Cloud Computing Business Framework

Dr Victor Chang

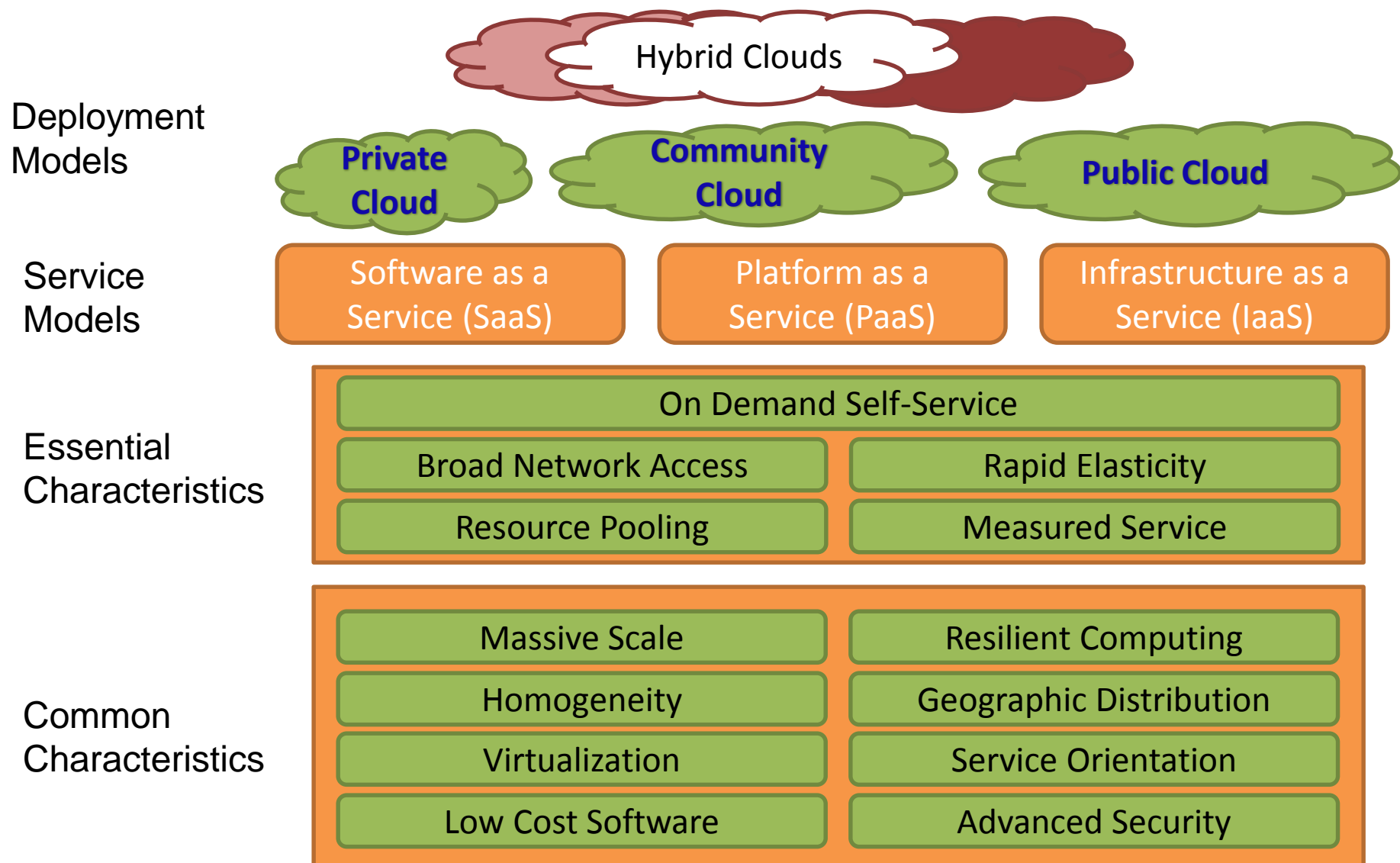25th November 2014, Paris, France

Overview

- Cloud Computing Overview

- Cloud Computing Business Framework

- Classification / Organizational Sustainability / Portability / Linkage (Business Integration)
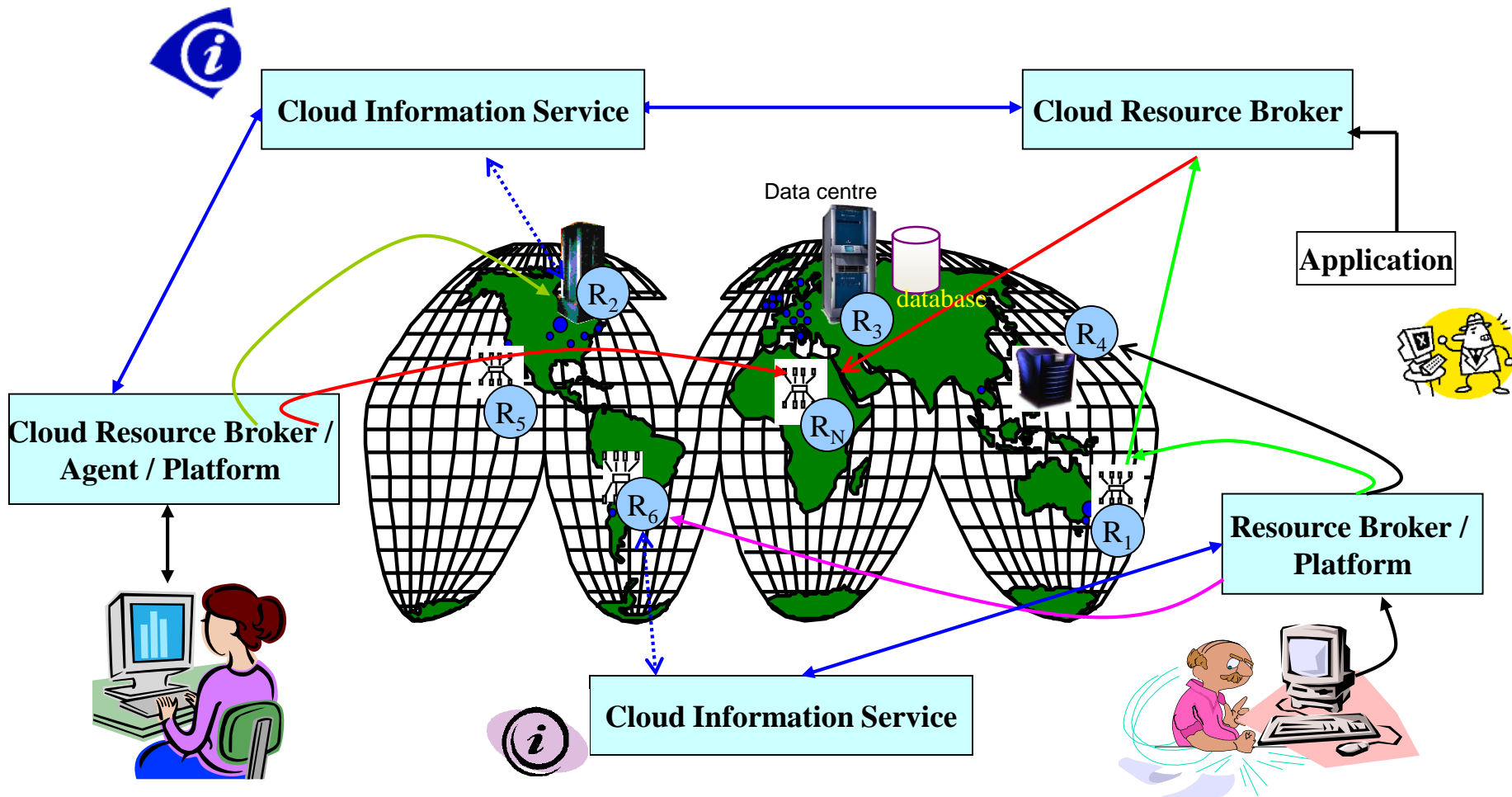
- Questions/Answers

Why Cloud Computing?

- Cloud offers a variety of benefits including cost-saving, agility, efficiency, resource consolidation, business opportunities and green IT (Ambrust 2010, Foster et al, 2008; Kagermann et al., 2011; Schubert, Jeffery and Neidecker-Lutz, 2010).

- Other characteristics include: Elasticity; Pay-per-use; Multi-tenancy and so on.

- Armbrust et al. (2010) explain current challenges for cloud computing which include (1) Vendors' lock-in (2) interoperability and (3) security. There are more researchers focusing on technical rather than organizational/adoption challenges. Identified adoption challenges:

1. "Best strategies and best practices for Cloud adoption".
2. "No structured measurement of Cloud business performance".
3. "Portability".
4. "No connections between different services".

Before discussing Research (Cloud): The NIST Cloud Definition Framework

Deployment Models

Hybrid Clouds

Private Cloud **Community Cloud** **Public Cloud**

Service Models

| Software as a Service (SaaS) | Platform as a Service (PaaS) | Infrastructure as a Service (IaaS) |

Essential Characteristics

On Demand Self-Service

Broad Network Access | Rapid Elasticity

Resource Pooling | Measured Service

Common Characteristics

Massive Scale | Resilient Computing

Homogeneity | Geographic Distribution

Virtualization | Service Orientation

Low Cost Software | Advanced Security

# Cloud Computing: Mobile & Community (or hybrid) Cloud

Research Overview

- Not many frameworks address organizational challenges for Cloud adoption. There are a few consulting firms offering similar but expensive services.

- Cloud Computing Business Framework (CCBF) is the proposed future work if I'm employed. CCBF has 4 key areas.

- **Classification** of business models to offer Cloud-adopting organizations right strategies and business cases.

- **Organizational Sustainability**: Offer a structured framework to review cloud business performance accurately.

- **Portability**: Deal with application portability from desktops to clouds and, between clouds offered by different vendors.

- **Linkage**: Provide linkage between different cloud research methodologies, and between IaaS, PaaS, SaaS and Business Models. Business Integration as a Service (BIaaS) is used to demonstrate.

- It is a conceptual framework that can be validated in each component and by simulations.

CCBF Overview

| Adoption challenges	Research questions	CCBF key areas
Best strategies and best practices for Cloud adoption	How do you classify Cloud business models in business context?	**Classification**: Offer Cloud-adopting organizations right business models and strategies.
Do not have a structured measurement of Cloud business performance	How do you measure cloud business performance accurately?	**Organizational Sustainability**: Measure cloud business performance, supported by eight case studies and each one has a different ROI presented.
Portability	How do you demonstrate Cloud portability?	**Portability**: Deal with Cloud portability of all types, supported by Financial Software as a Service (FSaaS) and Healthcare Platform as a Service (HPaaS).
No connections between different services	How do you link and integrate different services?	**Linkage**: Link and integrate different activities and between different types of Cloud services. This develops a new and innovative area called Business Integration as a Service (BIaaS).

Classification
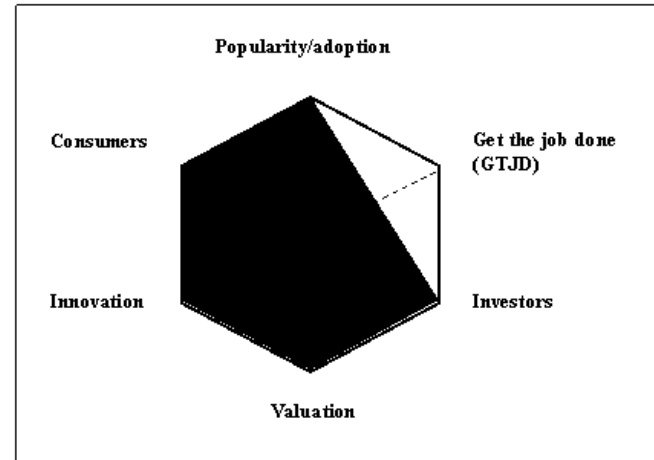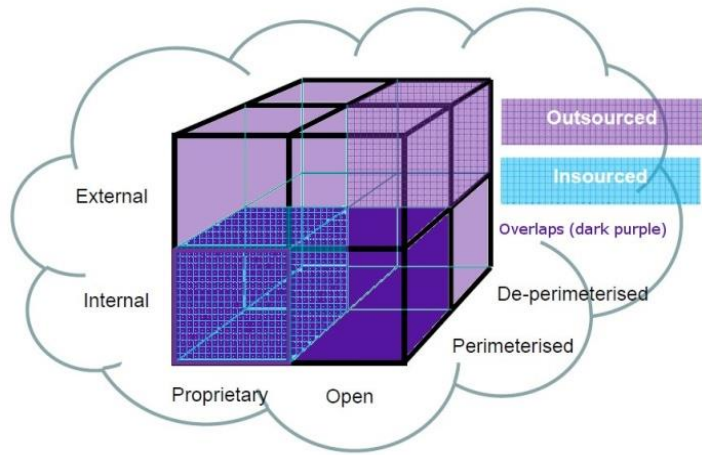
Categorization into eight business models and multiple uses of models:
- Service Provider and Service Orientation;
- Support and Services Contracts;
- In-House Private Clouds;
- All-In-One Enterprise Cloud;
- One-Stop Resources and Services;
- Government funding;
- Venture capitals
- Entertainment and Social Networking.

Classification part 2
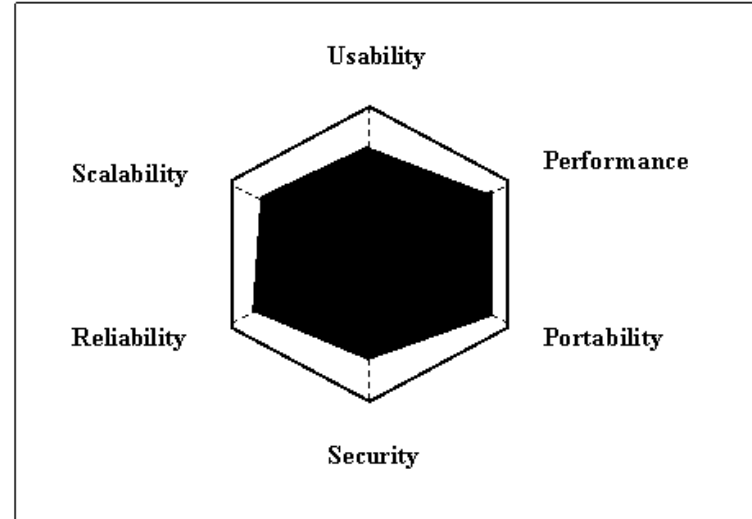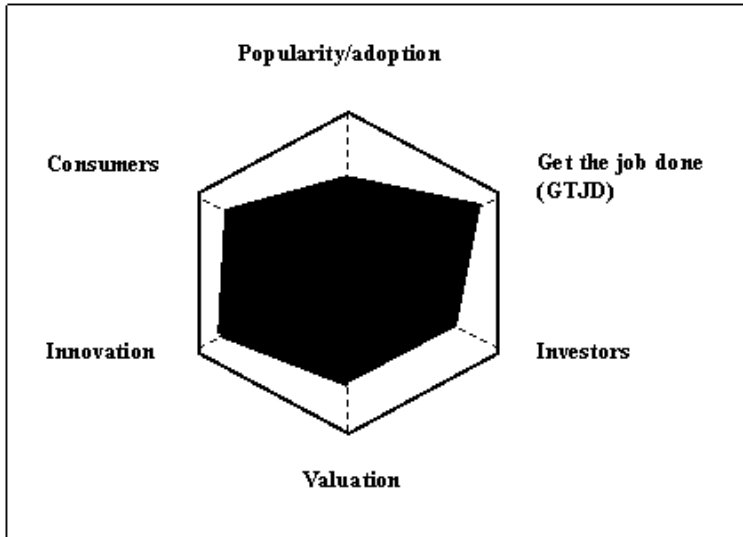
- Develop a pair of Hexagon Models. 1 is focused on Business Model and 1 is on IT Services. Can be used to measure a project or a service's performance (qualitative focused).
- Rationale has been explained in my publication. Greenwich University example for IT projects are shown above.
- Business Model: Its development has been used by some firms for Cloud adoption or consulting.

# Organizational Sustainability
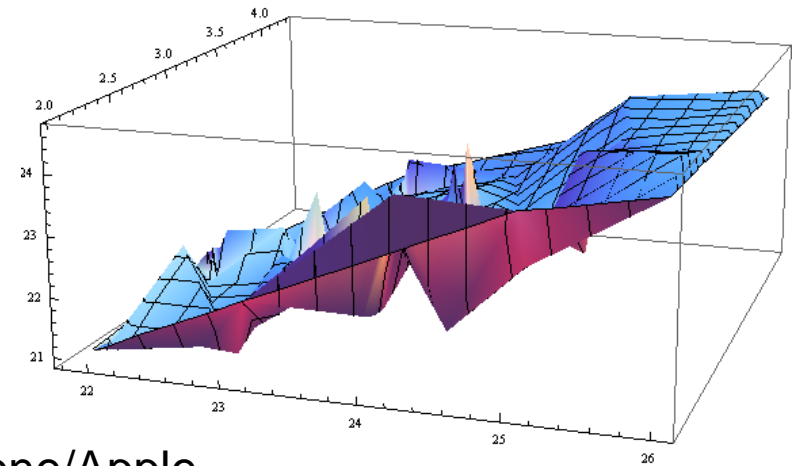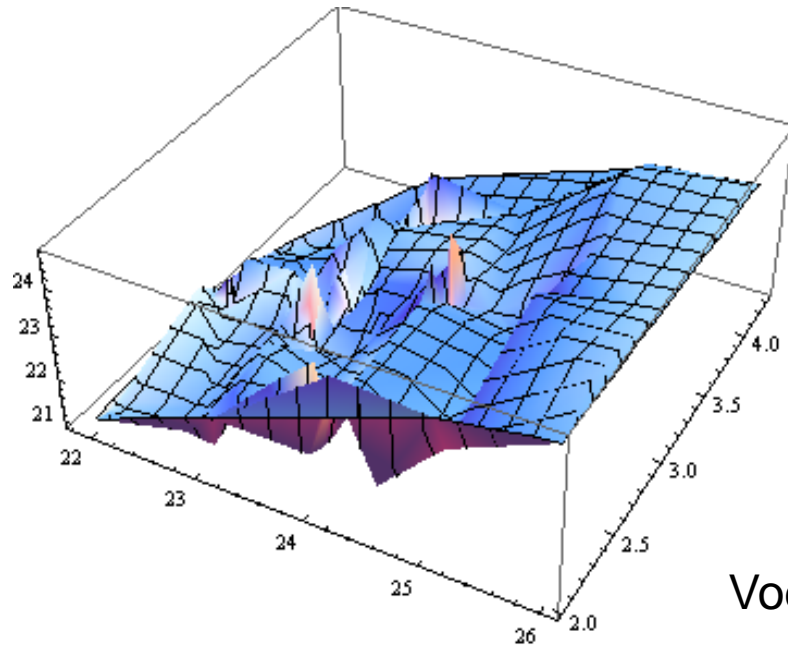

Vodafone/Apple

- Improved version of Capital Asset Pricing Model (CAPM). It's a Nobel-winning model (Sharpe, 1990). Aims to get rate of return.

- Use statistical computing. Present analysis in 3D Visualization. No hidden data or missing area.

- CAPM is suitable in predicting the firms' growth and sustainability if data is defined and given. Focused on 3 aspects: technical, cost and user. Ideal to measure business performance/ROI.
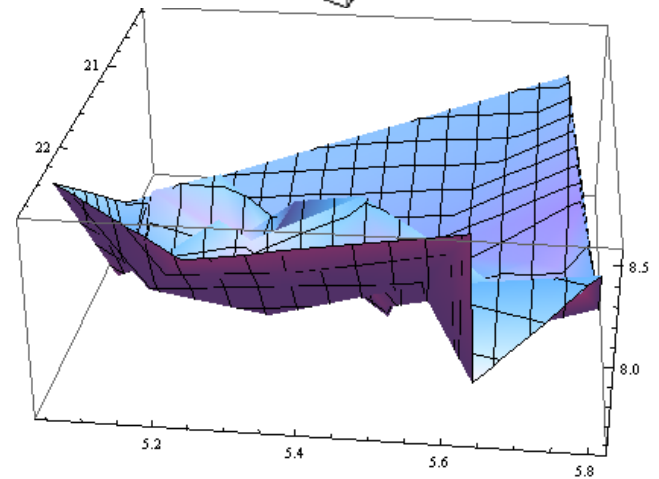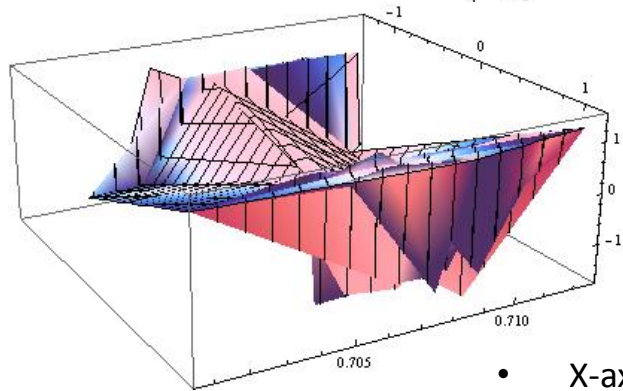
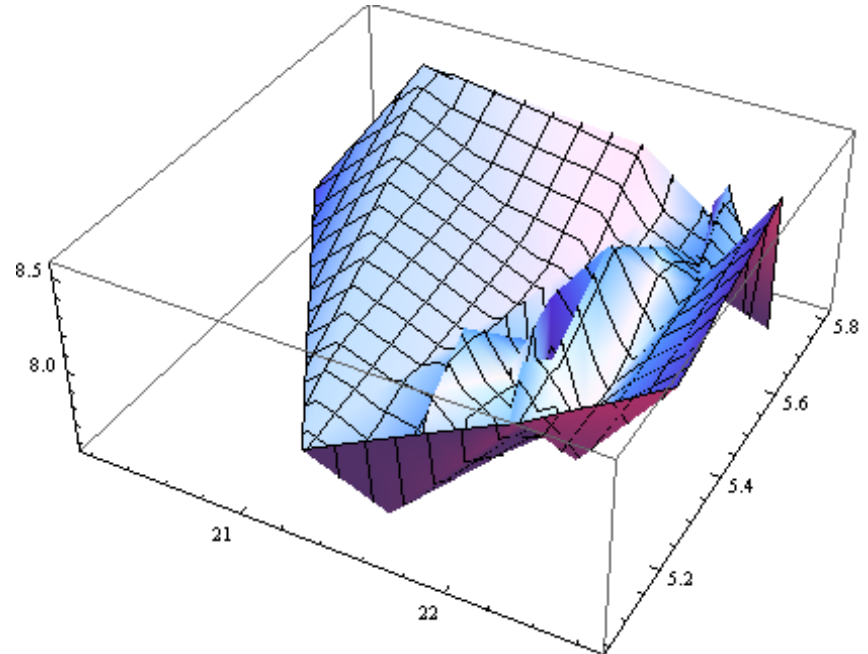# 3D Visualization for a start-up

Easy to understand. Present cloud business performance in visualized ways and aim to provide a good and accurate ROI measurement
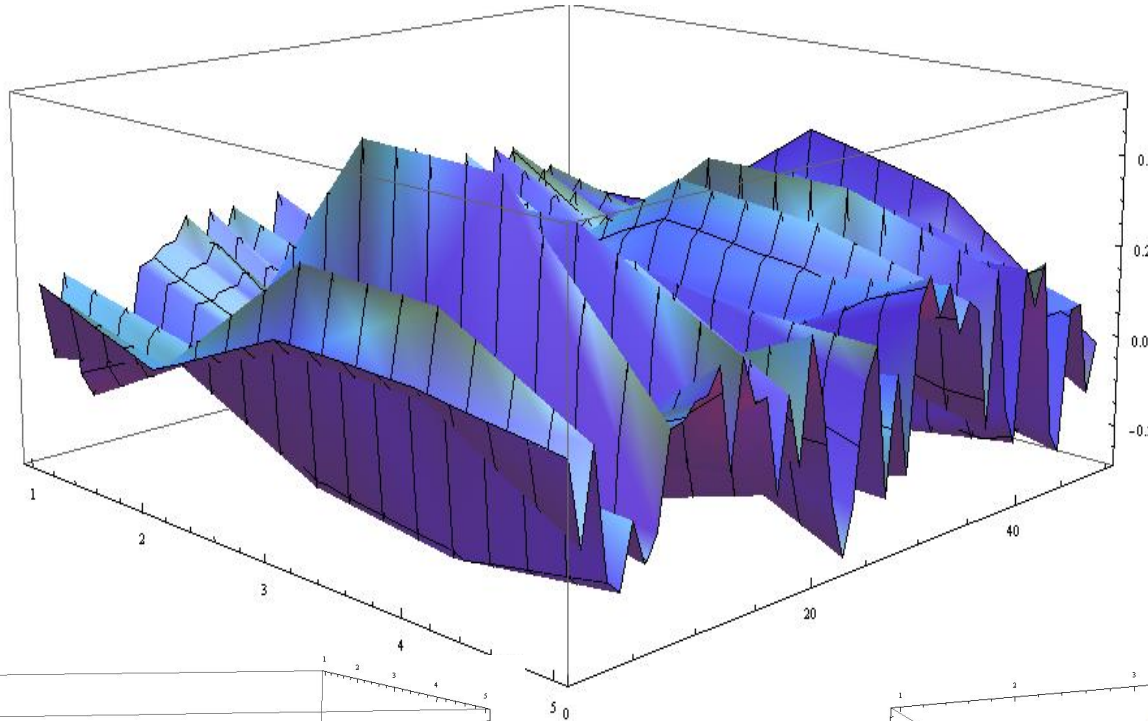
- X-axis: Actual return
- Y-axis: Expected return (risk premium of market)
- Z-axis: risk-free rate (minimum resources, time or cost required)
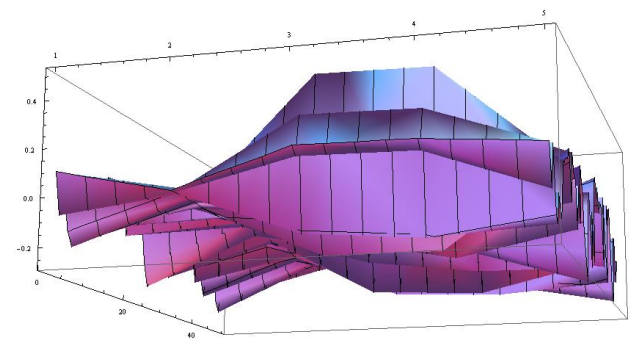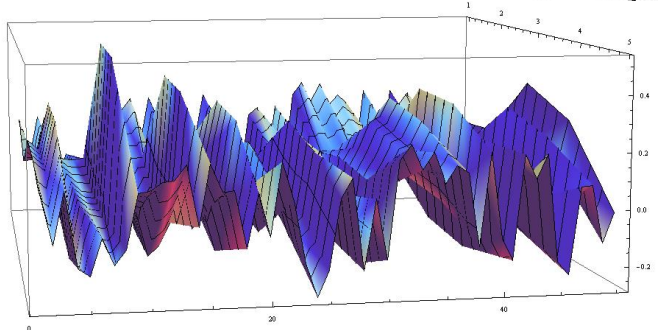
Some models: SAP (loss control/cost-saving) and VMware/SME (cost-saving)
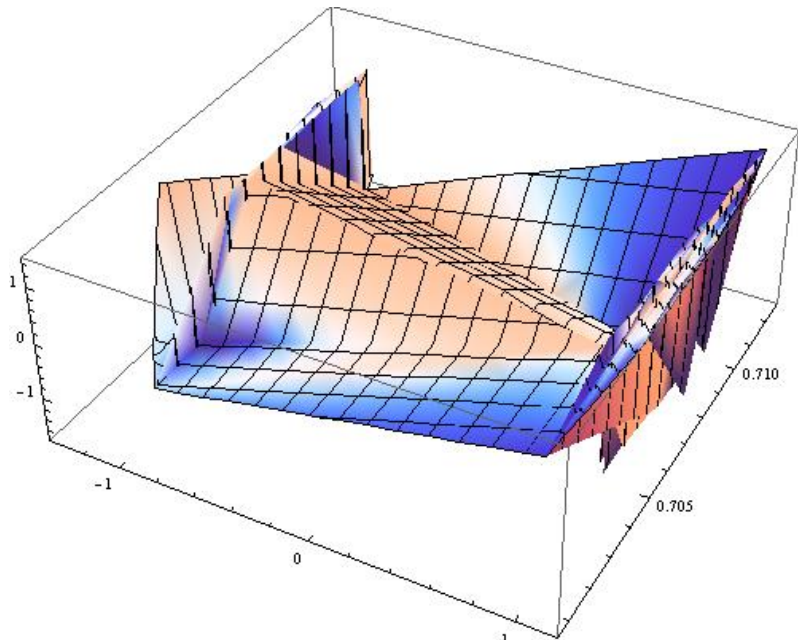
- X-axis: Actual return
- Y-axis: Expected return (risk premium of market)
- Z-axis: risk-free rate (minimum resources, time or cost required)

NHS Infrastructure and Bioinformatics

- X-axis: Actual return
- Y-axis: Expected return (risk premium of market)
- Z-axis: risk-free rate (minimum resources, time or cost required)

University of Southampton: Cost-saving & User Satisfaction

- X-axis: Actual return
- Y-axis: Expected return (risk premium of market)
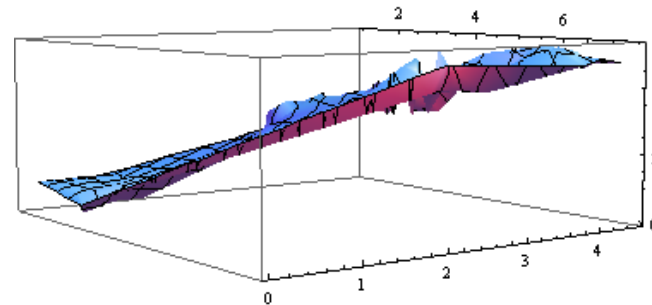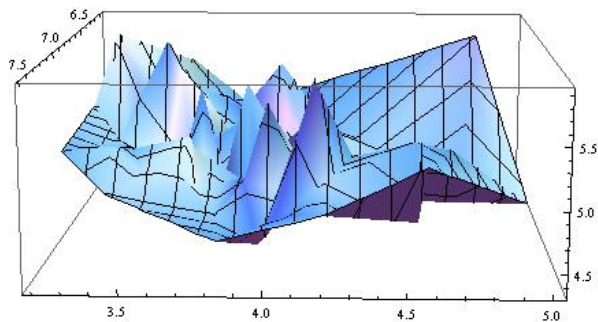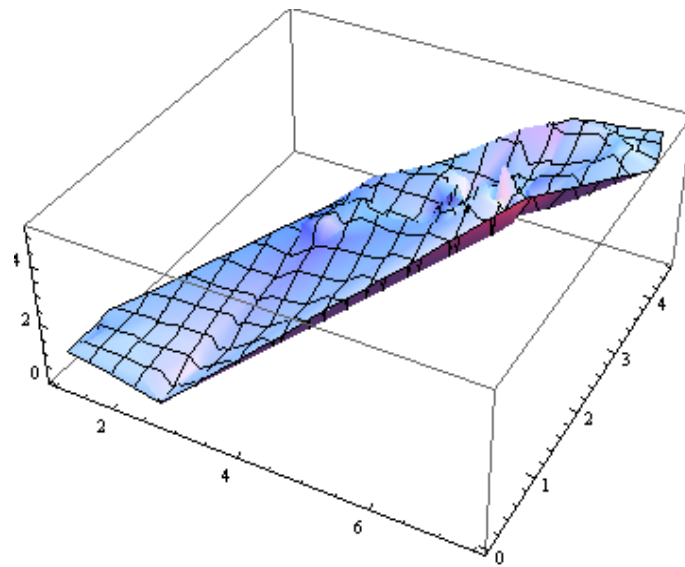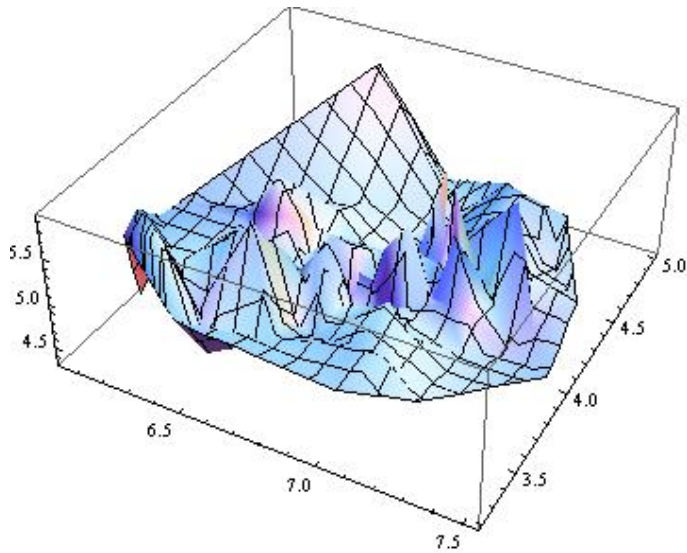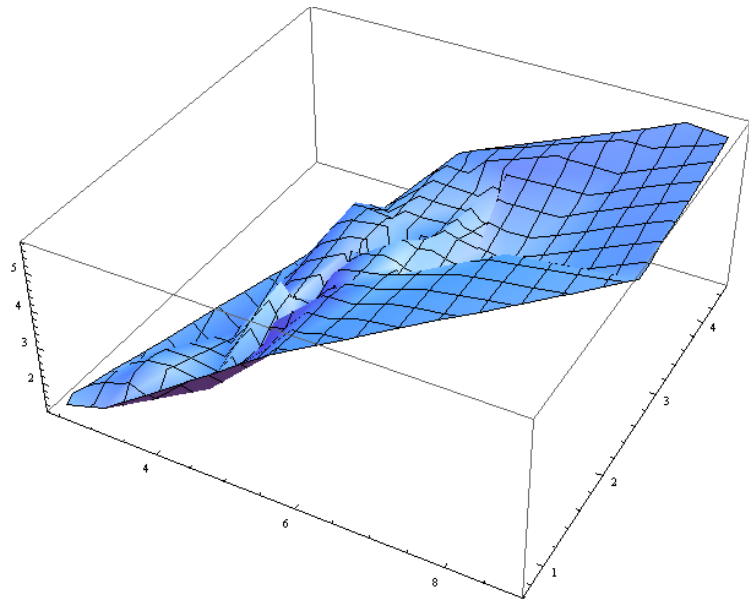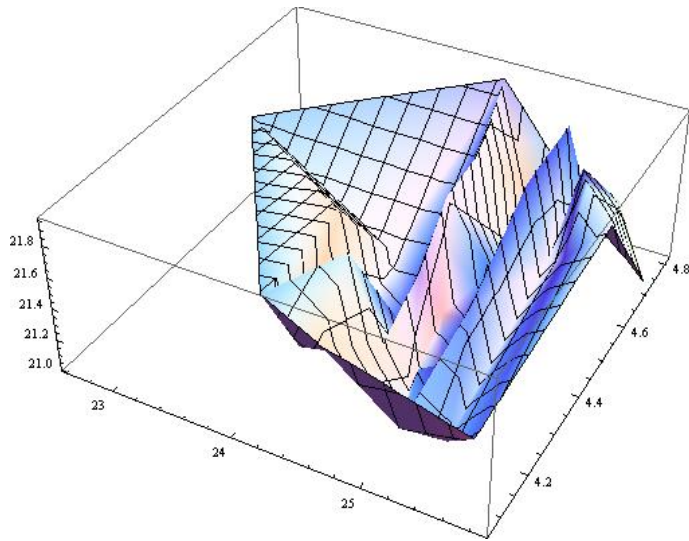- Z-axis: risk-free rate (minimum resources, time or cost required)

- The University started using virtualization/private Cloud since 2007. Worked with three departments – had up to three-year data. Focused on cost and users to measure ROI.

Portability

- Help organizations to migrate to Cloud – either building from scratch or migrating from desktops to Cloud.

- Focus on Finance and Healthcare domains. Portability in each domain can be different due to requirements etc.

- In Finance, Financial Software as a Service (FSaaS) is used for demo, where Risk Assessment as a Service (RAaS) is part of it. FSaaS uses Monte Carlo Methods (MCM) and Black Scholes Model (BSM) for simulations.

- RAaaS has a series of steps of MCM (Variance-Gamma Process, VPG; and Least Square Method, LSM) and BSM.

- Healthcare – focuses on Cloud Storage (won an award) and 3D Bioinformatics.

Portability (Finance)

Sequence	Process	What is aimed for	Outcomes
1.	(Variance Gamma Process) VGP in MCM	Detect and correct errors	If errors are still found, run analysis again. The improved analysis can be passed onto next sequence.
2.	Least Square Method (LSM) in MCM	Provide fast and reliable calculations with an excellent performance. Obtain benchmark.	Most of calculations and benchmark can be obtained here. If errors are found, go back and check. The improved analysis can be passed onto next sequence.
3.	Risk Modeling in BSM	To compute risk in 3D Visualization. There are 3 different scenarios presented.	The focus is to compute the extent and risk, and present in a way to be visually accessible. So that no hidden risk involved. The improved analysis can be passed onto next sequence.
4.	Advanced risk modeling	To obtain a good quality of FSaaS on Cloud.	This can demonstrate the key benefits of Cloud Portability: to allow speed, accuracy, reliability, usability and performance on using Cloud for FSaaS.

Financial Cloud (Risk modelling and security)

Access Control And Firewall

IDS/IPS

Strong isolation of guest environment to contain possibly subverted and/or malicious hosts

Lockdown the management domain

Weak isolation of the guest environment entails strong integrity mechanisms

Enterprise users

The Internet

Enterprise users

Enterprise users

DoS, Anti-spoofing

Known vulner-abilities

Parameter Tampering

Cross Site Scripting

Pattern-Based Attacks

SQL Injection

Cookie Poisoning

Port Scanning

Leverage risk data/insights

Applications (e.g. risk mgmt for car loan)

Analysis report

Leverage risk insights (e.g. delinquency)

Loan Origination/ Servicing

Cloud platform for Risk/Fraud Data Aggregation, Anonymization, Predictive Analysis

Strong information security with appropriate isolation between banks required

Share risk data

Bank Clients

Bank

Bank

Bank

*A scenario based on ORX

Portability (Finance): Selected results
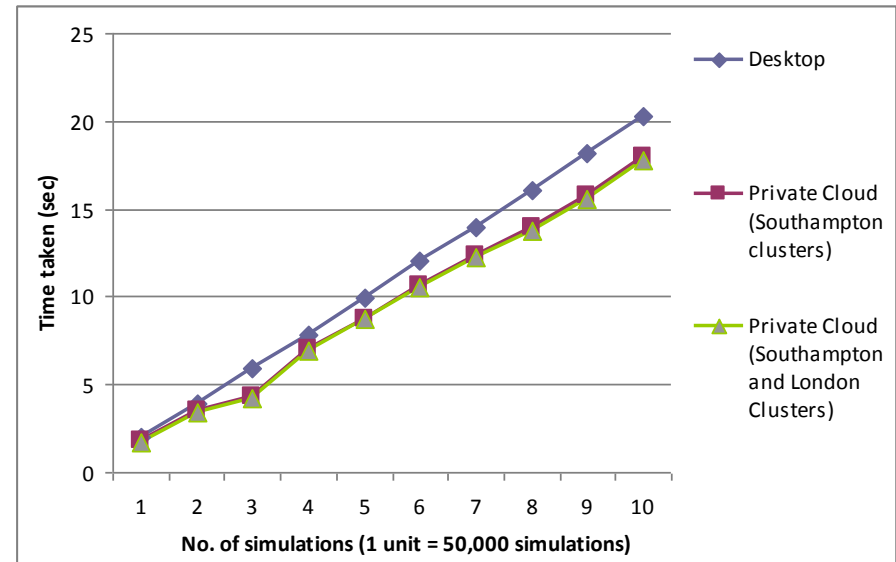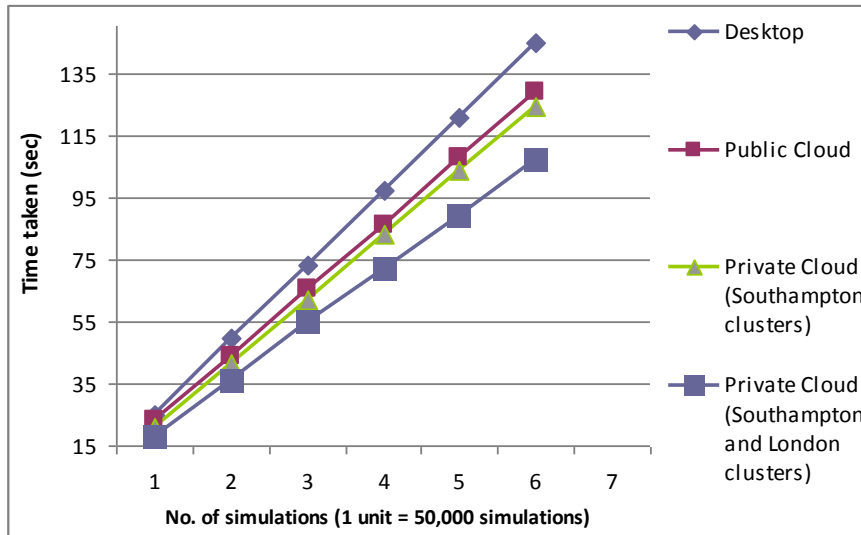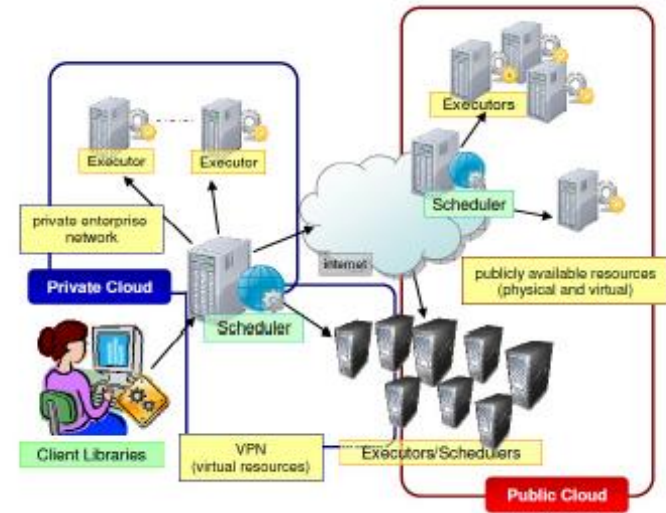

500,000 simulations in 1 go.
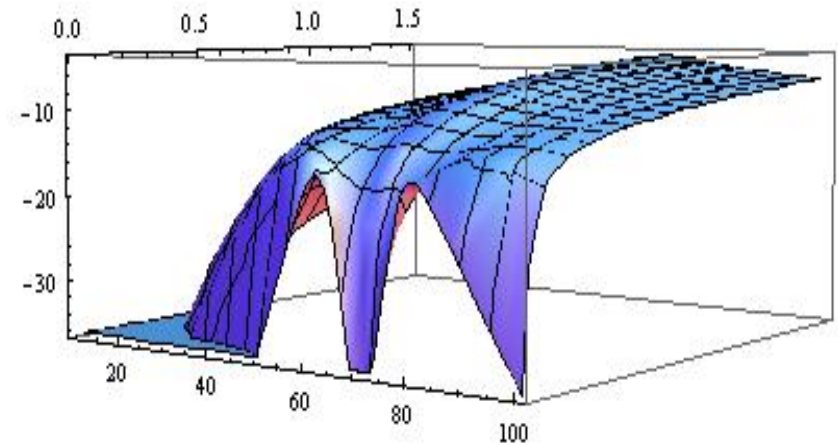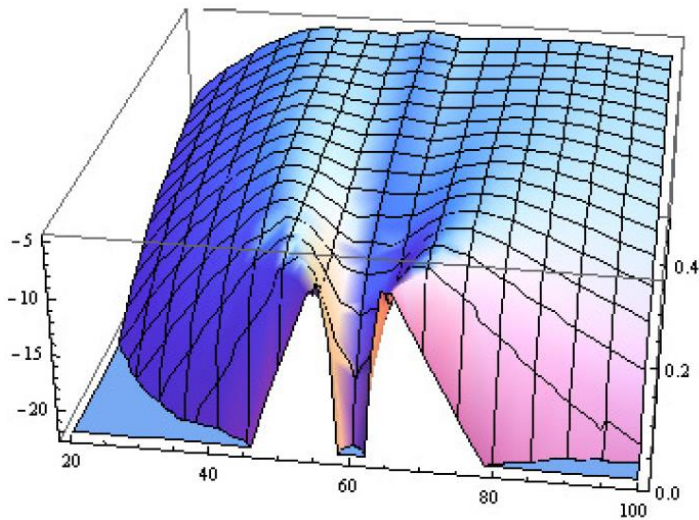
Financial crisis in 2008 and 2011 (EU)

Healthcare Private Cloud

Databases, bioinformatics, storage/backup, security, statistics & virtualization.
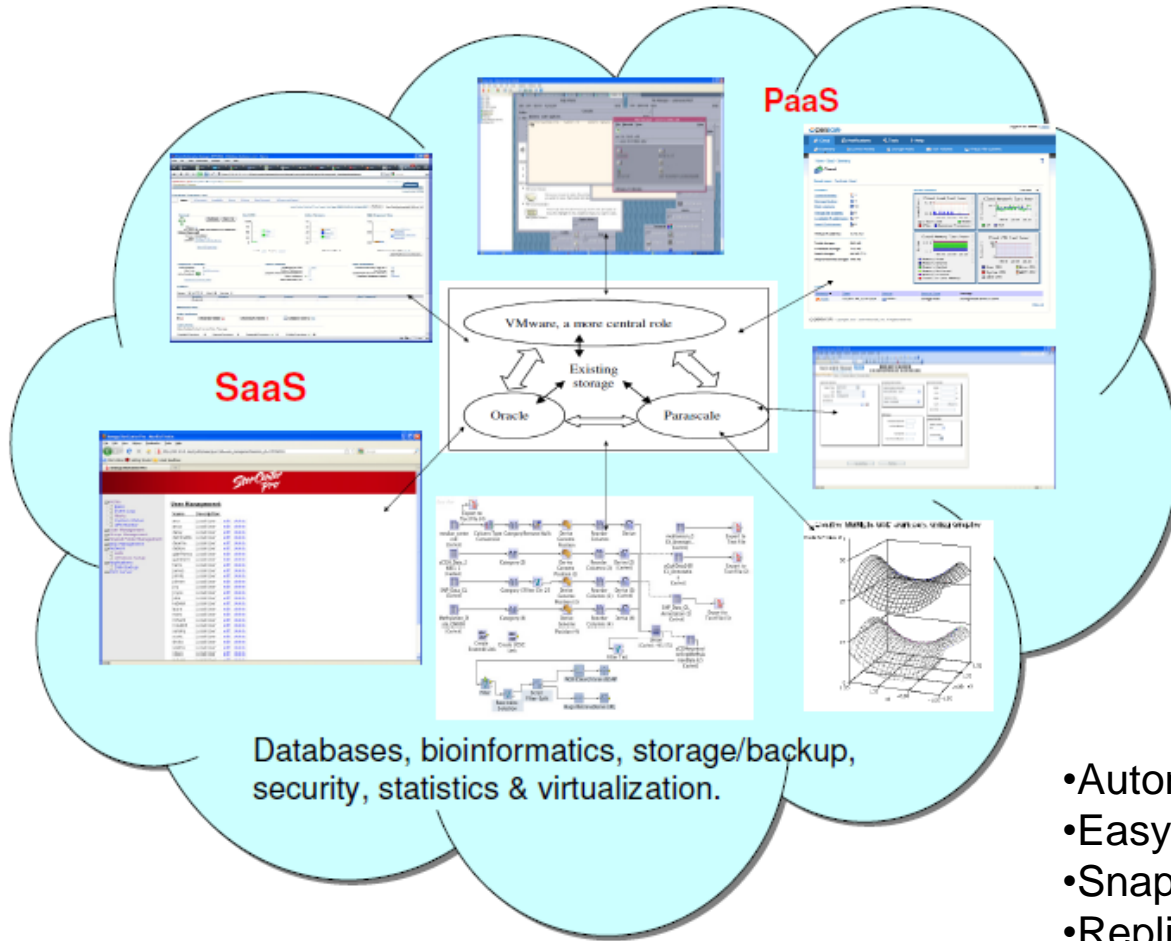
- Automation
- Easy backup and archiving
- Snapshots, mirroring
- Replication
- Recovery
- Data Migration
- Test-bed
- Heterogeneous network & OS support
- Offer user support

Healthcare: Cloud Storage

- Has been used on daily basis and provides automated and easy-to-use features and functionality. Useful for data-intensive work. Focuses on "Backup Automation", "Data Recovery" and "Data migration". "Backup Automation" always stays 2% and below for failure rate. The other two do not.
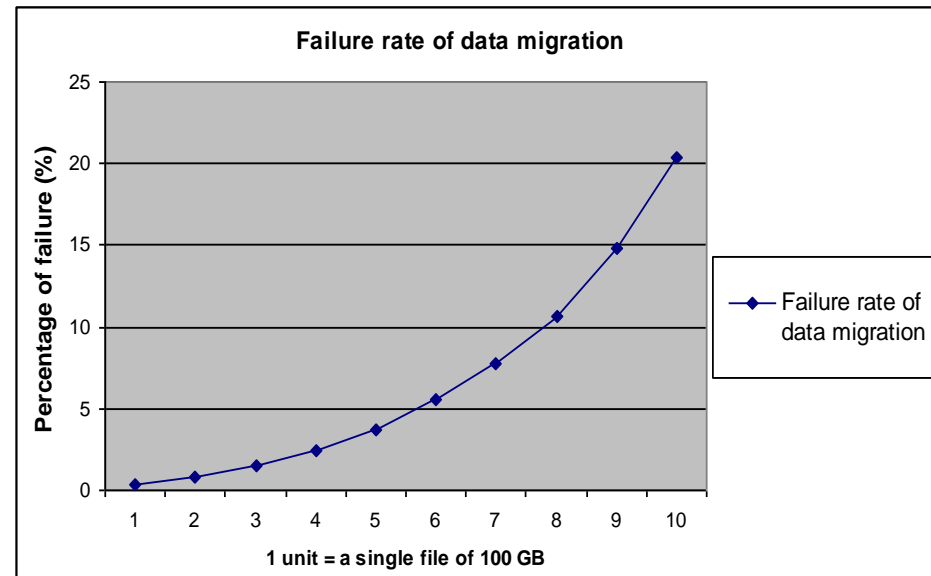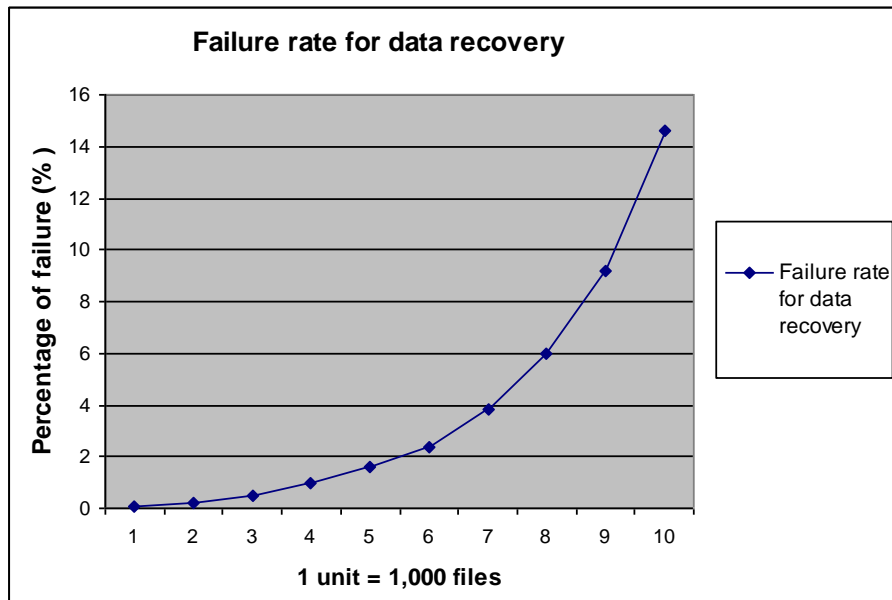
Failure rate for data recovery and data migration

Healthcare: Bioinformatics
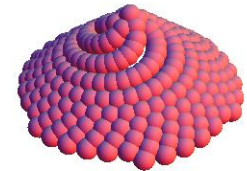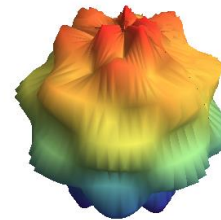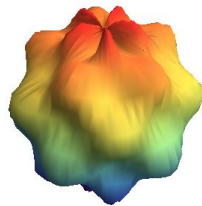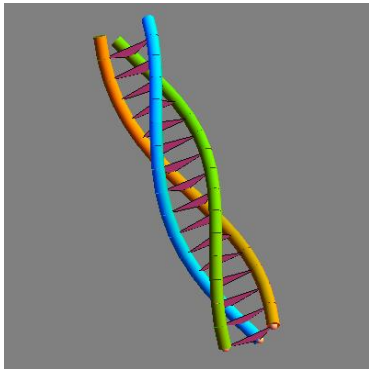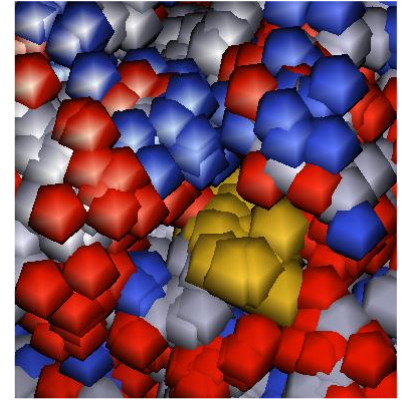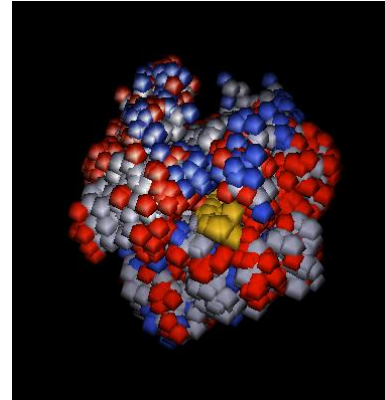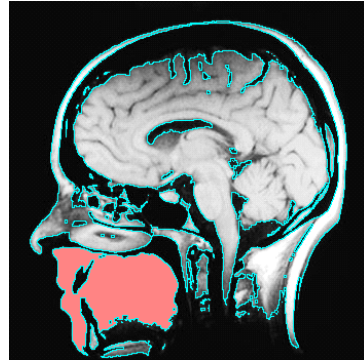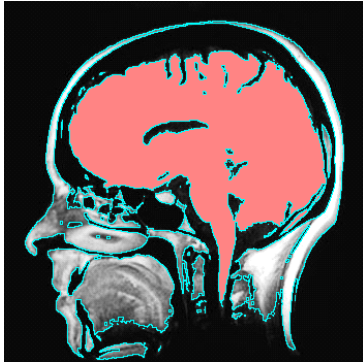
- Medical imaging, 3D insulin molecules, tumor modeling, 3D DNA and, spirals in plants and so on.

Linkage: presented by Business Integration as a Service (BIaaS)

Motivation:

- There is no communication between services. Each time two types of service requests and activities have to done at different periods of time.

- Creation of additional work and cost. It also costs more to pay two service providers.

- It is difficult to check consistency of computational results from different service providers.

BIaaS benefits (apart from cost-saving, improvements in efficiency etc):

- To allow two or more different services to work together where traditionally each service would be separate from the others.

- To permit the outcome of one service to be used as input for another; integrating two or more services into one.

Demonstration includes

- **ROI Measurement as a Service (RMaaS)**: The aim is to measure Cloud business performance. Work is similar to Organizational sustainability.

- **Risk Analysis as a Service (RAaaS)**: The purpose of this service is to calculate risks and evaluate its impact on an organisation. Work is similar to RAaS earlier (except no 3D risk).

Demonstration requires how RMaaS and RAaaS can work as a single service in a private cloud environment.

System Architecture and Explanation
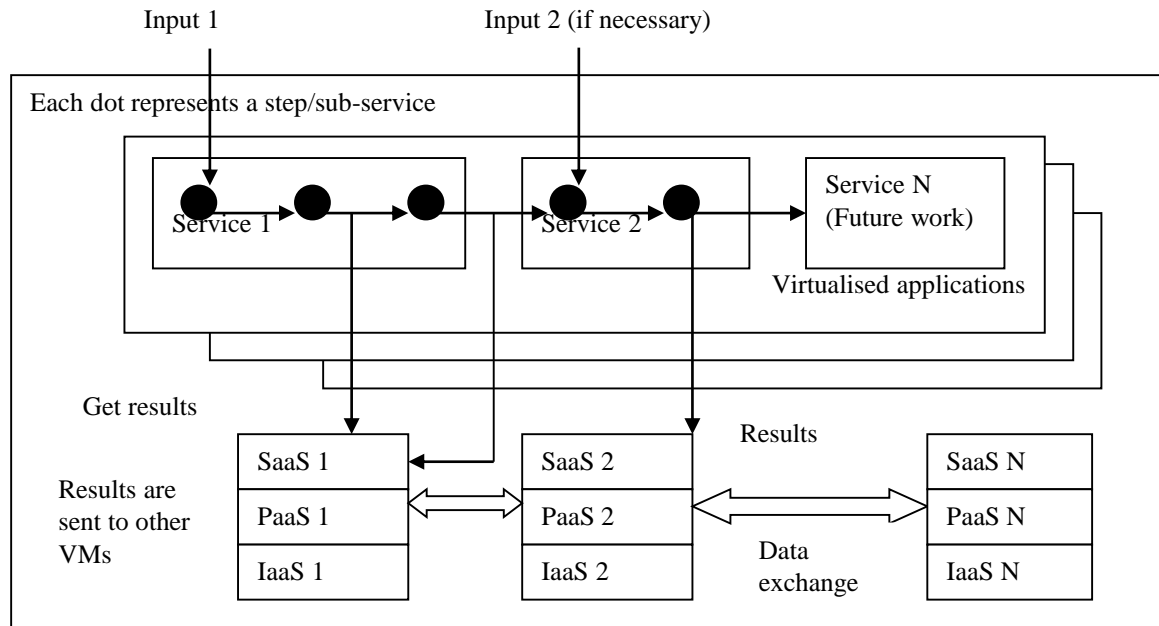
In RMaaS:

- Statistical service: This computes Cloud business performance with key statistical data offered by SAS, a statistical program.
- Visualization service: Results from statistical service pass onto this step which presents key data using 3D Visualization enabled by Mathematica.

In RAaaS:

- VGP risk analysis service: This reduces inconsistencies and errors & calculates the risk pricing, showing frequency of occurrence and risk pricing.
- LSM risk analysis service: This computes high-performing simulations and calculates the most likely risk pricing and its upper and lower bounds.

Case Study: University of Southampton
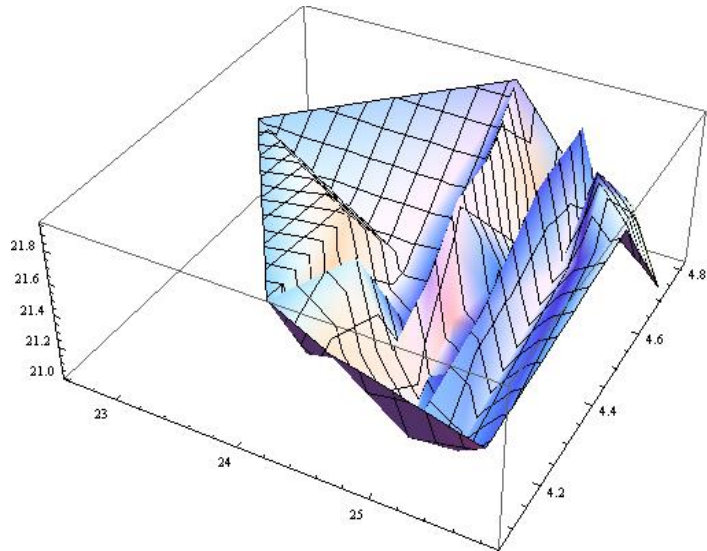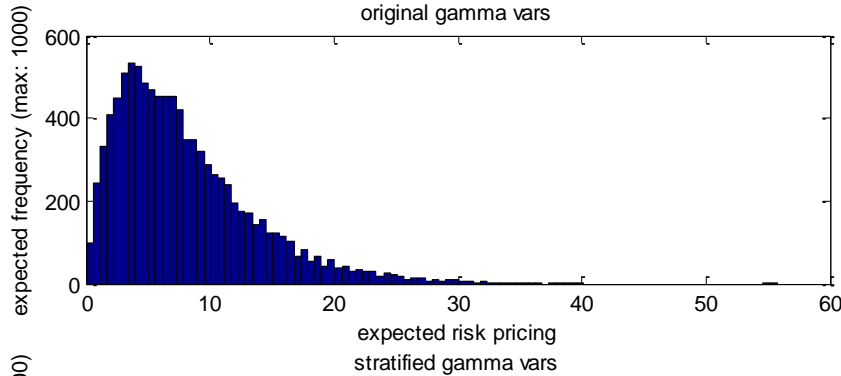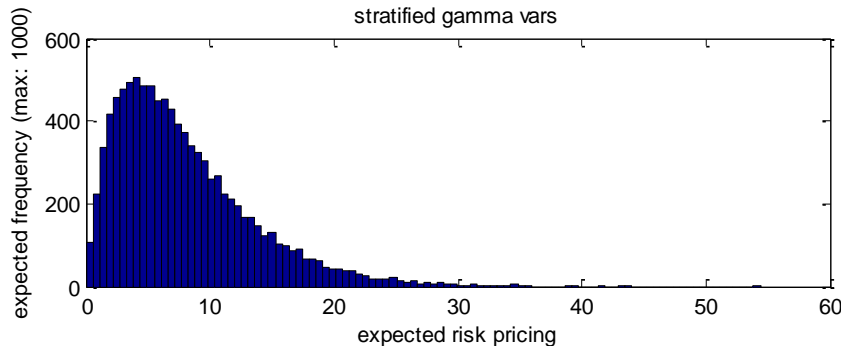
Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	------- joint ------ adj chi2(2)	Prob>chi2
x-axis	82	0.7916	0.3201	1.11	0.3740
y-axis	82	0.7649	0.0094	6.30	0.0428
z-axis	82	0.5257	0.0000	16.09	0.0003

original gamma vars

stratified gamma vars

MCM simulations with LSM (1 unit = 10,000 simulations), time step= 10
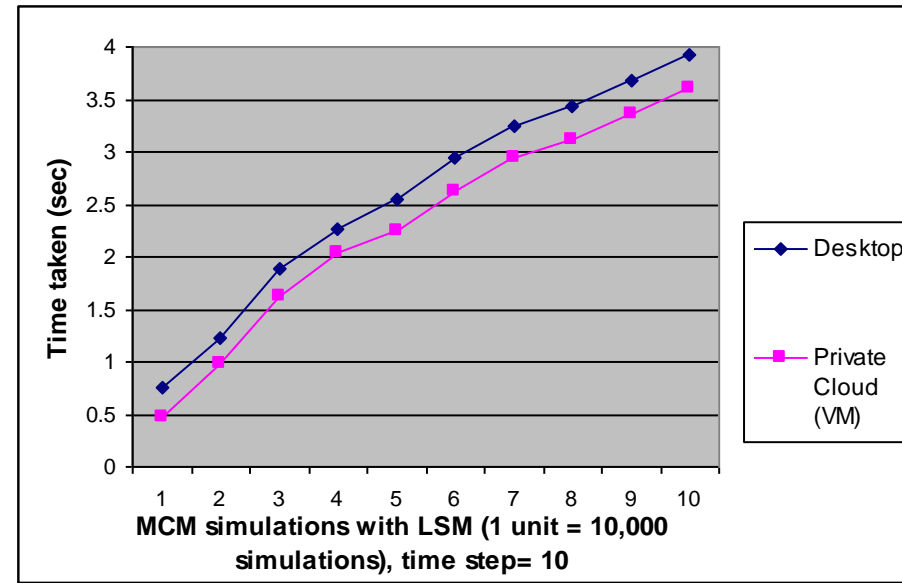
[LowerLimit MCPrice UpperLimit]
Call Prices: [4.260768 4.312682 4.364596]
Put Prices: [7.585452 7.640954 7.696455]

Case Study: Vodafone/Apple

original gamma vars

stratified gamma vars
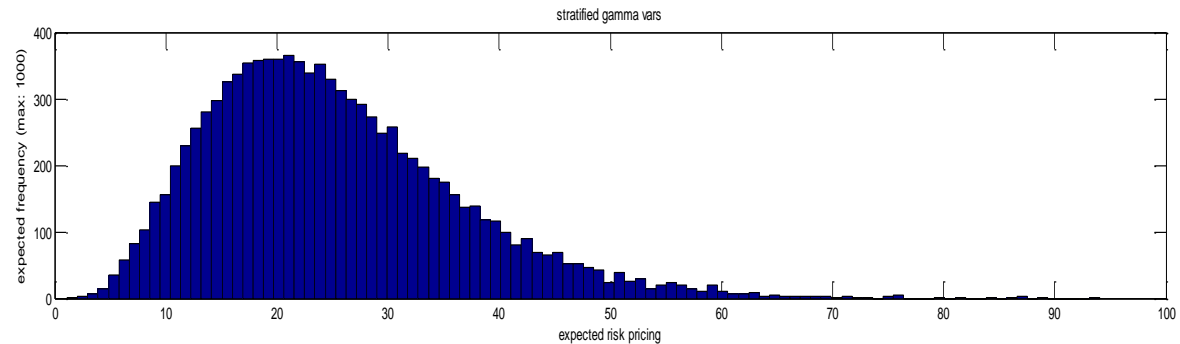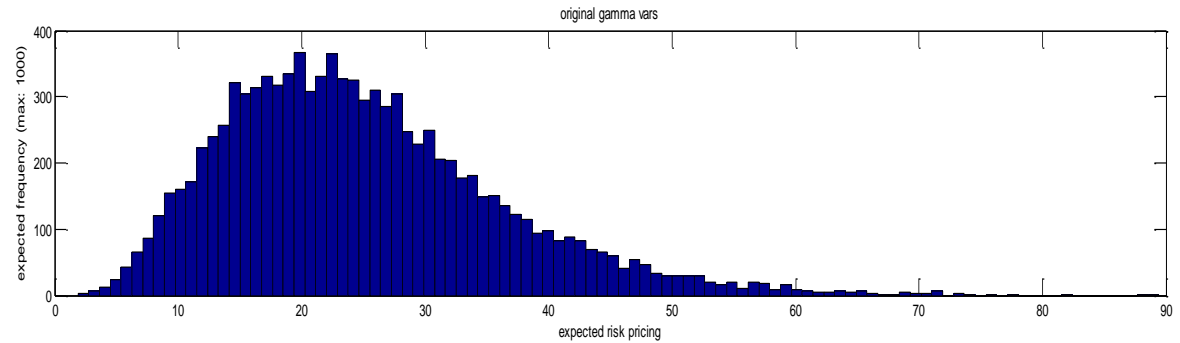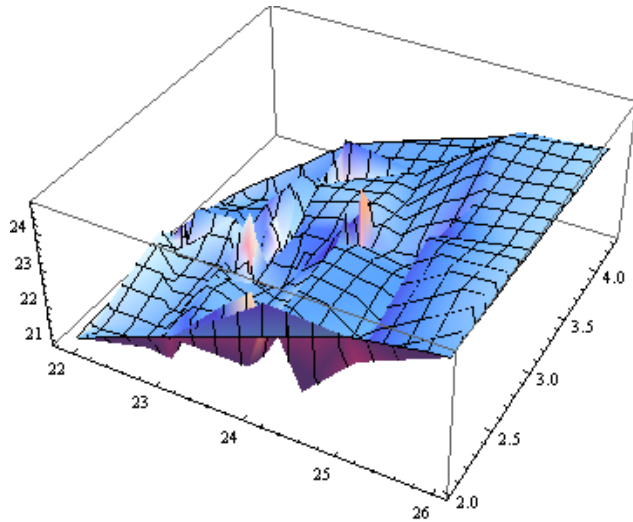
		Skewness/Kurtosis tests for Normality			
				------- joint ------	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
x-axis	111	0.0754	0.1075	5.58	0.0616
y-axis	111	0.9383	0.1735	1.90	0.3868
z-axis	111	0.0200	0.0205	9.39	0.0091

- MCAmericanPrice = 23.8412
- MCEuropeanPrice = 21.1682

     [LowerLimit MCPrice UpperLimit]
Call Prices: [20.490137 21.189824 22.289510]
Put Prices: [22.794581 23.940547 25.086512]

Have done another case study: SAP
(from SME's angle)

Conceptual framework (and next page)

Arrows move upwards so that existing services can be upgraded to cover a wider range of services.

Dotted arrows: Dependency and requirements to pass on.

SaaS

Computation

Organisational Sustainability Modelling	Service Portability

Collaborators

PaaS

Storage, job submission….

Organisational Sustainability Modelling	Service Portability

Collaborators

IaaS

Organisational Sustainability Modelling	Service Portability

Collaborators

IaaS, PaaS and SaaS are connected to Business Models.

Business Model	
Classification	

Hexagon Model for Business Model

Linkage: Hexagon Model

PaaS	
Storage, job submission….	
Organisational Sustainability Modelling	Service Portability

Collaborators

SaaS	
Computation	
Organisational Sustainability Modelling	Service Portability

Collaborators

IaaS, PaaS and SaaS are connected to Business Models.

IaaS	
Organisational Sustainability Modelling	Service Portability

Collaborators

The Hexagon Model for IaaS, PaaS and SaaS: Linkage to other methods and models

A List of organizations – in collaboration with or related to CCBF

Organizations	CCBF key areas involved
Guy's and St Thomas' NHS Trust (GSTT) and Kings College London (KCL)	Classification Organizational Sustainability Portability Linkage
Other NHS Trusts and	Organizational Sustainability Portability
OMII-UK	Organizational Sustainability
ECS, Southampton	Organizational Sustainability Portability Linkage
University of Southampton	Organizational Sustainability Portability Linkage
University of Greenwich	Organizational Sustainability Portability Linkage
Oracle	Organizational Sustainability
SAP	Classification Organizational Sustainability Linkage
Commonwealth Bank, Australia (CBA)	Portability Linkage

IBM US	Portability Linkage
VMware and SME relying on Vmware	Organizational Sustainability
Apple/Vodafone	Classification Organizational Sustainability
Small and Medium Enterprises (SME)	Classification Organizational Sustainability Portability Linkage
Zeus	Classification Organizational Sustainability
Intel and AMD	Organizational Sustainability Portability
Salesforce	Organizational Sustainability
MyExperiment, Oxford and Southampton	Linkage
Several financial Institutions	Portability
Selected number of organisations	Classification Linkage

Contributions

CCBF key areas	Research Contributions (in brief)	Other contributions
Classification	Use of CCM and the pair of the Hexagon Models to help collaborators to understand strategies and business cases for Cloud adoption, including multiple business models.	Part of future work with Greenwich Business School, and a few more individual researchers, consulting firms or business schools.
Organizational Sustainability	Use CAPM to measure cloud business performance and present complex statistical data in 3D Visualization, which makes analysis easier. This helps stake-holders to understand their ROI of any Cloud projects.	OSM is presented in a way that CAPM has never been used as before. It uses 3D Visualization and is an improvement of a Nobel-Prize model. 3D Visualization ensures no hidden data or missing area for analysis. It is easier to understand.
(Enterprise) Portability	Demonstrate how portability can be achieved including the use of HPaaS for platform portability and FSaaS for application portability. Experiments, simulations and benchmarking are used to demonstrate portability.	There are not many Cloud portability demonstrations, although some are available in industry and a very expensive service. CCBF has developed HPaaS for GSTT and KCL, and also FSaaS for IBM US, CBA and others.
Linkage	Link and integrate different activities and between different types of Cloud services. A new concept, Business Integration as a Service (BIaS), is used for demonstration supported by case studies.	CCBF has provided services for University of Southampton, Vodafone / Apple, University of Greenwich, and MyExperiment.

Some other work (future work or for fun)

3D Simulations by Victor C
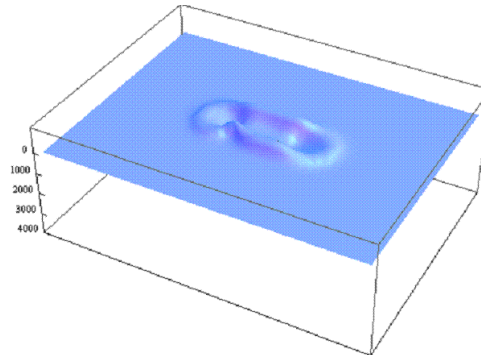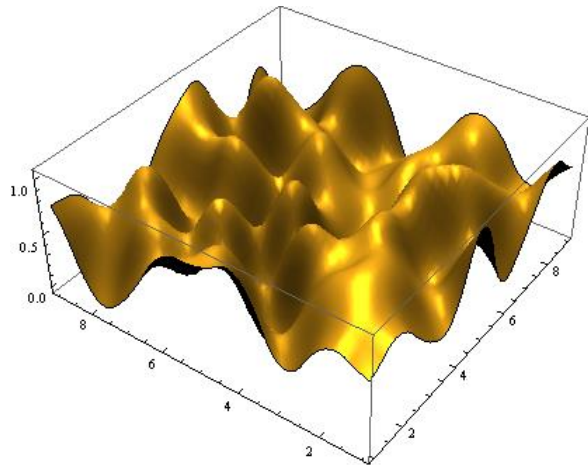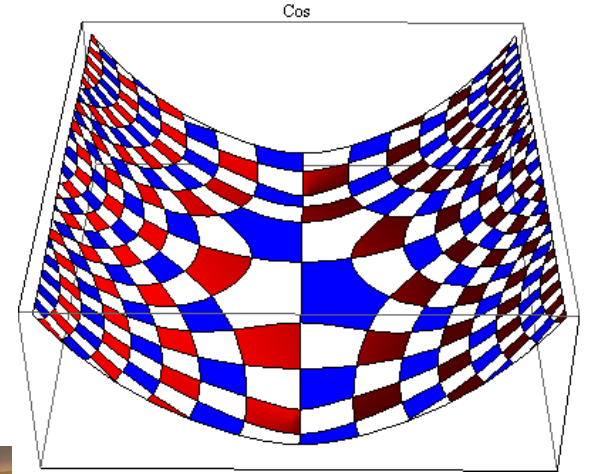
Future Work 1: Evolving Business Models/ROI
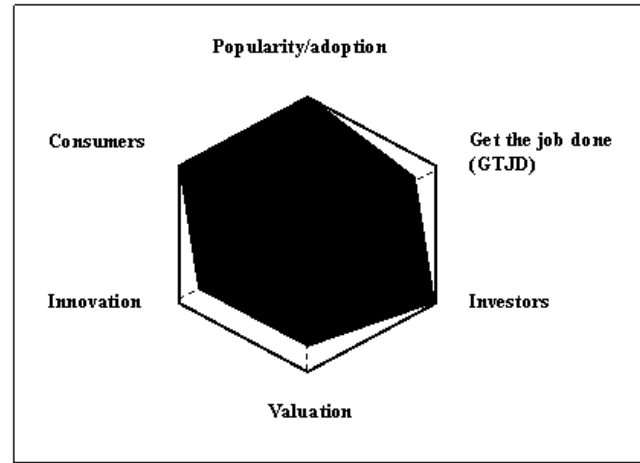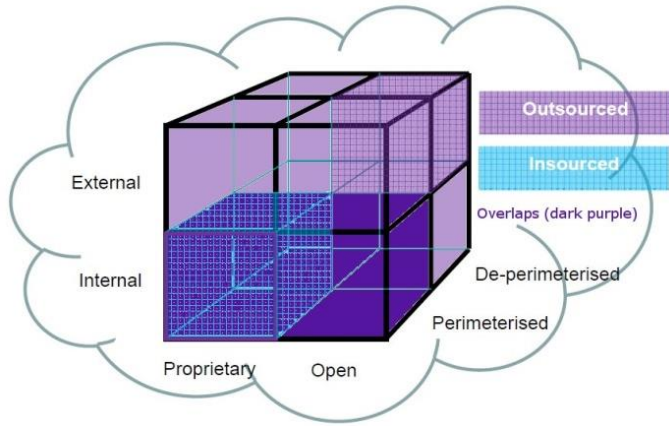
Business Model Classification for Success
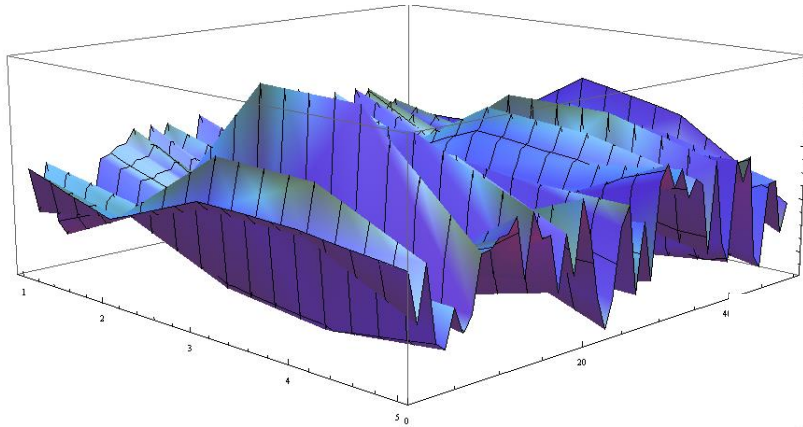
Security as a Service

Cloud cases in emerging economies
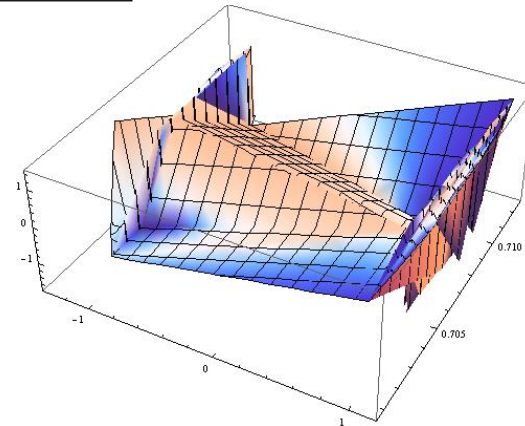
Review Business Performance, and is a better/fairer way than using stock market.
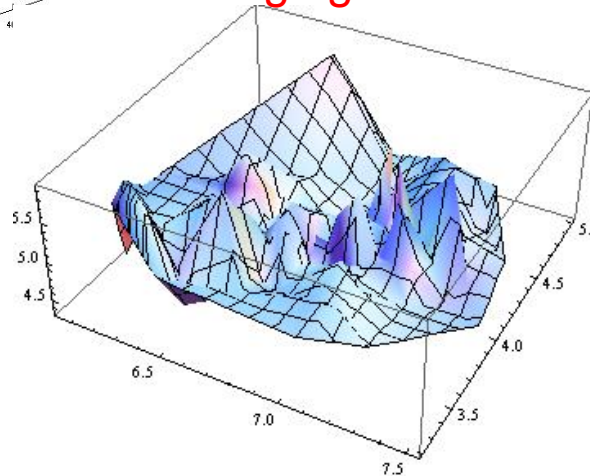
GPU for Cloud

Future Work 2: Emerging Clouds (Mobile, social network, Finance, Education and data-intensive)
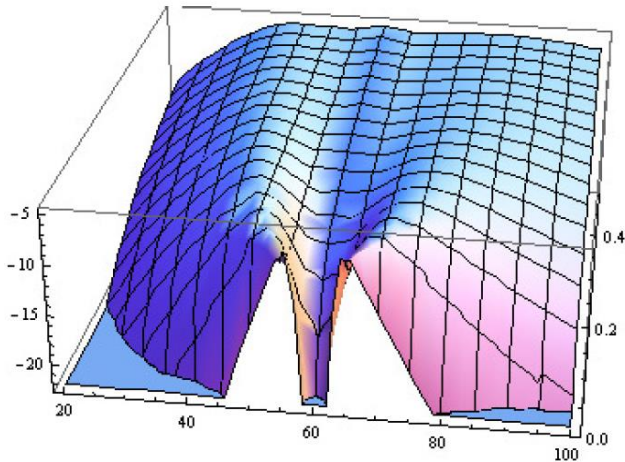
Low-cost teleconferencing
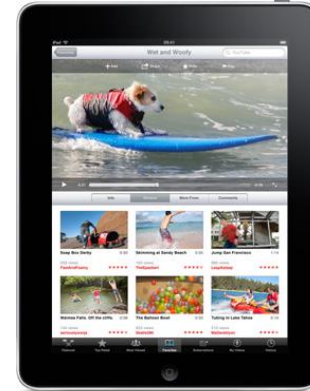
Live event update and app
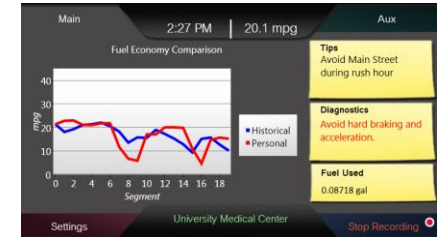
Gaming Cloud
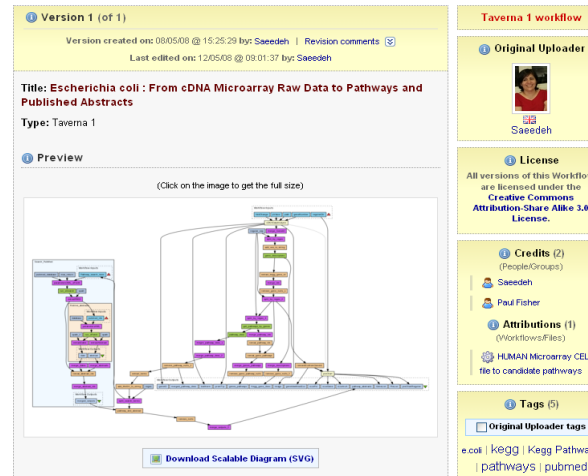
Social Networking for Academia, Professionals, Scientists etc.

Education as a Service

Data-Intensive research Cloud

Conclusion

- Cloud Computing is highly relevant for IS and challenges are not just technical.

- Cloud Computing (particularly private cloud) adoption is important for organizations where Cloud deployment and design need to match requirements and be able to overcome challenges.

- CCBF has 4 key areas and each area has its own contributions supported by demonstrations and case studies. They are useful for those organizations and enterprise research.

- CCBF is a dynamic framework that each case study meets the different type of design, deployment and services.

Questions?

Thank you!!

1 CAPM example: Codes and Results

```
data omii;
  input r_m r_f omii;
  r_omii = omii - r_f;
  r_mkt = r_m -r_f;
  label r_m='Market Rate of Return'
      r_f='Risk-Free Rate of Return'
      omii='Rate of Return for OMII-UK'
      r_omii='Risk Premium for OMII-UK'
      r_mkt='Risk Premium for Market';
datalines;
proc gplot data=omii;
  plot r_omii * r_mkt / haxis=axis1 hminor=4
      cframe=ligr
      vaxis=axis2 vminor=4;
  symbol1 c=blue v=star;
  axis1 order=(-0.3 to 0.3 by 0.1);
  axis2 label=(angle=90 'OMII. Risk Premium')
    order=(-0.4 to 0.6 by 0.2);
  title 'OMII-UK CAPM Sustainability';
  title2'Plot of Risk Premiums';
  title3'OMII-UK versus the Market';
run;
```

Root MSE   0.15107   R-Square
0.1344
Dependent Mean   0.02493   Adj R-Sq
0.1248
Coeff Var   606.03266
Parameter Estimates
Parameter   Standard
Variable   Label   DF   Estimate
Error   t Value   Pr > |t|

Intercept   Intercept   1   0.01282
0.01608   0.80   0.4274
r_mkt   Risk Premium for Market 1
0.39653   0.10609   3.74   0.0003
Actual and Predicted Values   6
The REG Procedure
Model: MODEL1
Dependent Variable: r_omii Risk Premium for
OMII-UK
Durbin-Watson D   2.034
Pr < DW   0.5602
Pr > DW   0.4398
Number of Observations   92
1st Order Autocorrelation   -0.032

System Architecture and Deployment

London Greenwich

2 servers (with VMs), 9 GHz, 20 GB at total

NAS: 16 TB at total

University of Southampton

ECS, server 1 (with VMs), used for simulations, 3.0 GHz, 12 GB RAM

ECS, server 2 (with VMs), used for simulations, 3.0 GHz, 4 GB RAM

London Data Centre, advanced parallel computing infrastructure

HPC servers: 30 GHz (six-cores) and 60 GB RAM at total

NAS: Archive (24 TB at total, 12 TB effective, RAID 10)

5 services
- 1. Statistics
- 2. Statistics
- 3. Database
- 4. Bioinformatics
- 5. Virtualisation

Lead author's home, Southampton

Home server 1 (with VMs), 4.2 GHz, 8 GB RAM

Home cluster (8 servers with VMs), 20 GHz, 24 GB RAM

Home NAS 1 (6 TB at total and effective, RAID 0)

Red arrows: simulations and computational connections between different networks.
Blue arrows: simulations and computational connections between internal networks.
Green (dotted line): interactions between different sites which need to pay for access.

Healthcare portability: Architecture/deployment

University of London Computing (Data) Centre (ULCC)

GSTT and KCL

Bioinformatics services, (IP) iscsi SAN

NAS 1 (3TB at total, 2.1 TB in effective, RAID 5) — Used by Bioinformatics Group

NAS 6: Backup Database (3.63 TB at total, 1.8 TB in effective, RAID 1)

NAS 2 (3TB at total, 2.1 TB in effective, RAID 5) — Used by Bioinformatics Group

Backup and archiving

NAS 3 (3TB at total, 2.1 TB in effective, RAID 5) — Used by Epidemiology and Breast Cancer Biology Group (BCBG): This is an important Gateway NAS to backup files and archiving.

(IP) iscsi SAN

NAS 7 (used as a NAS): Archive (12 TB at total, 6TB effective, RAID 10)

5 services
1. Statistics
2. Statistics
3. Database
4. Bioinformatics
5. Virtualisation

NAS 4 (3.63 TB at total: 1.8 TB in effective, RAID 1) — Mirror services at a different location

NAS 8 (used as a NAS): Archive (12 TB at total, 6TB effective, RAID 10)

NAS 5 (3.63 TB at total and effective, RAID 0) — Initially it is used to back up digital cancer cluster. It helps backing up important data in NAS 3.

Digital cancer (2 clusters) — Used by Tissue Bank Group and occasionally Bioinformatics Group.

Red arrows: automated and secure backup to London University Data Centre.
Blue arrows: automated, easy-to-use and secure backup internally and between GSTT and KCL.

Bioinformatics cluster