Amirkabir University of Technology
(Tehran Polytechnic)

Cloud Computing

OpenStack Nova Architecture

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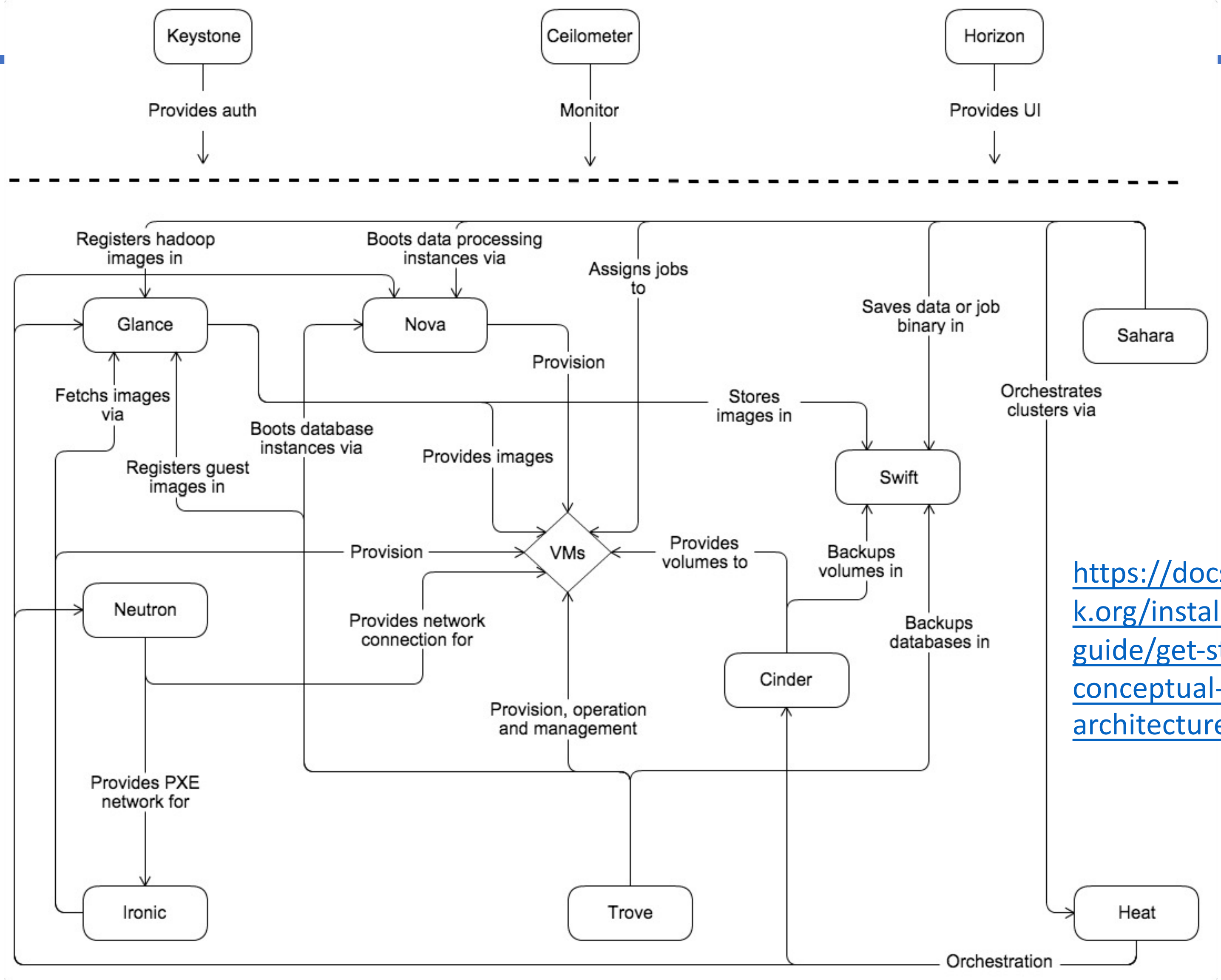
Fall 2022

https://www.slideshare.net/HaimAteya/an-intrudction-to-openstack-2017

https://docs.openstack.org/security-guide/introduction/introduction-to-openstack.html

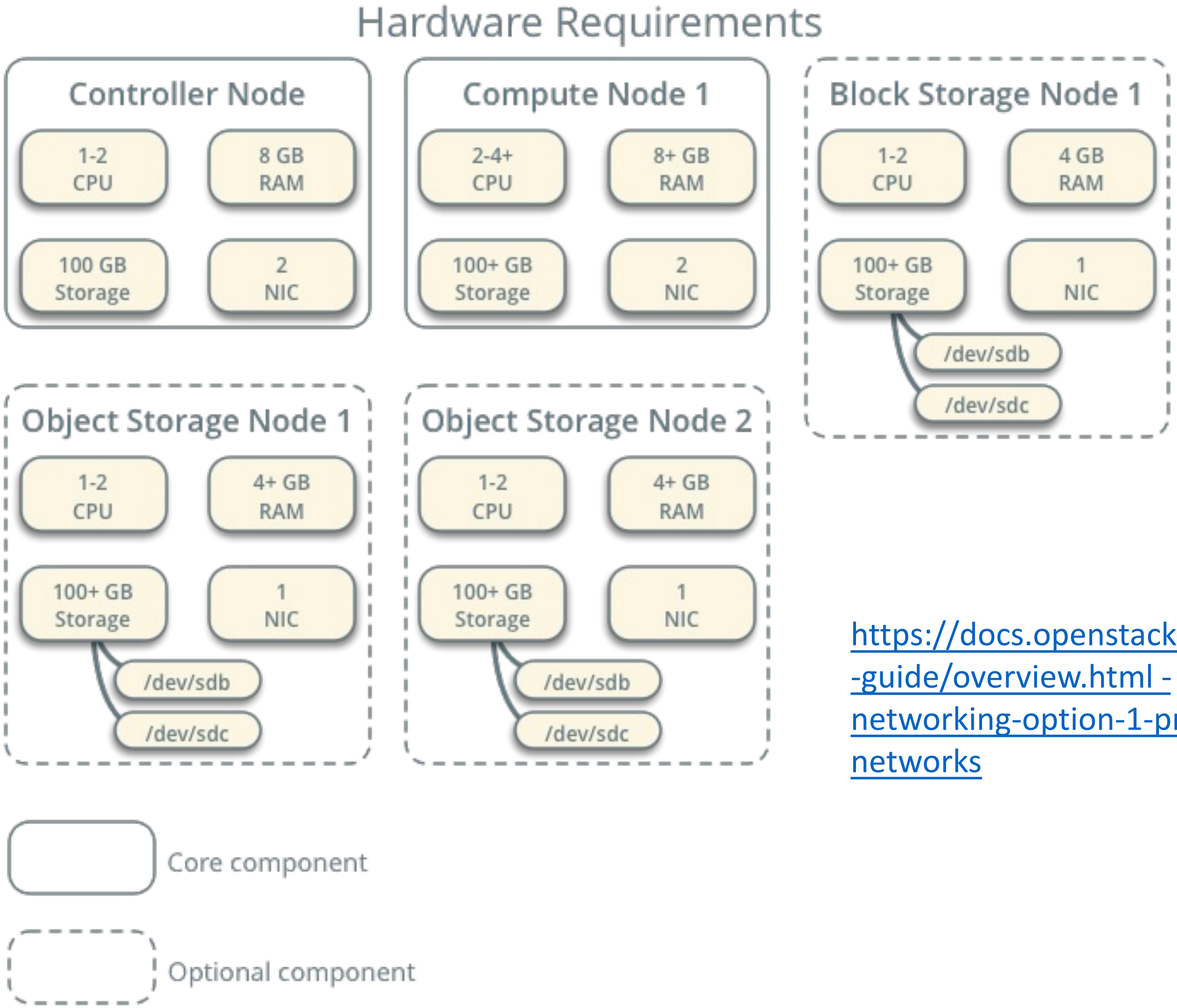
Overview

OpenStack Conceptual Architecture



https://docs.openstack.org/install-guide/get-started-conceptual-architecture.html

OpenStack Installation



Hardware Requirements

Controller Node

1-2 CPU

8 GB RAM

100 GB Storage

2 NIC

Compute Node 1

2-4+ CPU

8+ GB RAM

100+ GB Storage

2 NIC

Block Storage Node 1

1-2 CPU

4 GB RAM

100+ GB Storage

1 NIC

/dev/sdb

/dev/sdc

Object Storage Node 1

1-2 CPU

4+ GB RAM

100+ GB Storage

1 NIC

/dev/sdb

/dev/sdc

Object Storage Node 2

1-2 CPU

4+ GB RAM

100+ GB Storage

1 NIC

/dev/sdb

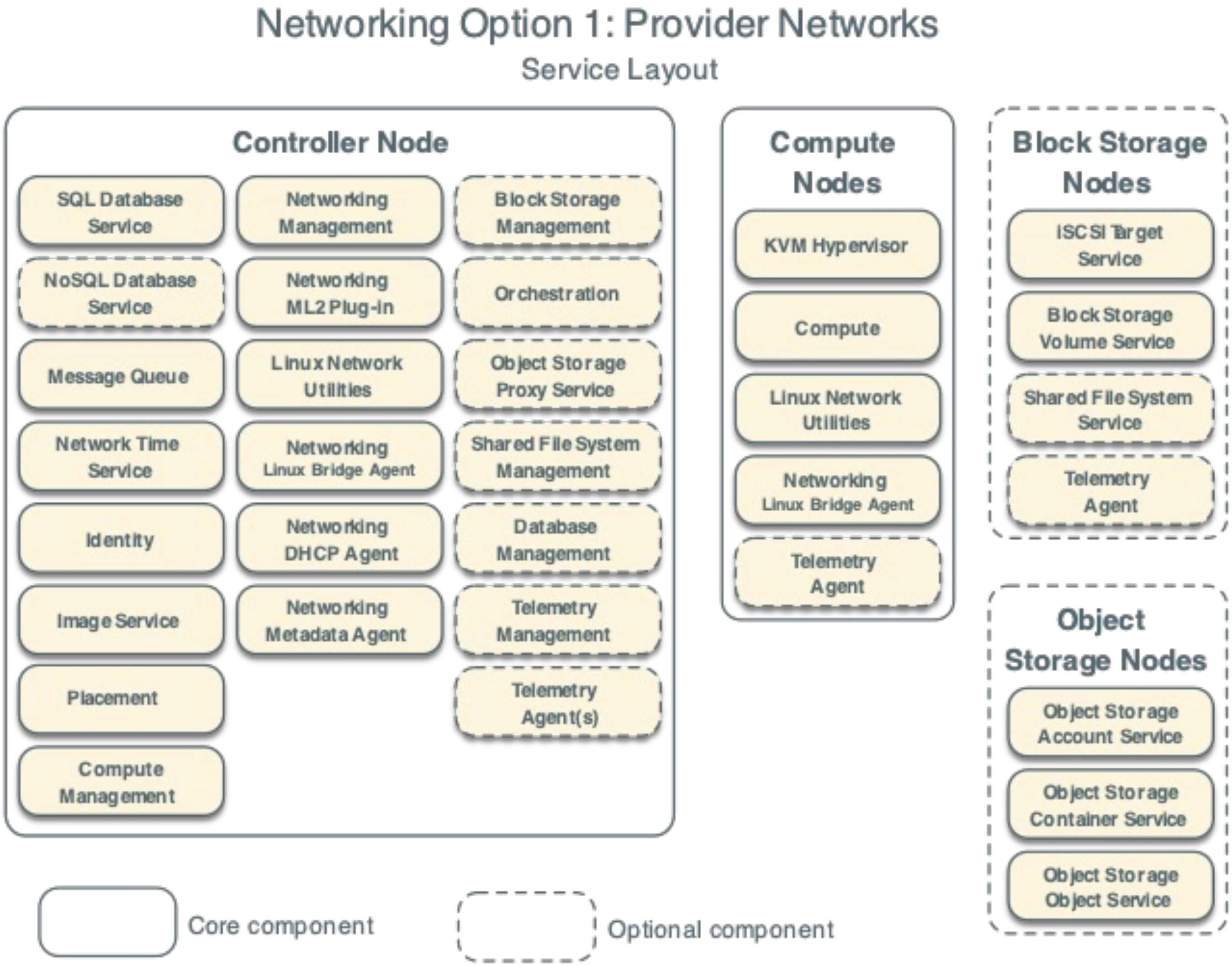
/dev/sdc

Core component

Optional component

https://docs.openstack.org/install-guide/overview.html - networking-option-1-provider-networks

OpenStack Installation



Networking Option 1: Provider Networks

Service Layout

Controller Node

SQL Database Service

NoSQL Database Service

Message Queue

Network Time Service

Identity

Image Service

Placement

Compute Management

Networking Management

Networking ML2 Plug-in

Linux Network Utilities

Networking Linux Bridge Agent

Networking DHCP Agent

Networking Metadata Agent

Block Storage Management

Orchestration

Object Storage Proxy Service

Shared File System Management

Database Management

Telemetry Management

Telemetry Agent(s)

Compute Nodes

KVM Hypervisor

Compute

Linux Network Utilities

Networking Linux Bridge Agent

Telemetry Agent

Block Storage Nodes

iSCSI Target Service

Block Storage Volume Service

Shared File System Service

Telemetry Agent

Object Storage Nodes

Object Storage Account Service

Object Storage Container Service

Object Storage Object Service

Core component

Optional component

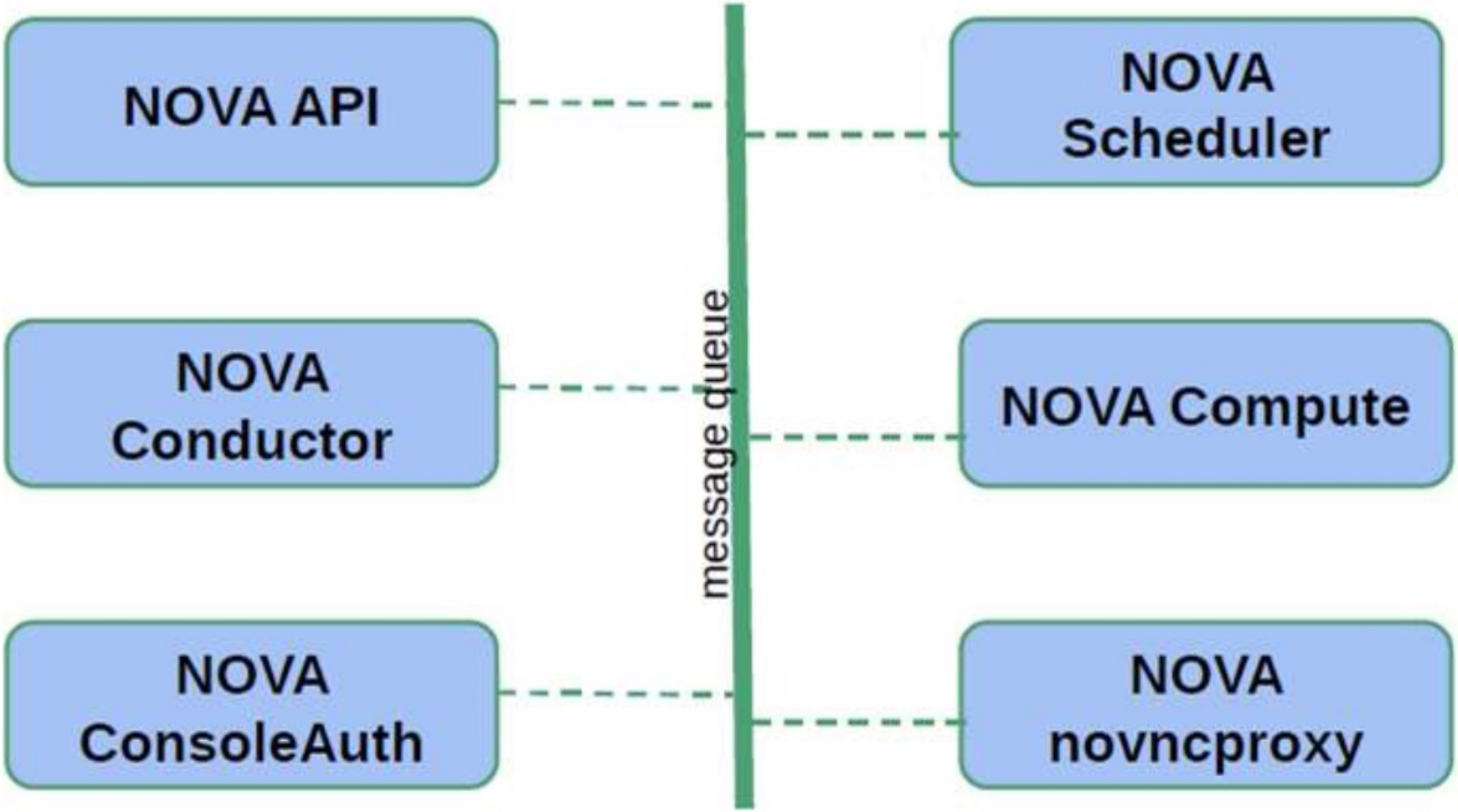
Run Kubernetes Cluster on OpenStack

- Check slides and watch the video
  - https://object-storage-ca-ymq-1.vexxhost.net/swift/v1/6e4619c416ff4bd19e1c087f27a43eea/www-assets-prod/summits/27/presentations/24157/slides/OpenInfra-Summit-Shanghai-OpenShift-on-OpenStack.pdf
  - https://www.youtube.com/watch?v=DuBYWXTnnsg
  - https://www.youtube.com/watch?v=uiplRQ2pQfc&t=176s

Nova

- Provided compute as service
- The main part of an IaaS system
- It is designed to manage and automate pools of computer resources
- Compute's architecture is designed to scale horizontally

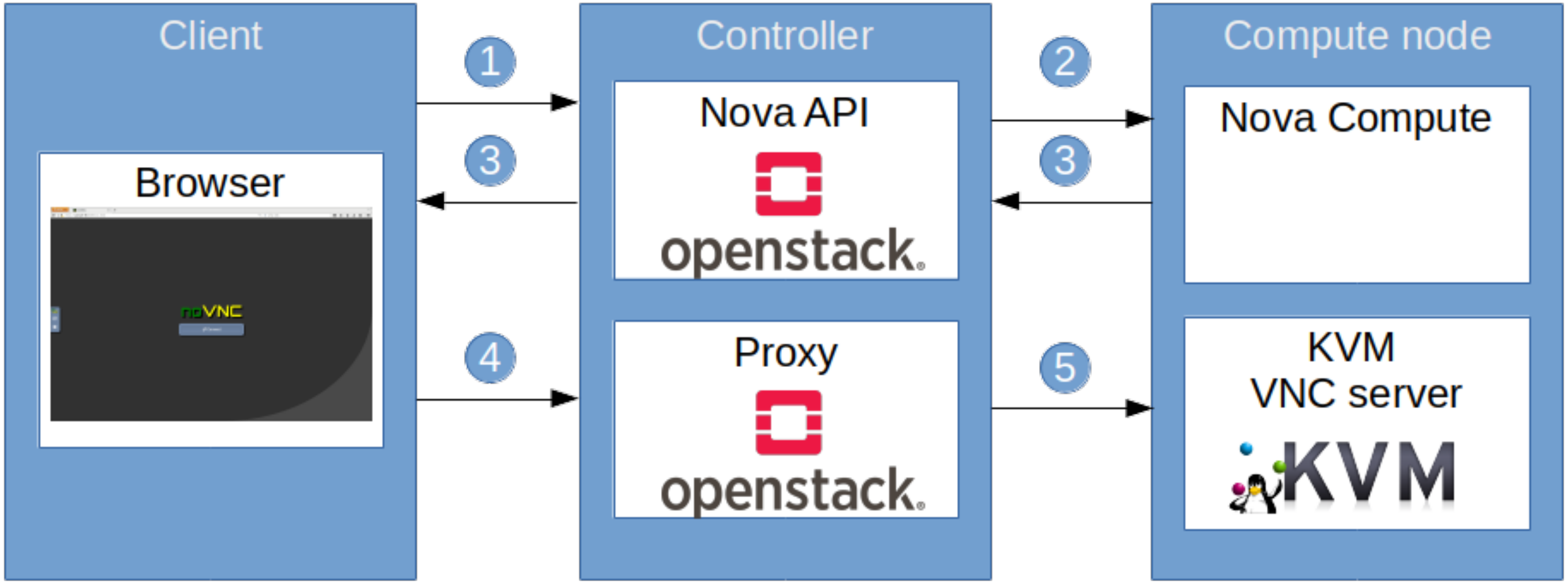
Nova Components



Nova Components

- Nova-conductor
  - Provides database-access support for Compute nodes
- Nova-consoleauth
  - Handles console authentication
- Nova-novncproxy
  - Provides a VNC proxy for browsers

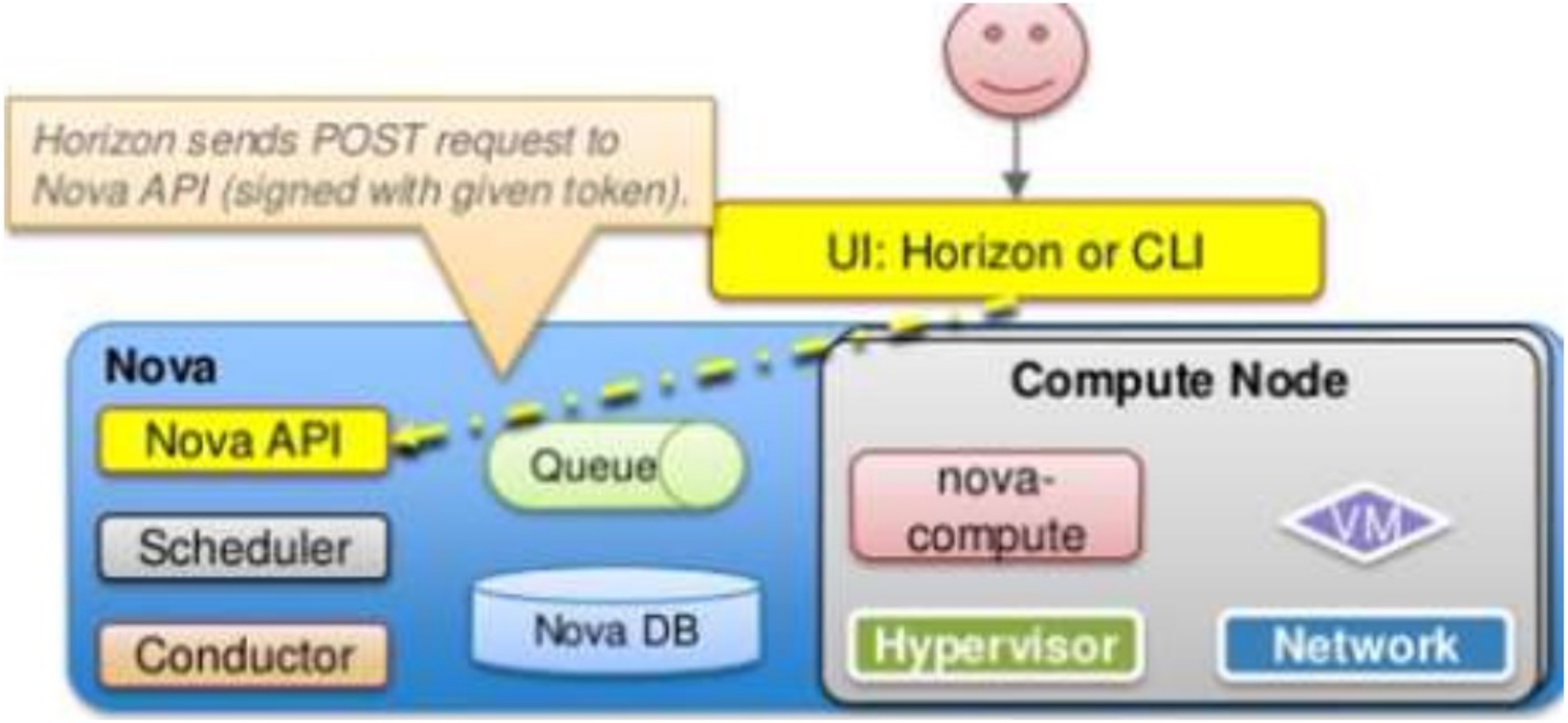
The Nova VNC proxy



https://leftasexercise.com/2020/02/14/openstack-nova-installation-and-overview/

NOVA API

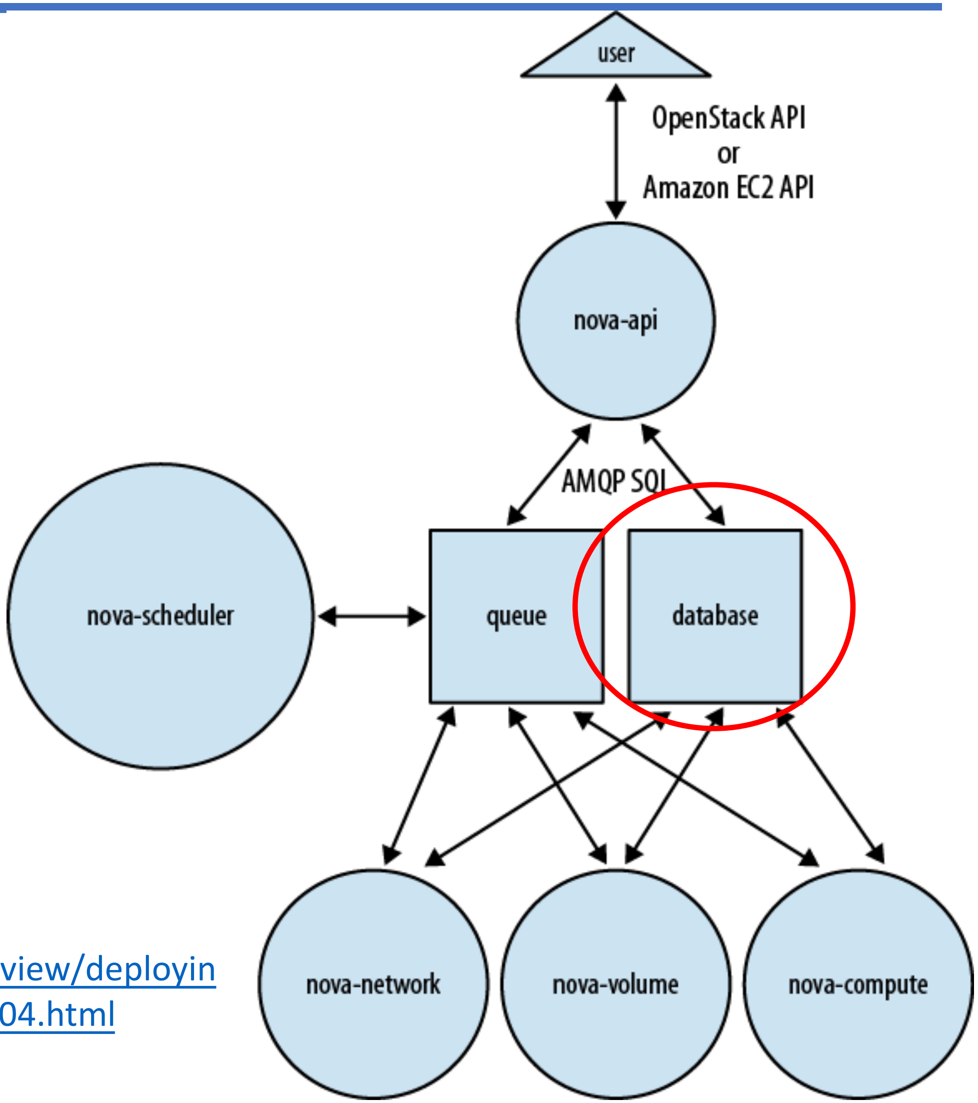
- NOVA-API is responsible to provide an API for users and services to interact with NOVA



On Compute Node

- There is a periodic task (Resource Tracker), which collects host information.

- This information is then stored to ***database***

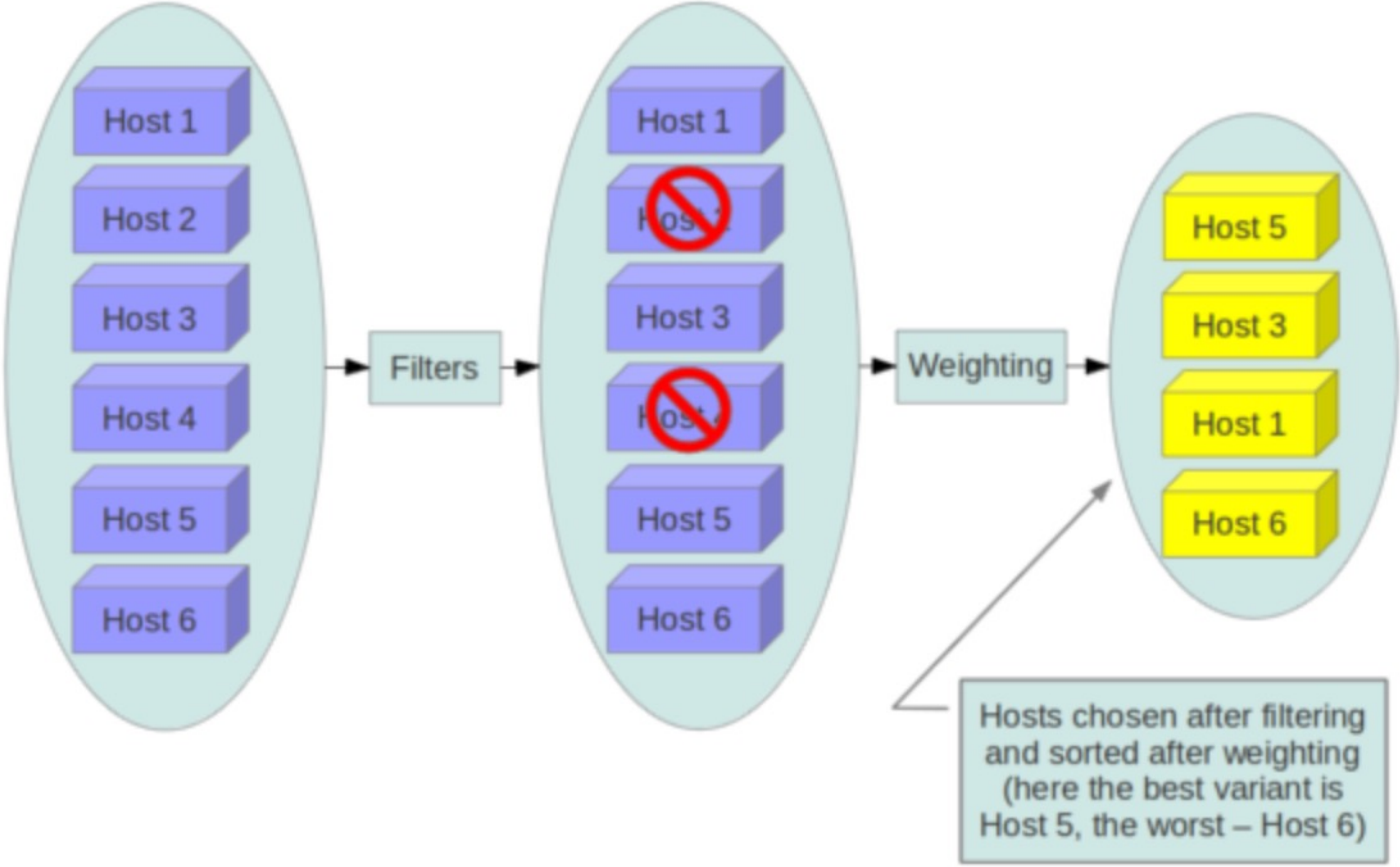


https://www.oreilly.com/library/view/deploying-openstack/9781449311223/ch04.html

On Controller Node

- Request from nova API reaches conductor
- Conductor interacts with the scheduler
- Scheduler ***uses filters*** to identify the best node
  - From the information stored in ***database***
- Selected host information is sent back to conductor
- Conductor uses the compute queue and directs it to selected host
- The compute node then launches the instance

Filters and Weights



Hosts chosen after filtering and sorted after weighting (here the best variant is Host 5, the worst – Host 6)

Some Common Filters

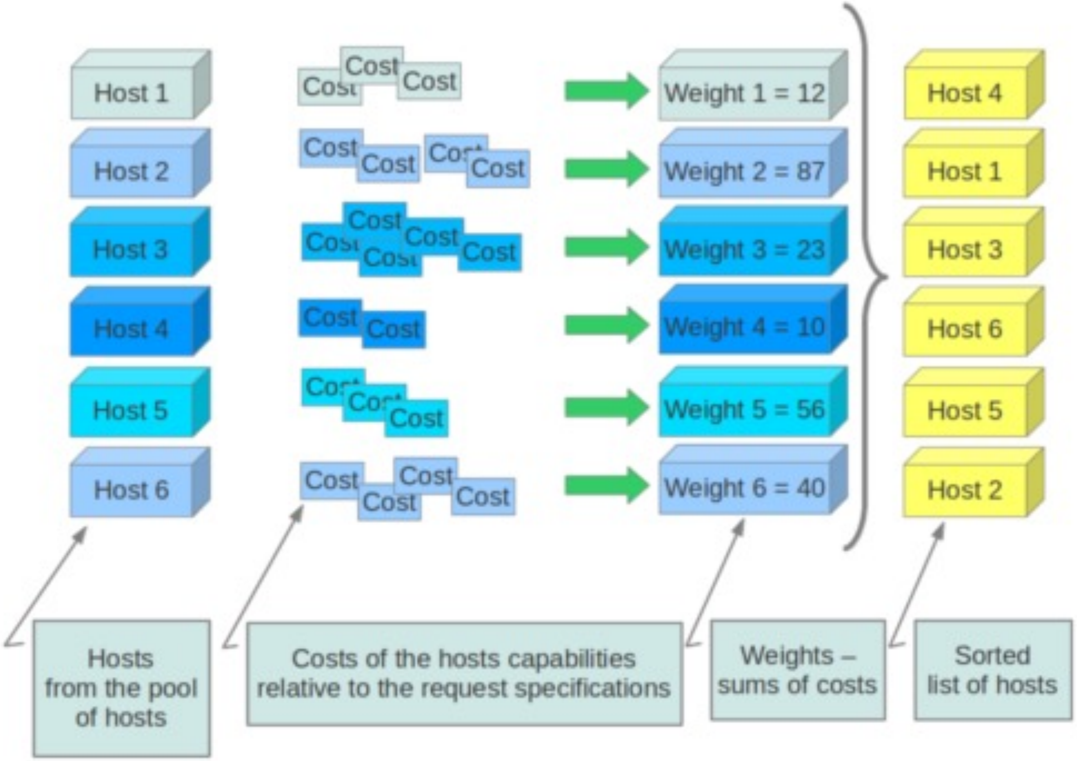
- **AvailabilityZoneFilter**
  - Return hosts where node_availability_zone name is the same as the one requested
- **RamFilter**
  - Return hosts where (free_ram * ram_allocation_ration) is greater than requested ram.
- **ComputerFilter**
  - Return hosts where asked instance_type (with extra_specs) match capabilities

Some Common Filters (cont.)

- **DiskFilter**
  - Returns hosts with sufficient disk space available for root and ephemeral storage.
- **RetryFilter**
  - Filters out hosts that have already been attempted for scheduling purposes.

Weights

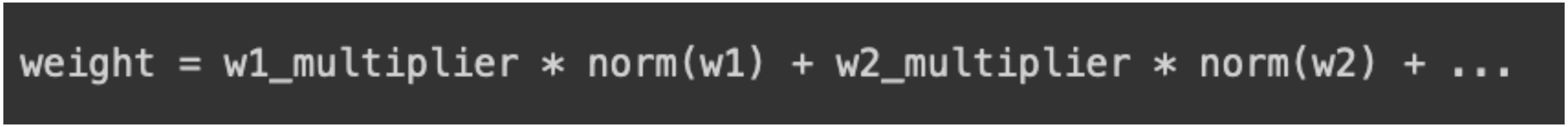
- Scheduler applies cost function on each host & calculates the weight.



https://docs.openstack.org/nova/latest/admin/scheduling.html

Some Possible Cost Functions

- Considering free RAM among filtered hosts.
  - Highest free RAM wins.
- Considering least workload (e.g., IO ops) among filtered hosts.
- Can consider any specific metric we want to consider in a similar fashion.
  - Can be enabled from configuration file.



```
weight = w1_multiplier * norm(w1) + w2_multiplier * norm(w2) + ...
```

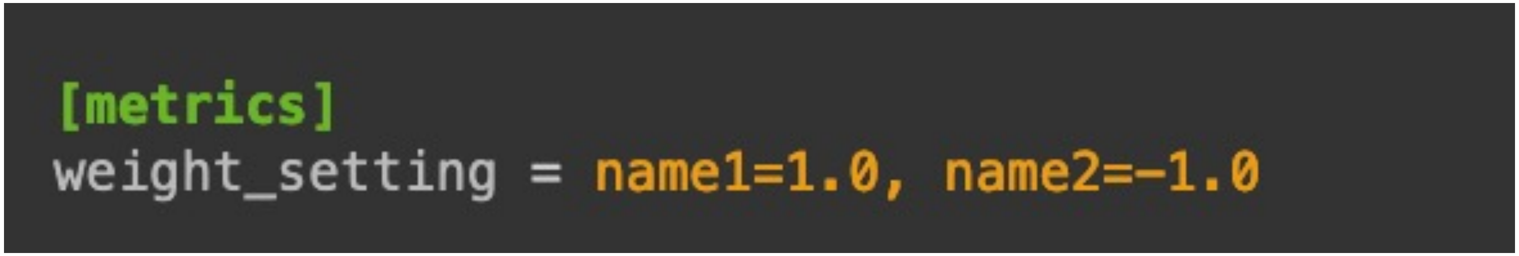
Weights (cont.)

- **RAMWeigher**
  - Compute weight based on available RAM on the compute node. Sort with the largest weight winning.
- **CPUWeigher**
  - Compute weight based on available vCPUs om the compute node. Sort with the largest weight winning.
- **DiskWeigher**
  - Hosts are weighted and sorted by free disk space with the largest weight wininng.

Weights (cont.)

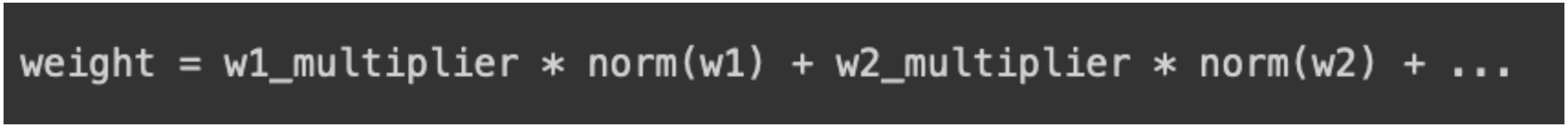
MetricWeigher

- This weigher can compute the weight based on the compute node host’s various metrics.
- The to-be weighed metrics and their weighing ration are specified in the configuration file as the followings:



```
[metrics]
weight_setting = name1=1.0, name2=-1.0
```

General Cost Function



```
weight = w1_multiplier * norm(w1) + w2_multiplier * norm(w2) + ...
```

Metric	Range
CPU utilization	(0, 100) usage percentage
Outbound network traffic	(0, 10^9) byte per second

Least Loaded Server with No Normalization

Weight (Load) = 1 * (CPU utilization) + 1* (Outbound network traffic)

	CPU utilization	Outbound network traffic
Host1	95	100000
Host2	10	100090

Least Loaded Server Without Normalization

Weight (Load) = 1 * (CPU utilization) + 1* (Outbound network traffic)

	Weight
Host1	(1 * 95) + (1 * 100000) = 100095 ✓
Host2	(1*10) + (1* 100090) = 100100

Host1 is selected!

Not good ☹

Min-Max Normalization

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

Getting Back to the Previous Example

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

	CPU utilization	Outbound network traffic
Host1	95	100000
Host2	10	100090

	CPU utilization	Outbound network traffic
Host1	(95-0)/(100-0)=0.95	(100000-0)/(10^9-0)=0.0001
Host2	(10-0)/(100-0)=0.1	(100090-0)/(10^9-0)=0.00010009

Least Loaded Server with Normalization

Weight (Load) = 1 * norm(CPU utilization) +

1* norm(Outbound network traffic)

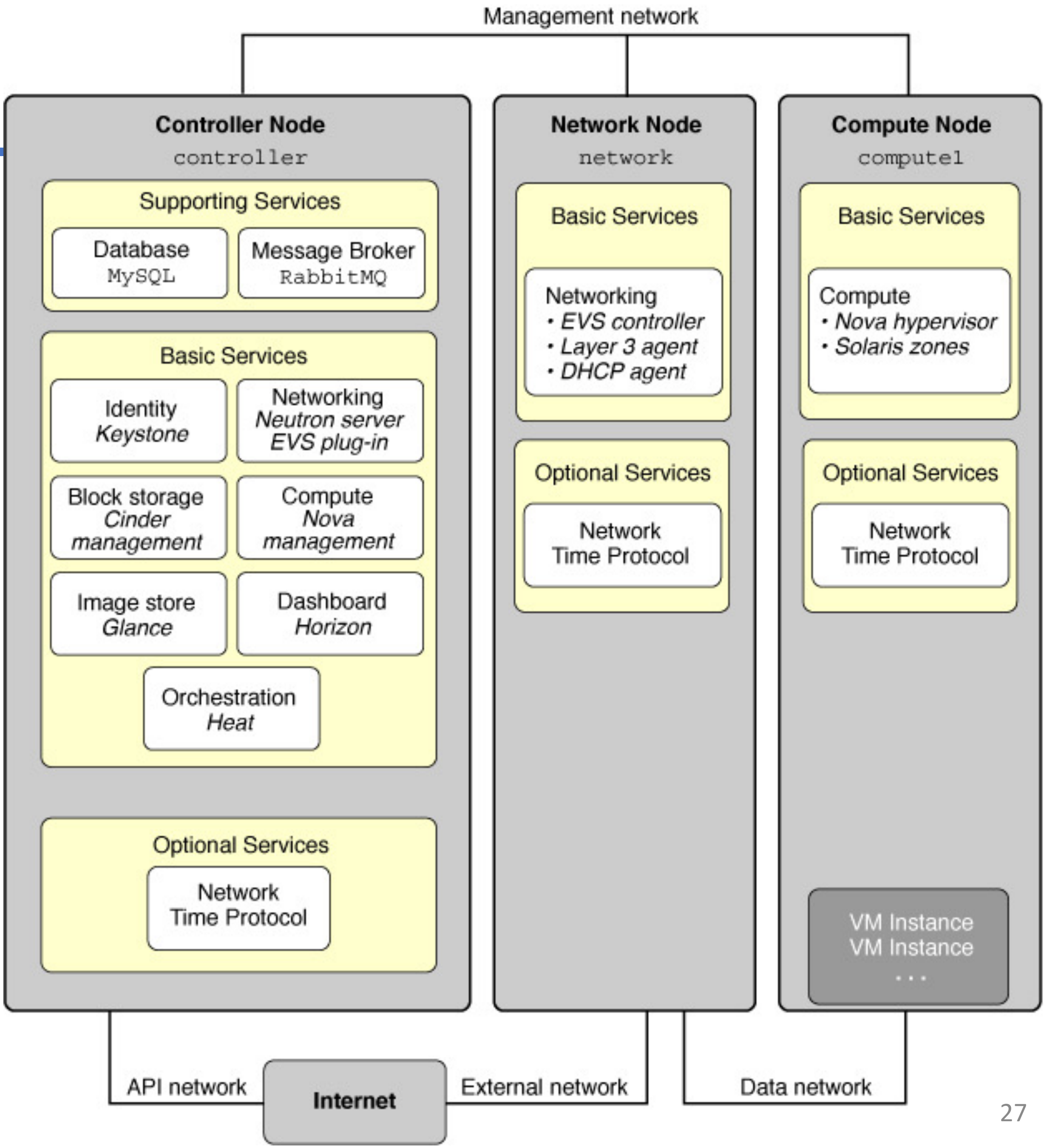
	Weight
Host1	(1 * 0.95) + (1 * 0.0001) = 0.9501
Host2	(1*0.1) + (1* 0.00010009) = 0.10010009✓

Host2 is selected!

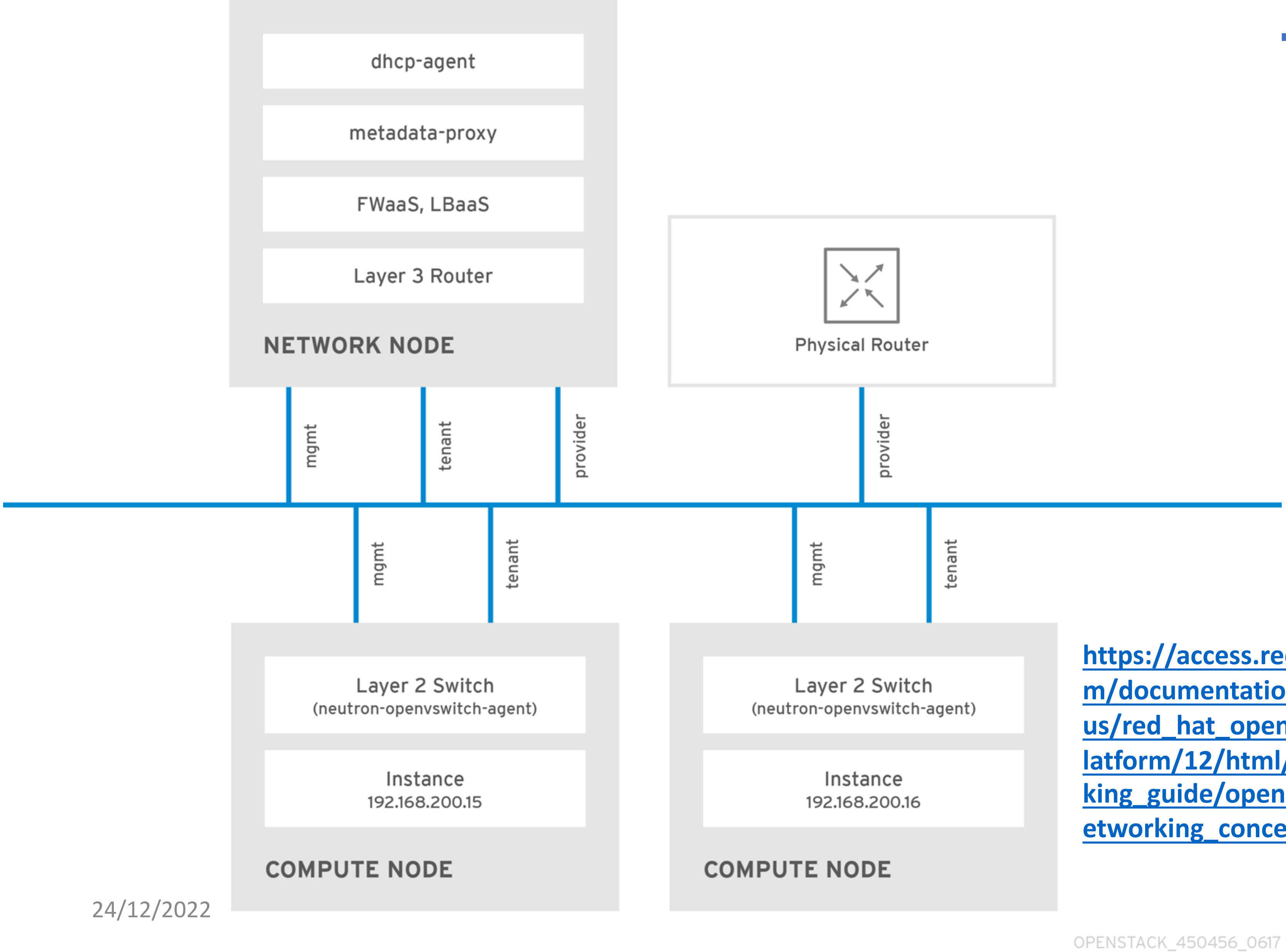
Good job :)

Recap

https://docs.oracle.com/cd/E36784_01/html/E54155/archover.html



Recap (cont.)



https://access.redhat.com/documentation/en-us/red_hat_openstack_platform/12/html/networking_guide/openstack_networking_concepts