UNIVERSITY of BRADFORD

MPhil to PhD Progression Presentation on

Fault Tolerance in Cloud Computing Environment

By

Bashir Mohammed,

School of Electrical Engineering and Computer Science
Cloud Modelling and Simulation research group
University of Bradford,
Bradford, BD7 1DP UK
B.Mohammed1@Bradford.ac.uk

Supervisors: Prof I-U.Awan, Dr. Mariam Kiran

Presentation Outline

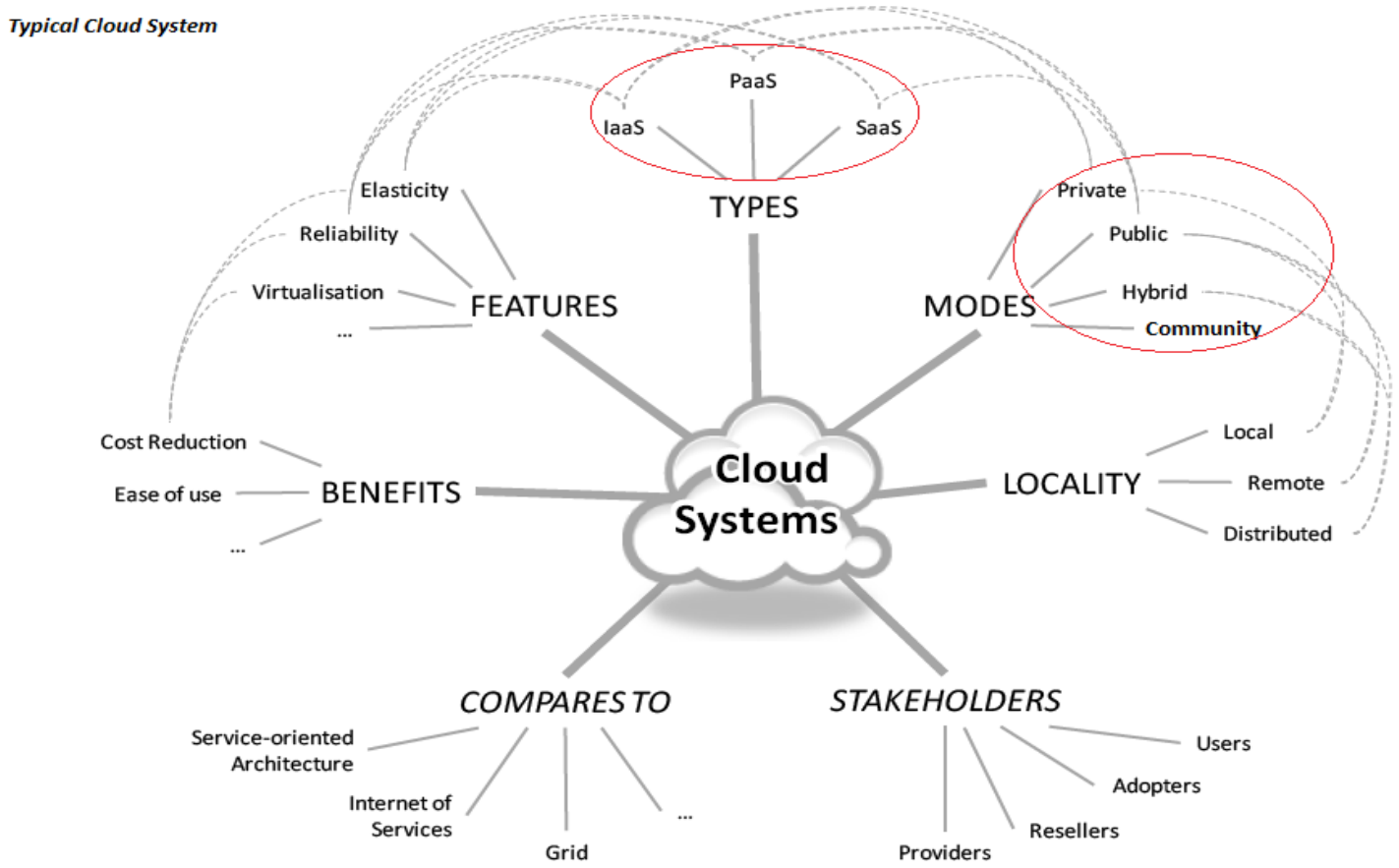
- Introduction
- Research 1– Analysis of Cloud Testbed using OSS
- Research 2 – Experimental Case Study using OpenStack
- Research 3 – Fail Over Strategy for Fault Tolerance in Cloud
- Research Progression
- Conclusion & Future Work

UNIVERSITY of BRADFORD

Analysis of Cloud TestBed using OpenSource Solution

RESEARCH 1

Introduction



- ✓**Suitability of software** tools
- ✓**Compatibility**
- ✓**Scalability**
- ✓**Interfaces**
- ✓**Parameters** for creating and deploying Cloud testbeds

Problem Statement

- A comprehensive guide to build a robust cloud infrastructure is not very common.
- Unavailability of guidelines for building and managing such infrastructures.
- In Academics, open source solutions are mainly used because of interchangeability between different organizations, and ***proprietary software requiring funds***, which is one of the major challenge.

Research Objective

To discuss the concepts of virtualization from a practical point of view:

We Present an in-depth critical analysis of **EIGHT** open source cloud implementation tools.

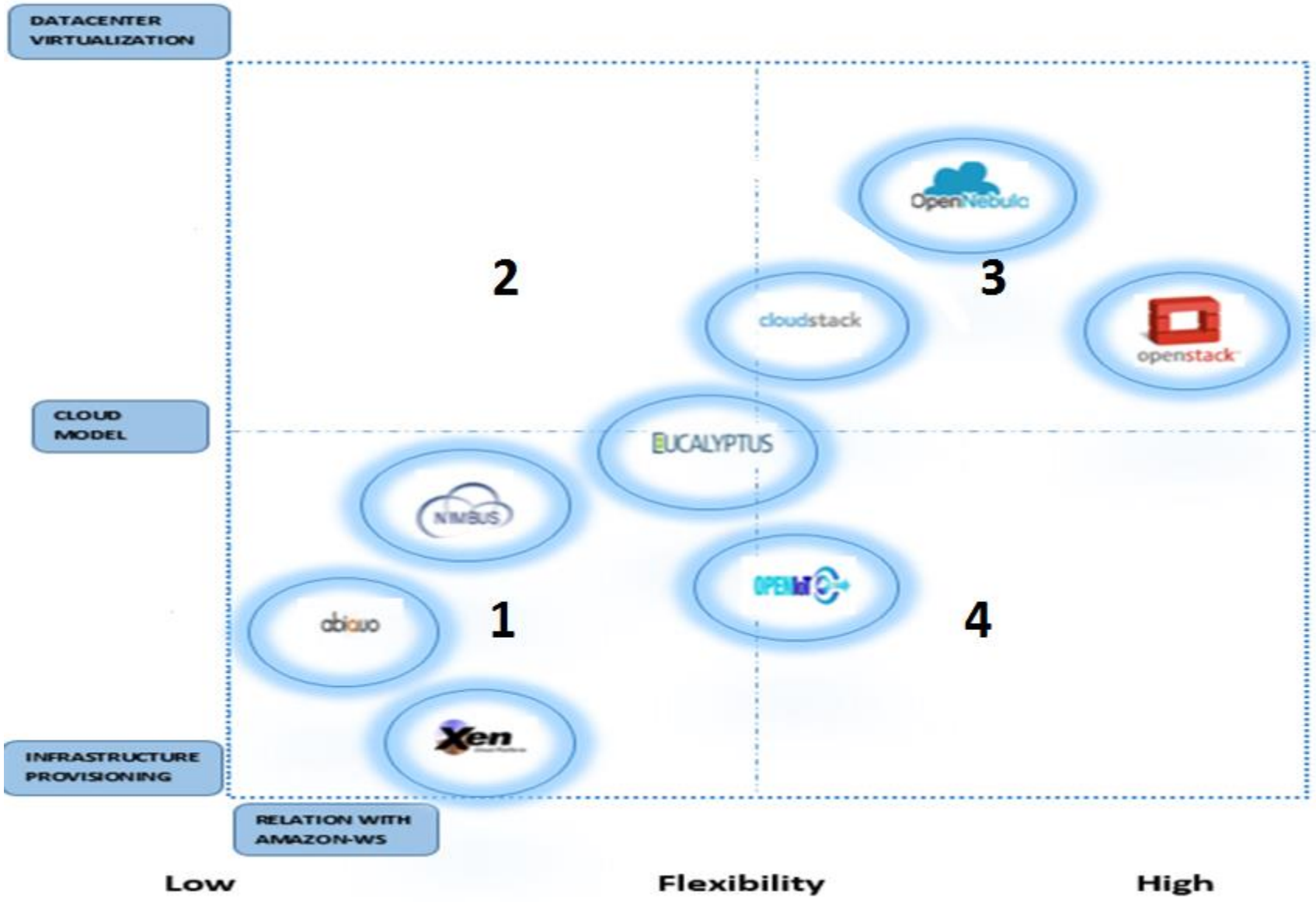
Analyze the various toolkits, parameters of these tools, and their usability for researchers looking to deploy their own Cloud testbeds.

Develop an experimental case study using **OpenStack** to construct and deploy a testbed using current resources available.

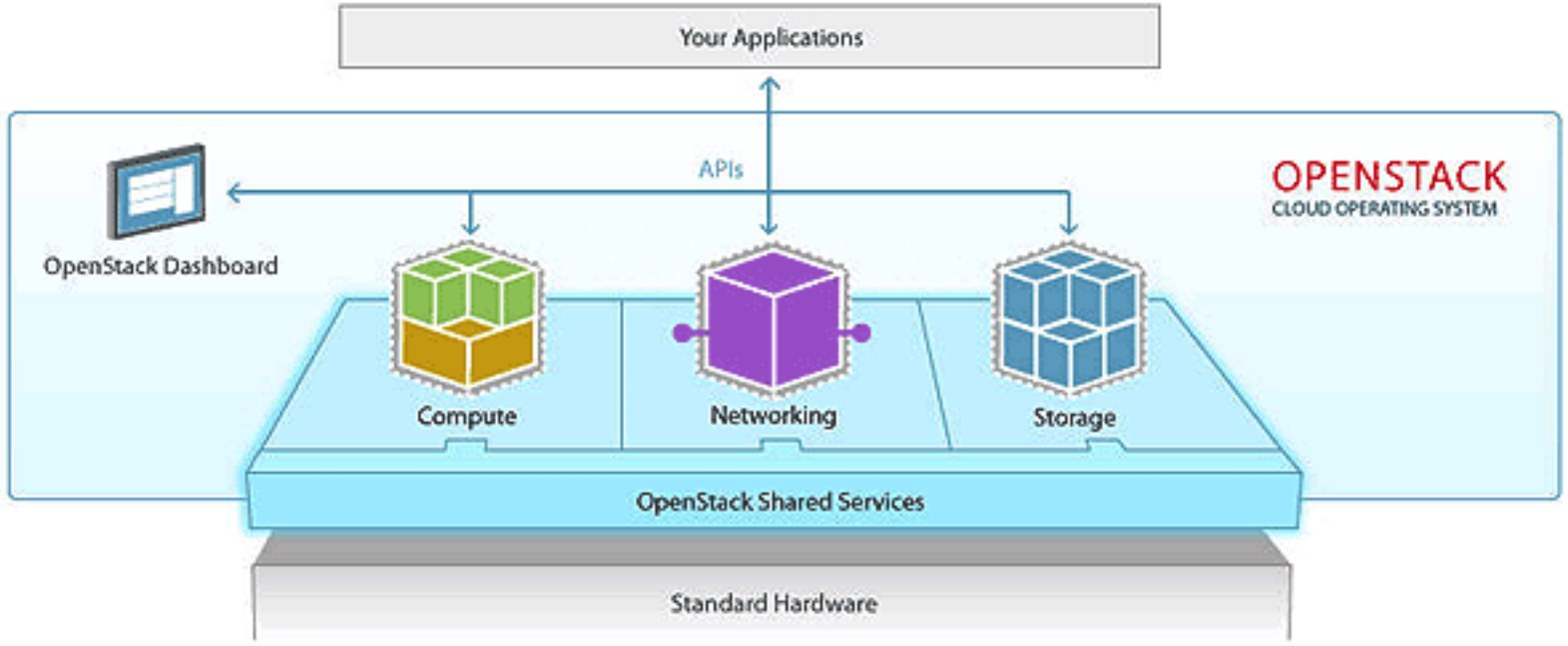
COMPARATIVE ANALYSIS OF CLOUD TOOLS

	EUCALYPTUS	CLOUDSTACK	OPENSTACK	OPENEBULA	NIMBUS	XCP	ABICOUD	OPEN-IOT
YEAR/LICENSE DEV. BY	2008/GPL UNI.OF CALIFONIA	2008/ GPL CLOUD.COM	2010/APACHE LICENSEV2/ RACKSPACE, NASA	2005/APACHE LICENSE V2/ EU	2009/APACHE LICENSE V2/ UNI.OF CHIC.	2012/GPL/ CITRIX XEN SERVER	2009/GPL/ ABICO	2013/GPL/ EU- dev. In frmwk for IERC
HYPERVISOR SUPPORTED	XEN,KVM,VM WARE	XEN SERVER, XCP,KVM,VM WARE	VMWARE, ESX ESXi,HYPERV, XEN,KVM, V- BOX	XEN KVM VMWARE vCENTER	XEN+KVM	XEN	XEN,V-BOX KVM, VMWARE	VDK,VIRTUAL BOX,VMWARE
ARCHITCTURE	CC,WALRUS, CLUSTER-C, STORAGE-C	MONOLITHIC (Reduced installation flexibility)	DISTRIBUTED COMPUTE(NOVA) OBJECT,STORAGE (SWFT)IMAGE SERVICE (GLANCE)	CLASSICAL CLUSTER	VIRTUAL CLUSTER	CENTRLZD. 3 COMPONENT S.MIN.OF 2 SERVERS	CENTRLZD. 3 COMPONEN TS.MIN.OF 2 SERVERS	IOT CC, MESSAGE BROKER, SENSOR CLIENTS
R/SHIP WITH AMAZON/ TARGET USERS	EMBRACES AWS API/ ENTERPRISE	YES/ ENTERPRISE	YES/ENTERPRISE, SERVICEPROVIDERS RESEARCHERS	YES/ ENTERPRISE	YES/SCIENTIFIC COMMUNITIES	YES/ ENTERPRISE	NO/ ENTERPRISE	YES SENSOR API,CLIENT'API/ ENTERPRISE
CLOUD IMPLEMEN-TATION	PRIVATE CLOUD	PRIVATE & PUBLIC	PRIVATE & PUBLIC	PRIVATE, PUBLIC & HYBRID	PRIVATE, COMMUNITY	TUNKEY VIRTUIZATION	PRIVATE, PUBLIC	SENSOR – CENTRIC PRIV.& PUB.
DATABASES/ PROG.FRAM	POST GRE SQL/ JAVA,C, PYTHON	MYSQL/JAVA, PYTHON	SQLITE3,MYSQL & POSTGRE,SQL/ PYTHON,XML,JAVA SCRIPT	SQLITE,MYSQL/ C++, C+, RUBY, JAVA, SHELL SCRIPT	POSTGRE SQL/ JAVA PYTHON	VASTSKY/ OCALM LANG.	HDFS	MYSQL/ JAVA
OS-SUPPORT	GNU,LINUX	GNU,LINUX	CENTOS-OS, DEBIANFEDORA RHEL, UBUNTU	CENTOS-OS, DEBIANFEDORA RHEL, UBUNTU	MOST LINUX DISTRIBUTION	LINUX,FEDOR A,RHAT,CENT OS	LINUX,UBUN TU,CENTOS, WINDOWS	MOST LINUX DIST. & CROSS PLATFORM
LOAD BAL. /FAULT TOL.	CC/ CLUSTER CONTROLLER'S SEPERATION	CLOUD-C/ REPLICATION	CLOUD-C/ REPLICATION	NGIX/DATABASE BACKEND	LE CONTEXT BROKER/PERIO DIC VERIFICTN OF C-NODE	XAPI /VM STATE SYNC.	ABI SERVER /NO	CC/NO
VM MIG. SUP.	NO	YES	YES	YES	NO	YES	NO	NO
ACCESS INTERFACE	EC2 WS API	WEB INTERFACE	WEB INTERFACE	EC2 WS API OCCI API	ECS WS API NIMBUS WSRF	CMD LINES	WEB INTER.& ADOBE FLEX	WEB INTERFACE

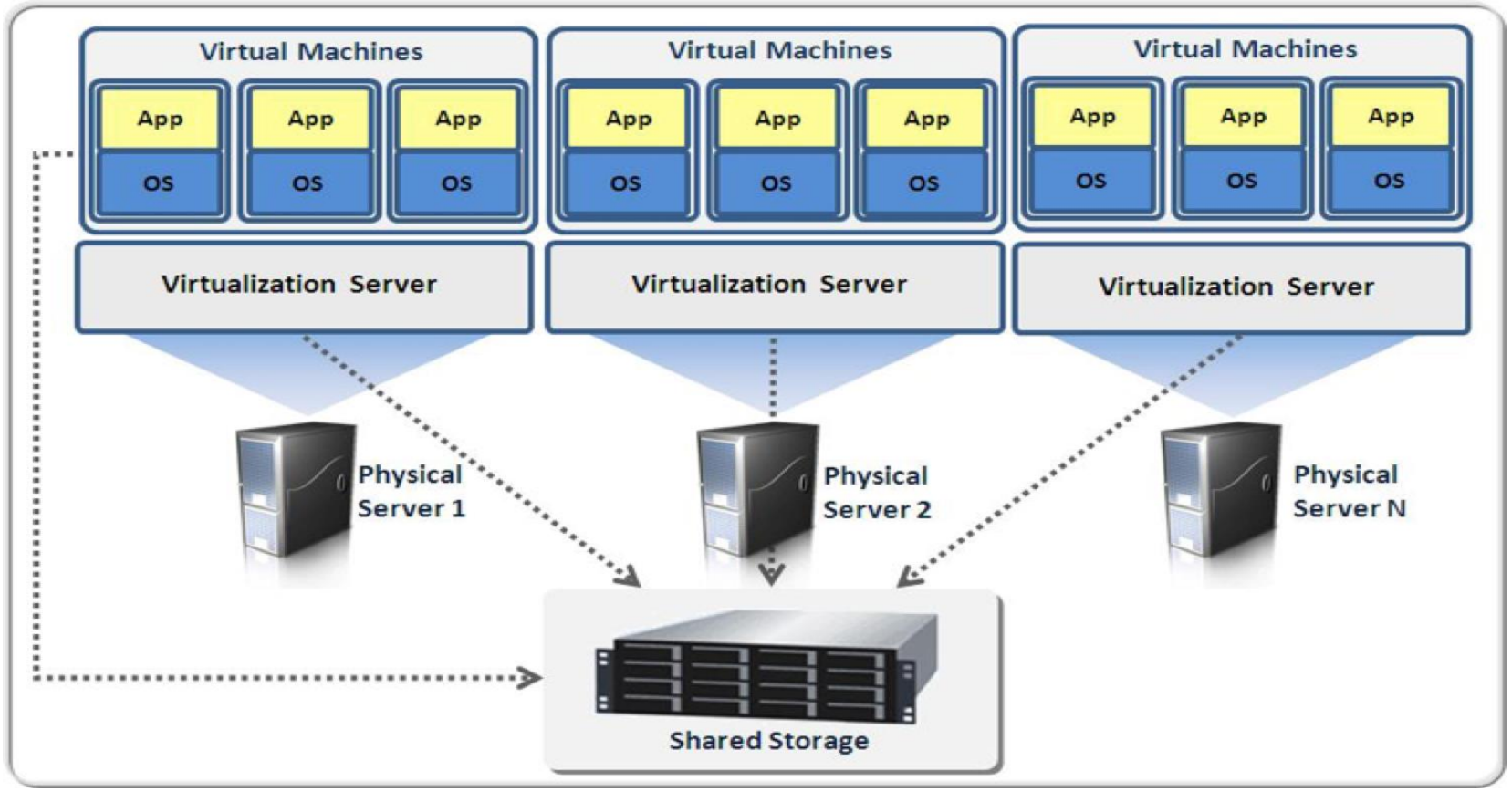
CMP MAGIC QUADRANT



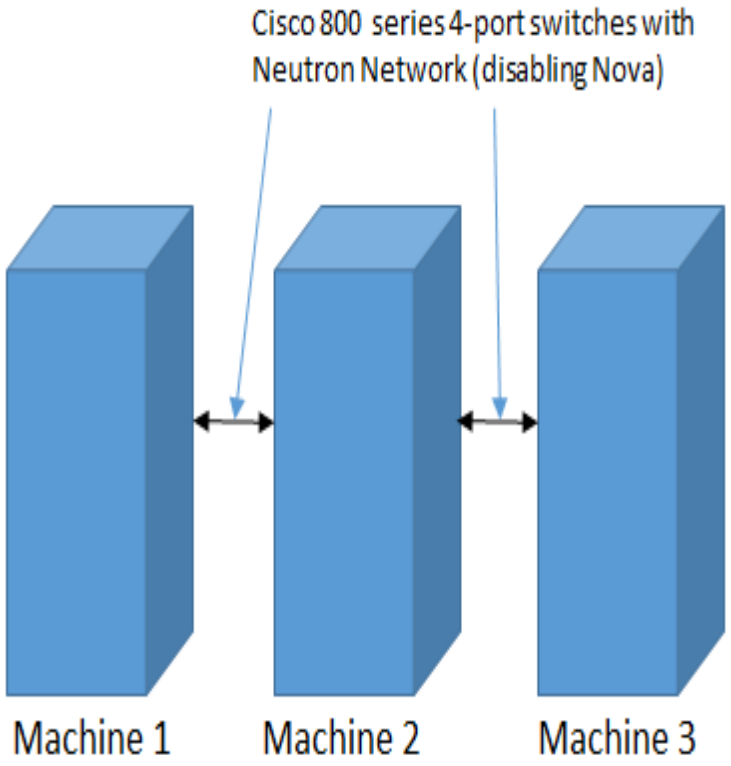
OpenStack


Your Applications
APIs
OPENSTACK
CLOUD OPERATING SYSTEM
OpenStack Dashboard
Compute
Networking
Storage
OpenStack Shared Services
Standard Hardware

Experimental Setup



Experimental Setup

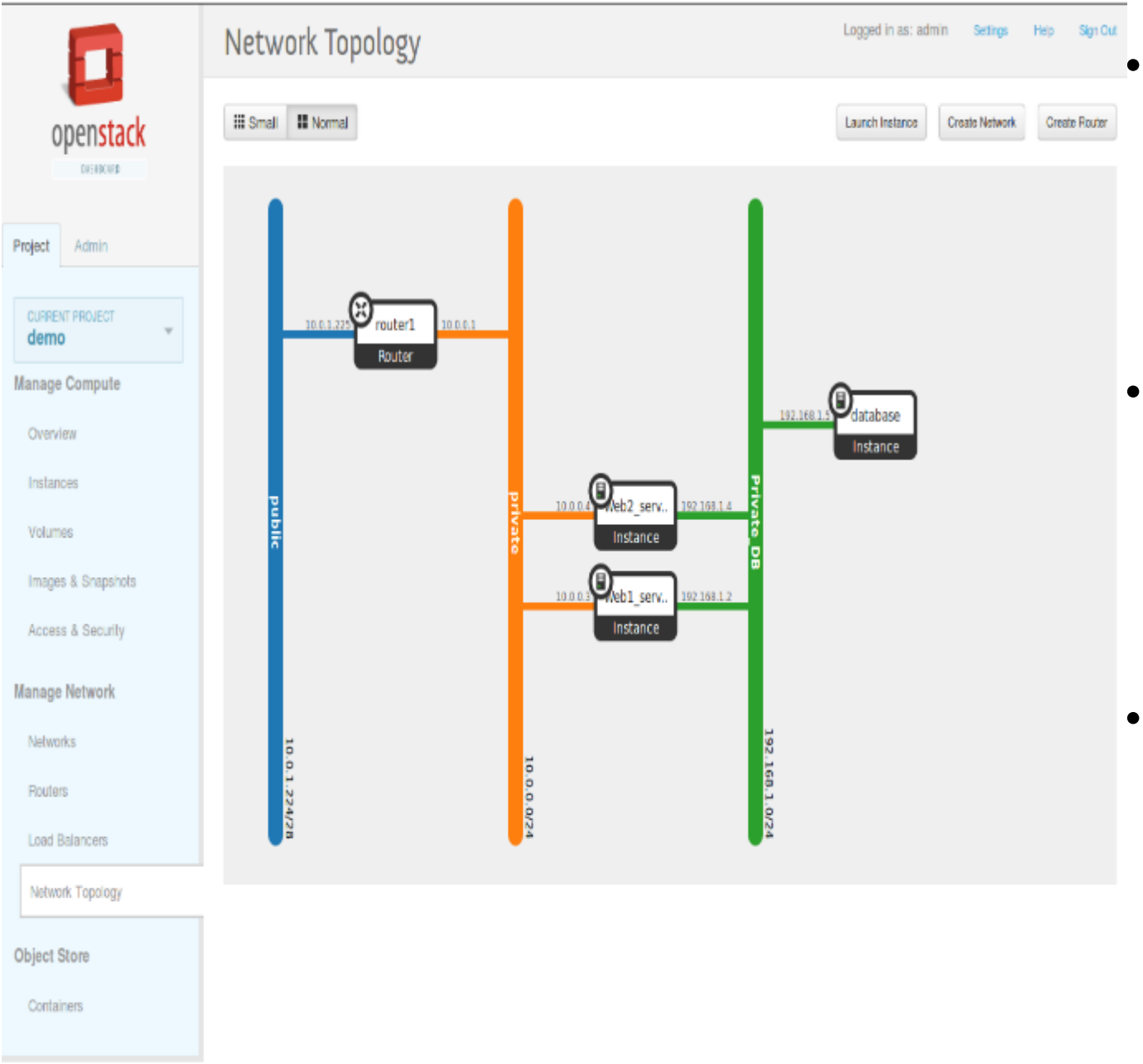


The testbed was constructed using three hosts:

- The first server hosts a WEB service
- The second server hosts a DATABASE service.
- The third server hosts the application.

These exact physical servers, network equipment and their configurations were replaced by spinning up virtual instances on the testbed.

Topology



- To show a PoC highlighting steps involved in setting up a cloud lab for testing and experiments at UOB.
- We also performed a further experiment of LB solution by building a pool using the Round Robin method on HTTP protocol.
- The Virtual IPs were created to freely float between cluster nodes for the pools created.

Conclusion and Future Work

The comparative analysis of the most popular and commonly used open source cloud platforms;

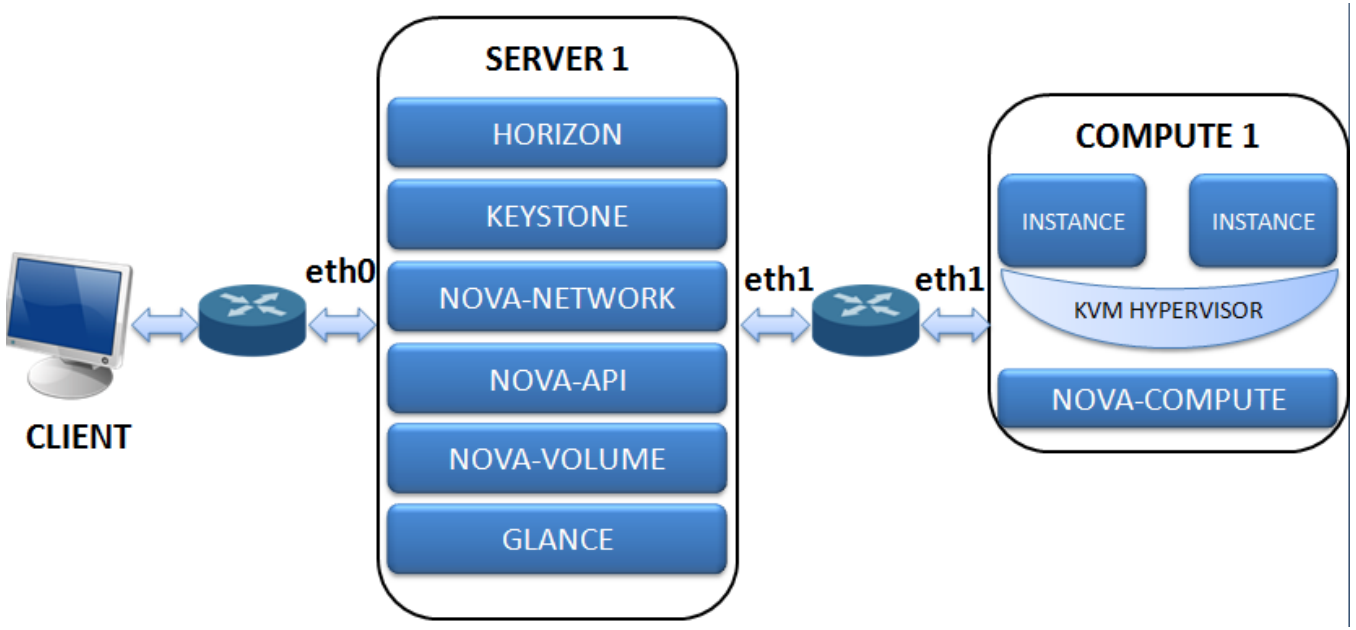
- Will allow Users, Research groups, administrators and interested readers to choose the most suitable services according to their requirement and understand the features or characteristics of the tool.
- This will also aid in making a more unified decision on the open source cloud platform according to their **compatibility, interfaces, implementation, deployment and scalability.**
- Further work on load balancing of client traffic from one network to application services and Fault tolerance will be considered.

RESEARCH 2

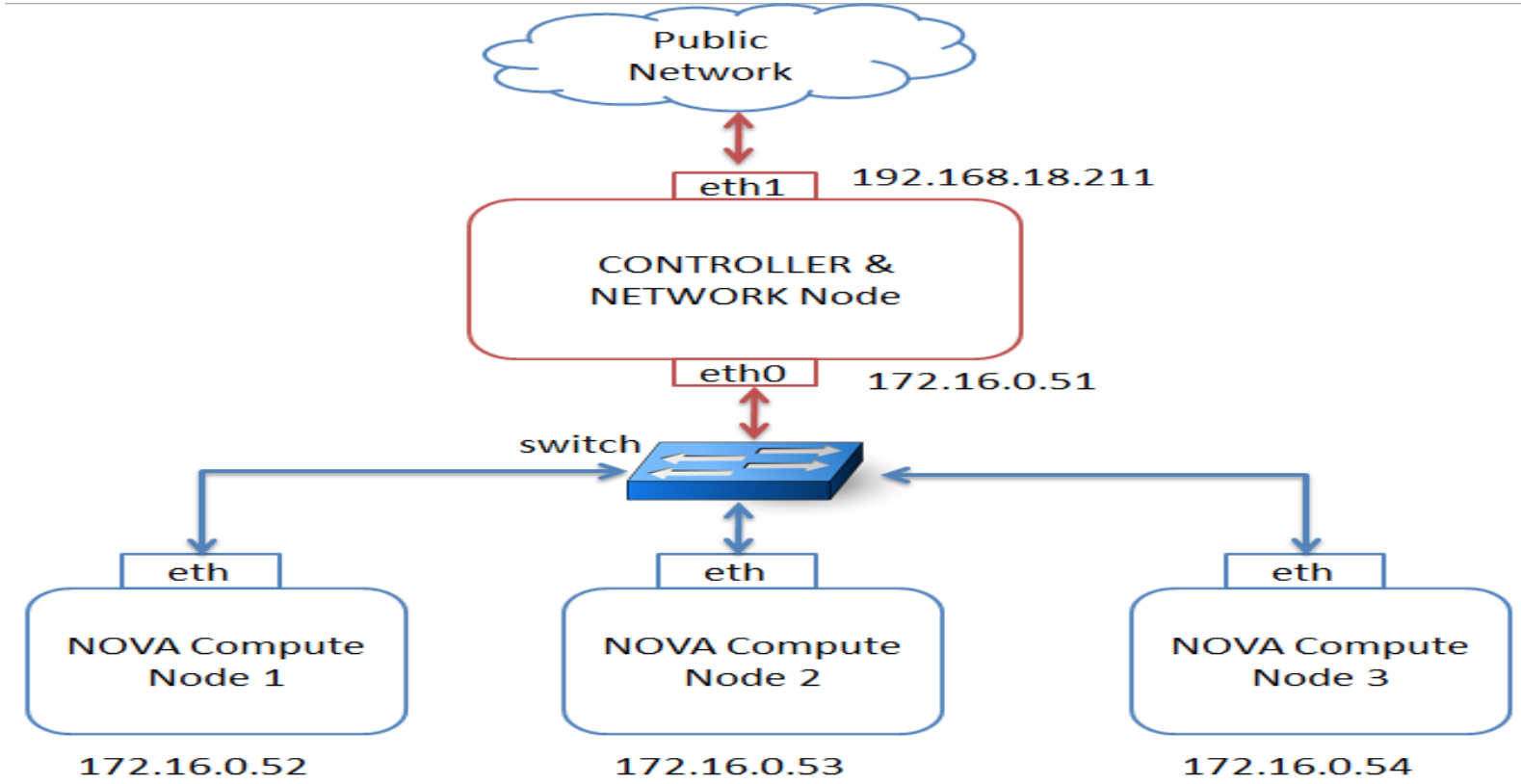
Experimental Case Study using OpenStack

RESEARCH 2

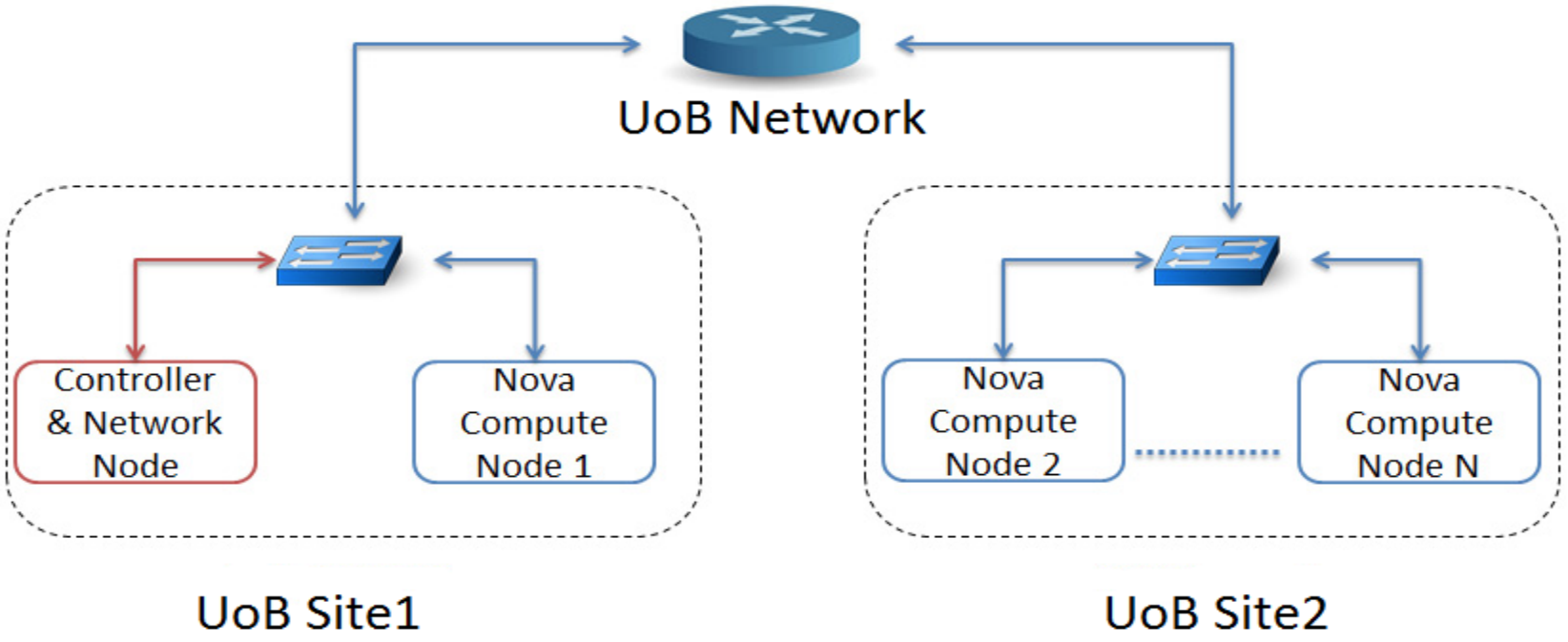
Single Node Deployment Architecture(SNA)



Multi-Node Architecture(MNA) (Private)

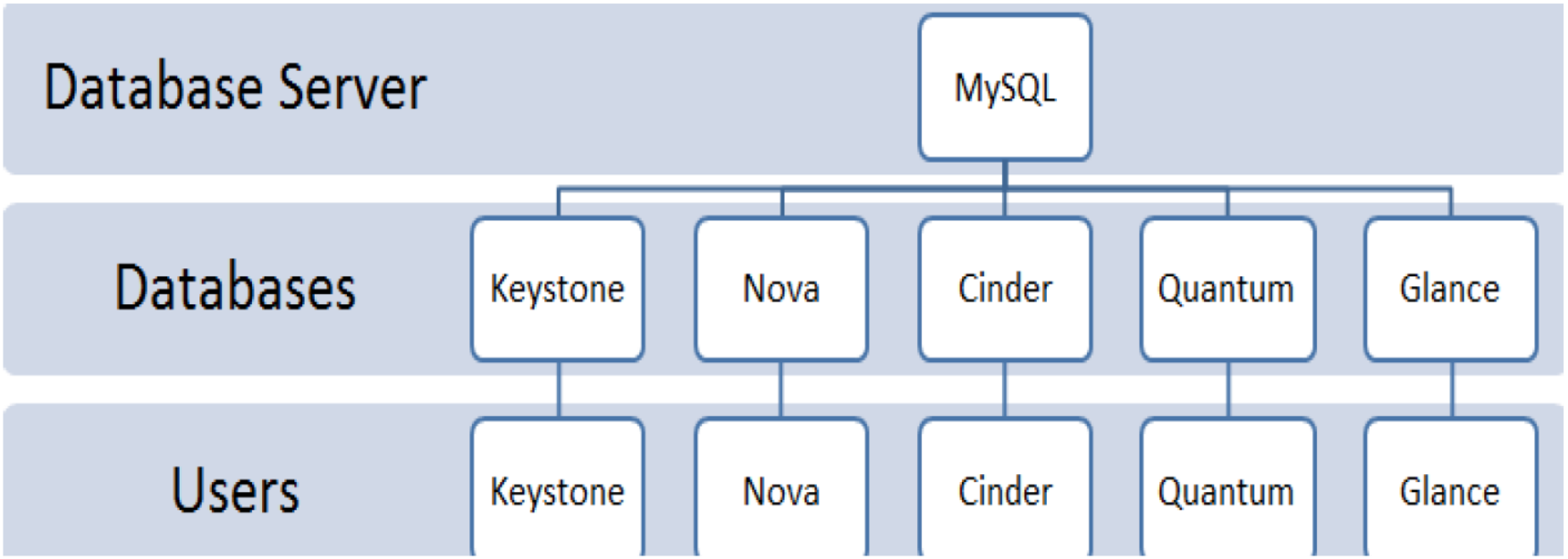


Multi-Node Architecture(MNA) (Public)



University of Bradford geographically separated nodes.

Database Layout



On-going Research

- CPU utilization at Compute-Node when instance are created.
- Network statistics and Network Utilization on the Controller-Node during instance creation
- Fault Tolerance in the VMs
- FT in HPC Clusters
- Supporting Research Group or Projects requesting for additional resources to support their research as well as experimenting Use-Case scenarios.

Challenges and Proposed Solution

INFRASTRUCTURAL CHALLENGE:

1. AWS Grants for Research and Education.
2. Our Industrial Partners(Sardina Systems)–providing us with a dynamic and scalable OpenStack platform.
3. Internship with the Apollo HPC Cluster at the University of Sussex.UK(over a Million Pounds infrastructure with about 3000 cores and Petabytes Storage)

- ✓ Weather Forecasting
- ✓ Markov Models
- ✓ Image processing
- ✓ Virtual screening (e.g. in drug discovery)
- ✓ parameter exploration (simulations)
- ✓ Statistical analysis (e.g. bootstrap analysis)

RESEARCH 3

UNIVERSITY of BRADFORD

Optimal Checkpoint/Replay Strategy for Fault Tolerance in Cloud

RESEARCH 3

Research Objective

- To develop a Smart failover-fault tolerance approach for cloud data centers, using the pass rate of computing virtual nodes, Decision mechanism algorithm and a Fault manager by integrating it with cloud virtualization.

- To conduct a performance comparison of existing methods with our proposed method.

- To validate our approach through experimental results and Mathematical model.

Research problem investigated and why?

- Possible failures emerging within the cloud infrastructure and subsystem.
- Failures in real time cloud applications running on virtual machines in a cloud environment.

Why??

In other to ensure High-availability, stability and reliability in cloud systems. Proactive preventives measures are needed.

For instance:

- In August 2015 HSBC system failure delays 275,000 payments due to IT glitch.
- A 20 % revenue loss was reported by Google due to an experiment that caused an additional delay of 500ms in response time[7].
- Million of customers were left without Internet access for 3days when a core switch failure occurred affecting BlackBerry's network.
- A minor failure that occurred in one of UK's top cellular lasted for three days affecting about 7million subscribed customers[7], [8].

In August 2015 HSBC system failure delays 275,000 payments due to IT glitch[5].

A 20 % revenue loss was reported by Google due to an experiment that caused an additional delay of 500ms in response time[7].

Million of customers were left without Internet access for 3days when a core switch failure occurred affecting BlackBerry's network.

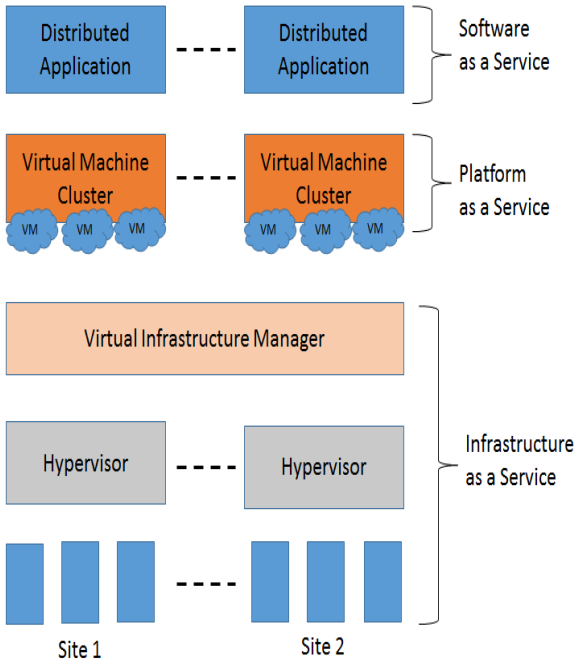
A minor failure that occurred in one of UK's top cellular lasted for three days affecting about 7million subscribed customers[7], [8].

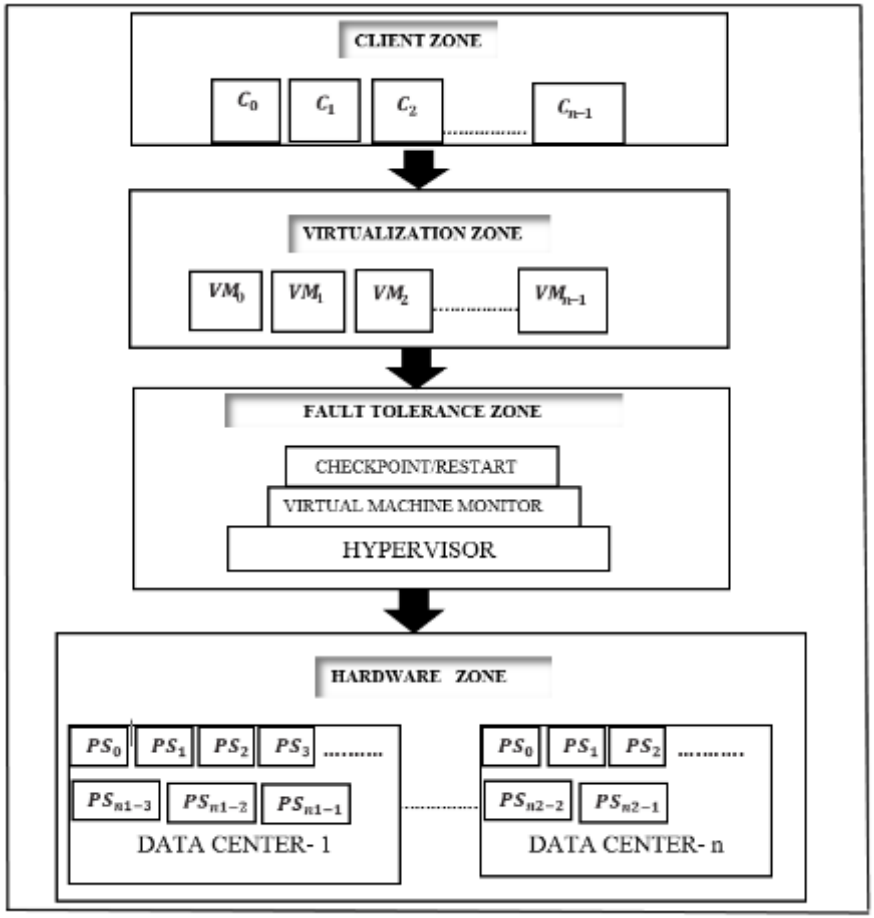
Amazon reported a 1% decrease for an additional delay of 100ms in search result[9]

Motivation

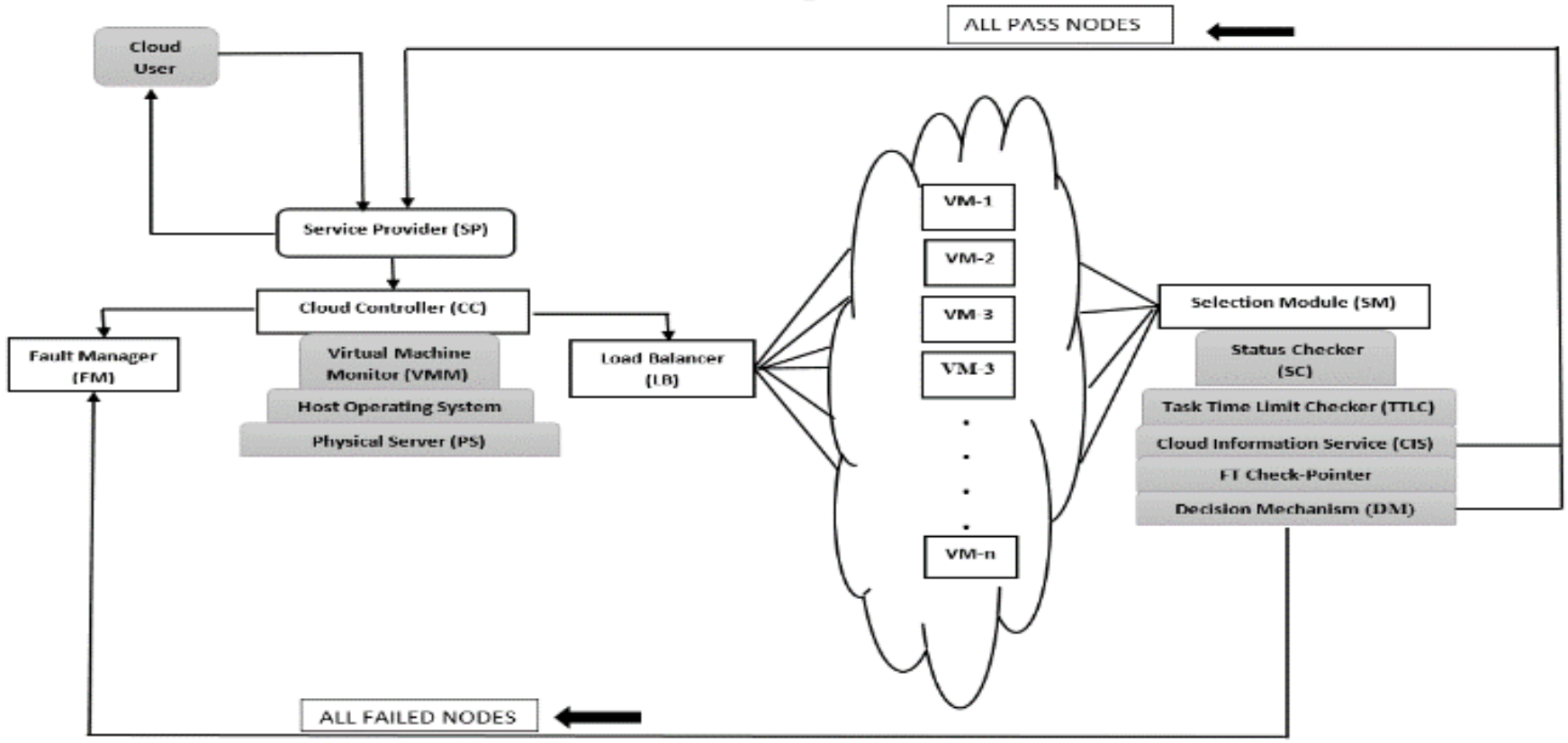
- Growing amount of datacenter resources presents the infrastructure of ICT services at a global proportion, and cloud users employ this services to handle business-critical and high computing processes

Fault Tolerance Architecture

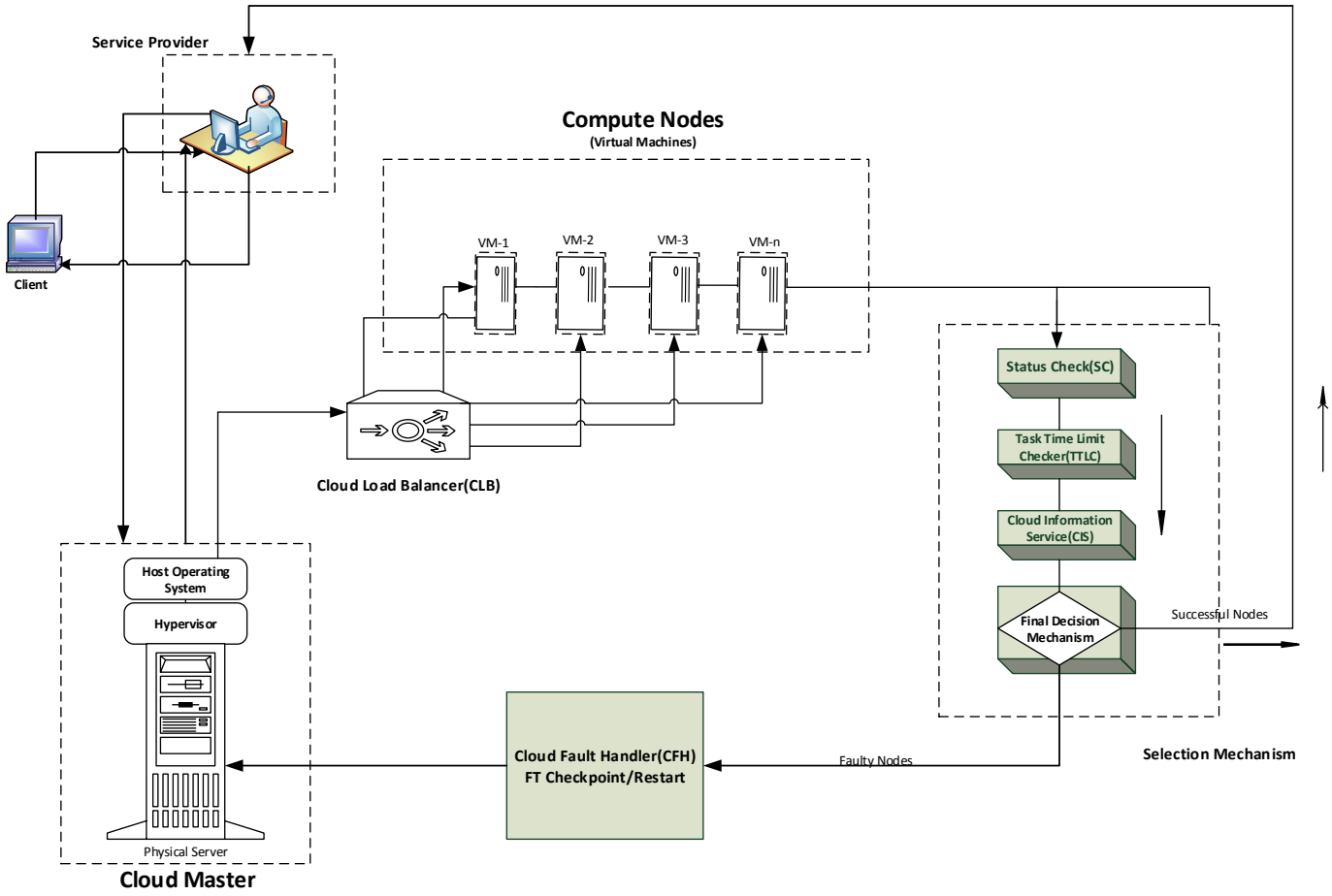




Proposed System Model(Block Diagram)



Proposed System Model



Rules

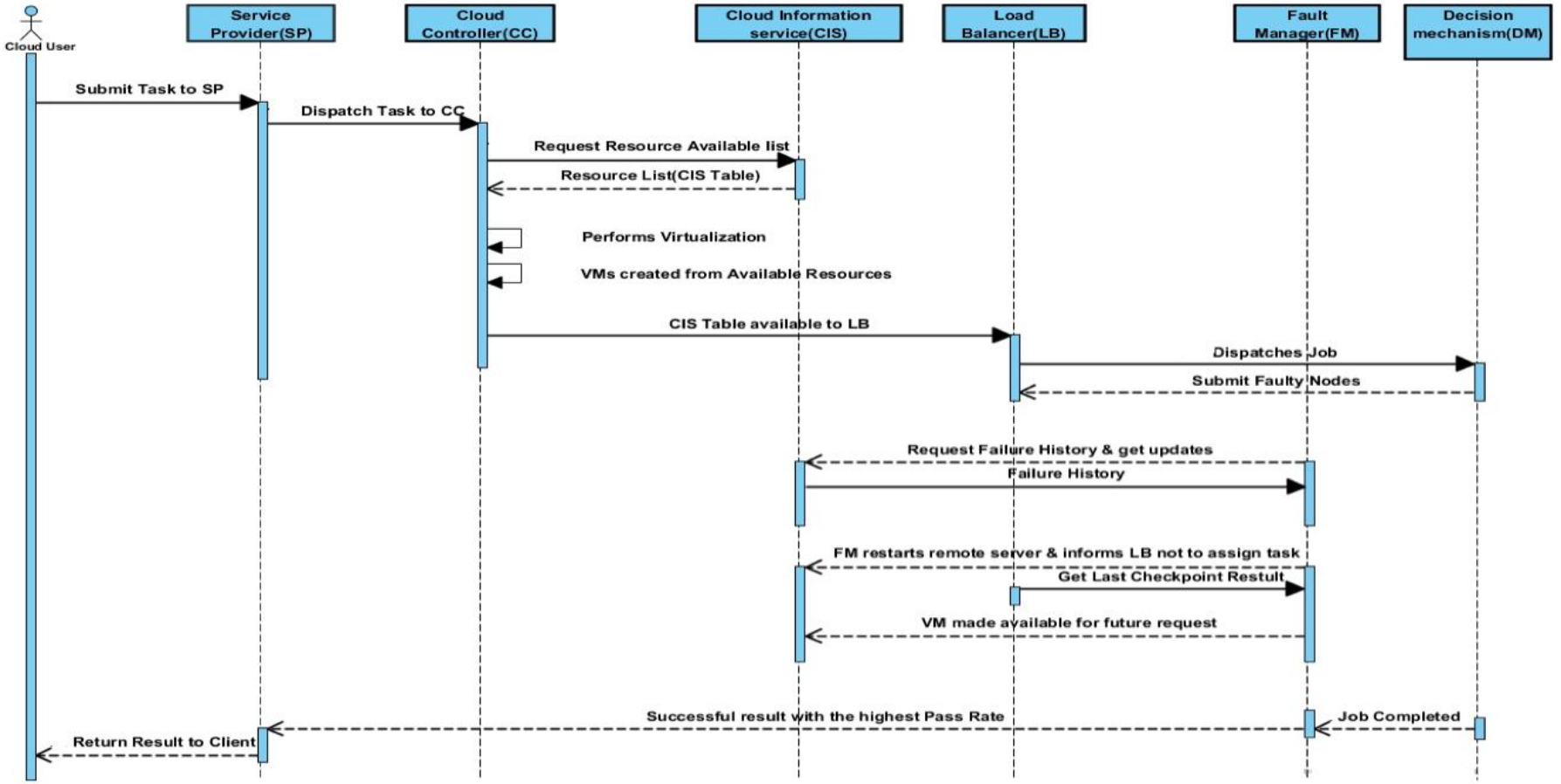
1. *If (SC status == true) && (TTLC status ==true)*
   Then increase PR and forward to selection module for decision & selection

2. *If (SC status == true) && (TTLC status ==false)*
   Then update database in CIS module ,decrease PR, and corresponding VM not considered for selection

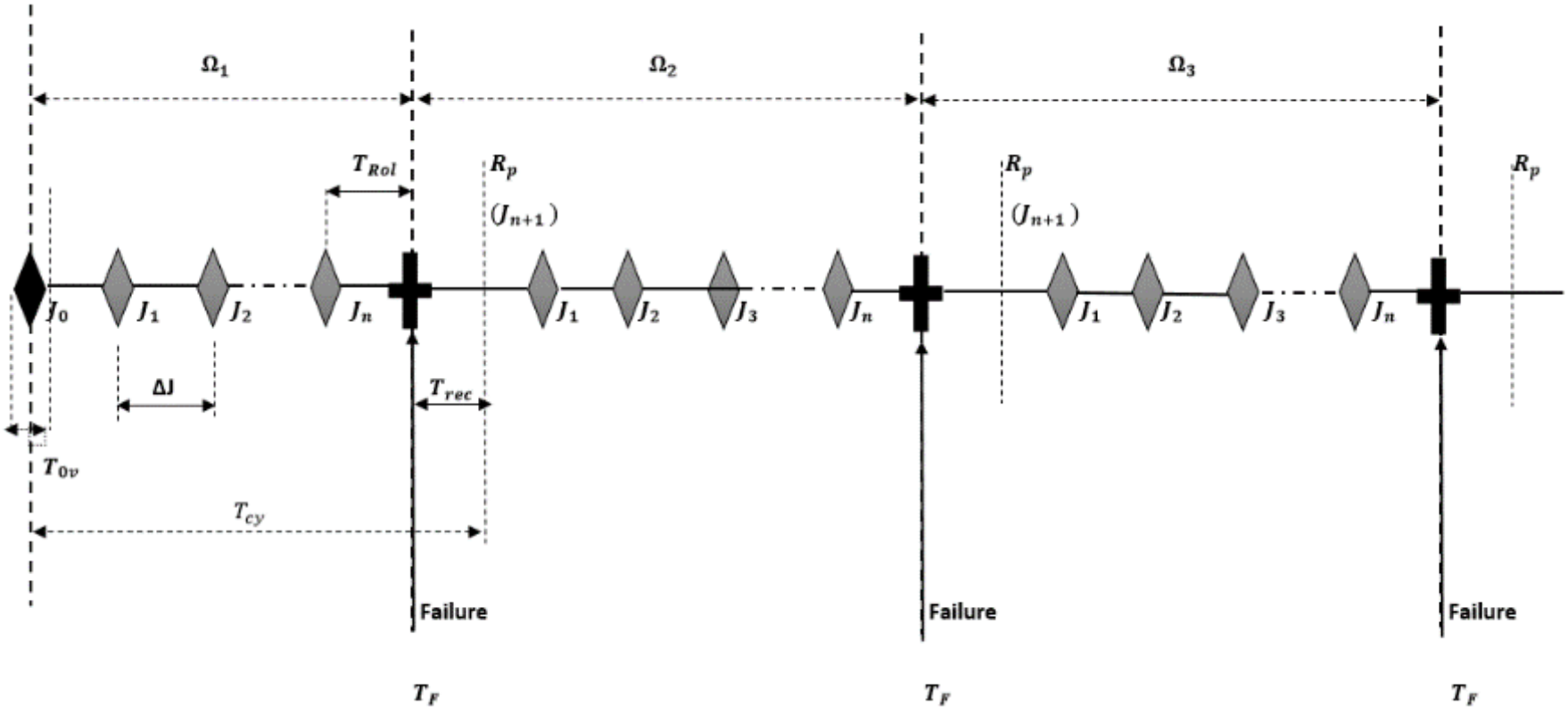
3. *If (SC status == false) && (TTLC status ==true)*
   Then decrease PR and node sent to FM for identification, detection & recovery

4. *If (SC status == false) && (TTLC status ==false)*
   Then also decrease PR and node sent to FM for detection &recovery

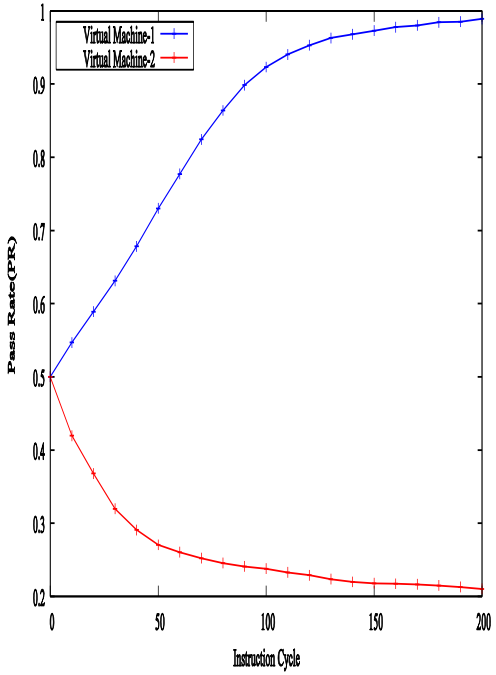
Sequence Diagram

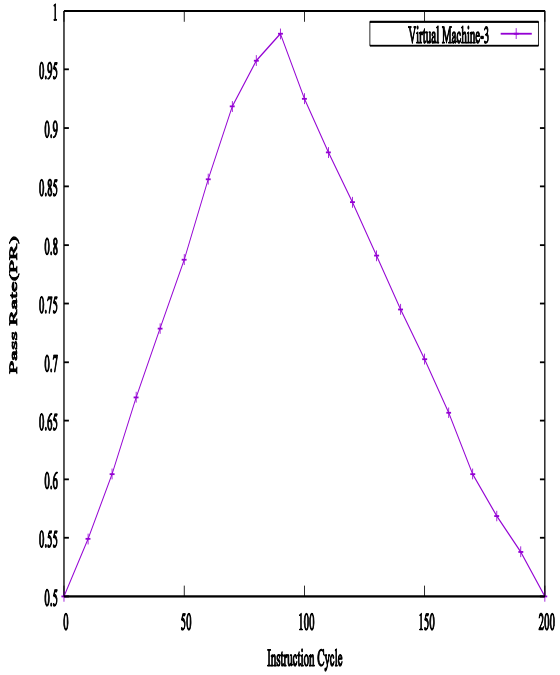


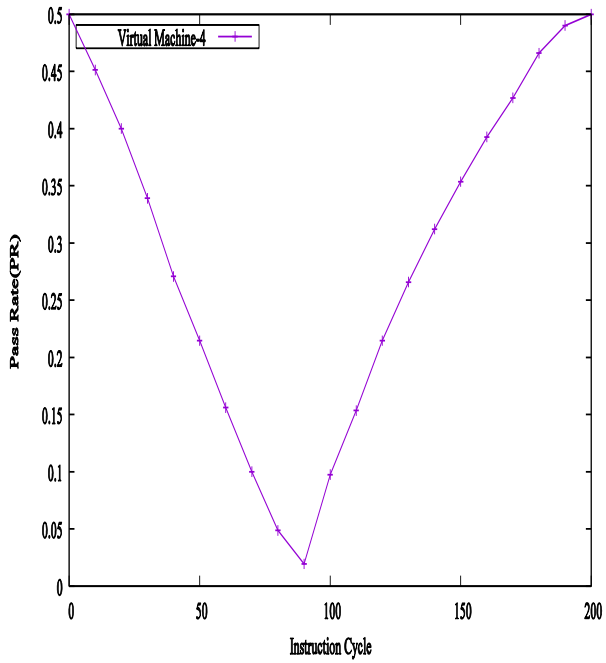
Check pointing Strategy Failure Model



VM Use Case Scenarios







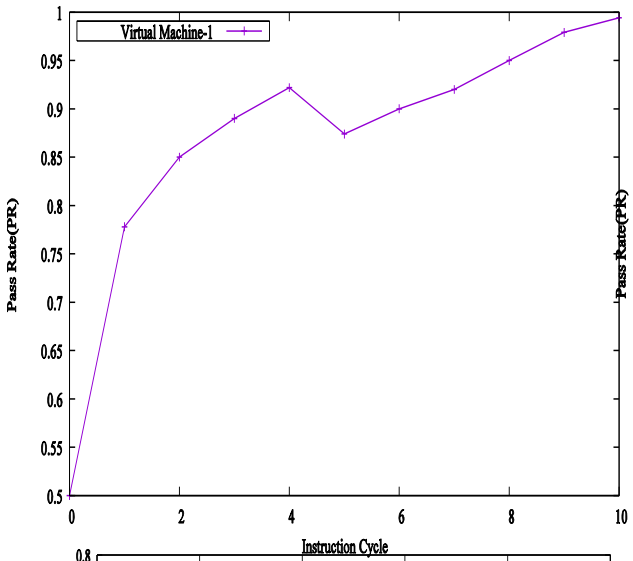
Simulation results & PR Assessment

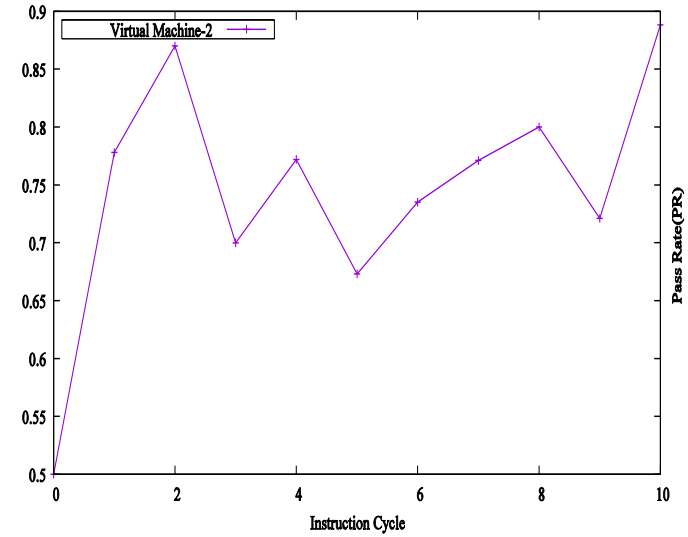
Table II. Simulation results for the Pass Rate Assessment

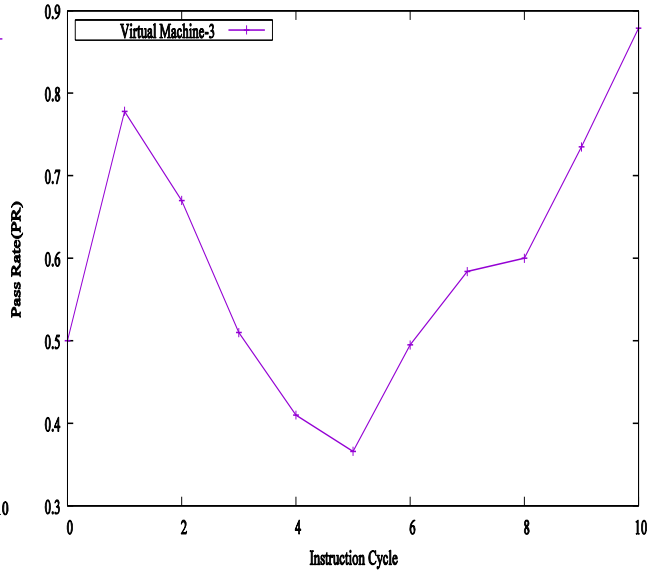
		VIRTUAL MACHINE -1				VIRTUAL MACHINE -2				VIRTUAL MACHINE -3				VIRTUAL MACHINE -4				VIRTUAL MACHINE -5				VIRTUAL MACHINE -6				NODE CHOSEN
CYCLE	TASK TIME LIMIT	SC	TTLC	TFT	PR	SC	TTLC	TFT	PR	SC	TTLC	TFT	PR	SC	TTLC	TFT	PR	SC	TTLC	TFT	PR	SC	TTLC	TFT	PR	
Start	0	0	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
1	1800	T	T	1700	0.778	T	T	1701.7	0.778	T	T	1701.7	0.778	T	T	1750	0.778	F	F	1900	0.64	T	T	1720	0.778	NODE-1
2	1701	T	T	1700.5	0.85	T	T	1700.1	0.87	T	F	1720.3	0.67	T	F	1790	0.64	T	F	0	0.6	T	T	1700	0.62	NODE-2
3	1801	T	T	1800.7	0.899	T	F	1802.5	0.7	T	F	1810.8	0.51	T	F	1909	0.59	T	T	1650	0.8	T	T	1740	0.762	NODE-1
4	1750	T	T	1701.1	0.922	T	T	1705.8	0.772	T	F	1780	0.41	T	F	0	0.49	T	T	1670	0.88	T	T	1721	0.861	NODE-1
5	1700	T	F	1709.8	0.874	T	F	1707.3	0.6731	T	F	1703.6	0.366	F	F	0	0.389	T	T	1600	0.978	F	F	1670	0.415	NODE-5
6	1890	T	T	1706	0.9	T	T	1702.4	0.735	T	T	1723	0.495	T	T	1724	0.397	T	T	1639	0.984	F	F	1900	0.328	NODE-5
7	2001	T	T	1400.4	0.92	T	T	1706.9	0.771	T	T	1759.4	0.584	T	T	2269	0.443	T	T	1740	0.99	T	F	2331	0.301	NODE-5
8	1900	T	T	1712.1	0.95	T	T	1715.3	0.8	T	T	1821.7	0.6	T	T	1799	0.559	T	T	1800	0.93	T	F	0	0.271	NODE-1
9	1810	T	T	1722.2	0.979	F	F	0	0.7 21	T	T	1792.1	0.735	T	T	1700	0.651	T	F	1890	0.661	T	T	1500	0.397	NODE-1
10	1899	T	T	1764.5	0.994	T	T	1806.4	0.888	T	T	1656.2	0.879	F	F	1950	0.605	T	T	1822	0.73	T	F	1900	0.351	NODE-1

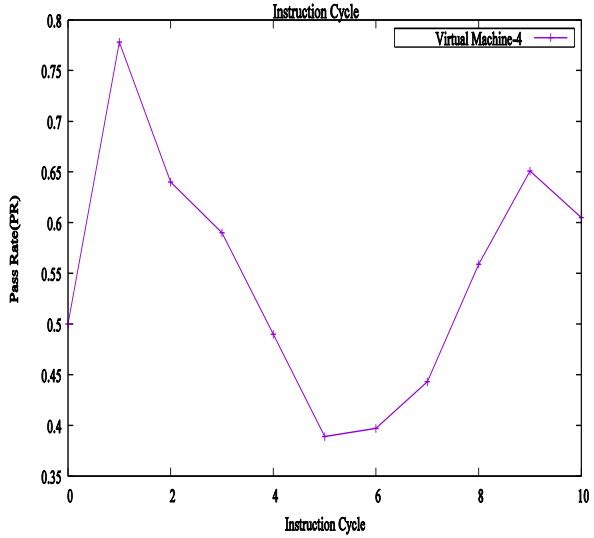
Here on the above table "T" denotes TRUE
"F" denotes FALSE
"SC" denotes STATUS CHECK
"TTLC" denotes TASK TIME LIMIT CHECK
"TFT" denotes TASK FINISH TIME
"PR" denotes PASS RATE

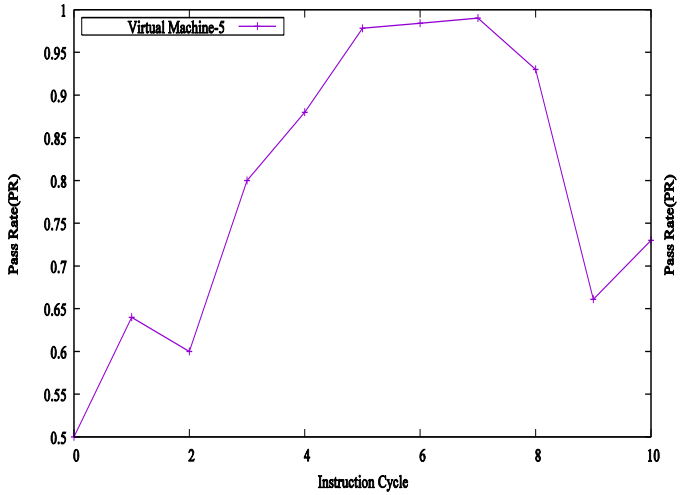
RESULTS

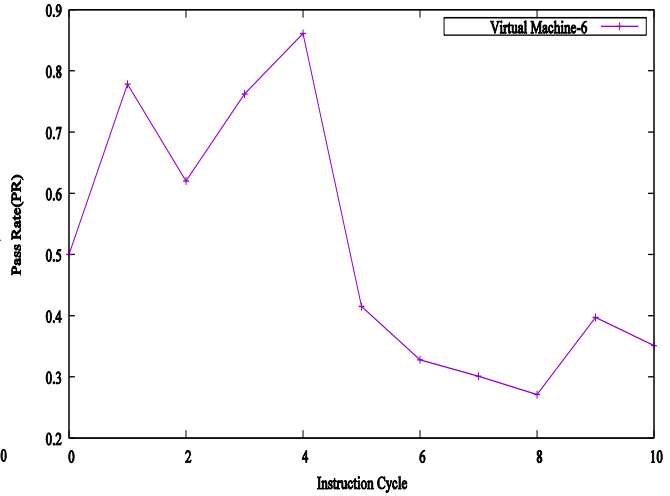

Virtual Machine-1
Pass Rate(PR)
Instruction Cycle


Virtual Machine-2
Pass Rate(PR)
Instruction Cycle

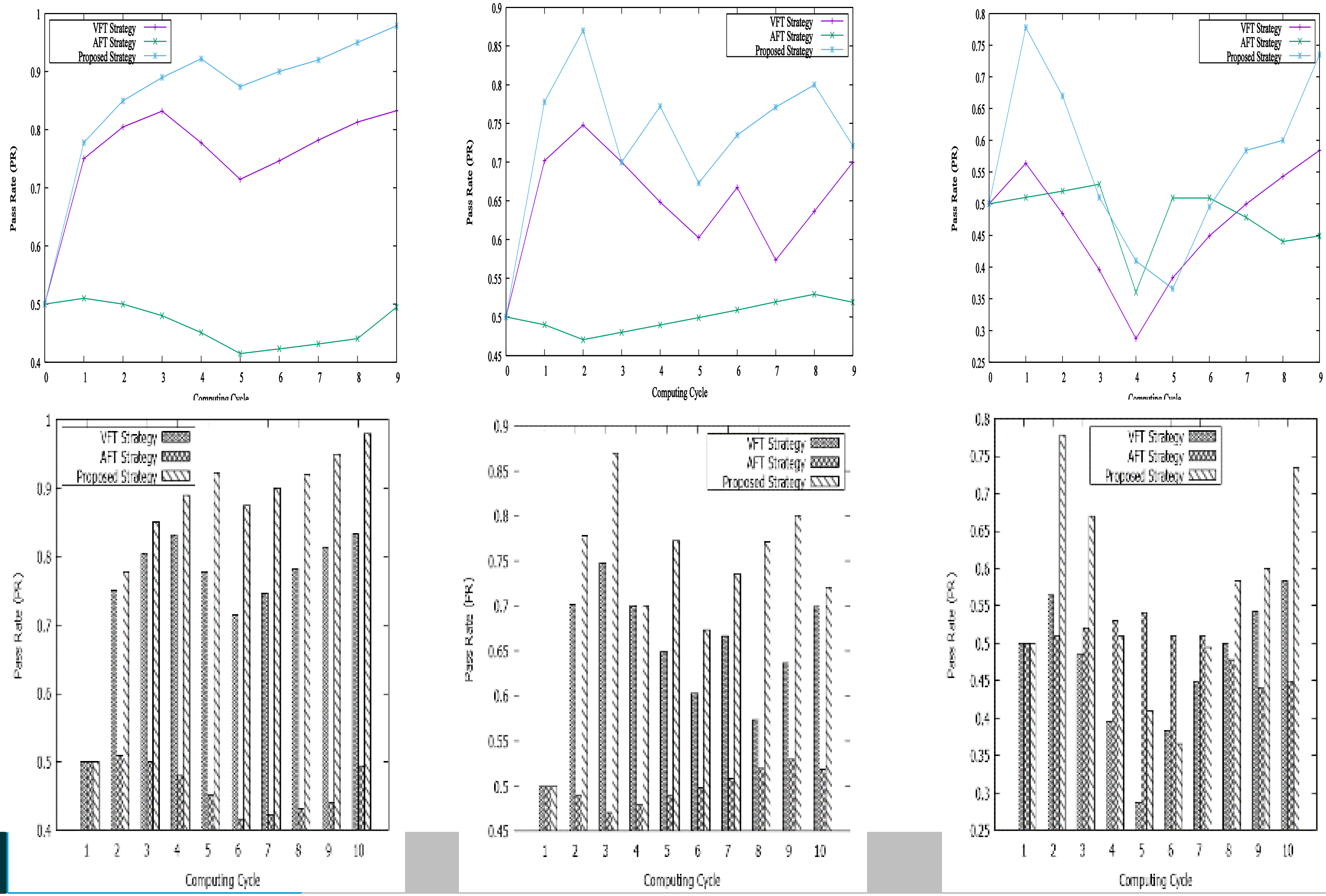

Virtual Machine-3
Pass Rate(PR)
Instruction Cycle


Virtual Machine-4
Pass Rate(PR)
Instruction Cycle

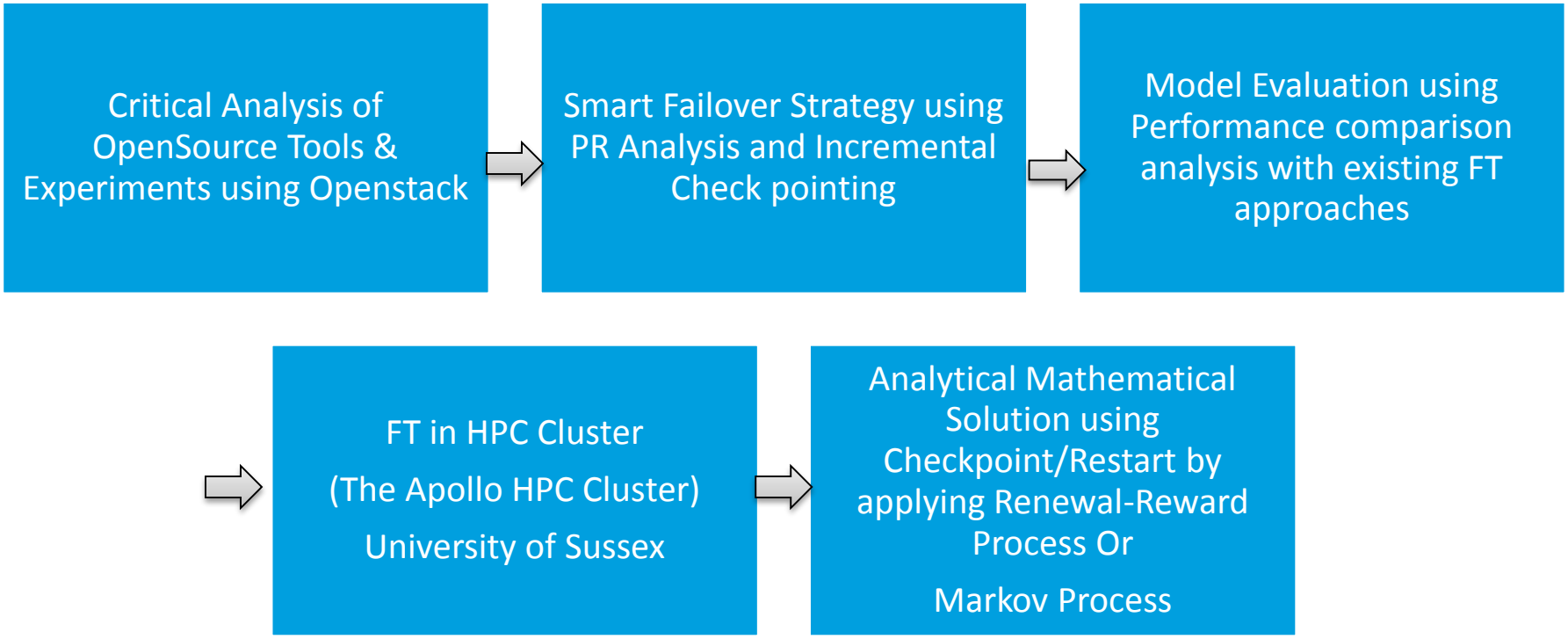

Virtual Machine-5
Pass Rate(PR)
Instruction Cycle


Virtual Machine-6
Pass Rate(PR)
Instruction Cycle

RESULTS


VFT Strategy
AFT Strategy
Proposed Strategy
Pass Rate (PR)
Computing Cycle

Research Progression



Conclusion and Future Work

- Having conducted a performance comparison of existing methods and our proposed Pass rate analysis we conclude that the proposed fault tolerance scheme gives a good performance.

- Our next task to measure the performance on FT systems using standard metrics such as throughput, Average turnaround time and Failure tendency.

- Proof our model analytically using Reward Renewal Process Theorem

- In future work, we will continue to work on some new enhancements on our strategy, so that our system can be more fault-tolerant. We will not only try to reduce effort of failures when they occur but we will focus mainly on achieving a proactive fault tolerant system thereby avoiding recovery from fault errors.

Publications

1. Bashir Mohammed, Mariam Kiran, *Analysis of Cloud TestBeds using OpenSource Solutions, The 3rd International Conference on Future Internet of Things and Cloud (FICLOUD 2015), Rome, Italy, August, 2015.-* ***Conference paper Accepted & Published.***
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=7300818&tag=1

2. Bashir Mohammed, M Kiran, *Experimental Report on Setting up a Cloud Computing Environment at the University of Bradford =arXiv preprint arXiv: 1412.4582, 2014. - Technical Report* ***-Accepted and Published.***

3. Mariam Kiran, Haroon Mir, Bashir Mohammed, Ashraf Al Oun, Kabiru Maiyama, *Agent-based Modelling as a Service on Amazon EC2 Opportunities and Challenges, 8th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2015), Limassol, Cyprus.* ***- Conference paper Accepted and published***

3. Bashir Mohammed, Mariam Kiran, Irfan-Ullah Awan, *Fail-over Strategy for Fault Tolerance in Cloud Computing Environment, Journal on Concurrency and Computation: Practice and Experience, John Wiley & Sons Ltd.* ***Journal Paper Submitted***

4. Bashir Mohammed, Mariam Kiran, Irfan-Ullah Awan, *Failover Strategy for Cloud Fault Tolerance approach, Network Security and Performance Engineering Workshop, 2015 at The University of Bradford (NeTSPen 2015).* ***- Presented a Paper***

5. Bashir Mohammed, Mariam Kiran, Irfan-Ullah Awan. *Adaptive Fail-over Approach in real time Cloud Computing Environment. The 4th International Conference on Future Internet of Things and Cloud (FICLOUD 2016), Vienna, Austria, August, 2016. -*
- Conference paper Submitted

6. Bashir Mohammed, Mariam Kiran, Irfan-Ullah Awan. *An Integrated Virtualized Strategy for Fault Tolerance in Cloud Computing Environment. The 16th IEEE International Conference on Scalable Communication and Communication (SCALCOM 2016), Toulouse, France, July, 2016.* ***- Conference paper Submitted***

Thanks for Listening
Questions?
Comments?

Bashir Mohammed,

School of Electrical Engineering and Computer Science
University of Bradford,
Bradford, BD7 1DP UK
B.Mohammed1@Bradford.ac.uk