2021 KoALICE National Workshop Research Activity Summary

(VM Scheduling Research and HEP SPEC Performance Comparison)

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Data Computing Laboratory

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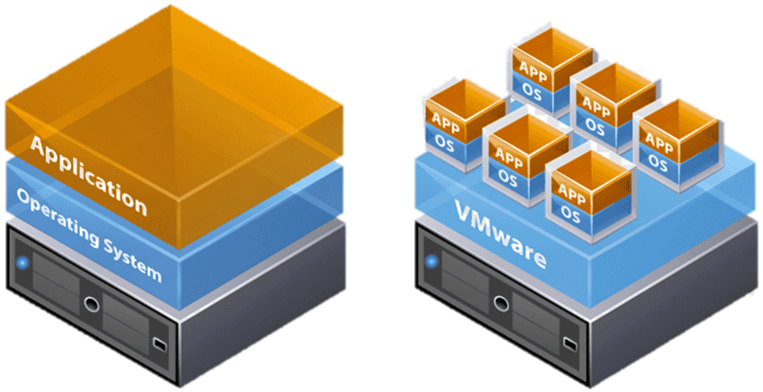
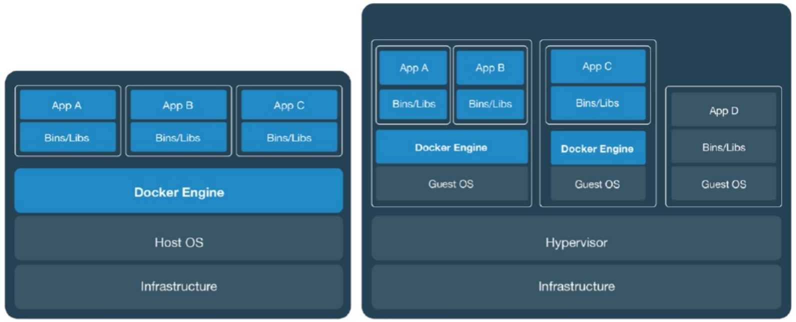
1. 2021 Timeline - Summary

2021 Activity Summary

1. Conference Paper (Domestic, KCC)
2. HEP SPEC Performance Comparison




App A | App B | App C
Bins/Libs | Bins/Libs | Bins/Libs
Docker Engine
Host OS
Infrastructure

App A | App B | App C
Bins/Libs | Bins/Libs | Bins/Libs
Docker Engine | Docker Engine | App D
Guest OS | Guest OS | Bins/Libs
Guest OS
Hypervisor
Infrastructure

VM Scheduling Study

- Stable operation in a virtualized environment
- Minimize overall operating costs
- Optimal performance improvement

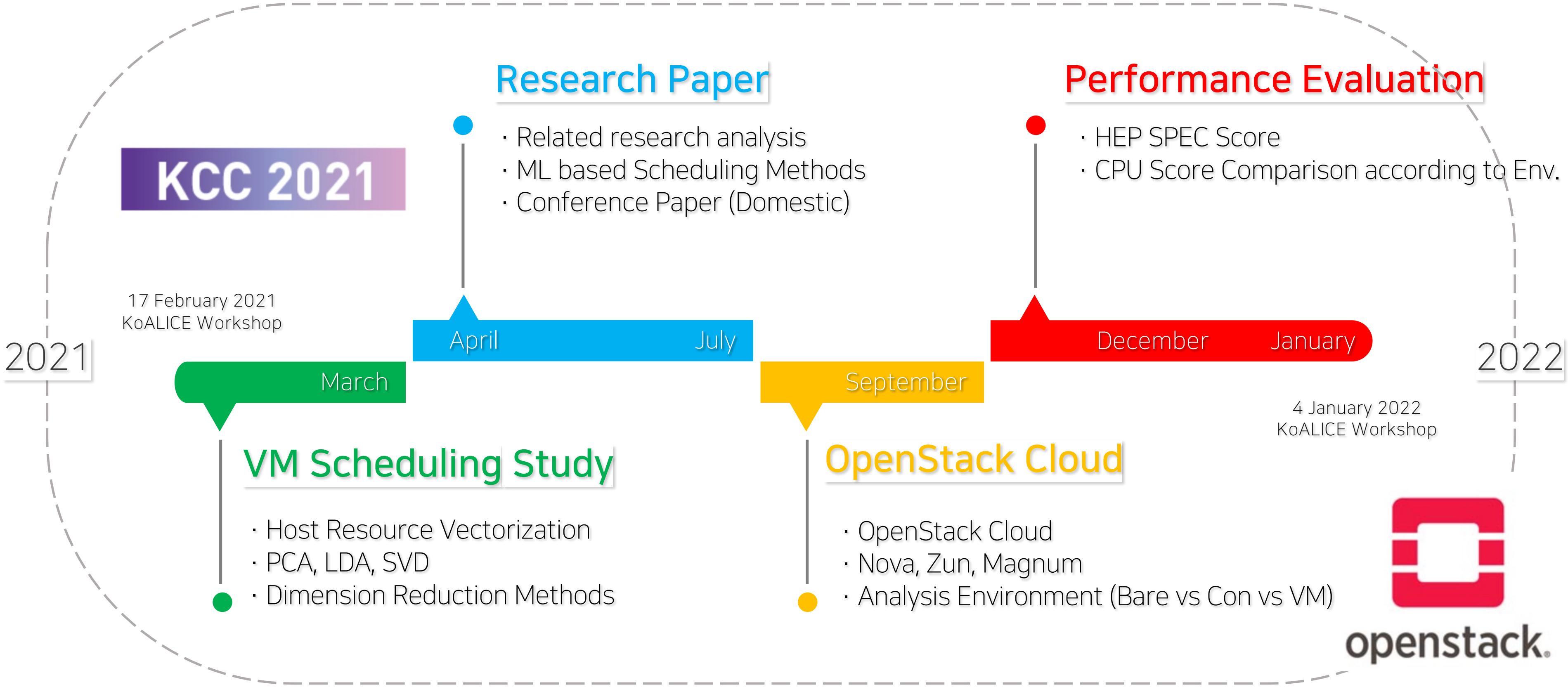
Performance Evaluation

- HEP SPEC Benchmark – Scientific Data Analysis
- Comparison of performance according to virtualization Env
- Selecting a virtualized environment suitable for the LHC

1. 2021 Timeline - Summary

2021 Activity Summary

1. Conference Paper (Domestic, KCC)
2. HEP SPEC Performance Comparison



2021

17 February 2021
KoALICE Workshop

VM Scheduling Study

- Host Resource Vectorization
- PCA, LDA, SVD
- Dimension Reduction Methods

Research Paper

- Related research analysis
- ML based Scheduling Methods
- Conference Paper (Domestic)

OpenStack Cloud

- OpenStack Cloud
- Nova, Zun, Magnum
- Analysis Environment (Bare vs Con vs VM)

Performance Evaluation

- HEP SPEC Score
- CPU Score Comparison according to Env.

4 January 2022
KoALICE Workshop

2022

2. VM Scheduling Research

Motivation

There are various resources to consider when deploying a virtual machine, such as CPU and RAM.
Considering all resources, it is possible to maximize the VM performance and host resource utilization.

· Resources to consider when deploying VMs

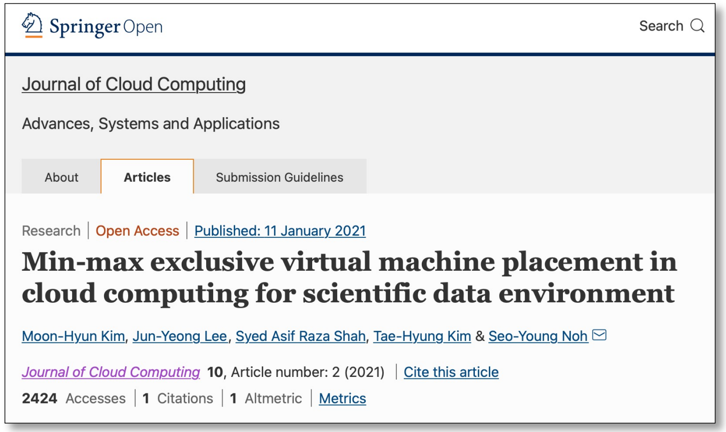
(1) CPU usage

(2) Ram usage

(3) Disk I/O usage

(4) Network bandwidth usage

…



Journal of Cloud Computing

Advances, Systems and Applications

Research | Open Access | Published: 11 January 2021

Min-max exclusive virtual machine placement in cloud computing for scientific data environment

Moon-Hyun Kim, Jun-Yeong Lee, Syed Asif Raza Shah, Tae-Hyung Kim & Seo-Young Noh

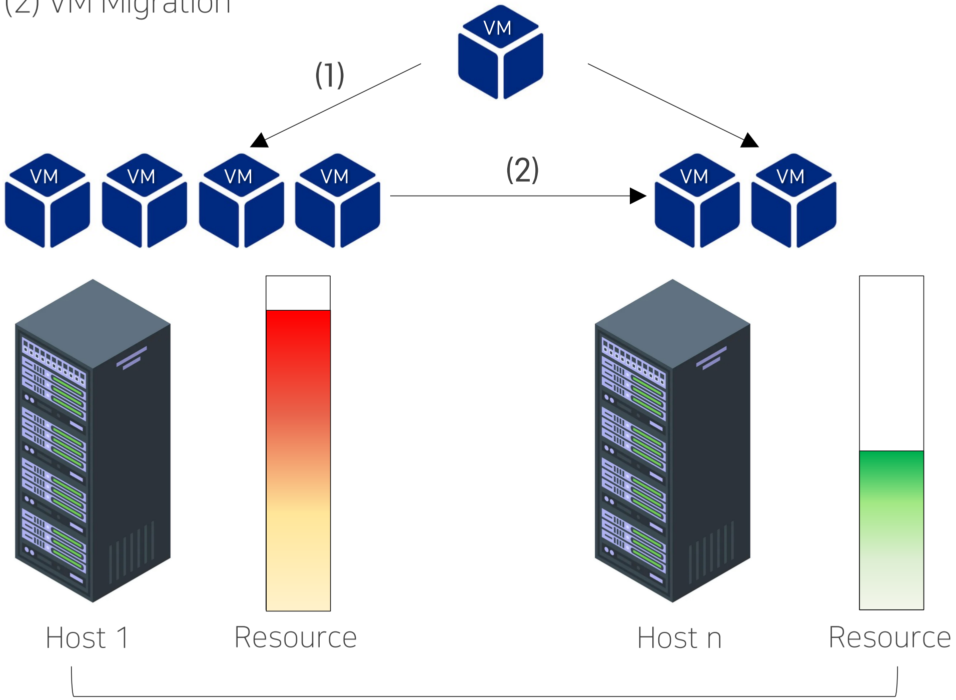
Journal of Cloud Computing **10**, Article number: 2 (2021) | Cite this article

2424 Accesses | **1** Citations | **1** Altmetric | Metrics

· Two Cases in VM Provisioning

(1) VM Launching

(2) VM Migration



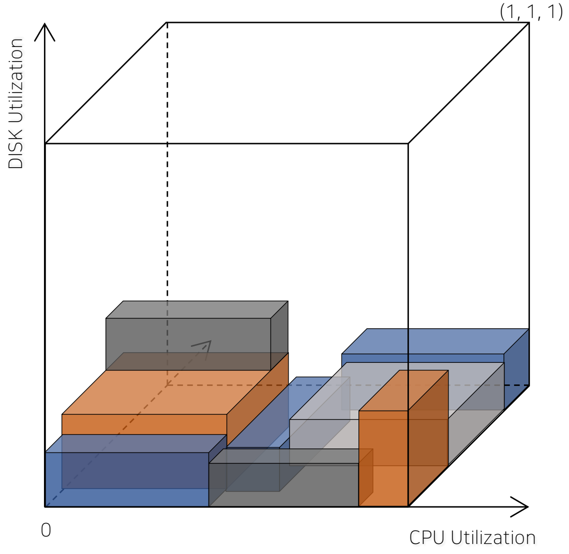
2. VM Scheduling Research

Related Research

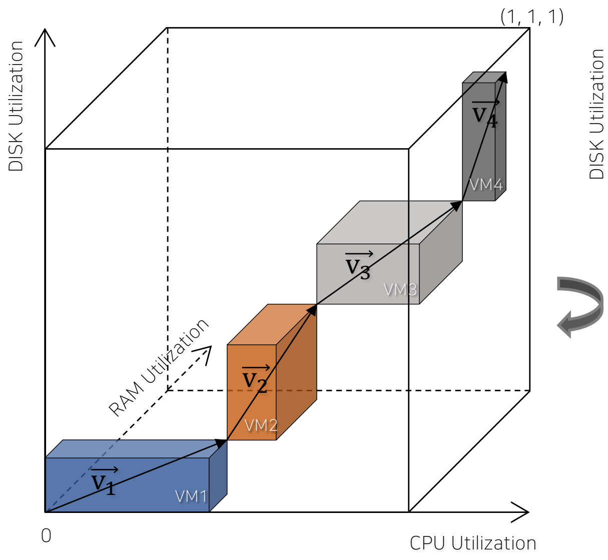
Research on methods that consider multiple resources from the existing method of placing VM

In order to consider all resources, the resources are vectorized and used for VM placement operation

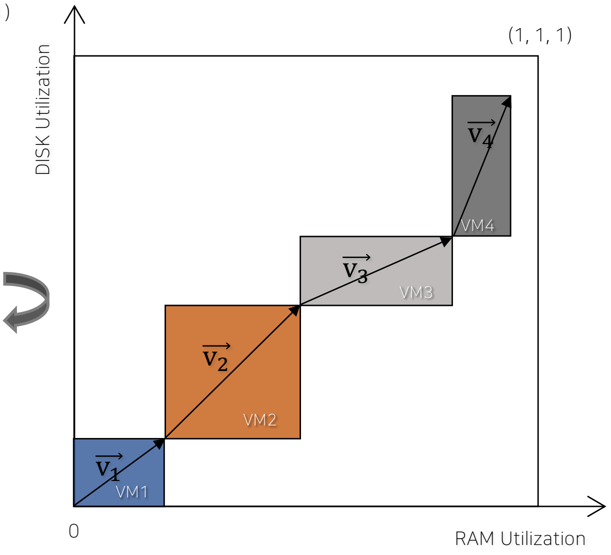
- [CPU, RAM, DISK] → [0.6, 0.3, 0.7]



[3D Bin-Packing Problem]



[3D Vector-Packing Problem]



[Vector-Packing Problem in 2D Aspect]

In 3D or higher, when the usage of one resource reaches the maximum, virtual machines cannot be placed any more.

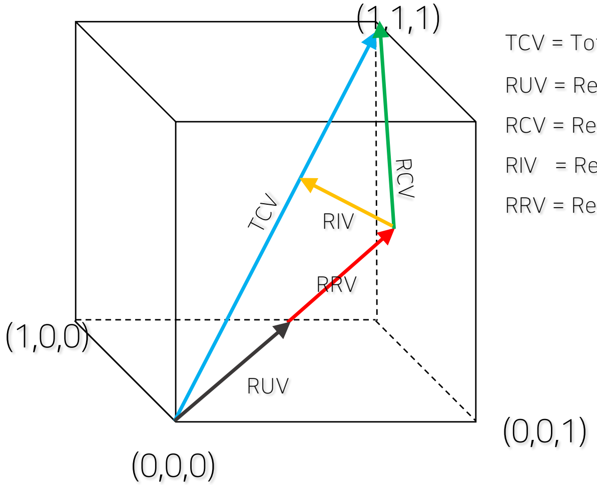
2. VM Scheduling Research

Related Research

A lot of computational resources are required for vector operation, which causes a load on scheduling.
As the dimension of the vector increases, the load also increases significantly.

If the scheduling calculation load increases, the deployment speed is decreased.

· [CPU, RAM, DISK] → [0.6, 0.3, 0.7]



TCV = Total Capacity Vetor

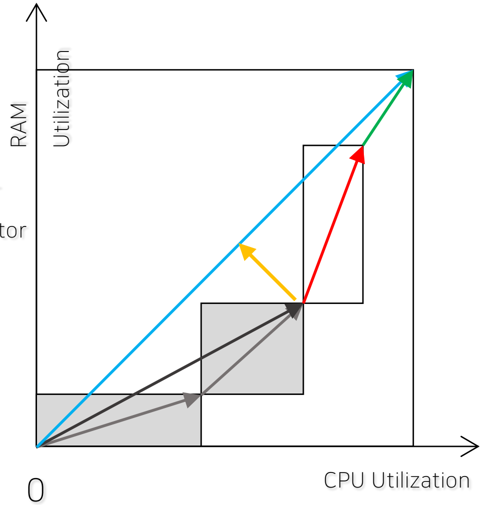
RUV = Resource Usage Vector

RCV = Remaining Capacity Vector

RIV = Resource Imbalance Vector

RRV = Resource Requirement Vector

[Vector representation of the host computing resource]



1) Calculate host RUV
2) Calculate host RIV
3) Selection of suitable hosts based on RIV
4) Calculate RUV of VM to be added
5) Calculate RIV of VM to be added
6) Calculate RCV of VM to be added
7) Evaluate the fit based on 5,6

[Vectorized resource-based VM provisioning process]

2. VM Scheduling Research

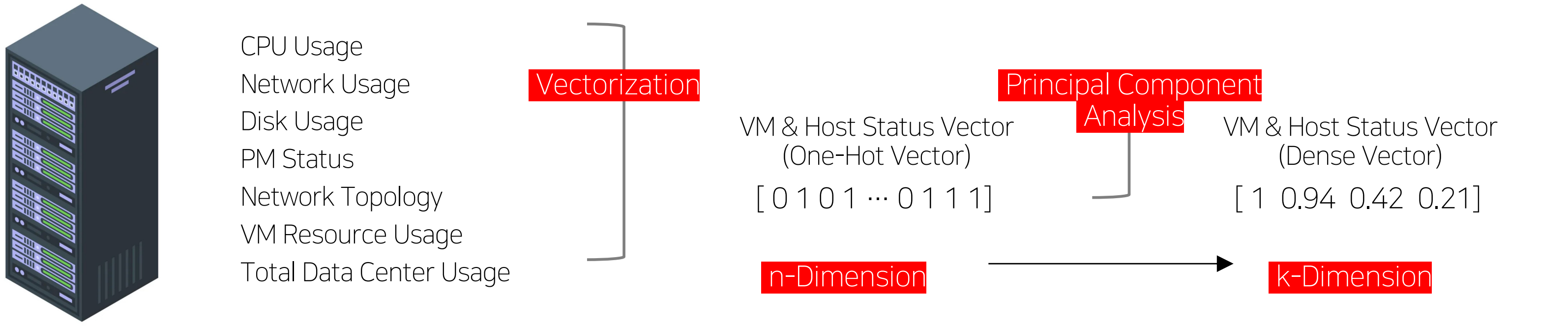
Proposed Method

Proposed a method that utilizes ML techniques to speed up scheduling while considering multiple resources of a host

1. Vectorization

2. Dimension Reduction

3. VM Clustering and Placement



CPU Usage
Network Usage
Disk Usage
PM Status
Network Topology
VM Resource Usage
Total Data Center Usage

Vectorization

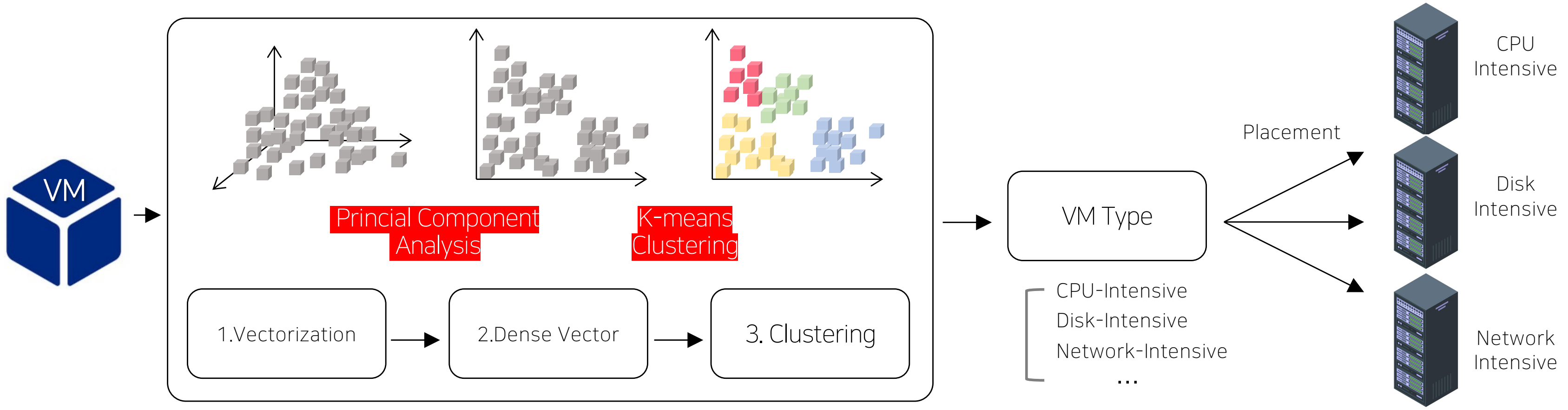
VM & Host Status Vector
(One-Hot Vector)
[0 1 0 1 ··· 0 1 1 1]

n-Dimension

Principal Component Analysis

VM & Host Status Vector
(Dense Vector)
[1 0.94 0.42 0.21]

k-Dimension



VM

Princial Component Analysis

K-means Clustering

1.Vectorization → 2.Dense Vector → 3. Clustering

VM Type

CPU-Intensive
Disk-Intensive
Network-Intensive
...

Placement

CPU Intensive

Disk Intensive

Network Intensive

3. HEP SPEC Performance Evaluation

Types of Virtualization

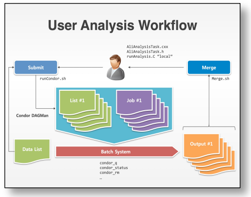
Comparison of performance based on virtualization method
Check how much performance difference each environment has

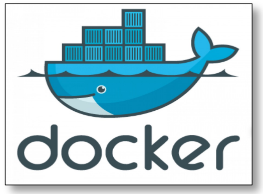
→ Performance comparison in OpenStack environment

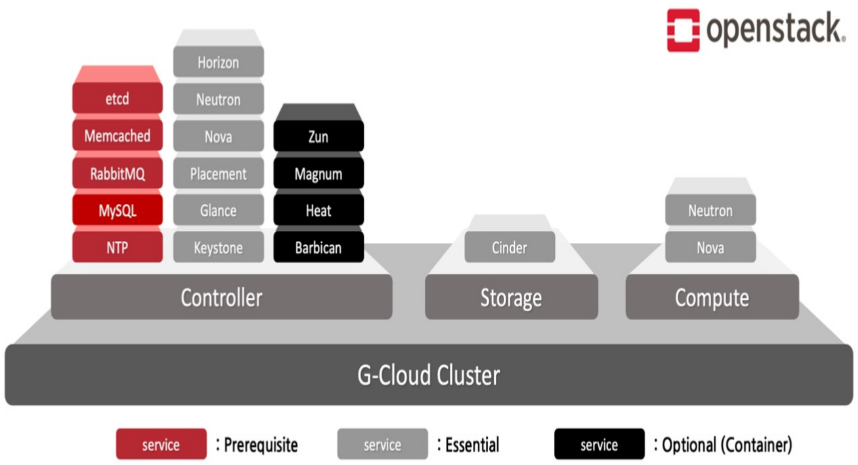
openstack.

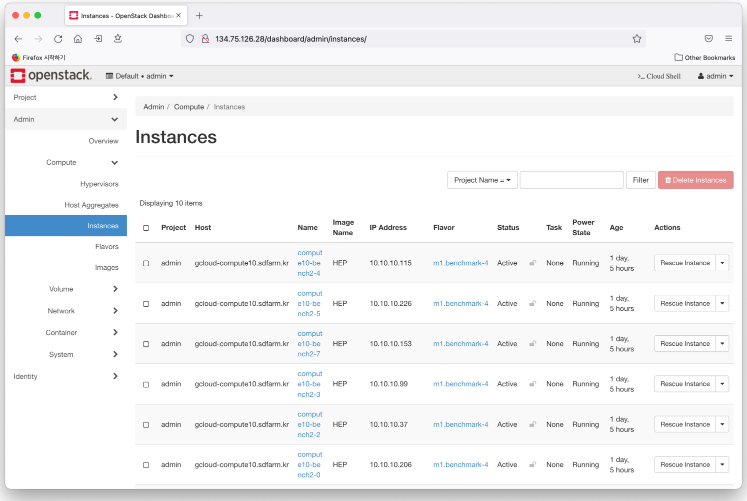
· Virtualized Environment

(1) Bare-metal
(2) Virtual Machine
(3) Container









Instances

Displaying 10 items

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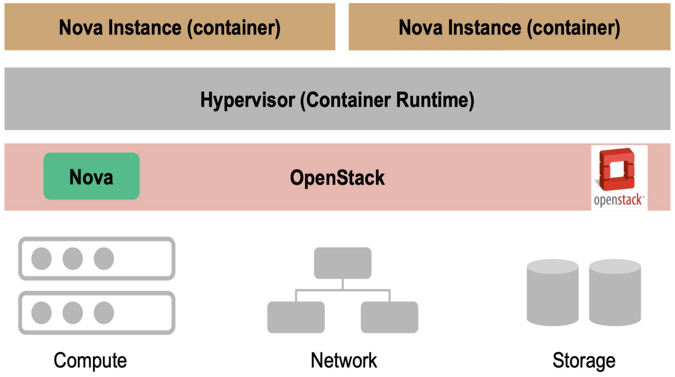
☐	admin	gcloud-compute10.sdfarm.kr	compute10-bench2-5	HEP	10.10.10.226	m1.benchmark-4	Active	None	Running	1 day, 5 hours	Rescue Instance ▾
☐	admin	gcloud-compute10.sdfarm.kr	compute10-bench2-7	HEP	10.10.10.153	m1.benchmark-4	Active	None	Running	1 day, 5 hours	Rescue Instance ▾
☐	admin	gcloud-compute10.sdfarm.kr	compute10-bench2-3	HEP	10.10.10.99	m1.benchmark-4	Active	None	Running	1 day, 5 hours	Rescue Instance ▾
☐	admin	gcloud-compute10.sdfarm.kr	compute10-bench2-2	HEP	10.10.10.37	m1.benchmark-4	Active	None	Running	1 day, 5 hours	Rescue Instance ▾
☐	admin	gcloud-compute10.sdfarm.kr	compute10-bench2-0	HEP	10.10.10.206	m1.benchmark-4	Active	None	Running	1 day, 5 hours	Rescue Instance ▾

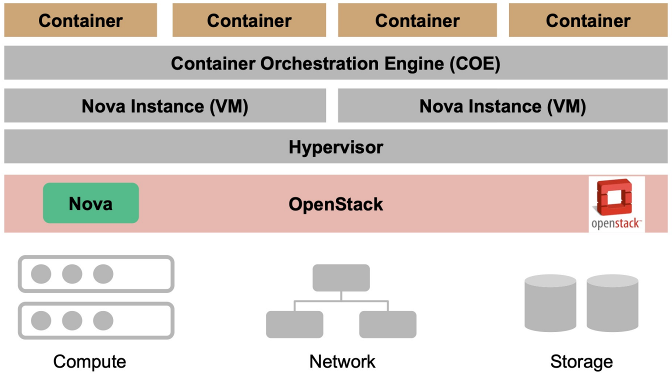
3. HEP SPEC Performance Comparison

OpenStack

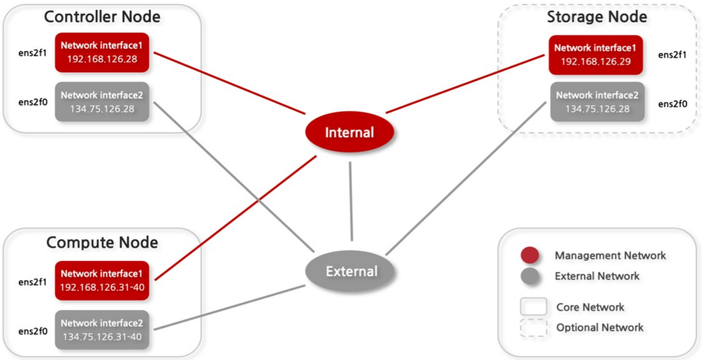
OpenStack is a free, open standard cloud computing platform. It is mostly deployed as infrastructure-as-a-service in both public and private clouds where virtual servers and other resources are made available to user



Nova Instance (container)
Nova Instance (container)
Hypervisor (Container Runtime)
Nova
OpenStack
openstack
Compute
Network
Storage



Test Case



· **16 CPU Host (HT-disabled)**

(1) 2CPUs – 4GB RAM VM(Con) x 8
(2) 4CPUs – 4GB RAM VM(Con) x 4
(3) 8CPUs – 4GB RAM VM(Con) x 2
(4) 16CPUs – 4GB RAM VM(Con) x 1

· **32 CPU Host (HT-enabled)**

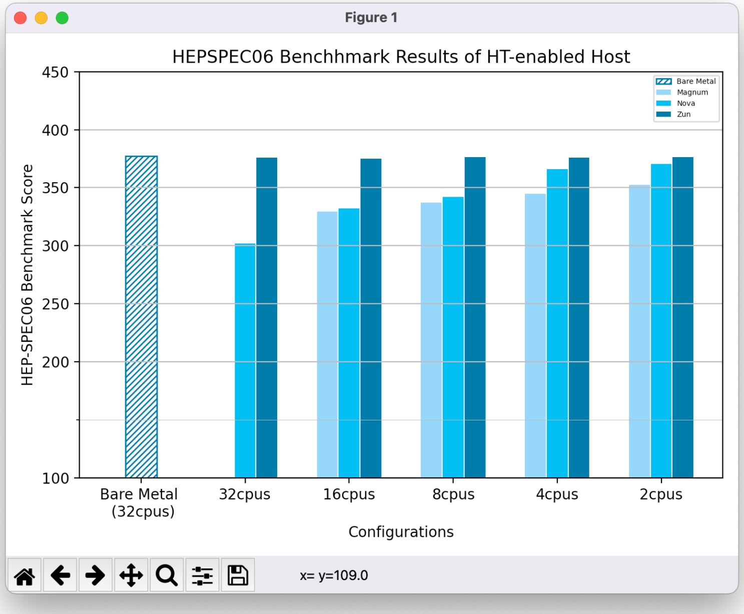
(1) 2CPUs – 4GB RAM VM(Con) x 16
(2) 4CPUs – 4GB RAM VM(Con) x 8
(3) 8CPUs – 4GB RAM VM(Con) x 4
(4) 16CPUs – 4GB RAM VM(Con) x 2
(5) 32CPUs – 4GB RAM VM(Con) x 1

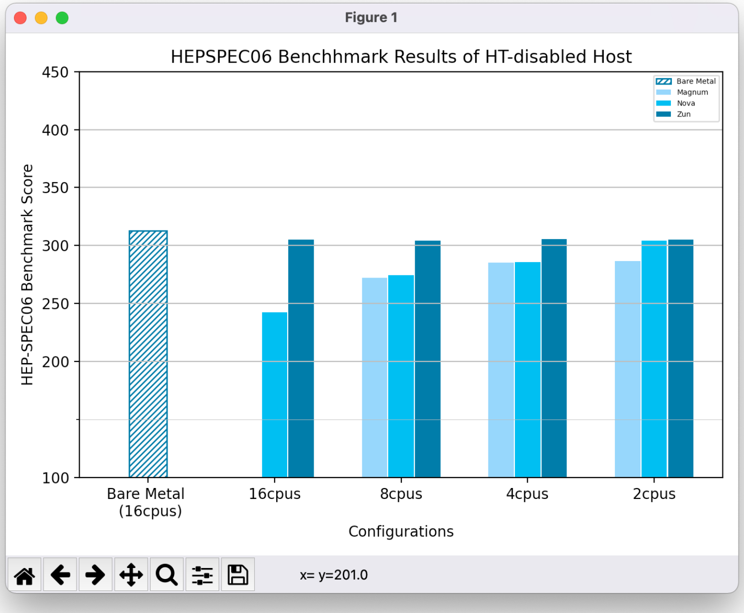
3. HEP SPEC Performance Comparison

HEP-SPEC06 Benchmark

It has been developed by the HEPiX Benchmarking Working Group in order to replace the outdated "kSI2k" metric.

The goal is to provide a consistent and reproducible CPU benchmark to describe experiment requirements, lab commitments, existing compute resources, as well as procurements of new hardware.

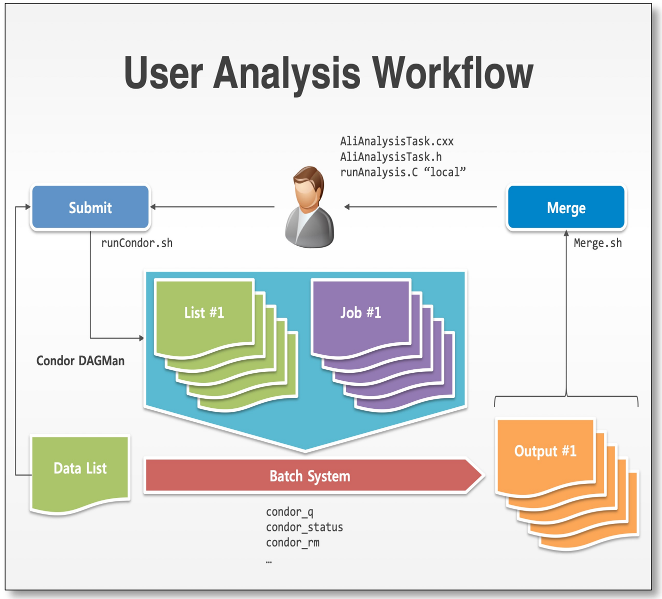


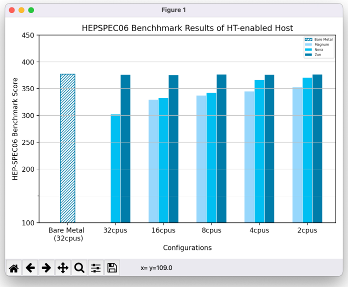


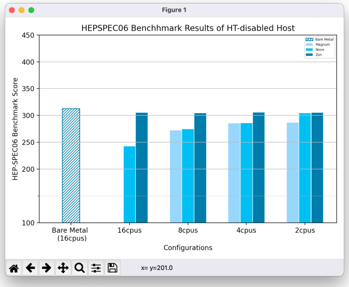
4. Plan

Future Plan

- Deriving benchmark results.
- Installing an experimental environment for HTCondor.
- HTCondor runtime time measurement and evaluation.







Thank you
for your attention.

KoALICE National Workshop 2021
(2022.1.4 – 1.7)

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