Cloud computing research activities at Jordan University of Science and Technology

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Yaser Jararweh: Bio sketch

- *Assistant Professor, Computer Science dept. at Jordan University of Science and Technology.*
- *PhD. The University of Arizona, Electrical and Computer Engineering Dept.* "NSF Center of Cloud and Autonomic Computing (CAC)", August 2010.
- *Research Interest:*
  - *Cloud Computing*
  - *Data and Network Security*
  - *Software defined X*
    - *Data Centers*
    - *Cognitive Radio Networks*

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Software Tools for Cloud Computing experiments and teaching (TeachCloud, CloudExp, and MCCSim).

Main Problem

- Cloud Computing needs professionals who are able to deploy, maintain, and advance the cloud technology.
- The diversity of cloud computing related areas requires the students to put great efforts to understand each one of these areas alone in addition to integrating them in a single platform.
- There are no Teaching\Experimental tools to cover the different aspects of cloud computing as a whole makes teaching more theoretical-oriented, and therefore, less effective.

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Main Problem

- At Jordan University of Science and Technology (**JUST**), we were one of the first universities in the MENA region to introduce cloud computing concepts in our courses for both graduate and undergraduate students. (2010)

- At the end of the course, we conducted a students' survey and asked the students to identify which challenges they thought were most important.

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students' survey Results

Challenge or Difficulty	Percentage Agreed
Lack of hands-on experience	93%
Lack of a comprehensive textbook	63%
Lack of help material on the Internet	57%
Insufficient background	17%
Vast amounts of different topics	17%

Challenges in Teaching Cloud Computing as Identified by Students

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Possible Solutions

- The use of real infrastructures such as EC2, IBM Smart Cloud, Azure, and on site cloud system.
  - Problem:

    Limited capabilities as a teaching tools, required some previous experience from the students, time consuming, and costly, etc.
- Solution:
  - Simulation
  - What is available : **CloudSim,** The University of Melbourne.
    - Problems: very limited, basic Cloud components modeling, hard to use in education and research (No GUI), No real workload Modeling, it lacks BPM and SLA components.

Our Solution: TeachCloud

- TeachCloud uses CloudSim as the basic design platform and introduces many new enhancements on top of it.
  - Developing a GUI for the toolkit.
  - Adding the Rain cloud workload generator to the CloudSim simulator.
  - Adding new modules related to SLA and BPM.
  - Adding new cloud network models (VL2, BCube, Portland, and DCell)
  - Introducing a monitoring outlet for most of the cloud system components.
  - Adding an action module that enables students to reconfigure the cloud system and study the impact of such changes on the total system performance.

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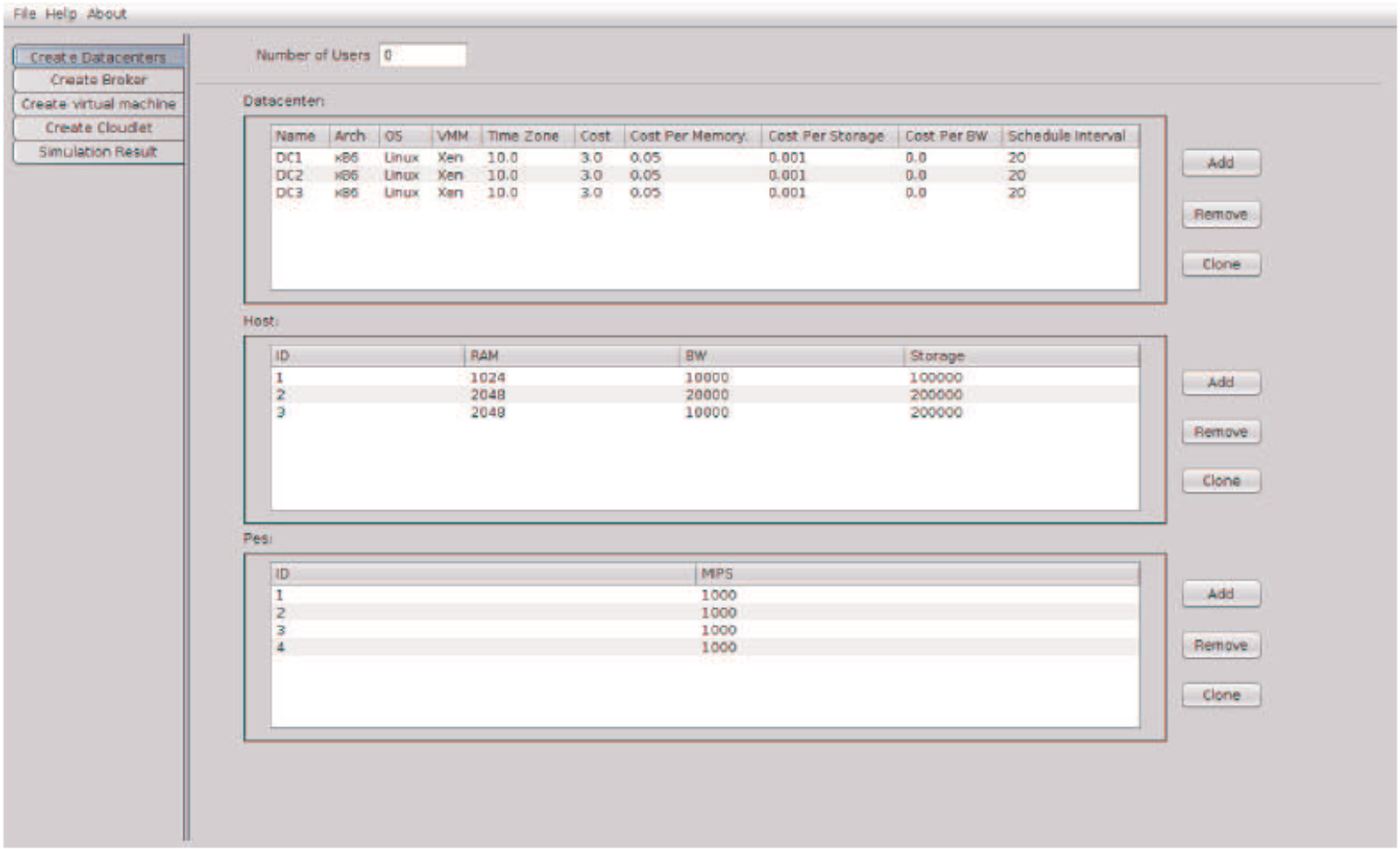

Creating data centers, VMs in TeachCloud

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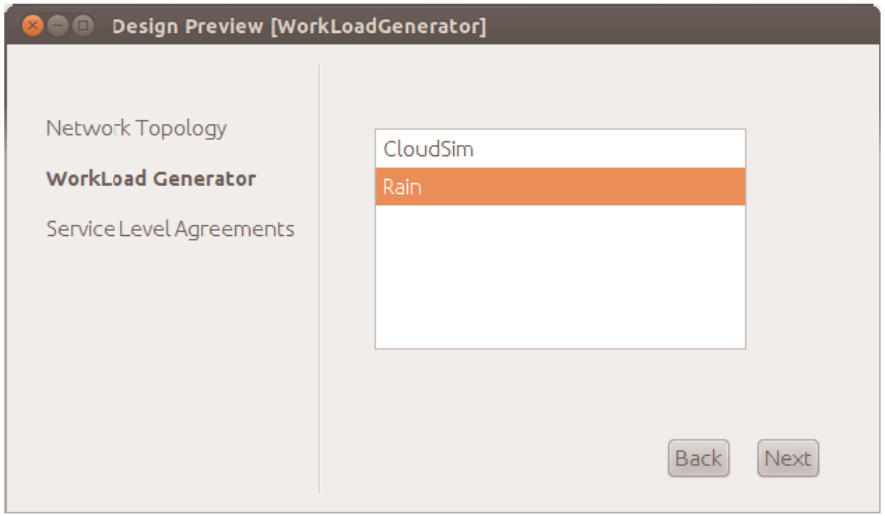

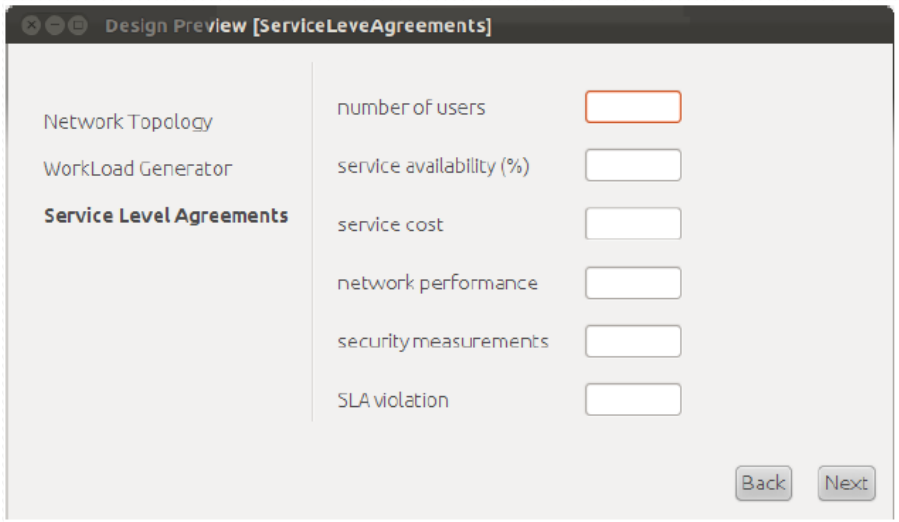

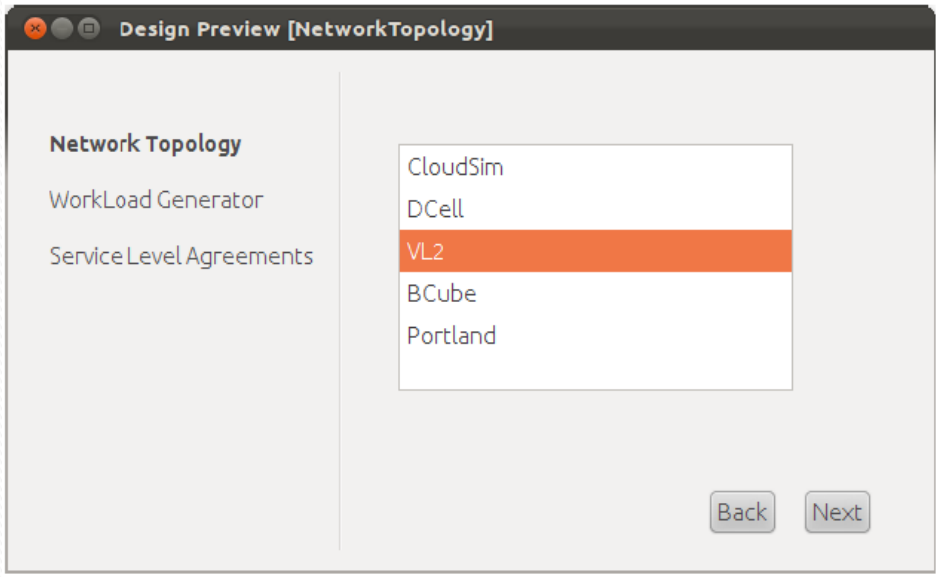

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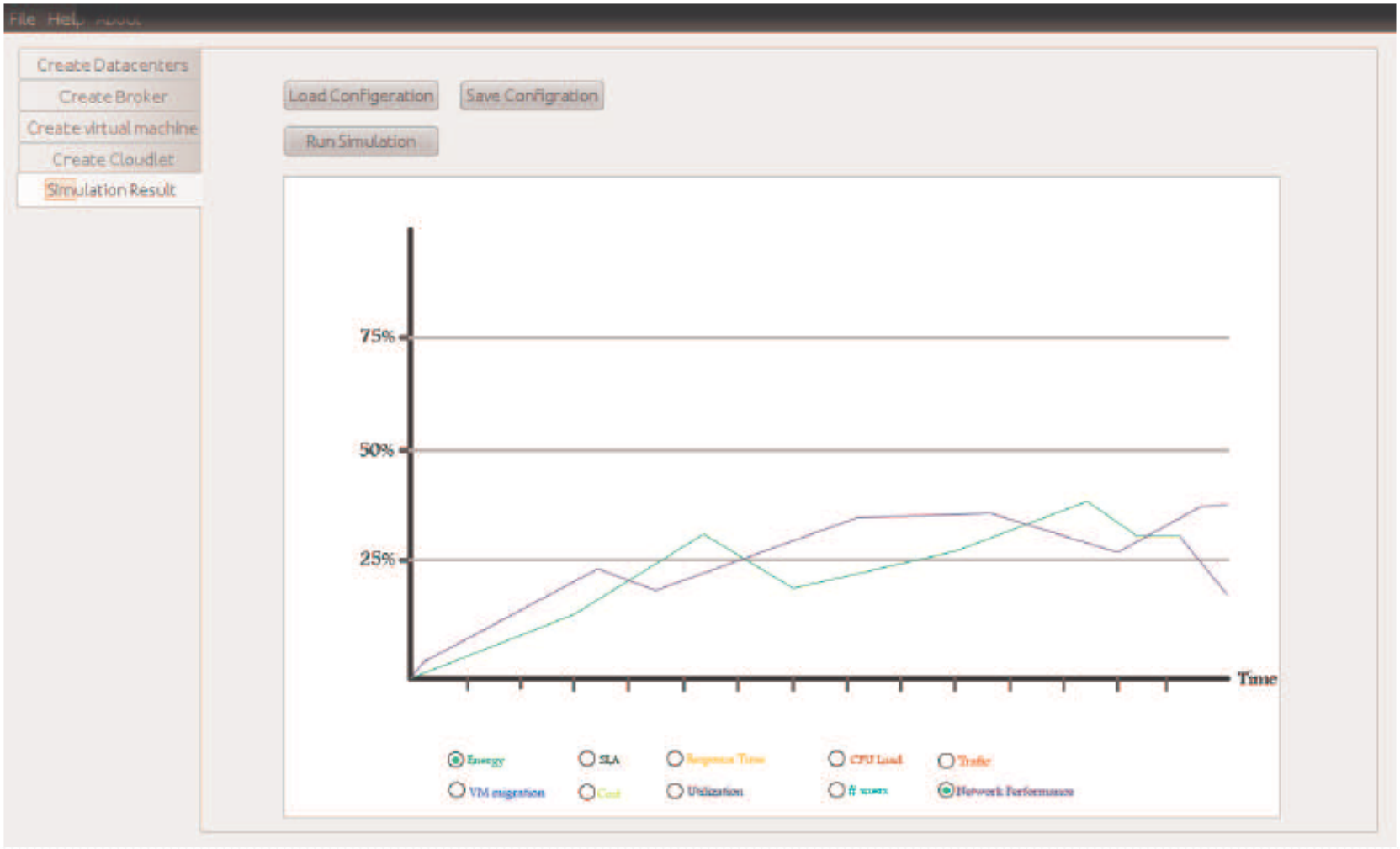

Sample of the simulation results in TeachCloud

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CloudExp and MCCSim

- CloudExp: Cloud Experiments
  - Provide an experimental framework for cloud computing researcher.
  - Very optimized to fully representing real cloud system.
  - Introduced new components such as:
    - Map-Reduce model
    - Power management evaluation
    - Resource management
- MCCSim: Mobile Cloud Computing Simulator
  - Provide a comprehensive experimental platform for MCC
  - Still under development

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UMCM: Unobtrusive Mobile Crowd Monitoring

Cloudlet-based Approach

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UMCM Introduction

- Monitoring and managing of large size crowds is very challenging issue due to the following:
  - The large amount of generated\collected data
  - Data communication
  - Data processing requirements
  - Data security and crowd privacy issues.
- The Unobtrusive *Large Scale* Crowd Monitoring (UMCM) system provide a viable solution to tackle the main challenges of crowed monitoring problem.

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Possible Scenarios

- Our proposed approach is general and is suitable for different large size crowds scenarios such as but not limited to:
  - Firefighters on the field.
  - Soldiers on the battlefield
  - Patients in hospitals
  - Patients in epidemically infected areas
  - School students
  - Babies in nursery school

UMCM Project Objective:

- Support continues monitoring of large size crowds and collecting important information about their current status (e.g. vital sign, location, mobility and behavior trends)
- Support mobile crowds monitoring in large scale geographical areas with different terrain state.
- Efficiently and cost-effectively handling the processing demands of large amount of generated data by the crowds.
- Provide a set of policies and techniques that handle security and privacy issues.
- Provide a complete and a unified stack of software's that efficiently handle different tasks of the system
- Inexpensive using available commodity and off the shelf materials that reduce cost.

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UMCM Characteristics

- UMCM provide unobtrusive data collection from the crowed members using smart wearable textiles with sensors.
- UMCM is exploiting the current advancement in big data processing and cloud computing fields to effectively handle the large amount of collected data from the crowed members.
- The processing of the collected data will include data refinement, data analysis, and decision making.

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UMCM Characteristics

- Security and crowed members privacy issues are on the core focus of UMCM system.
- A complete set of policies were deployed to ensure data security and member's privacy.
- A novel feature of UMCM system is the supporting crowed mobility by ensuring continues connectivity between crowed members and data sink.
- All the aforementioned characteristics of UMCM system is developed using a unified stack of software solutions

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UMCM: Cloud Computing and Big data Side

- UMCM use the **Cloudlet** system which is a small size cloud system that provide contentious connectivity with mobile objects using wireless communication technology such as Wi-Fi.
  - Cloudlet collects data from mobile objects, perform data processing and decision making on the cloudlet level
  - Cloudlet send refined collected data to the global cloudlet for farther processing and inter-cloud decision making
  - Inter-Cloudlet communication can be using wired or wireless communication system with higher range (WiMax)
  - Global Cloudlets are connected to an enterprise cloud computing system using Cellular communication system.

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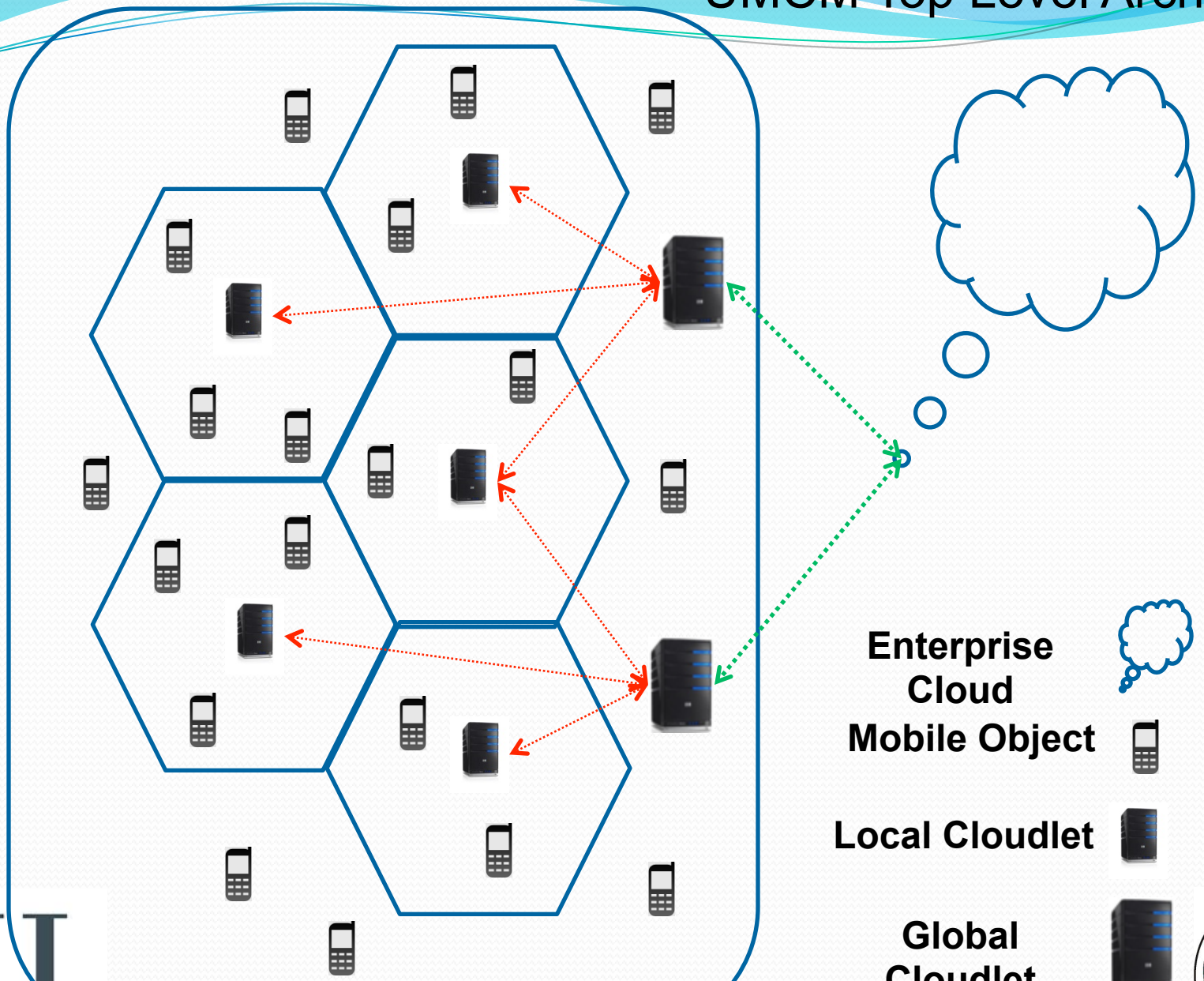
UMCM Top Level Architecture



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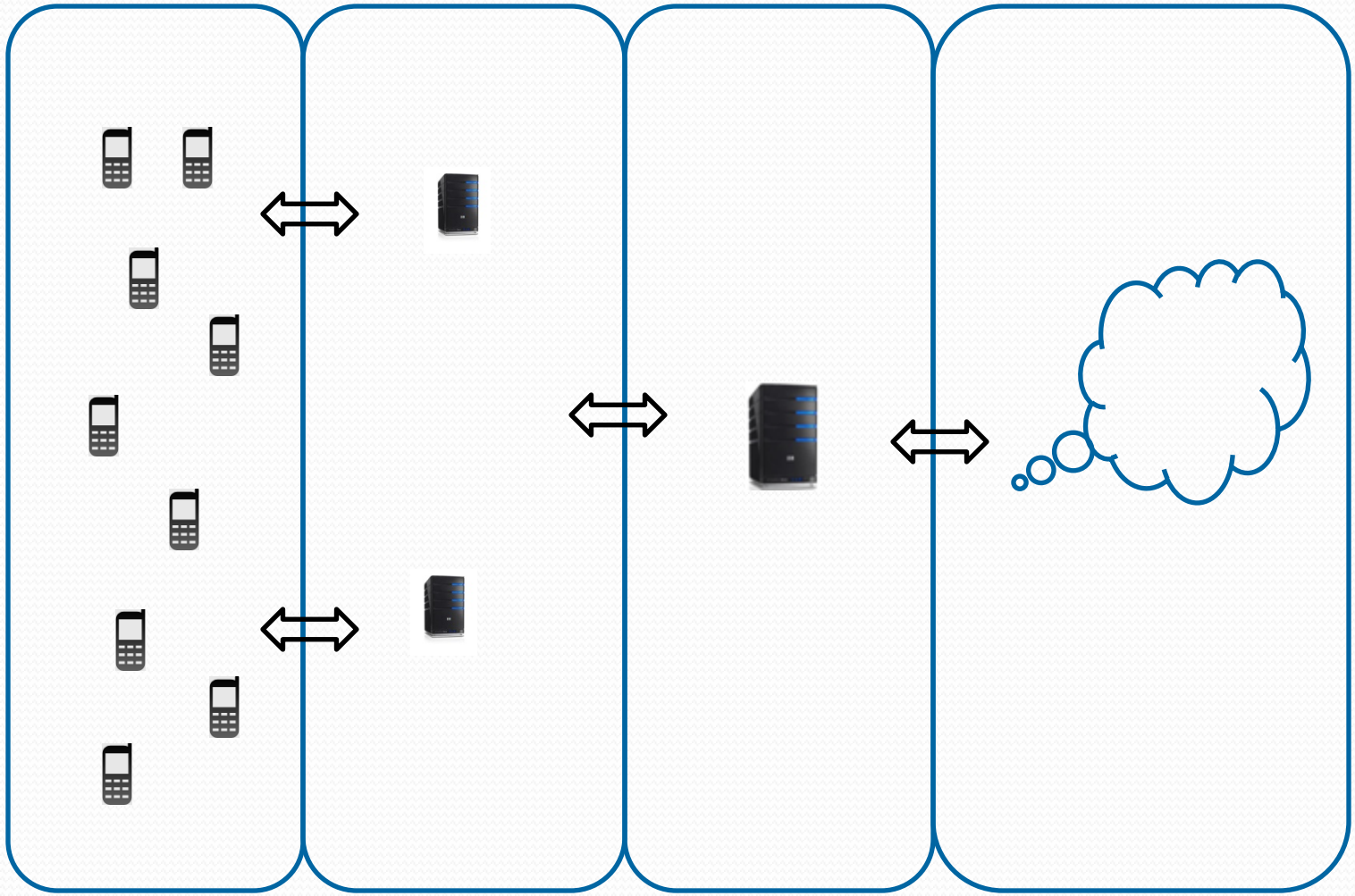
UMCM data flow



Data collection using sensors

Intra-cloudlet data processing and decision making

Date fusion, global Data processing and decision making

Enterprise cloud for data storage and global system management

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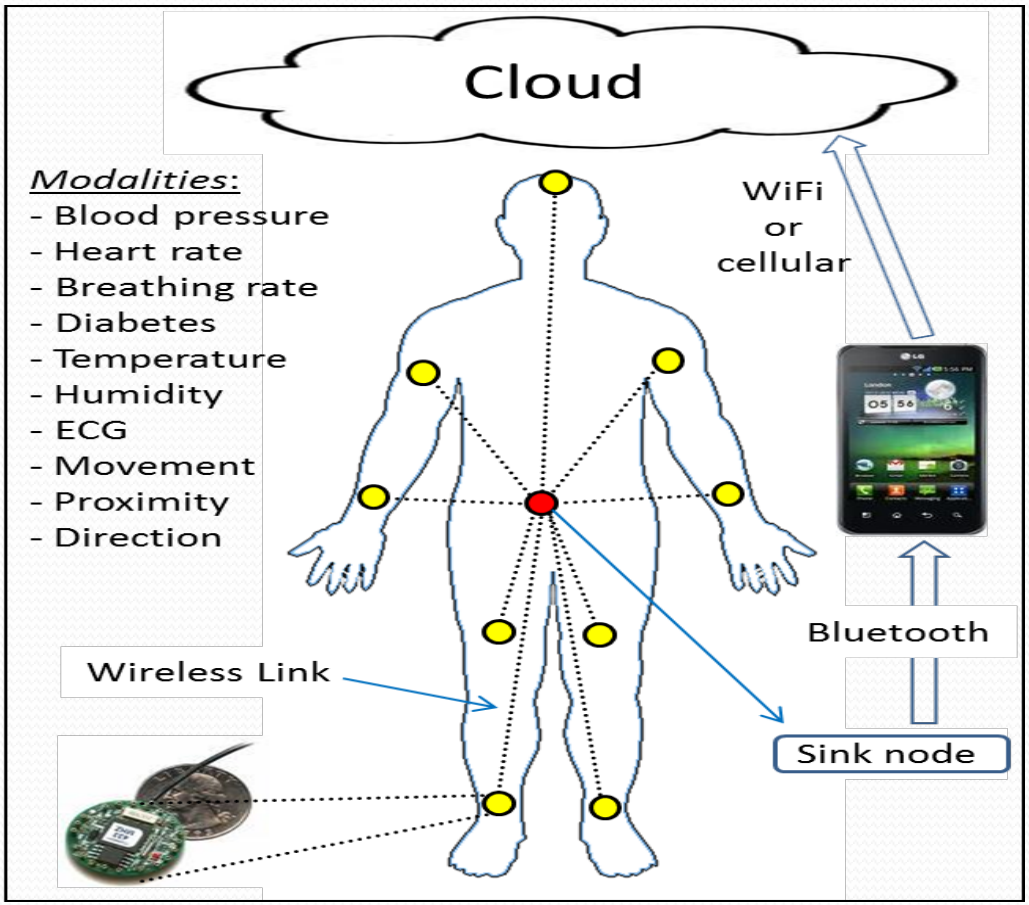
UMCM Support for WBANs



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Software-defined datacenter (SDD)

Introduction

- *SDD term coined by VMware's Steve Herrod.*
- *Basically:*
  - *"Software managed component(s)"*
  - *"Hardware-independent management"*
  - *Very bad news for specialized hardware vendors*
- *A new Buzz word or a new and efficient infrastructure management solution??*

Introduction (SDD)

- Software-defined datacenter (SDD) is the phrase used to refer to a data center where all infrastructure is virtualized and delivered as a service.
- The Control of the data center is fully automated by software, meaning hardware configuration is maintained through intelligent software systems.
- This is in contrast to traditional data centers where the infrastructure is typically defined by hardware and devices.

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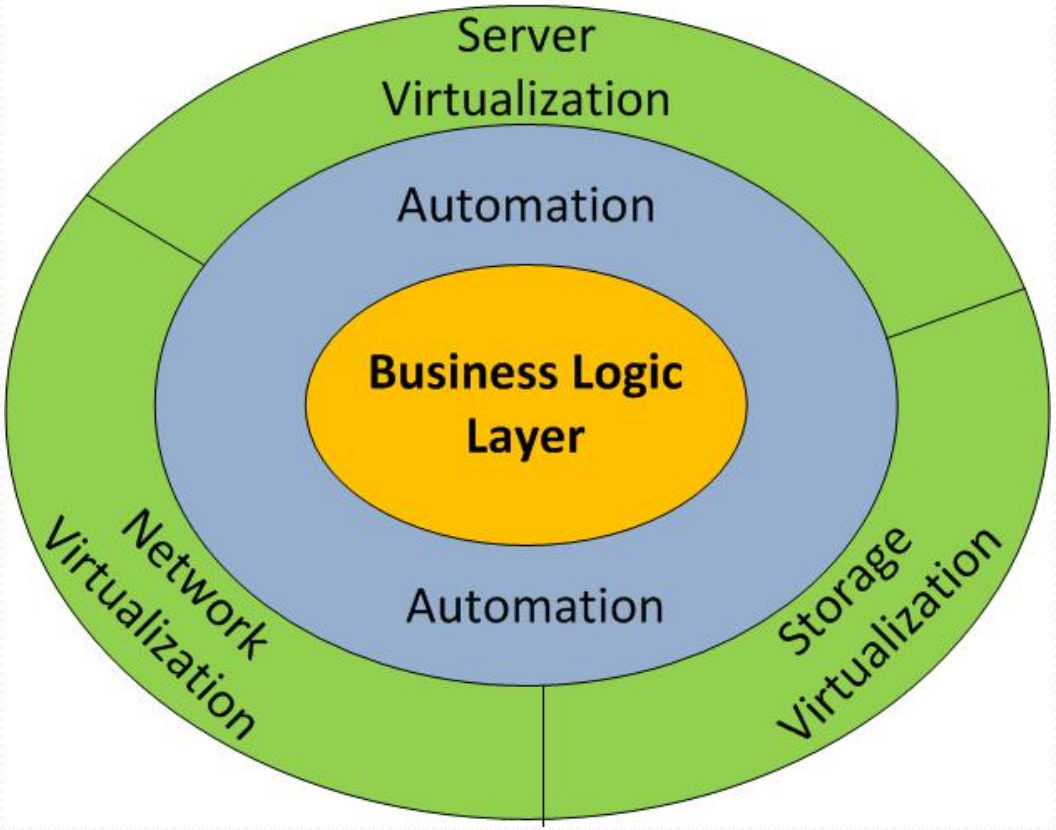
Introduction (SDD)

- Support Business Logic Driven Automation
  - Business oriented environment
  - Allow applications to define its own resource requirements based on corporate SLA and compliance policies
  - Business logic elements translated into a set of management instructions

Core Components of SDD



SDD is a layer of abstraction above multiple other SDx layers (network, virtualization, storage, etc),

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Core Components of SDD

- **Network Virtualization**
  - The user defined his needs and SLA then the software will take care of the rest.
  - Also called Software-defined networking (SDN)
- **Server Virtualization**
  - Hypervisor and VMs management
- **Storage virtualization**
  - Storage hypervisor concept
  - Abstracting the management software from the SAN allows customers to manage multiple storage types and brands from one single software interface.

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Objectives

- Software Defined DataCenter that provides the following:
  - Efficient power usage
    - Proportional power consumption
  - Efficient cooling system
    - Free cooling solutions where possible
    - Green DataCenters
  - Flexible system management and scalability.
- Consider other issues like
  - Geographical locations of data centers
  - Renewable Energy

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Efficient Power Usage (Power Proportionality)

- A power proportional system consumes power proportional to its active load.
  - Average data center resource utilization is very low
  - This leads to considerable resource idleness on average
  - This idle resources can consume almost as much energy as active ones
  - Significant amounts of energy can be wasted here
- Solution: Power down idle resources (servers, storage and network, etc..) to achieve power proportionality.

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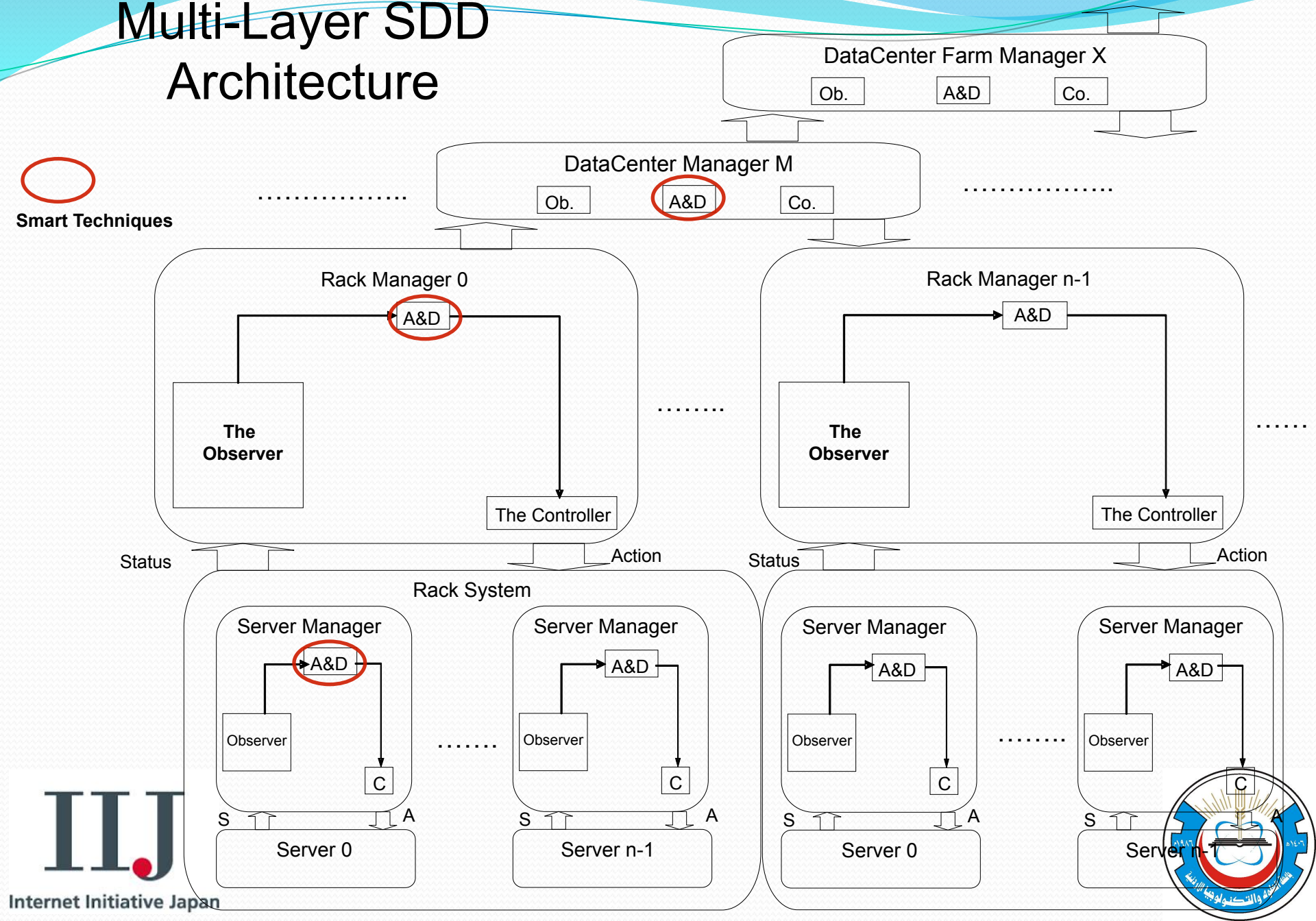
Multi-Layer SDD Architecture



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CloudFlow: An innovative Management Framework for Cloud Computing Systems.

Introduction

- A holistic and innovative management framework that is able to handle cloud computing management complexities and facilitate the integration of different management schemas in different cloud system levels like infrastructure, applications, SLA, brokerage, etc in one framework.
- Its provide efficient management solution that its integrated with the Software-defined datacenter (SDD)

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CloudFlow: How it works

- The managed cloud system status are continuously monitored to collect system parameters.
- System parameters will be analyzed using a cross-layered analysis hierarchy
- Optimally scale up and down the cloud resources i.e. virtual machine, network resources, cost, management overhead
- Cost, power and performance can be optimized to be within a predefined operational region "Safe Operational Zone" .

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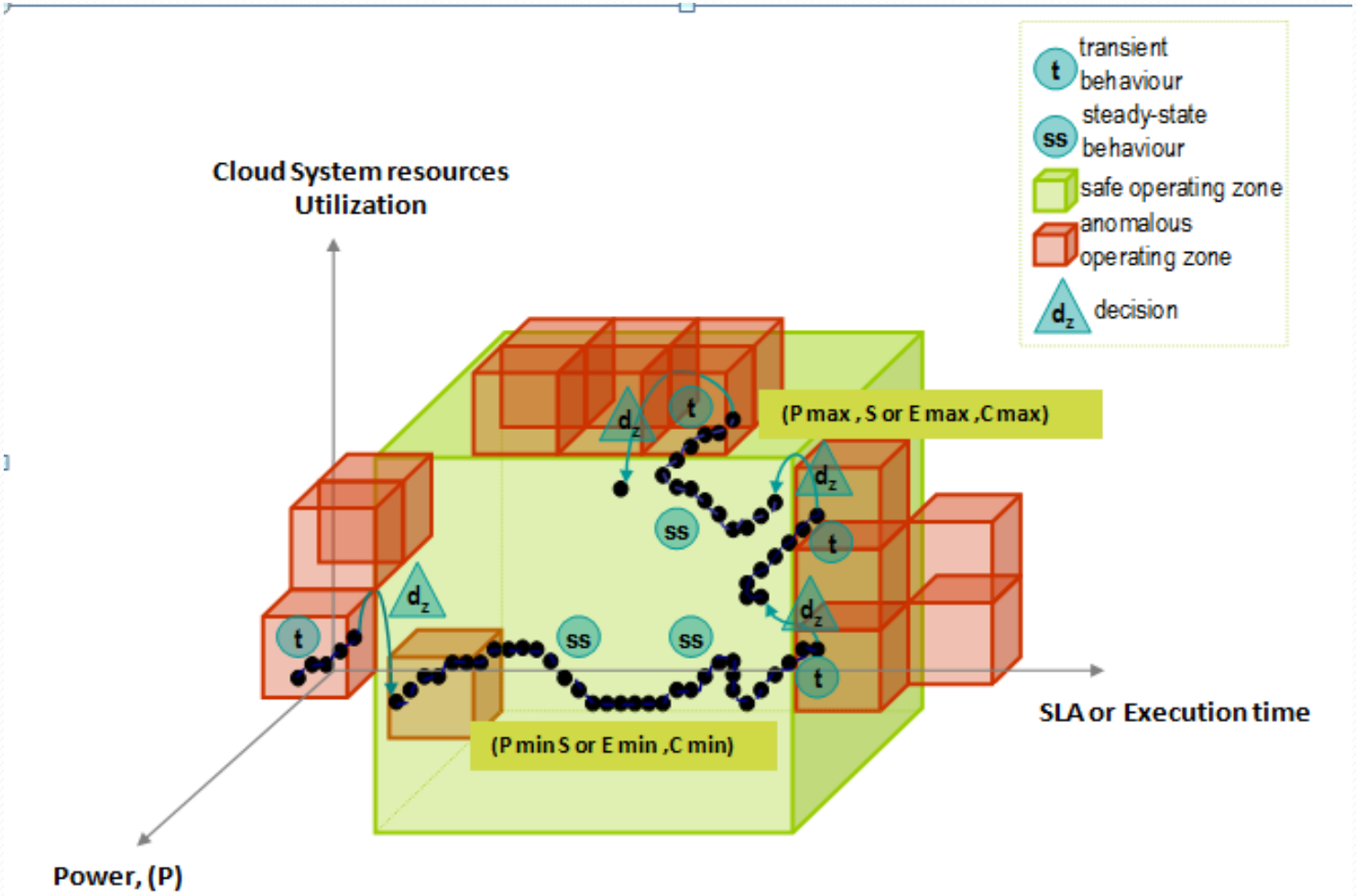
Safe Operational Zone Concept



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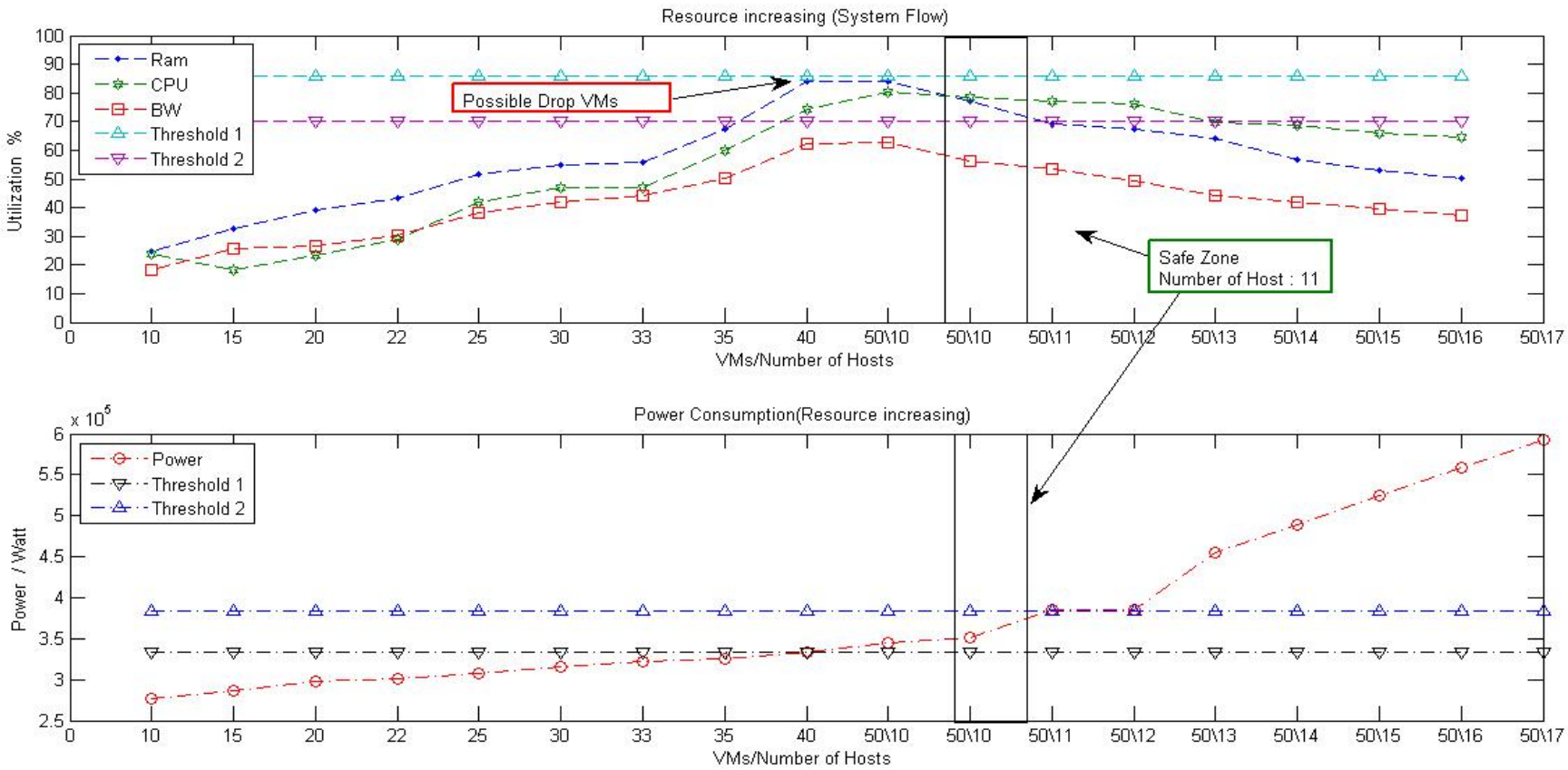
Safe Operational Zone Concept



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Thank You