIPng: next generation, for IPv6



- **Active participants(R0, R2):** advertise their routes
- **Passive participants(R1):** just listen to RIP messages and update their forwarding table

Problems

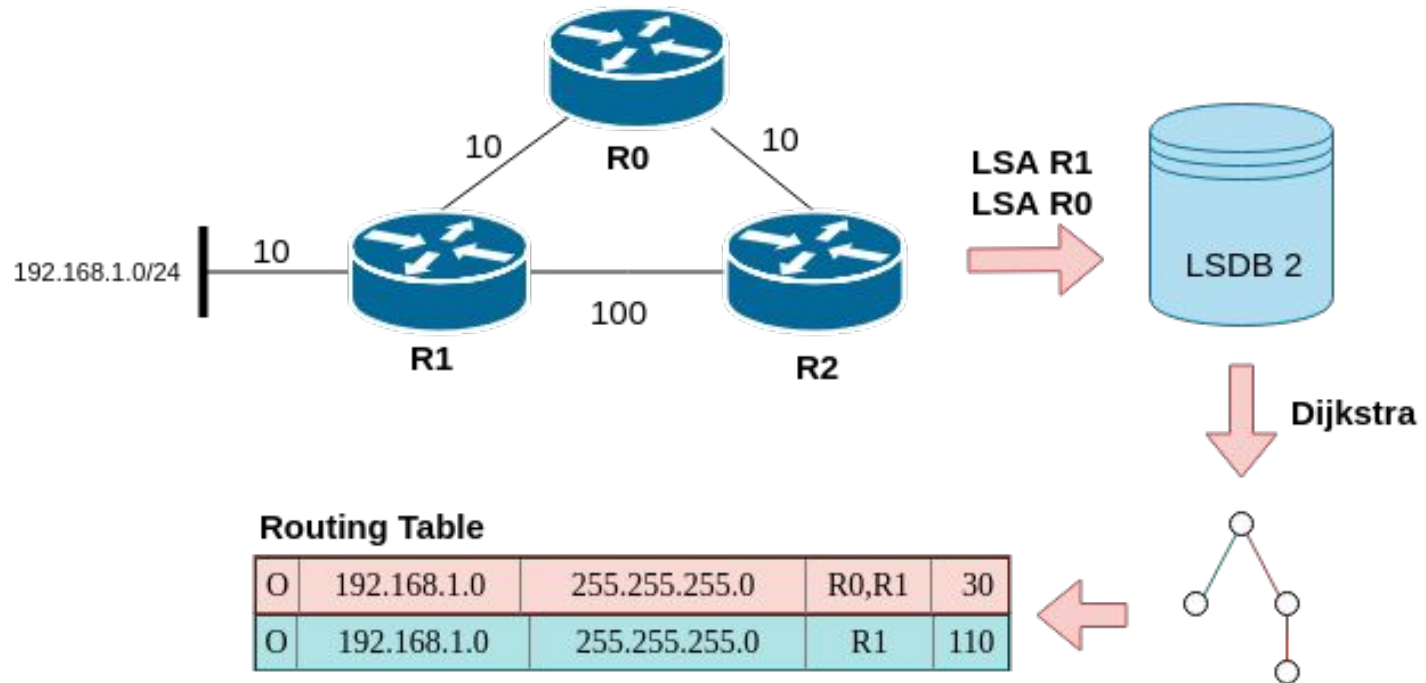
- Loop formation
- Slow convergence in bigger networks
- Hop count, does not always yield route with the least delay.



OSPF - Open Shortest Path First

Behaviour

- Each router have knowledge of the state of **all the interfaces and adjacencies**



RouterID

- Identifies the router within the AS
 - Assigned manually or,
 - Higher address loopback interface configured or,
 - Higher address physical interface configured

OSPF - Open Shortest Path First

Designated Router

- Act as a central point of communication to all other routers associated within an OSPF **area**:
 - Originate network link advertisements.
 - Participating in the synchronizing of the link-state databases.

Metric

- Calculates the cost of an interface based on the **bandwidth** of the interface.

$$Cost = (10^8) / bandwidth$$

A decorative network diagram in the top-left corner of the slide. It features a complex web of interconnected nodes and lines. The nodes are represented by circles of varying sizes, some with concentric circles inside, and are connected by thin, light gray lines. The overall structure is organic and sprawling, resembling a molecular or biological network.

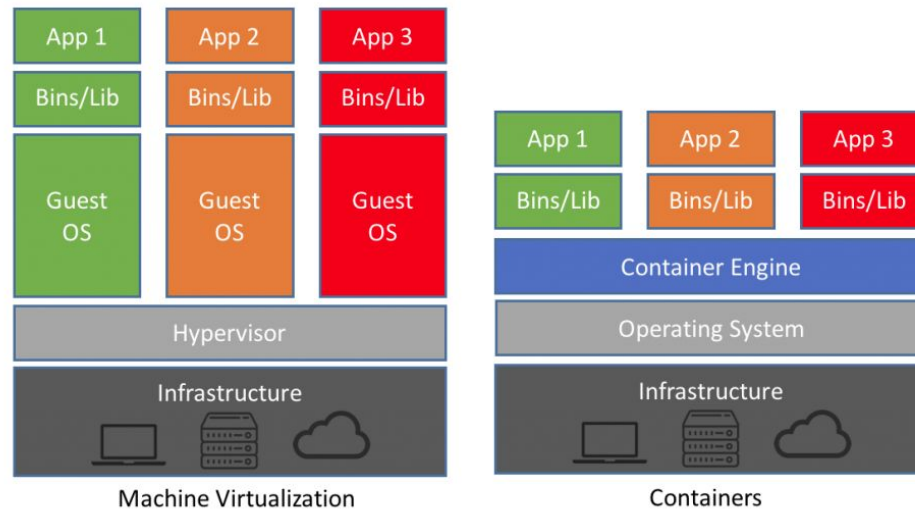
Lab!

1. Environment Setup - IPv4 and IPv6
 2. Editing the infrastructure
- 
- A decorative network diagram in the bottom-right corner of the slide. It is a smaller version of the network diagram in the top-left, featuring a complex web of interconnected nodes and lines. The nodes are represented by circles of varying sizes, some with concentric circles inside, and are connected by thin, light gray lines. The overall structure is organic and sprawling, resembling a molecular or biological network.

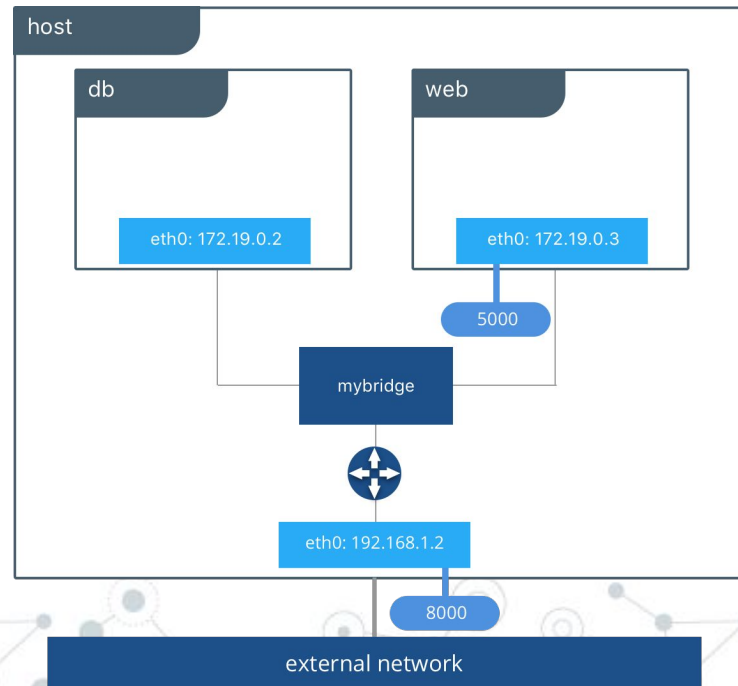
Docker & docker-compose

<https://www.menti.com/6a71d791>

What is Docker



How containers are connected ?



What is Quagga ?



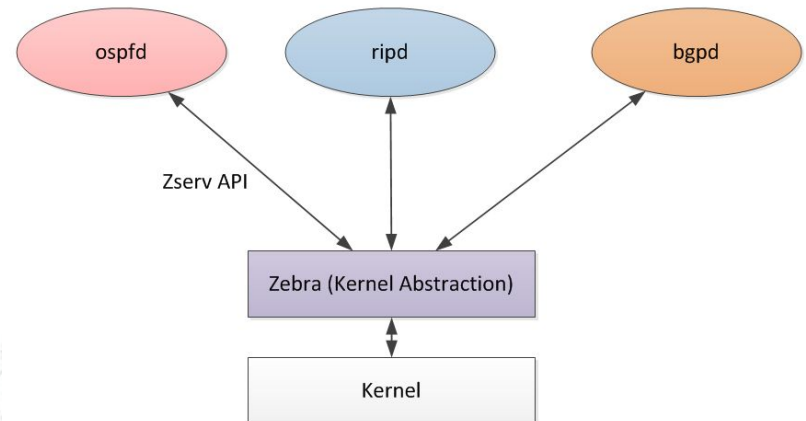
“The quagga (Equus quagga quagga) was a plains zebra that lived in South Africa until becoming extinct late in the 19th century.”

What is Quagga Router?

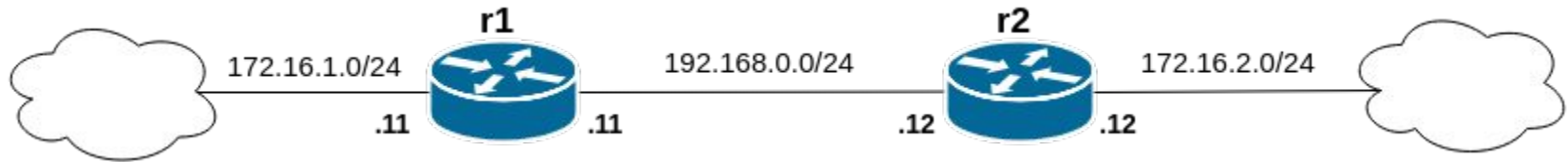


Open Source Routing

“Quagga is free software that manages various IPv4 and IPv6 routing protocols. Currently Quagga supports BGP4, BGP4+, OSPFv2, OSPFv3, RIPv1, RIPv2, and RIPv2 as well as very early support for IS-IS.”



Lab 1 - Environment Setup - IPv4 OSPF



Goals:

- Identify the topology in docker-compose file.
- Read quagga ospf configuration files
- Read IPv4 routing tables

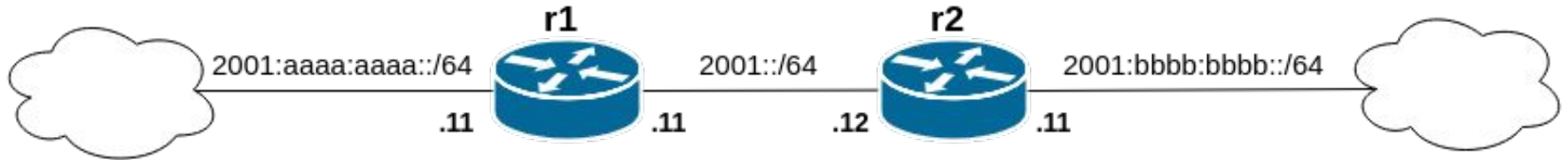
Steps:

- Clone the repository. (https://github.com/maticue/docker_quagga.git)
- Go to ospf folder. Run `docker-compose up`
- Verify docker port mapping in order to access the daemons via telnet

Useful commands:

- `telnet localhost <daemon_port>`
- `docker exec -ti <container_name> ash`

Lab 1 - Environment Setup - IPv6 OSPF



Goals:

- Identify the topology in docker-compose file.
- Read quagga ospf configuration files
- Read IPv6 routing tables

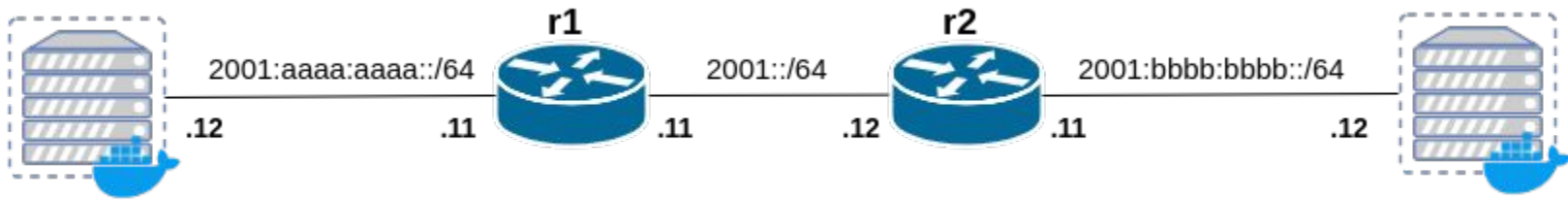
Steps:

- Uncomment ipv6 configuration in ospf/volumes/supervisord.conf and in Dockerfile
- docker-compose build in order to recreate the images

Useful commands:

- telnet localhost <daemon_port>
- docker exec -ti <container_name> ash

Lab 2 - Add hosts to your infrastructure



Goals:

- Add one host attached to each router
- Feel free to choose your favorite docker image

Resources

- https://www.juniper.net/documentation/en_US/junos/topics/concept/ospf-routing-designated-router-overview.html
- <https://learningnetwork.cisco.com/blogs/vip-perspectives/2017/11/08/ospf-graphs-lsas-and-the-lsdb>
- <https://docs.cumulusnetworks.com/display/CL332/Configuring+Quagga>
- Configuring FRRouting (Similar to quagga):
<http://docs.frrouting.org/en/latest/index.html>