

Multi-Clouds: From Models to Runtime support

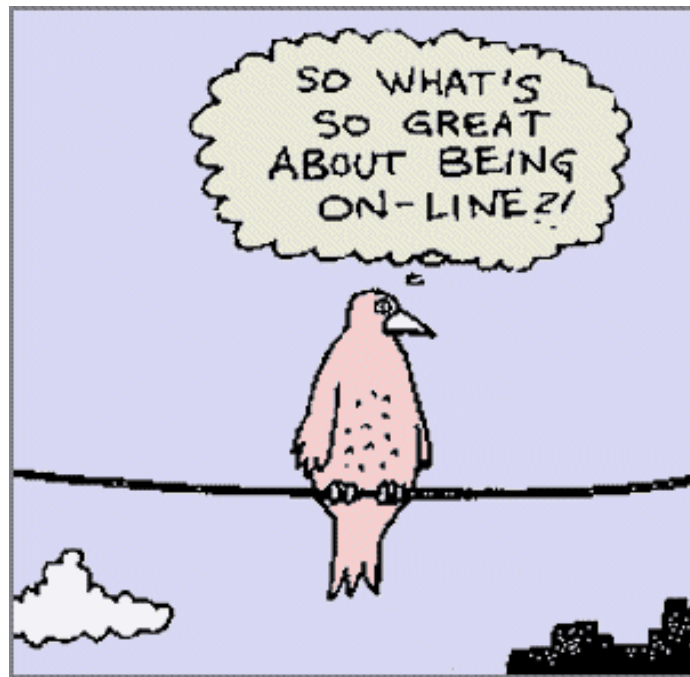
Prof. Dana Petcu

Institute e-Austria Timisoara & West University of Timisoara
petcu@info.uvt.ro, <http://web.info.uvt.ro/~petcu>

Today as MODAClouds Collaboration Director

Overview

1. Multi-Clouds: terminology & barriers
2. What is providing MODAClouds?



Why Multiple Clouds?

[USA-]NIST scenarios: Multiple Clouds

- **Clouds can be used**

1. serially, when moved from one Cloud to another, or
2. simultaneous, when using services from different Clouds.

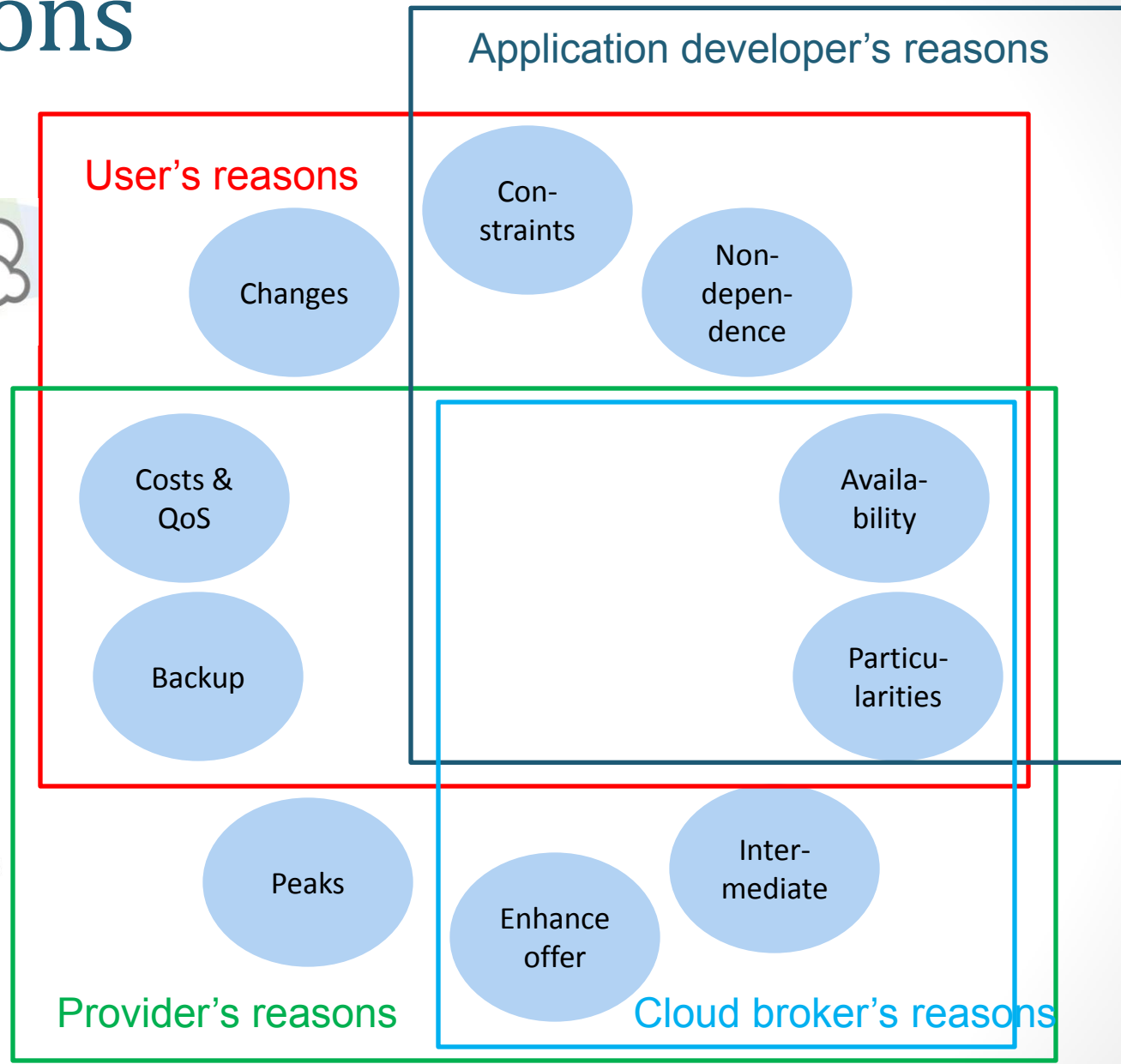
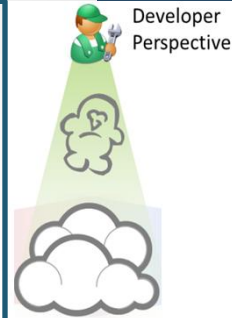
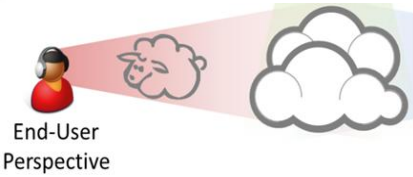
- **Simple scenarios:**

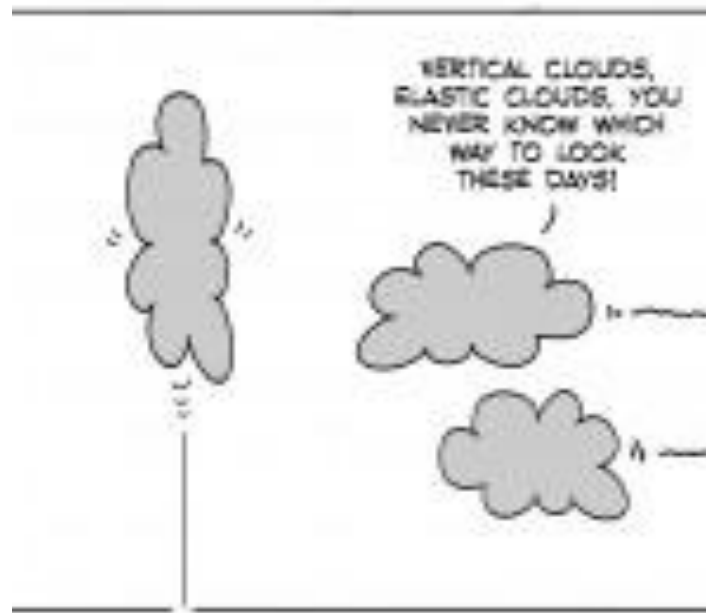
1. [serial] migration from a Private Cloud to a Public Cloud
2. [simultaneous] Hybrid Cloud, when some services are lying on the Private Cloud, while other services are lying on a Public Cloud

Top 10 Reasons for Multiple Clouds

1. deal with the **peaks** in service & resource requests using external ones, on demand basis;
2. optimize **costs** or improve quality of services;
3. react to changes of the **offers** of the providers;
4. follow the **constraints**, like new locations or laws;
5. **replicate** the applications or services consuming resources or services from different Cloud providers to ensure their high availability;
6. avoid the dependence on only one external provider;
7. ensure **backup-ups** to deal with disasters or scheduled inactivity;
8. act as **intermediary**;
9. enhance own Cloud resource and **service** offers, based on agreements with other providers;
10. consume different services for their **particularities** not provided elsewhere.

Reasons





Taxonomy of Multiple Clouds

Terminology

- Multi-Cloud,
 - Cloud Federation,
 - Inter-Cloud,
 - Hybrid Cloud,
 - Cloud-of-Clouds,
 - Sky Computing,
 - Aggregated Clouds,
 - Multi-tier Clouds,
 - Cross-Cloud,
 - Cloud Blueprint,
 - Cloud Merge,
 - Fog Computing,
 - Hierarchical Clouds,
 - Distributed Clouds
- ...

Delivery models for Multiple Clouds

1. Federated Clouds

- assumes
 - a formal agreement between the Cloud providers
- service providers
 - are sub-contract capacity from other service providers
 - offer spare capacity to the federated group of providers.
- the consumer of the service
 - is not aware of the fact that the Cloud provider he or she pays is using the services of another Cloud provider

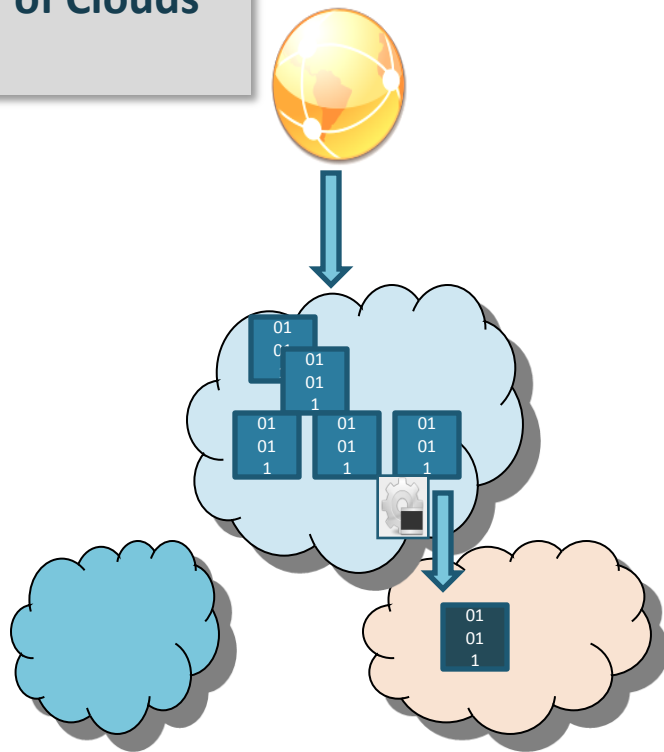
2. Multi-Cloud

- assumes that
 - there is no priori agreement between the Cloud providers
- a third party (even the consumer) is responsible for the services
 - contacts the service providers,
 - negotiates the terms of service consumption,
 - monitors the fulfillment of the service level agreements,
 - triggers the migration of codes, data and networking from one provider to another.

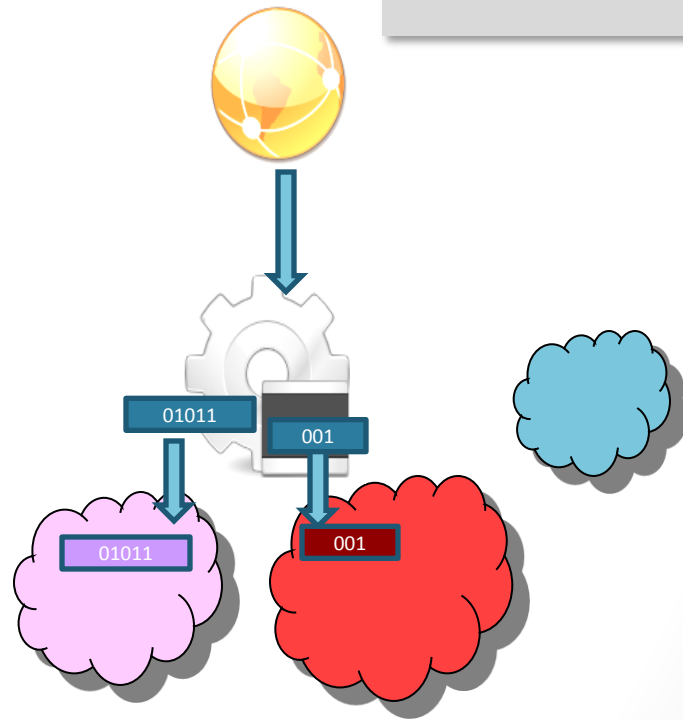
Source: <http://www.buyya.com/papers/InterCloud-Brokering-Taxonomy.pdf>

Scenarios for multiple Clouds

Federation of Clouds



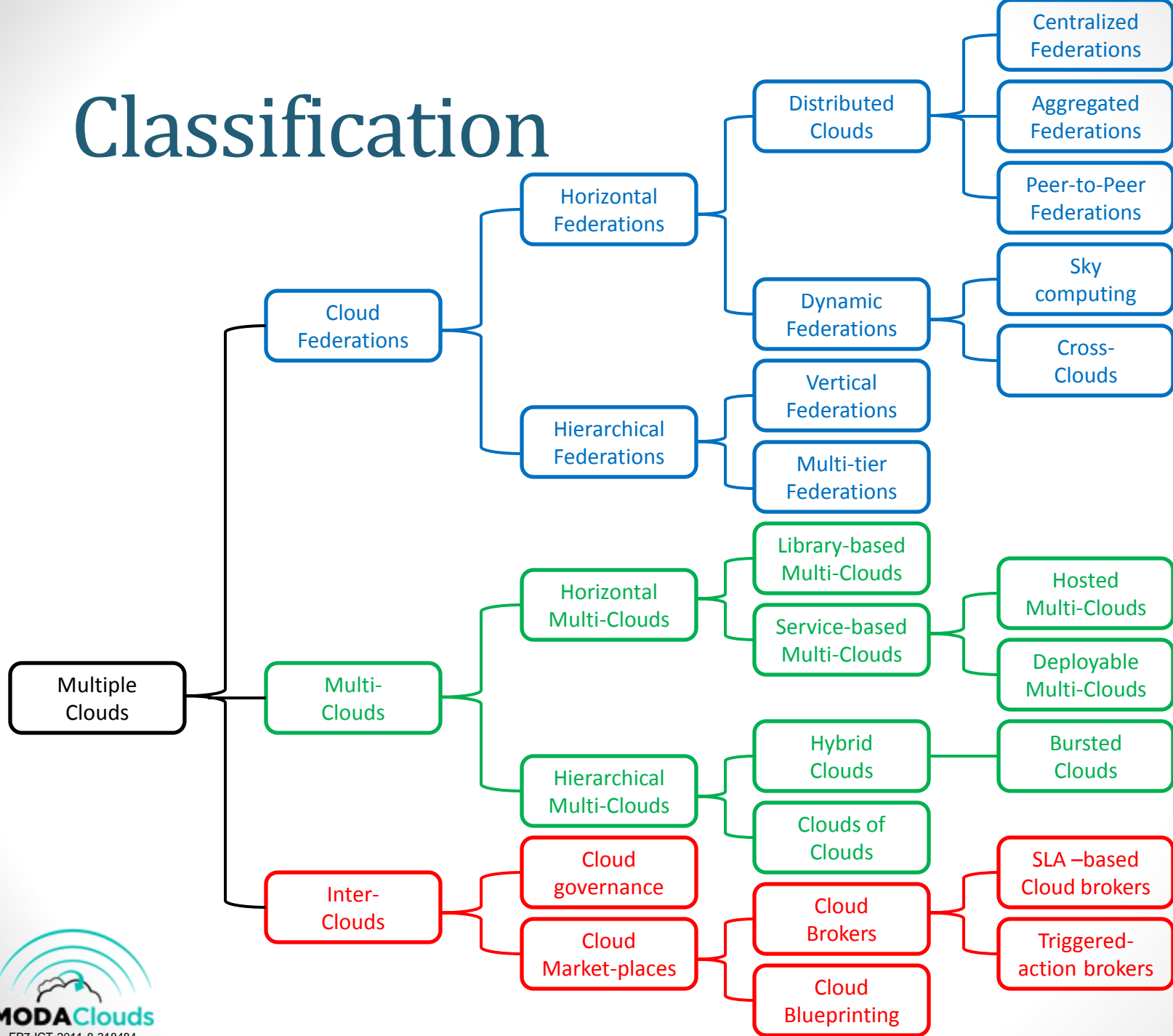
Multi Cloud



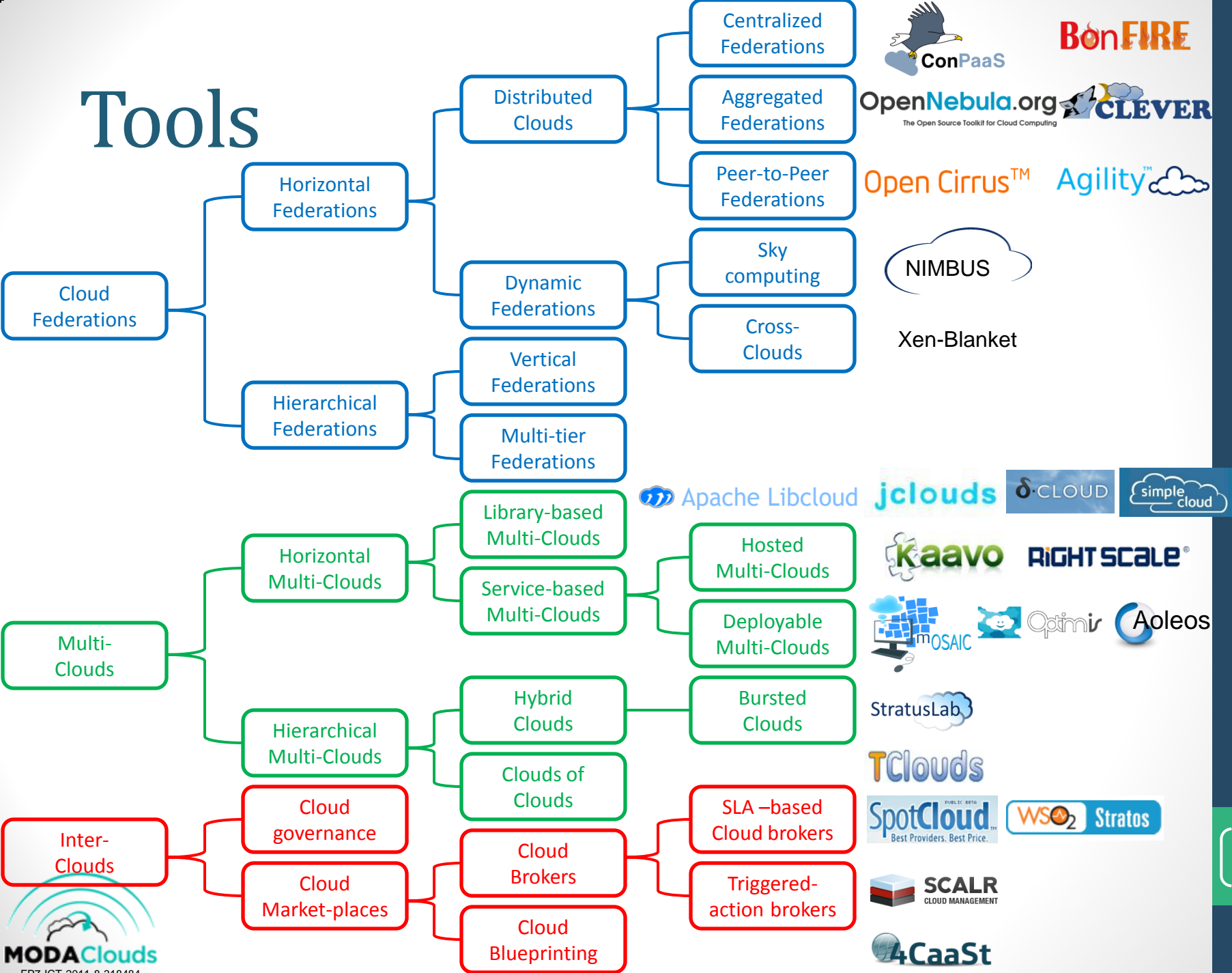
InterCloud & Cloud Broker

- **InterCloud:**
 - A Cloud Federation or a Multi-Cloud that includes at least one Cloud Broker and offers dynamic service provisioning
- **Cloud Broker**
 - an entity that manages the use, performance and delivery of Cloud services and intermediates the relationships between Cloud providers and Cloud consumers

Classification



Tools



To solve in

Cloud Federation

- Interoperability framework
- Integration as a service
- Match-making with available external services
- Live virtual machine migration
- Network overlay for connectivity problems
- Meta-schedulers
- Monitoring meta-system
- Intelligent management systems
- ...

Multi-Clouds

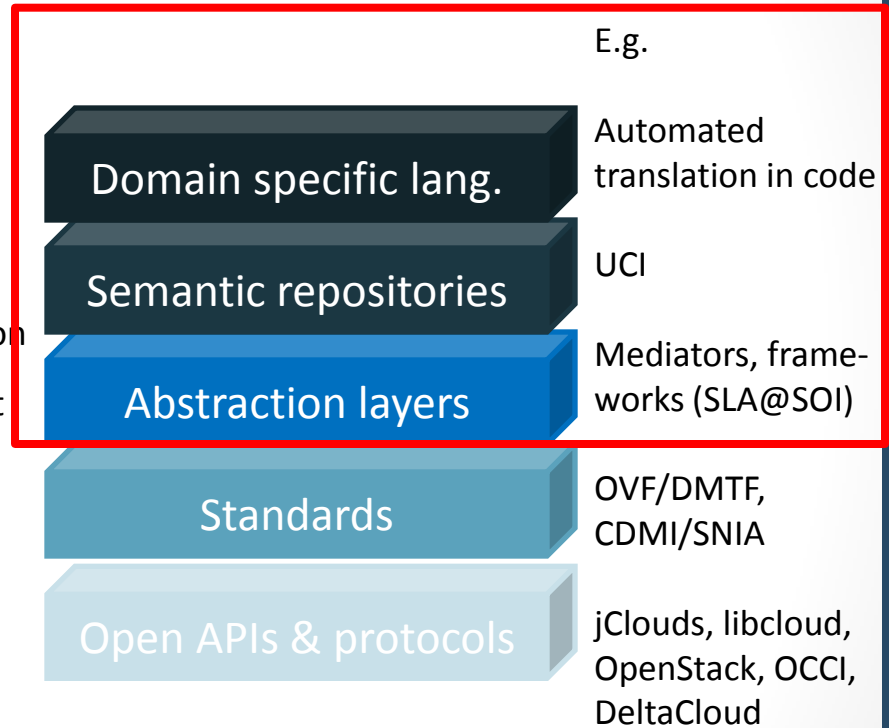
- Portability
- Resource/service selection mechanism and methodology
- Uniform APIs
- Search engines
- Automated deployment
- Service aggregator
- Governance
- ...

Current solutions for interop/portability

Levels



Techs



Barriers

1. Standards not adopted on large scale
2. Libraries that are loosing the particularities
3. No comprehensive methodology to compare services
4. Complexity of the selection multi-criterial problem
5. Heterogeneity from low (e.g. VM) to high level (e.g. Programming)
6. Lack of agreement between providers on the interfaces for certain actions
7. Portability or relocation are moving targets
8. Lack of trustfulness in Hybrid Clouds as the simple example of Multi-Clouds



Model-Driven Engineering of Clouds

MODAClouds (www.modaclouds.eu)

- Integrated Project n. 318484
- October 1st 2012 – September 30th 2015



MODAClouds objective

To provide

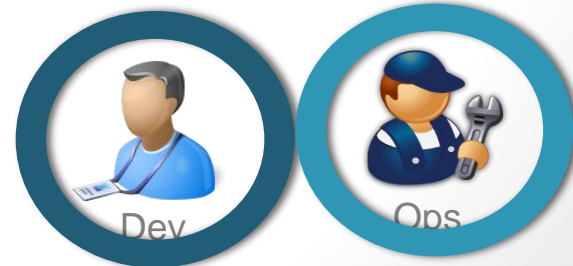
Methods +decision support system +
+ IDE + runtime environment

to support

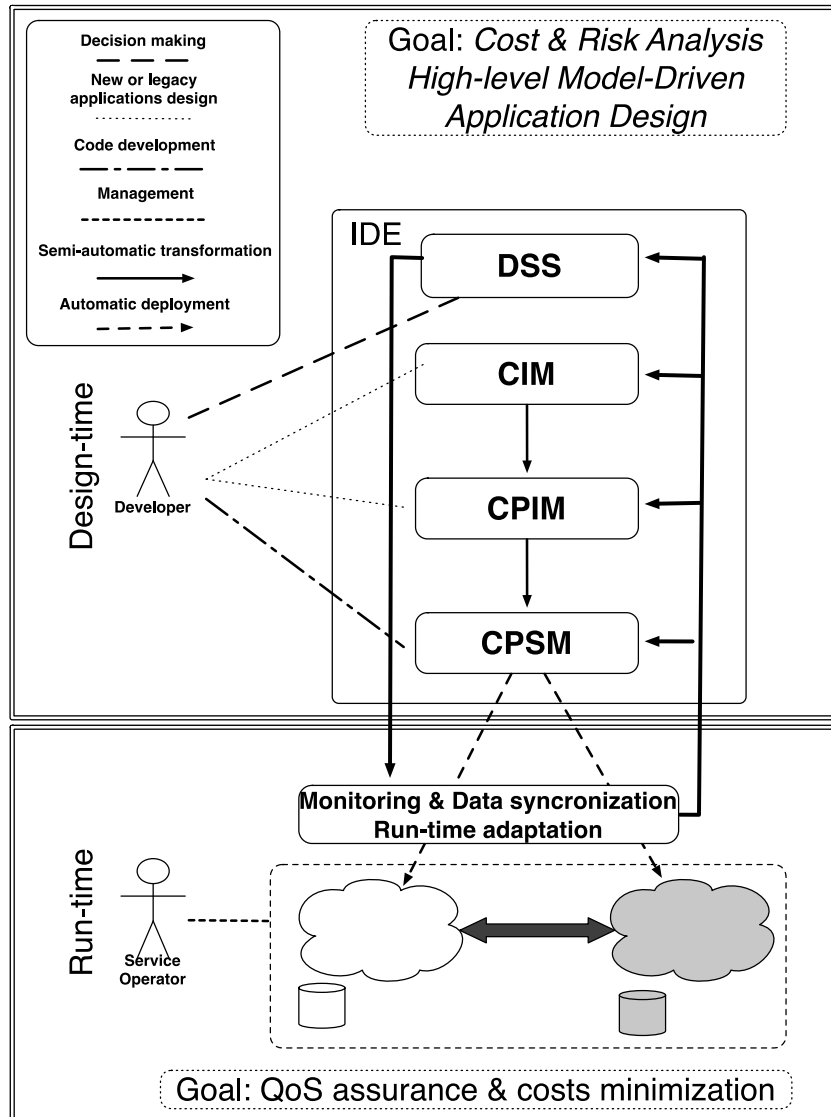
- High-level design
- Early prototyping
- Semi-automatic code generation
- Automatic (re)deployment
- Monitoring and self-adaptation

of applications on Multi-Clouds
with guaranteed QoS

**Multi-Cloud
Dev&Ops Management**

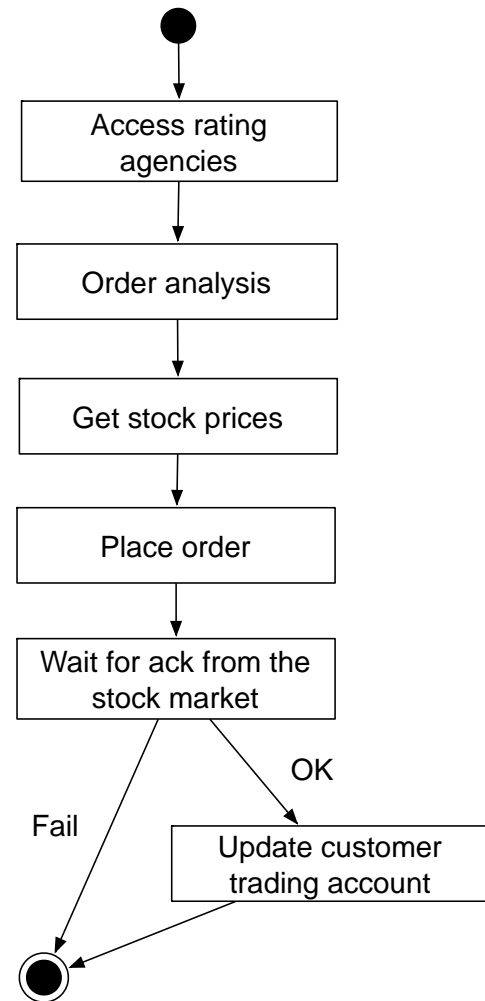


MODAClouds Vision

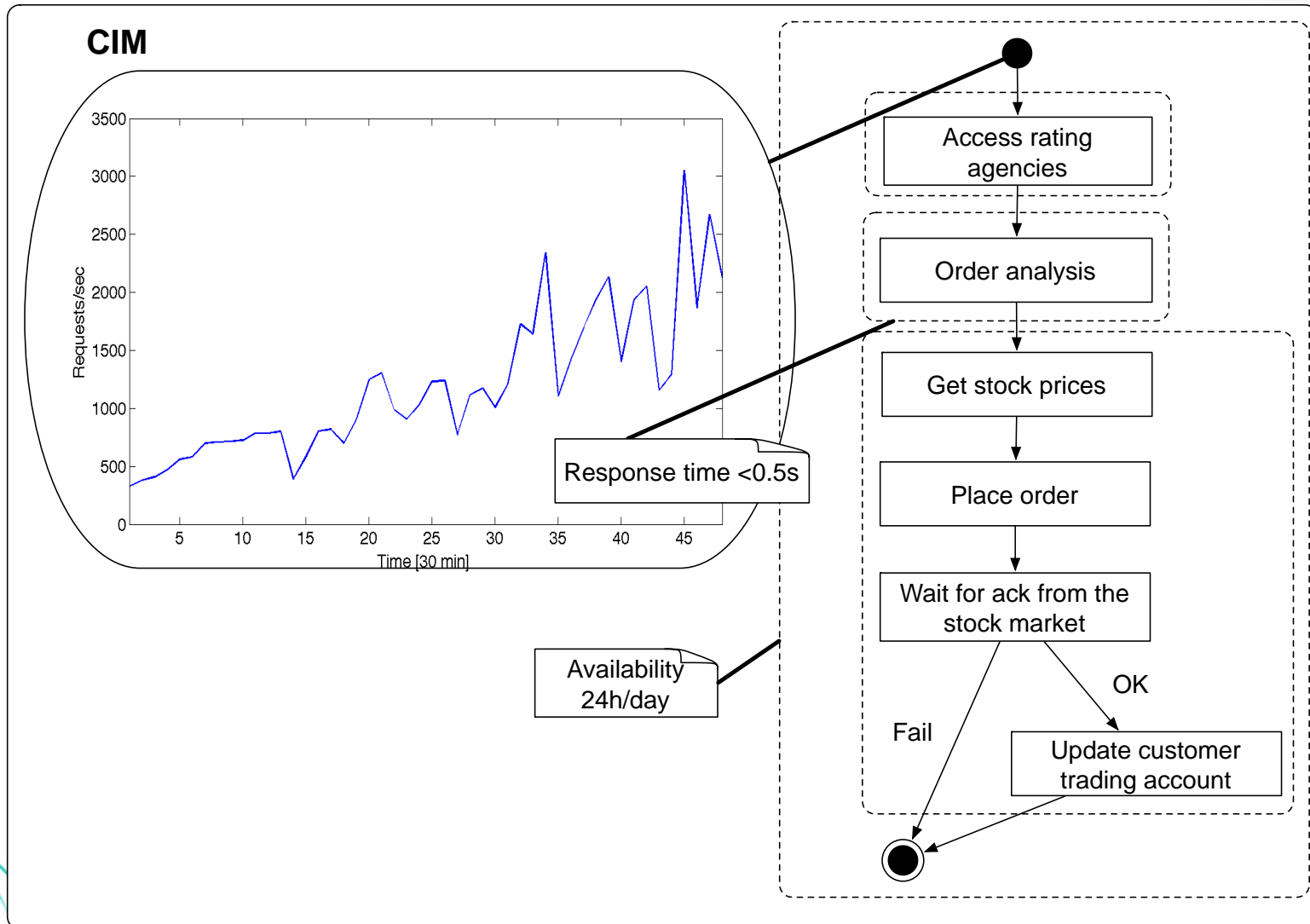


An example

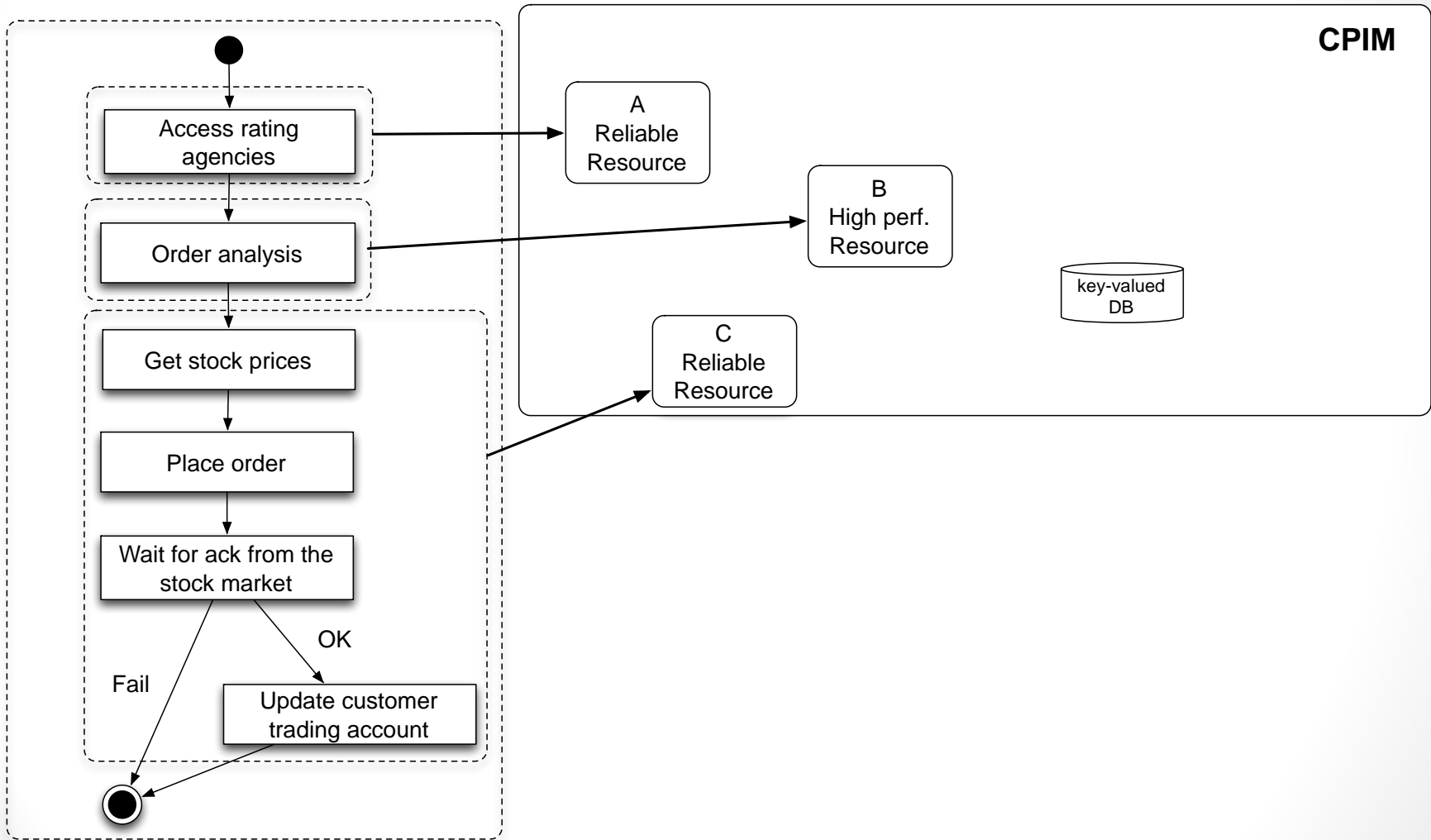
CIM



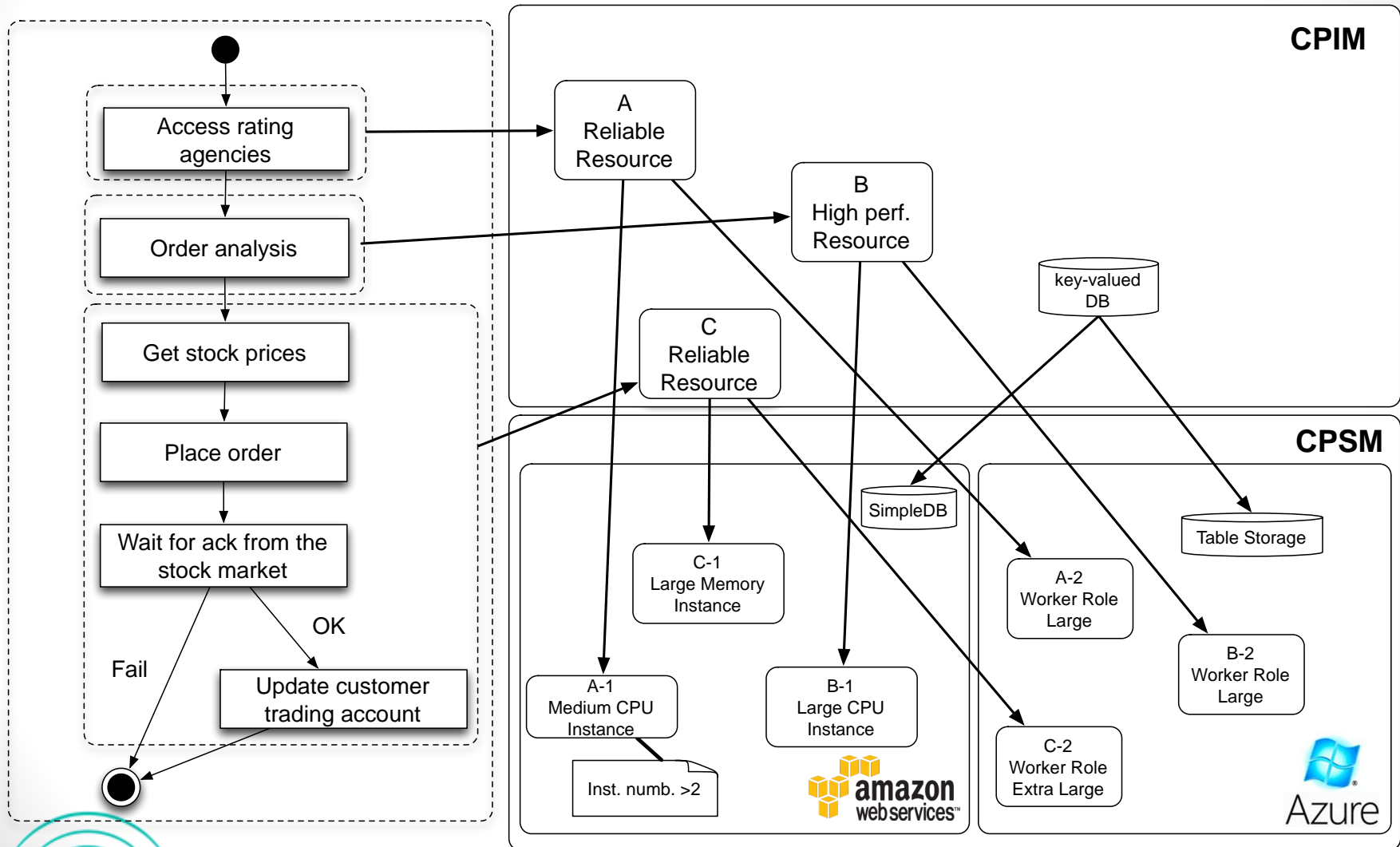
An example



An example



An example



Outputs

Cloud Development Tools

IDE +

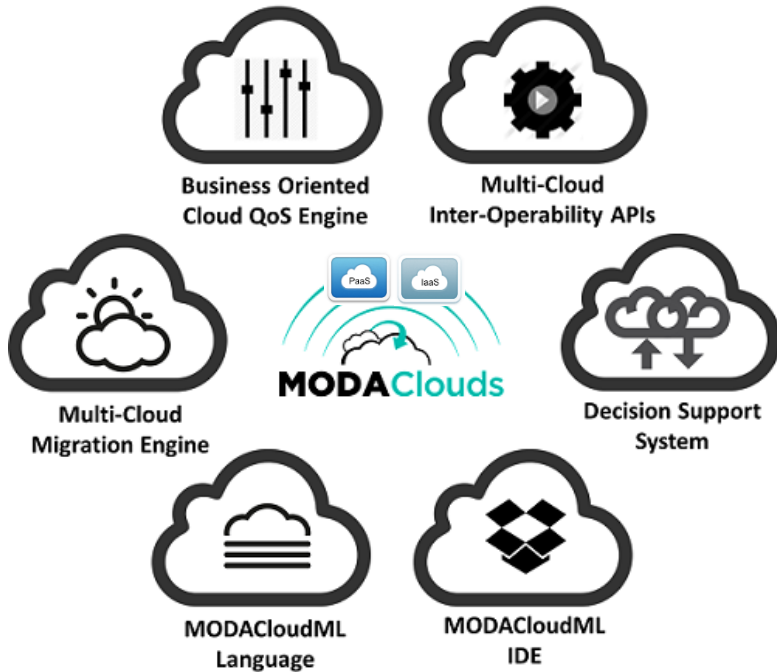
MODACloudML (agnostic and QoS ready) modelling language

Flexible Multi-Cloud Apps Management, Monitoring & Operation Environment

maximizes automation with QoS Engine, Monitoring, Portability of underlying infrastructure providers (IaaS / PaaS)

Decision Support System

Is a system on its own enables selection of provider at development & testing phase; and adds automation of runtime adaptation



Contexts of Use

Individual Technology Adoption

DSS, MODACloudML Language, MODAClouds' SLA & QoS, Monitoring, Runtime Data Synchronization, other capabilities by organizations or cloud management software ...

Standalone System

for individual organizations embracing DevOps tools internally for multi-cloud testing or production

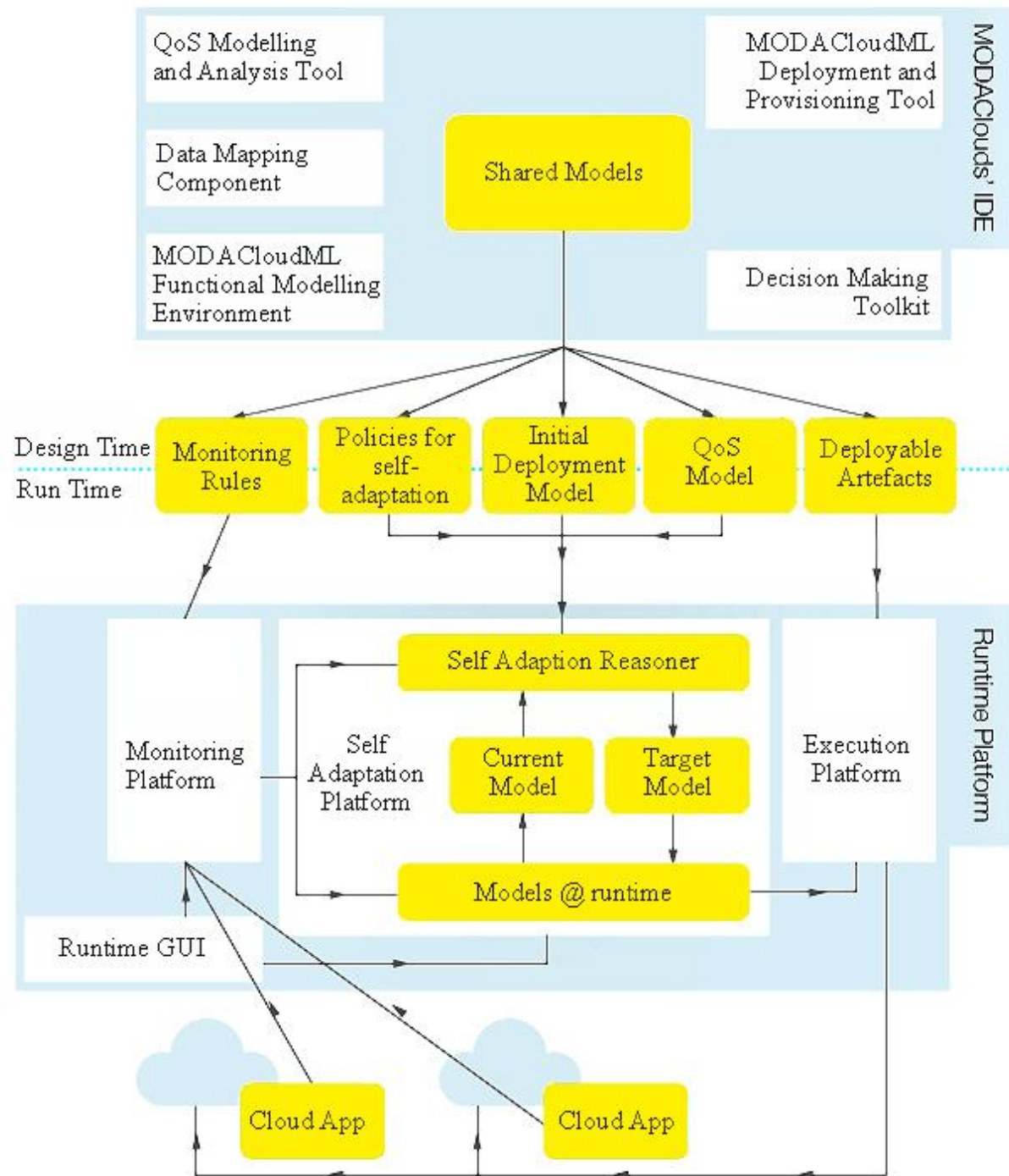


Platform Scenarios

as a standalone cloud broker providing services

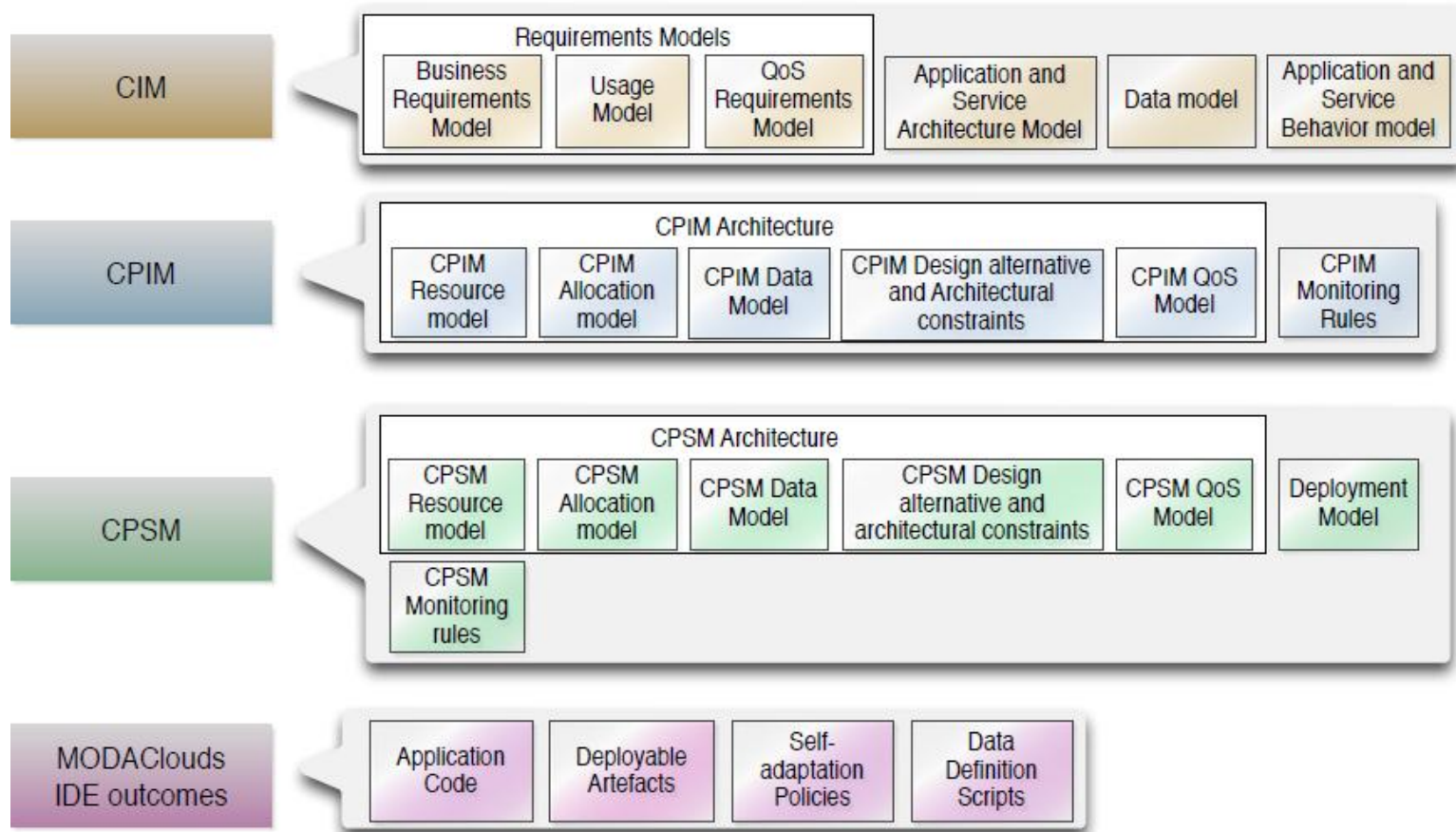
or in combination with third parties to extend their value proposition

Concepts & components maps



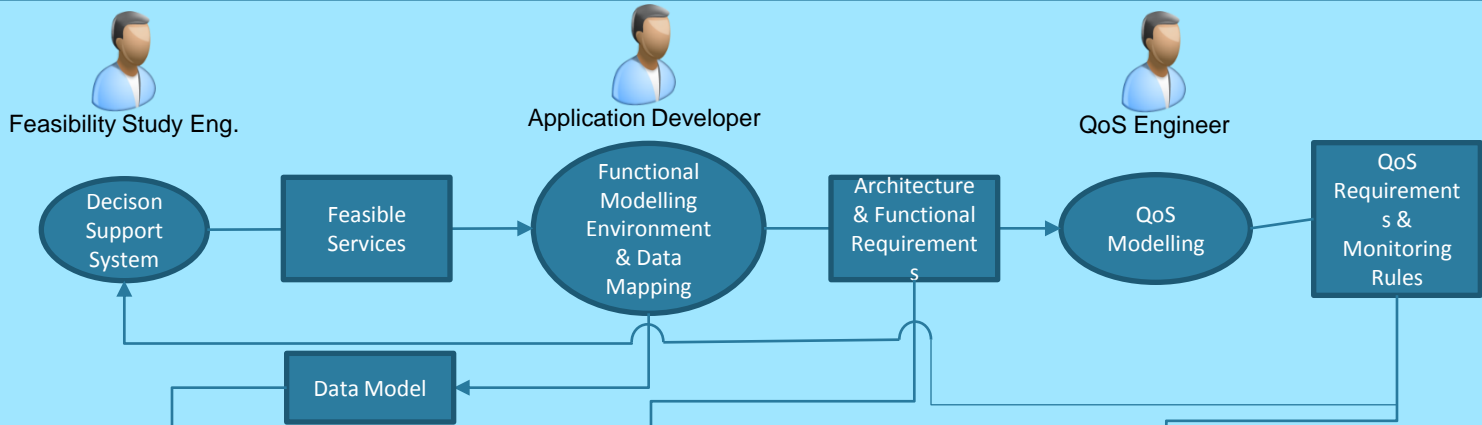
Details in the public deliverable D3.2.1

Shared models

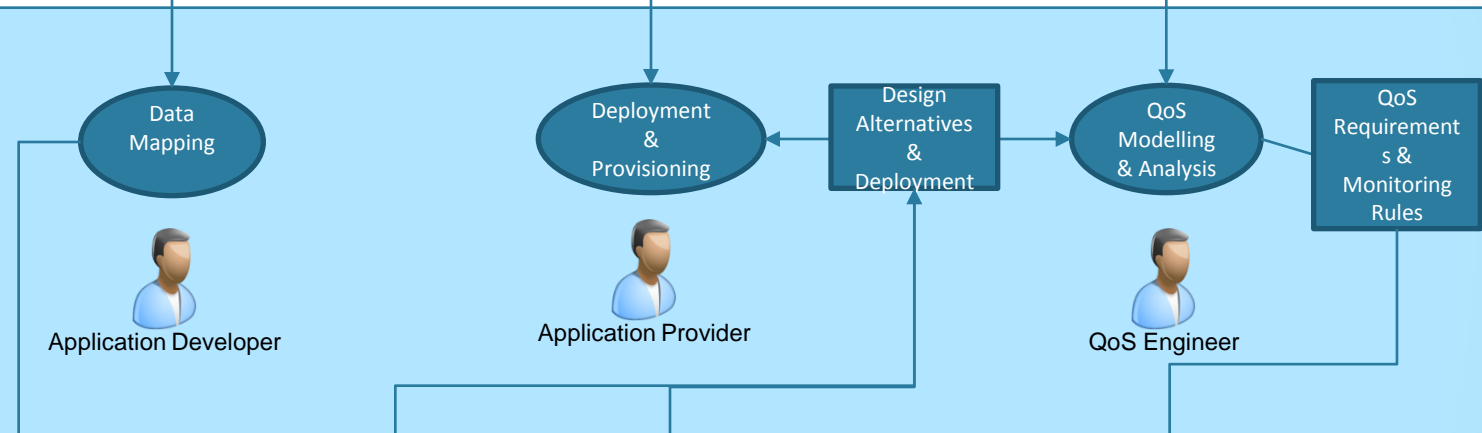


Details in the public deliverable D3.2.1

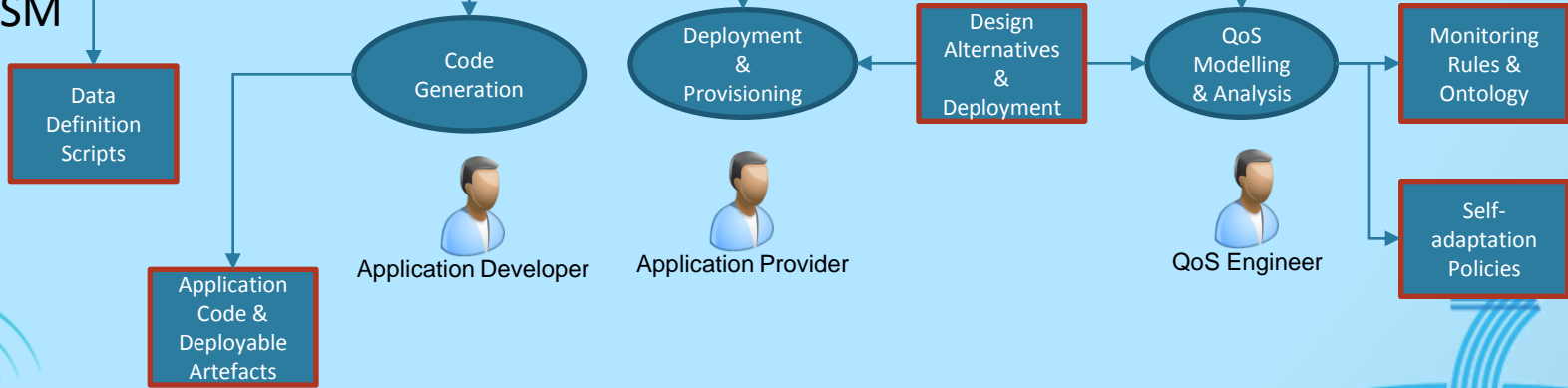
CCIM



CPIM



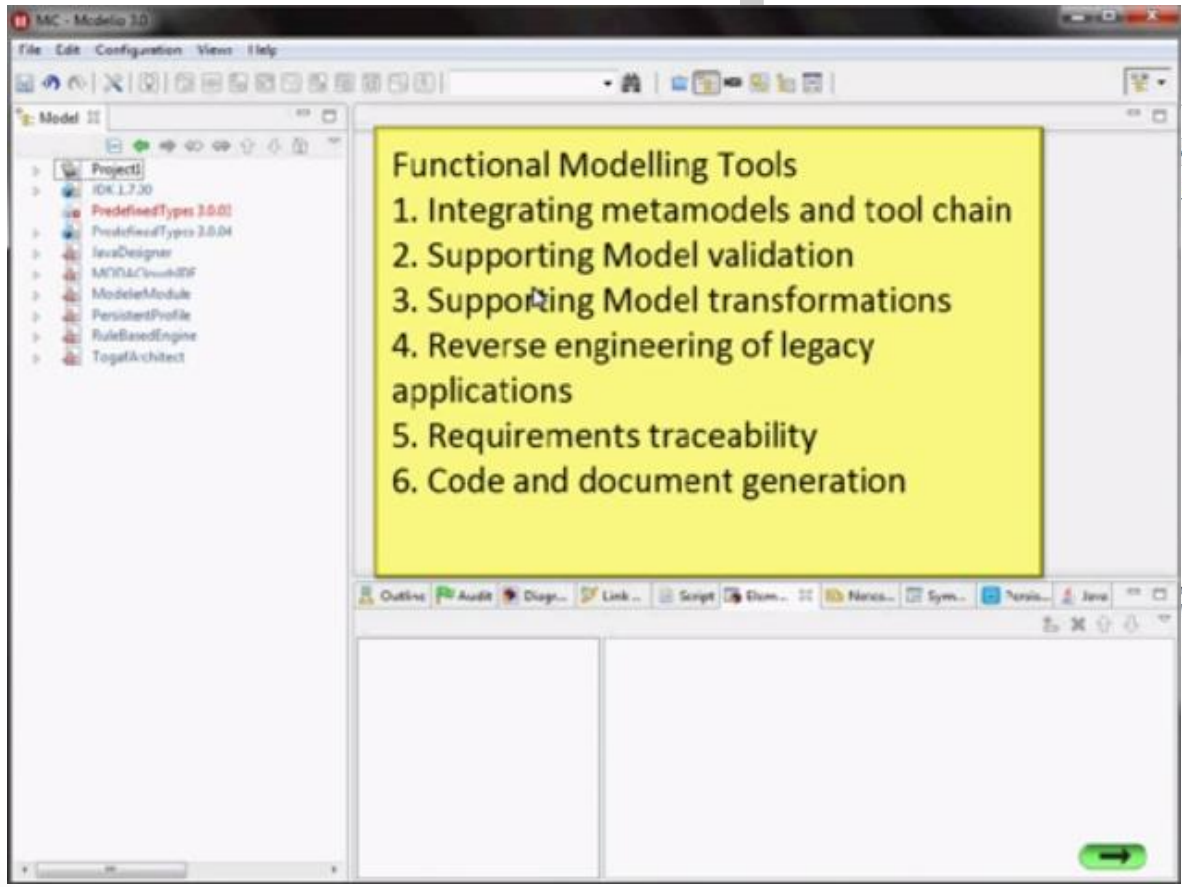
CPSM



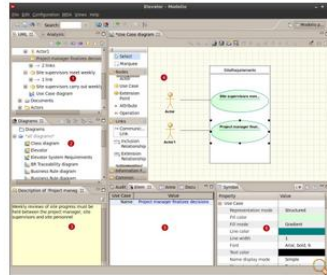
Modelio as IDE



Quick start guide
This won't take long!

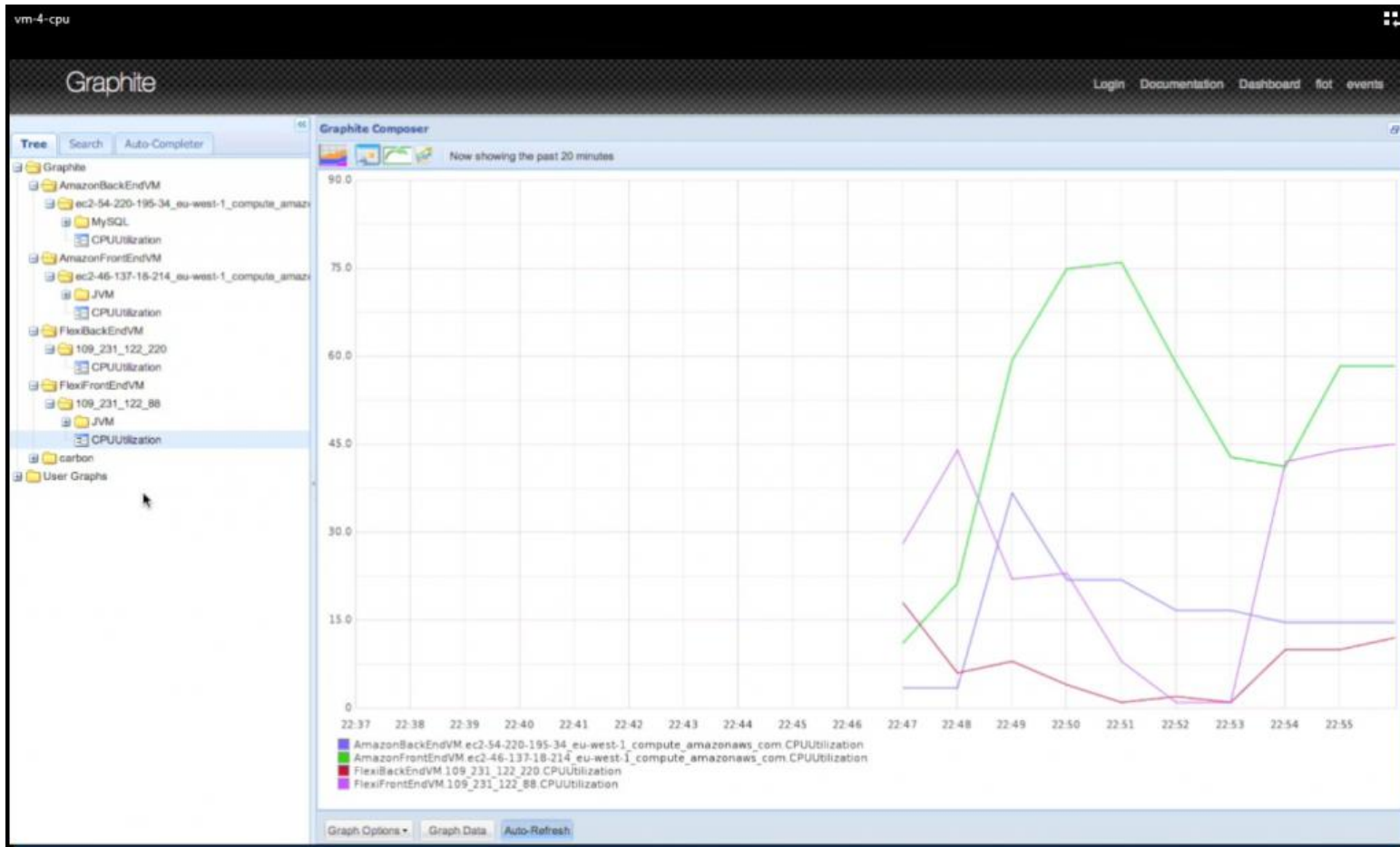


object Creating elements >
Interface

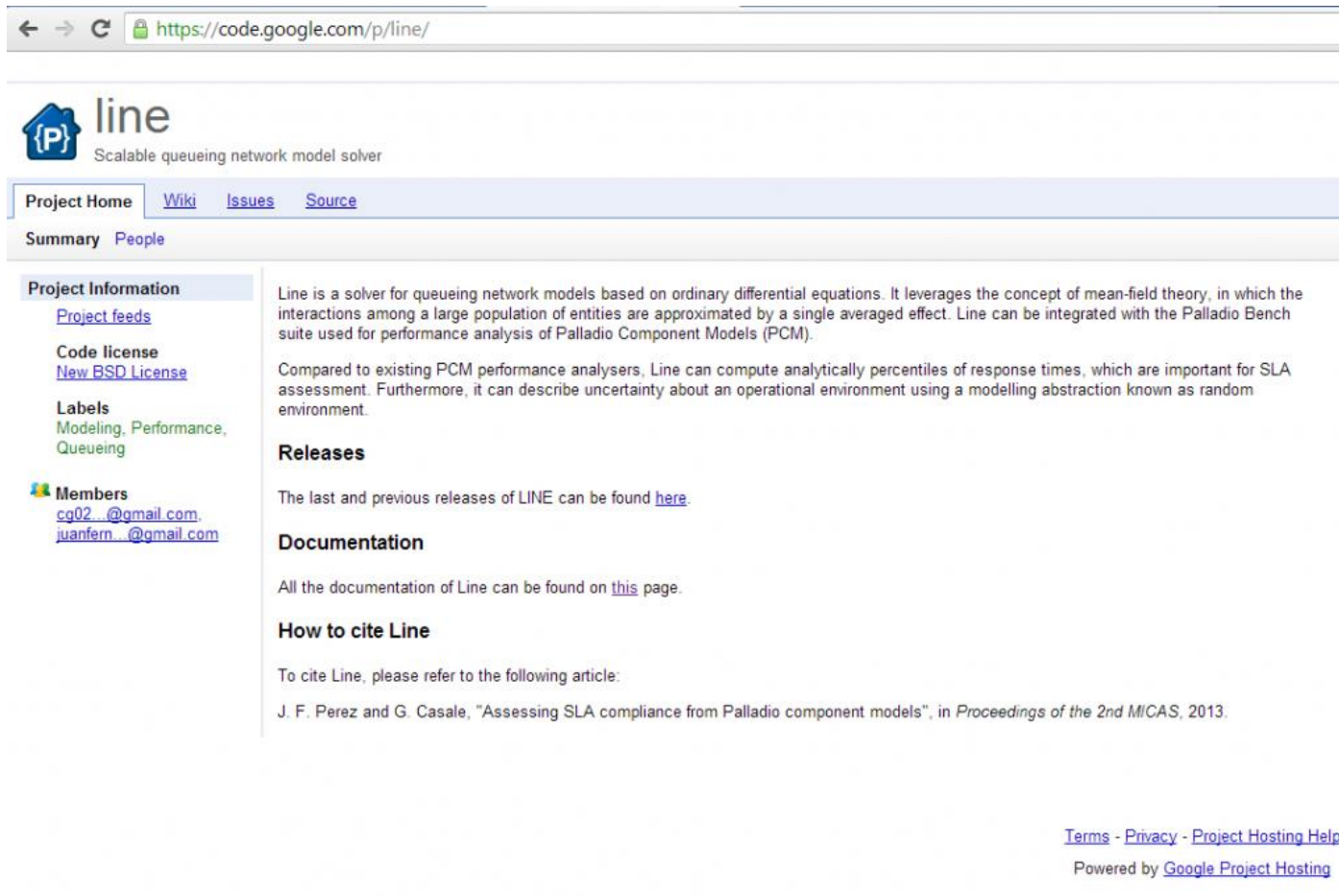


The Modelio user interface (click to enlarge)

Monitoring & statistical data analyzers



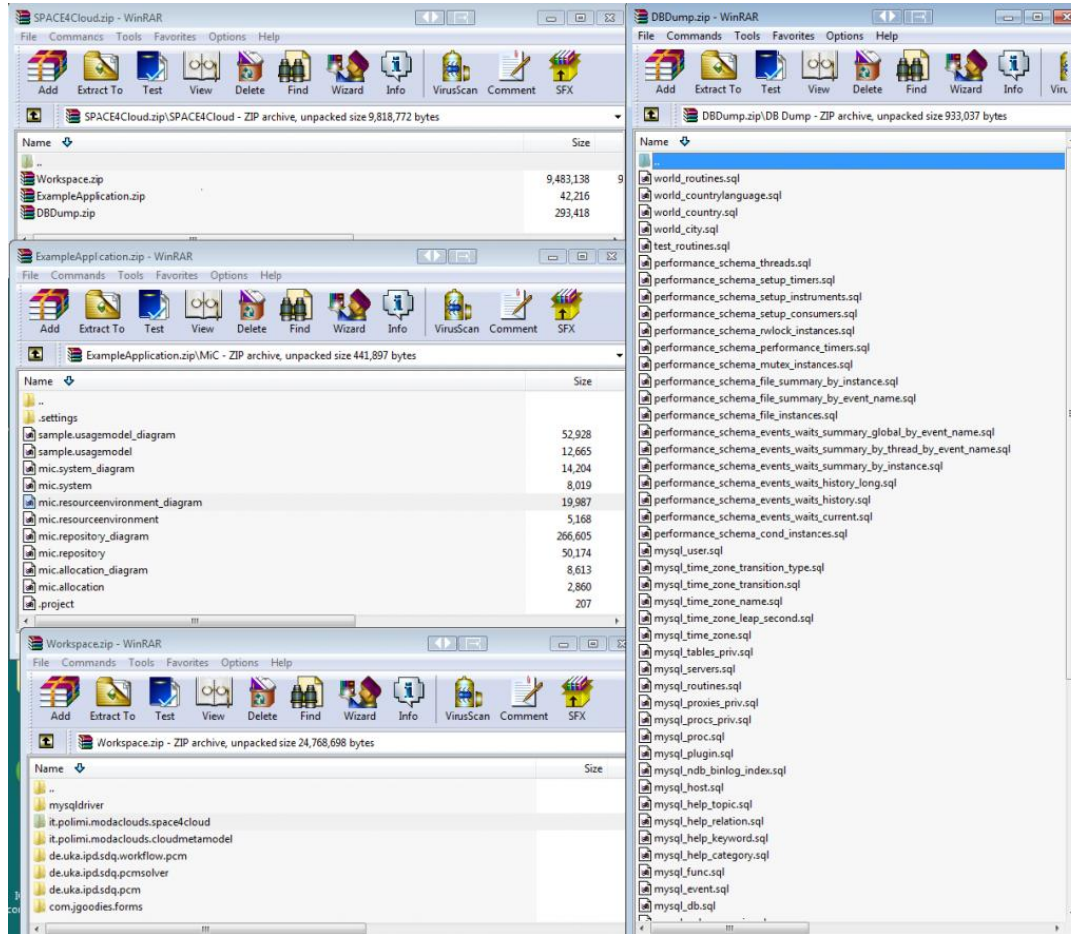
LINE: Performance analyzer



The screenshot shows the Google Code project page for 'line'. The browser address bar displays 'https://code.google.com/p/line/'. The project name 'line' is prominently displayed with a logo consisting of a blue house shape containing a white 'P'. Below the name, it is described as a 'Scalable queueing network model solver'. Navigation links for 'Project Home', 'Wiki', 'Issues', and 'Source' are visible. The 'Summary' tab is selected, showing 'Project Information' on the left sidebar and the main project description on the right. The main description states that 'line' is a solver for queueing network models based on ordinary differential equations, leveraging mean-field theory. It also mentions that 'line' can be integrated with the Palladio Bench suite. The 'Releases' section notes that the last and previous releases can be found [here](#). The 'Documentation' section states that all documentation can be found on [this](#) page. The 'How to cite Line' section provides a reference to a paper by J. F. Perez and G. Casale, 'Assessing SLA compliance from Palladio component models', in the *Proceedings of the 2nd MICAS*, 2013. At the bottom right of the page, there are links for 'Terms - Privacy - Project Hosting Help' and a note 'Powered by [Google Project Hosting](#)'.

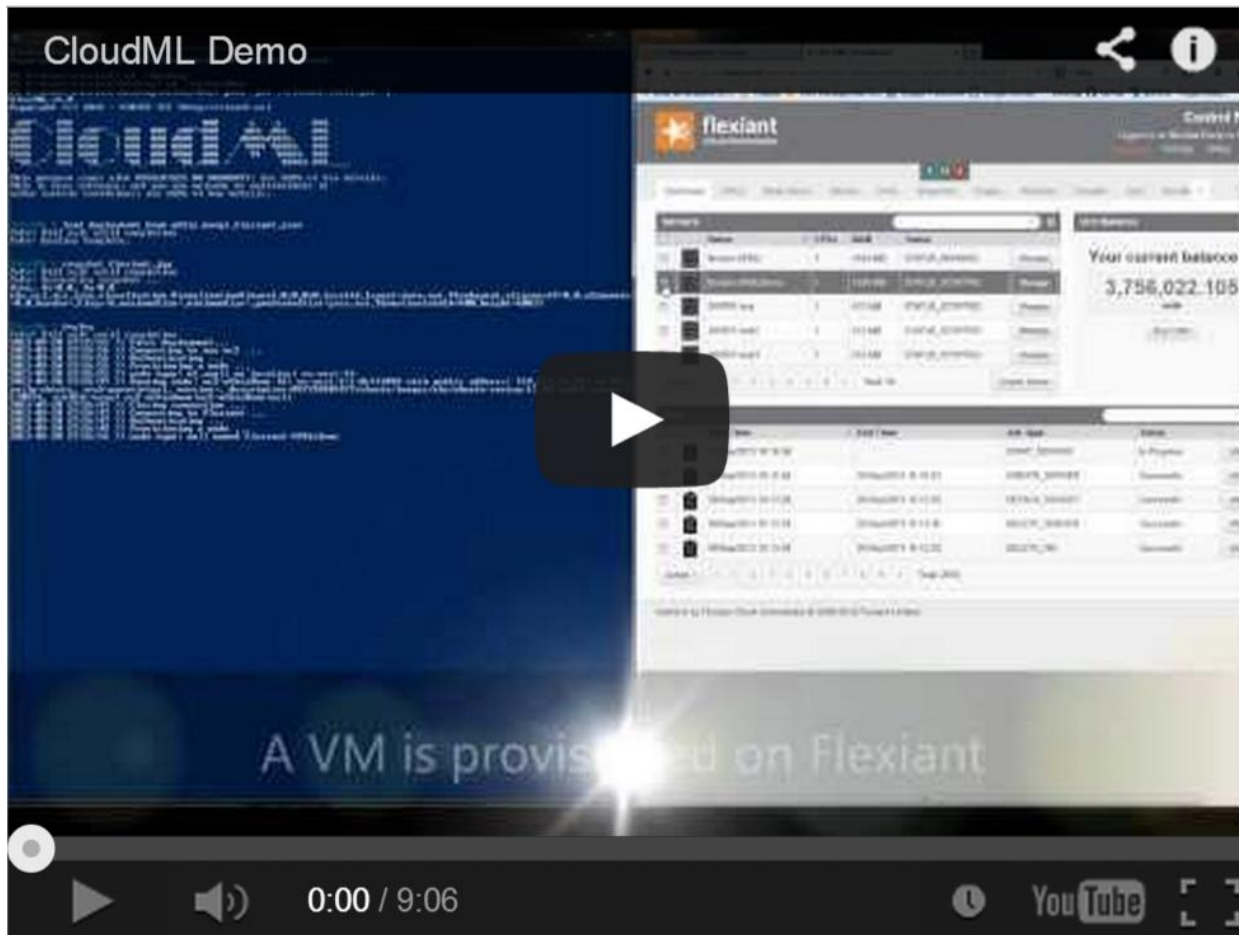
Space4Cloud

System Performance and Cost Evaluation on Cloud



CloudML

domain-specific modelling language + run-time environment that facilitate the specification of provisioning and deployment



mOSAIC: Run-time platform for Multi-Clouds

Open source API and platform for multiple clouds
Site of the mOSAIC API and Software platform developer

Dashboard mOSAIC Project mOSAIC

mOSAIC

ip 4 - Home by Stefan Siegel, last updated: 2016/05/18 11:30:11 (UTC+02:00)

- Guides of mOSAIC API and Platform
 - Getting Started
 - Testing Platform
 - Development Kit
 - Development Process
 - Benchmarks and tests
- mOSAIC Open Source Repositories
 - Java Platform
 - mOSAIC Linux
 - Main repository
 - Usages
- mOSAIC Development Tools
 - JPA
 - Jenkins
 - JFrog

mOSAIC Consortium

Embedded technologies

PTCConsole

Portable Testbed Cluster

View control cluster nodes authentication user data

In this section you can deploy an application based on a description.

App-Descriptor App-List

Registered application list:

Search list empty!

Useful Links

- mOSAIC Wiki
- mOSAIC Dev

COPYRIGHT © 2010-2011 MOSAIC CONSORTIUM - TEST TASK | TEST | MOSAIC

Portable Testbed Cluster - Co...

Portable Testbed Cluster... mOSAIC WebUI

192.168.178.106 1/18/10

AWS PTC Bitbucket

mOSAIC WebUI Console Log About

Login

MOSAIC/Notes/Platform/Tutorial

Attachments More Actions

Contents

- 1. Testing cloudlets on PTC
 - 1. PTC
 - 1. Prerequisites
 - 2. Installation
 - 3. Usage
 - 2. Cloudlets
 - 1. Prerequisites
 - 2. Installation
 - 3. Hello cloudlet
 - 1. Preparation phase
 - 2. Development phase
 - 3. Packaging phase
 - 4. Deployment phase
 - 4. Single cloudlets

Testing cloudlets on PTC

Mosaic/Notes/Platform/Tutori...

mOSAIC WebUI

Welcome to a new *distributed experience!*

Components Cluster Debugging

Link Create Nodes Ring Console Log Disc

Components

- List
- Create
- Call
- Call
- Stop

Case studies

Case study	MODACloud Challenges
Software development company/ <i>Project management server</i> (SOFTEAM)	<ul style="list-style-type: none">• Deploy legacy applications• IaaS to IaaS migration• Run-time monitoring effective resource scaling
Software development company/ <i>Business Process Modelling System</i> (BOC)	<ul style="list-style-type: none">• Migration of legacy application re-deployed as a SaaS• DSS, risk, and utility analysis to select the best IaaS• IaaS to IaaS migration• Parallel execution of long- running activities
Services for citizens in the health sector/ <i>Palliative care application</i> (ATOS)	<ul style="list-style-type: none">• Develop new application services• Data managed on a private IaaS• Heterogeneous environments: virtual desktops, application logic; hybrid Clouds (private IaaS, multiple public PaaS)• Validate activities for filling the gap between runtime and design time
IoT in crisis management/ <i>Smart City Urban Safety Planner</i>	<ul style="list-style-type: none">• Develop a new application• High performance, scalability, and availability requirements• Data design and run-time management• PaaS to PaaS migration

Where to find details

1. Concepts:

- Public deliverables
- Scientific Publications
- White paper

2. Software:

- Open-source components
- Demos videos

... all on the project web site

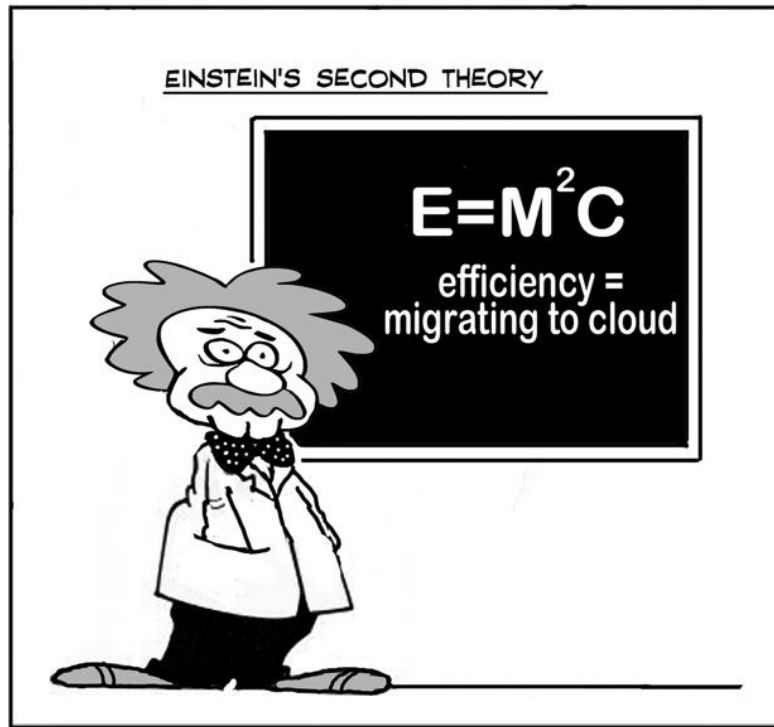
Papers behind this presentation

- **Multi-Clouds:**

- D. Petcu, [Consuming Resources and Services from Multiple Clouds. From Terminology to Cloudware Support](#), Journal of Grid Computing, January 2014, doi: [10.1007/s10723-013-9290-3](#)

- **MODAClouds:**

- E. Di Nitto et al, [Supporting the Development and Operation of Multi-Cloud Applications: The MODAClouds Approach](#). 15th SYNASC, 23-26 Sept. 2013, 417-423, doi: [10.1109/SYNASC.2013.61](#)
- D. Ardagna et al, [MODACLOUDS: A Model-Driven Approach for the Design and Execution of Applications on Multiple Clouds](#), Procs. MISE 2012, 50-56, doi: [10.1109/MISE.2012.6226014](#)



[From Cloud humor site](#)

Q & A ?