

ICT Based Research @ CApIC-ACE



17th June, 2020

A Presentation at the DSTN ACEPartners Online Seminar Series

CApIC-ACE Team Members



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1.0 INTRODUCTION

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❖ CApIC-ACE Research Projects – Specific Aim 5 (FEDGEN):

❖ Expand our existing High Performance Computing (HPC) facility to implement a federated cloud computing platform.

❖ This is to bring home genomic research to populations in Africa, customized to address specific issues of Health in Africa, namely *research capacity*, *health education*, *medication efficiency* and *enhancement of early disease diagnosis*.

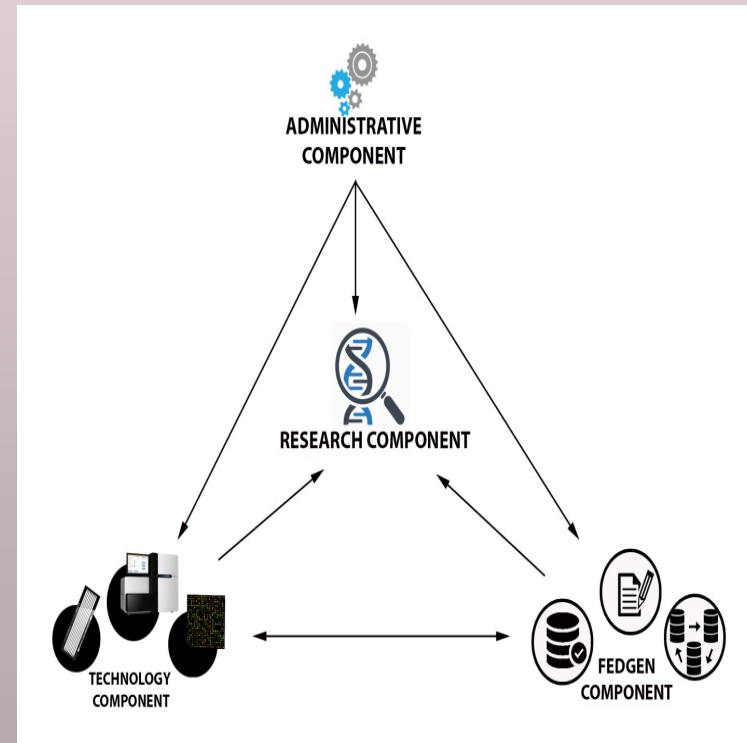


Fig 1.0: CApIC-ACE Components and Interactions

2.0 ONGOING ICT BASED RESEARCH @ CApIC-ACE

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2.1 Federated Genomic (FEDGEN) Cloud Infrastructure

Cloud Computing

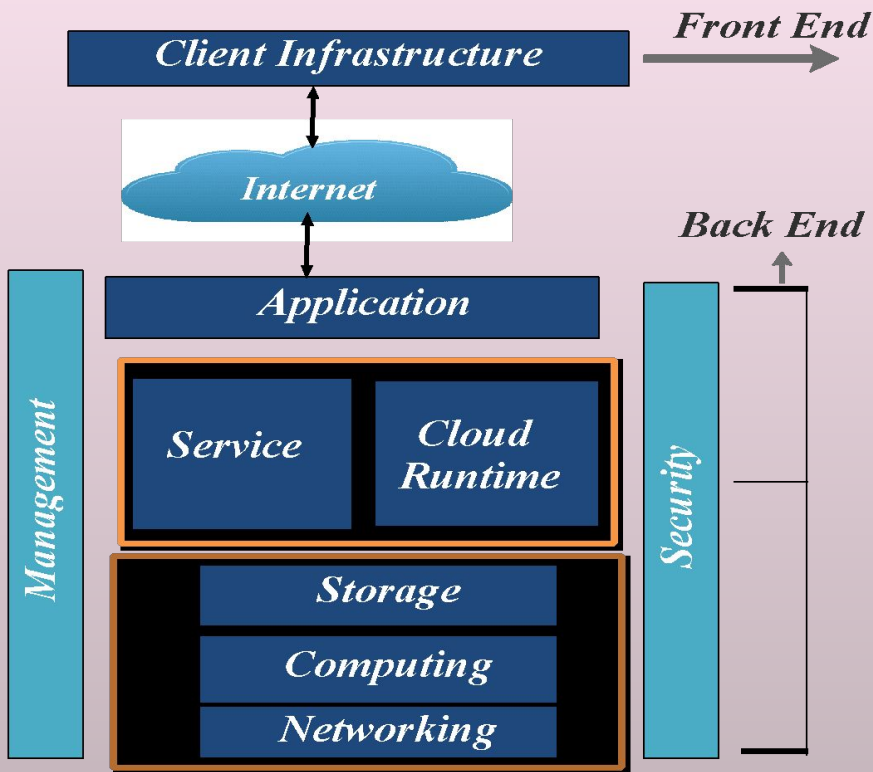
The fundamental idea of cloud computing is to deliver computational resources as services over the Internet (Habibi et al., 2019).



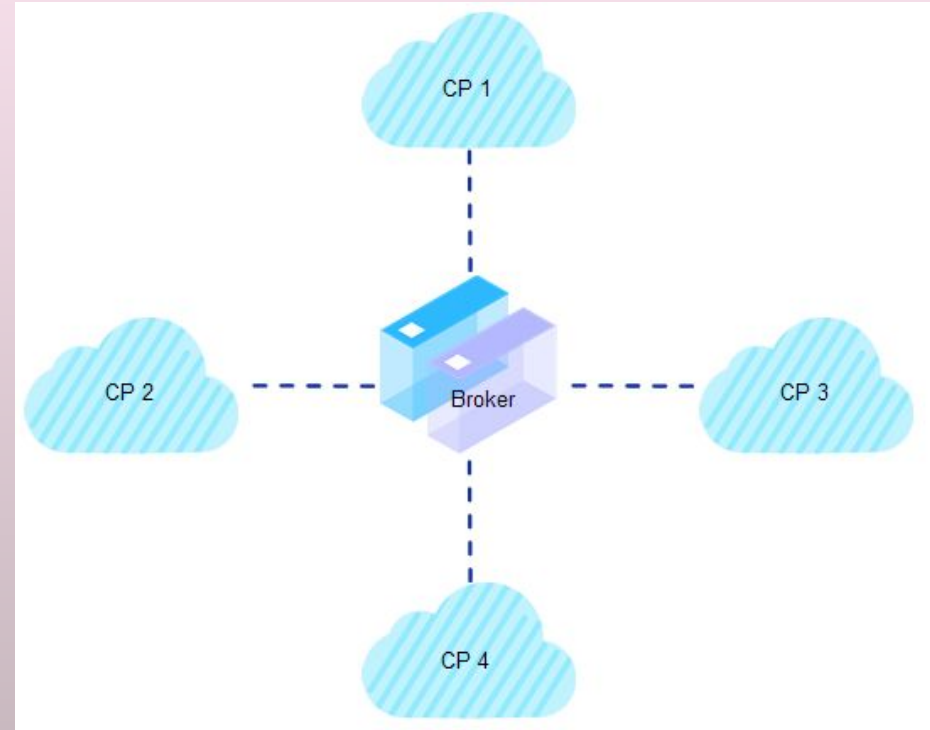
Federated Cloud

It is the deployment and management of multiple (external and internal) cloud platforms to share computing resources among collaborating institutions (Varghese & Buyya, 2018).





(a)



(b)

Fig 2.1: (a) Basic Cloud Computing Architecture (b) Federated Cloud Architecture (Habibi et al., 2019; Varghese & Buyya, 2018)

CP ≡ Cloud Provider

- ❖ The GAAR federated cloud architecture was extended to develop our FEDGEN cloud architecture (Fig. 2.2) with all regions adopting OpenStack as the cloud operating system (Fig. 2.3).

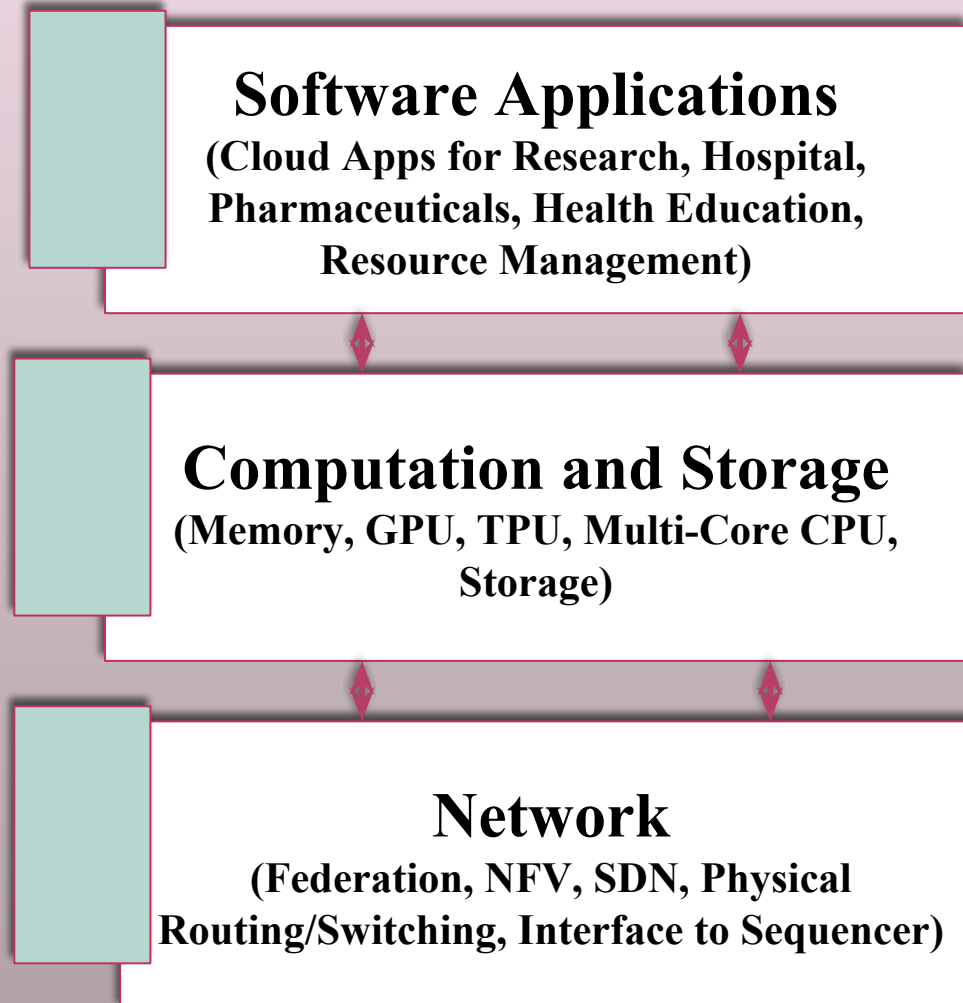


Fig 2.2: Layers in a FEDGEN Node

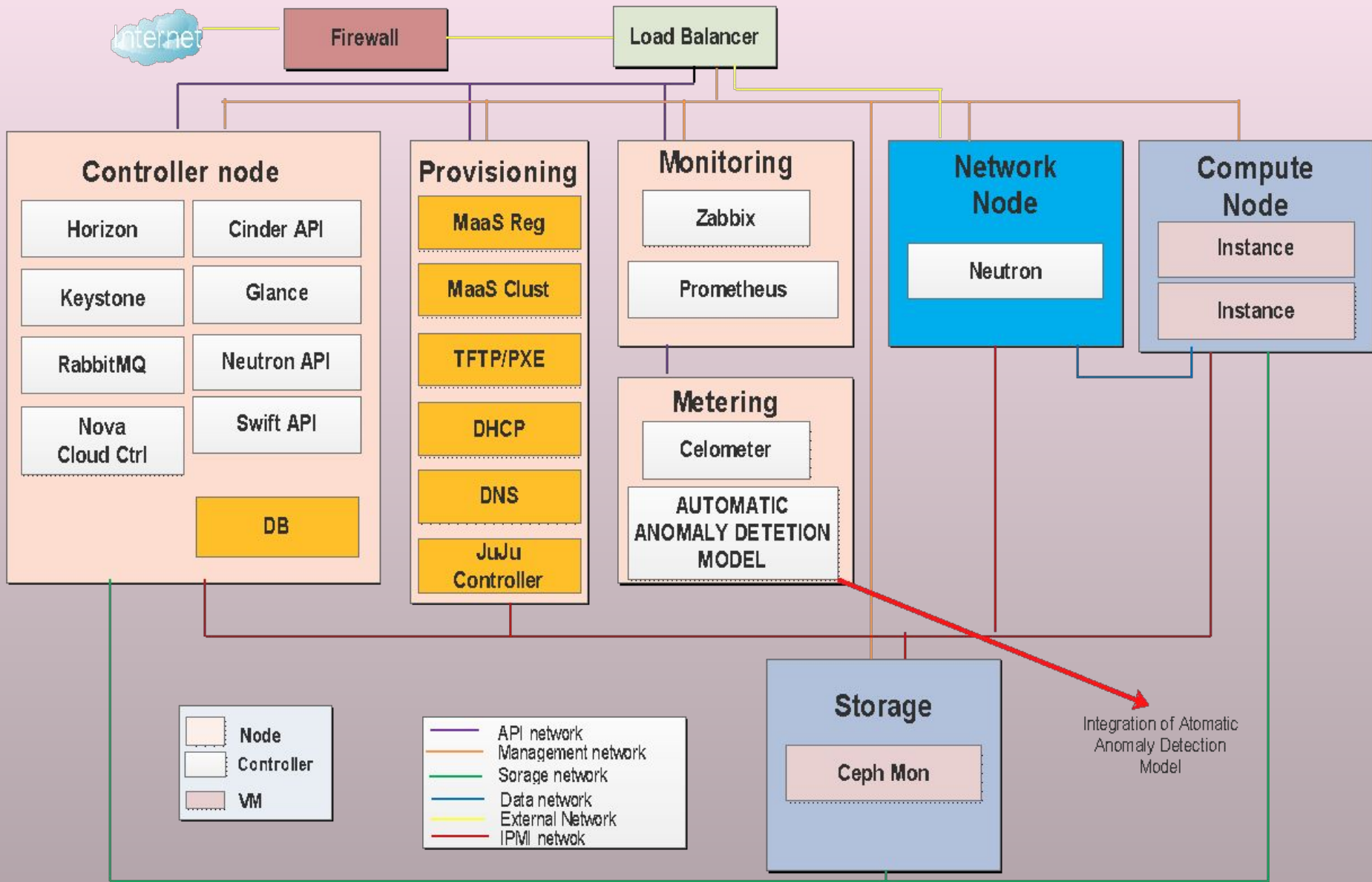


Fig 2.2: OpenStack Cloud OS Framework

2.2 Anomaly Detection in a Private Cloud

- In this ongoing study, we developed an anomaly detection model to be incorporated into the OpenStack cloud operating system leveraging on System Logs, Natural Language Processing (NLP) algorithms and Shallow Machine Learning (i.e. Support Vector Machine).

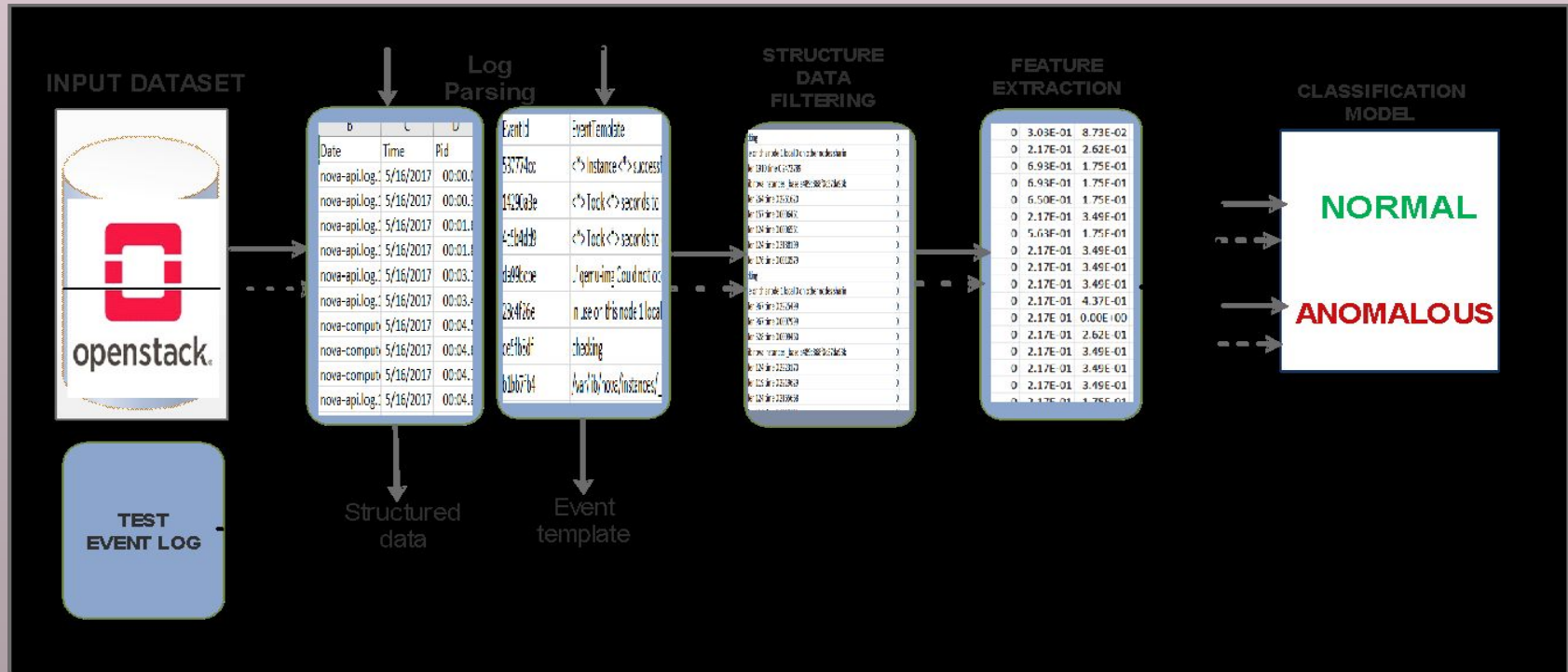


Fig 2.3: OpenStack Cloud OS Framework

- ❖ The log dataset utilized for the study was curated from Loghub (Zhu et al. 2019) and the computational blocks in Fig. 2.3 were implemented with Python 3.5.
- ❖ As a preliminary result, SVM classifier with linear kernel function (Fig. 2.4) gave the best result across all the metrics (testing time = 0.32min, accuracy = 100%, precision=1.0, recall = 1.0 and F-measure = 1.0).

Confusion matrix

Predicted	0	1196 50.81%	1196 100%
	1	49.19%	1158 100% ← Overall Precision
		1196	1158
			2354 ← Overall accuracy of 100%
	0	1	
		Actual	

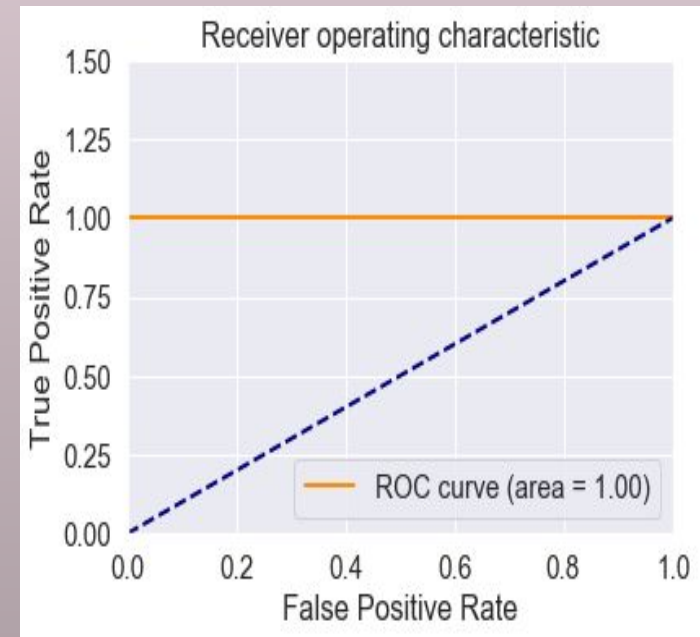


Fig 2.4: Confusion Matrix and ROC Curve for SVM Classifier with Linear kernel

Table 1: Performance Comparison Between DeepLog and Our Model

Metric	DeepLog (Du et al.,2017)	Our Model (Accepted for icABCD2020)
Recall	1.00	1.00
Precision	0.96	1.00
F-Measure	0.98	1.00

- ❖ This preliminary result has been accepted for the icABCD2020 – an IEEE conference to be held virtually in August 2020
- ❖ An M.Eng. student (from DRC) is currently working to extend the study to cover *more cloud based software applications(Linux, Spark, Hadoop, HDFS etc)*, achieve *federated anomaly detection* and ultimate *deployment on the OpenStack cloud OS*.

2.3 Federated Cloud Resource Management

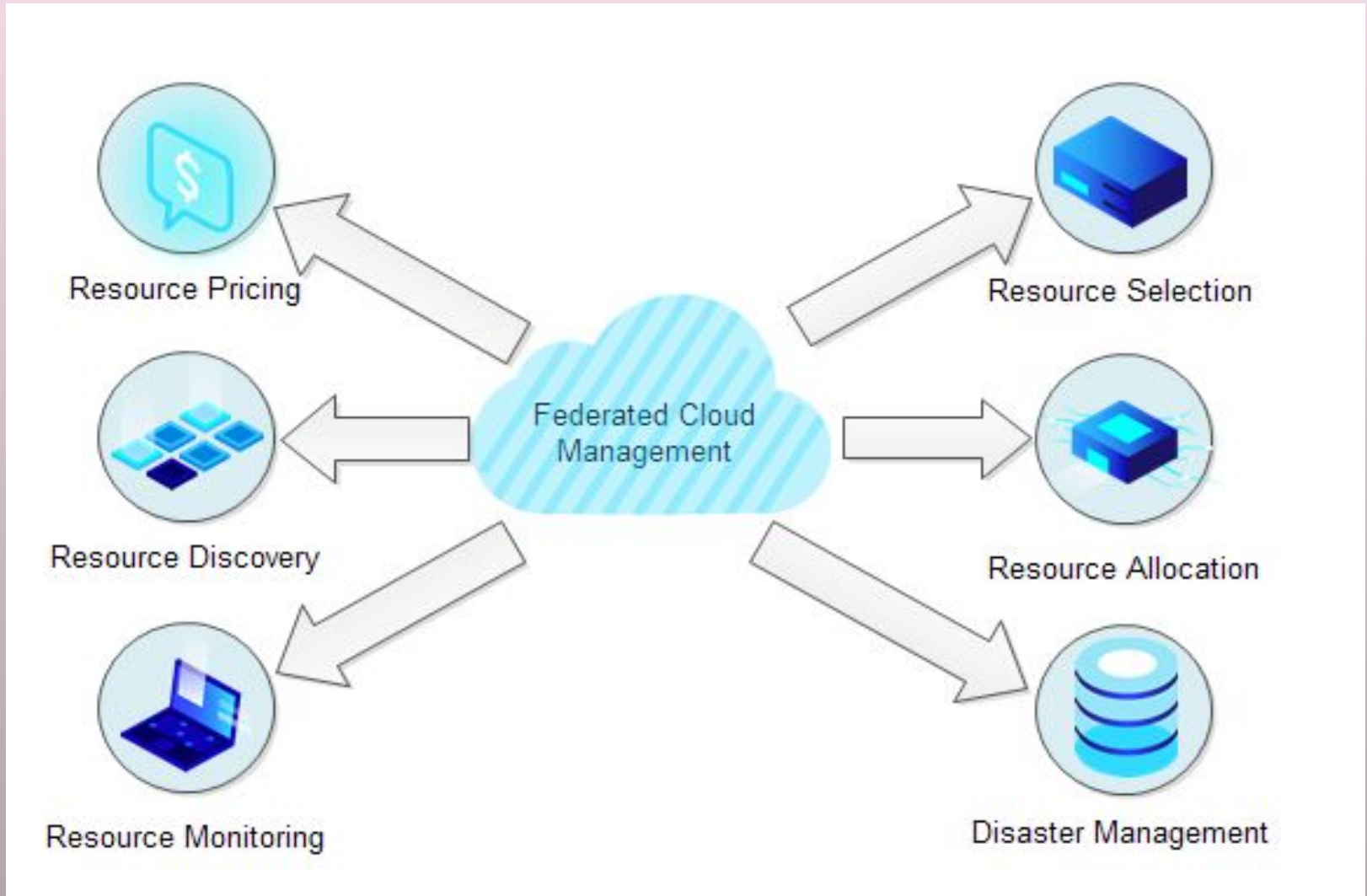


Fig 2.5: Components of Federated Cloud RM

❖ An M.Eng. Student(also from DRC) is working on *federated cloud resource monitoring* which provides(Syed et al., 2017) :

- ❖ Access control,
- ❖ Service elasticity,
- ❖ Service billing and
- ❖ Service Level Agreement(SLA) management.

❖ Another Ph.D student is working on *Multi-omics data integration* for the FEDGEN cloud infrastructure.

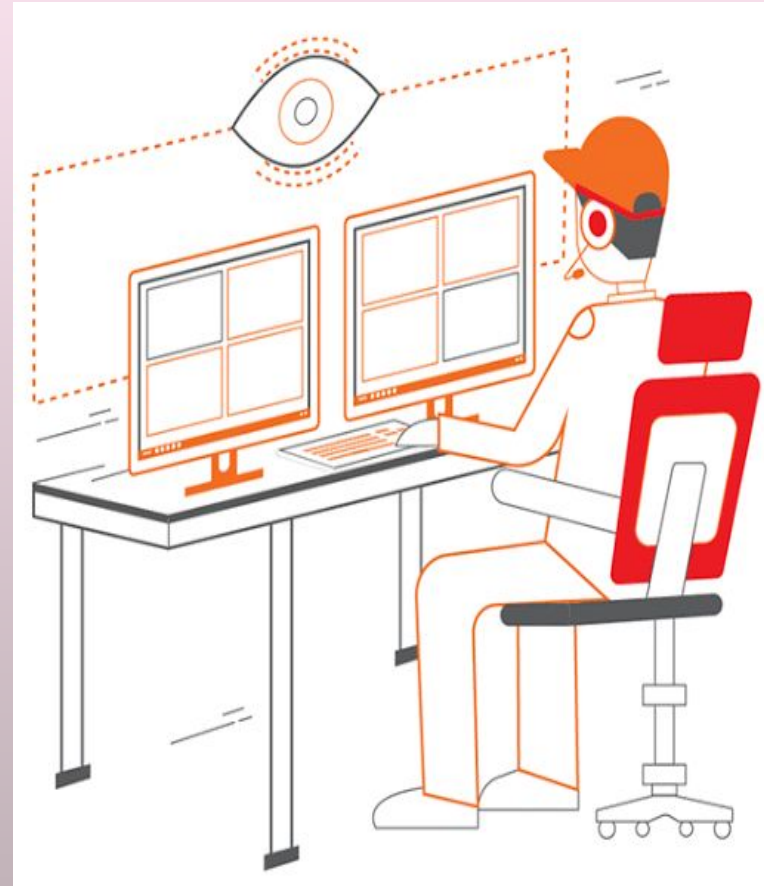


Fig 2.6: Schematic of Federated Cloud Resource Monitoring

3.0 RESEARCH INFRASTRUCTURE @ CApIC-ACE

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3.1 FEDGEN Testbed

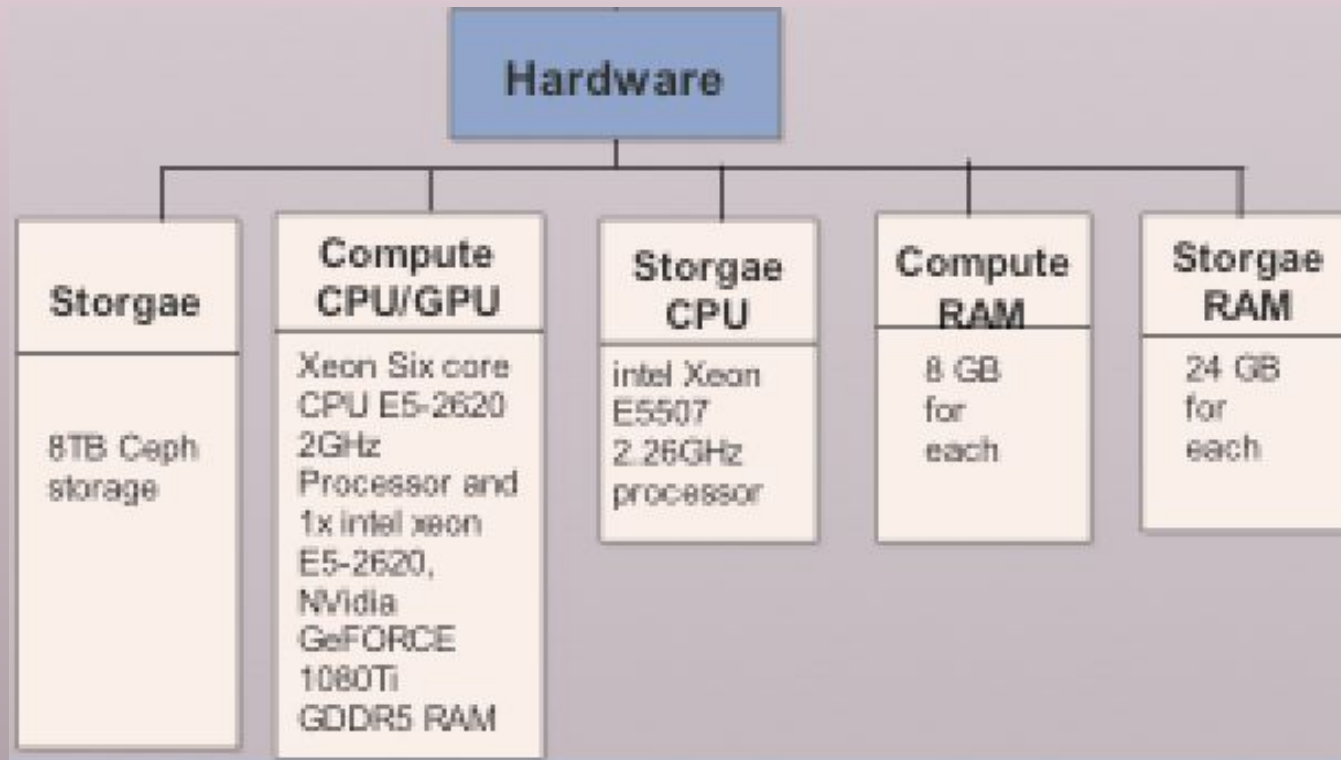


Fig 3.1: FEDGEN Testbed Hardware Components



Fig 3.2: FEDGEN Testbed in the Lab

3.2 High Performance Computer (HPC)

- ❖ The center currently has an installed HPC from an existing NIH grant.
- ❖ Some of the software applications currently running on the HPC are FASTQC, STAR, Trimmomatic, Trim_galore, Picard and R Studio.
- ❖ This infrastructure will be upgraded with additional HPCs to evolve a FEDGEN Cloud Datacenter.



Model: Dell PowerEdge C6145
CPU: 64 CPUs x AMD Opteron™ Processor 6386SE, 2.8GHz
Memory: 512 GB RAM
Storage: 101TB



4.0 CONCLUSION

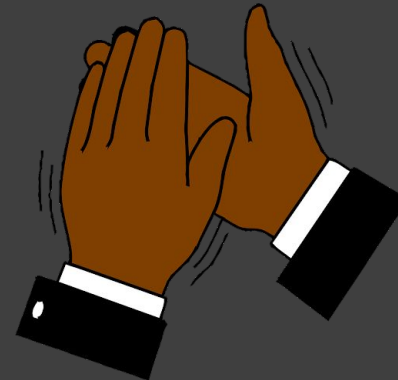
The FEDGEN project is a bold step to develop home grown private cloud infrastructure and capacity within the African space. We believe collaboration with other ACEs within the ACEPartners Digital Science and Technology Network (DSTN) will further strengthen our ability to achieve more cutting edge results.



Thanks For Your Attention

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