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

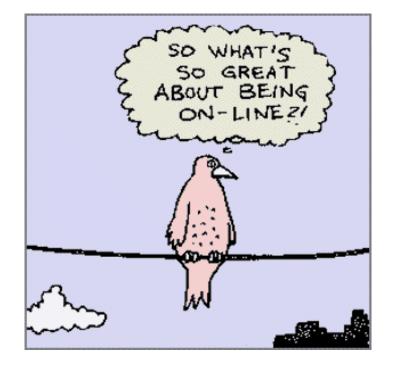




Multi-Clouds: terminology & barriers What is providing MODAClouds?



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Why Multiple Clouds?





[USA-]NIST scenarios: Multiple Clouds

Clouds can be used

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

• Simple scenarios:

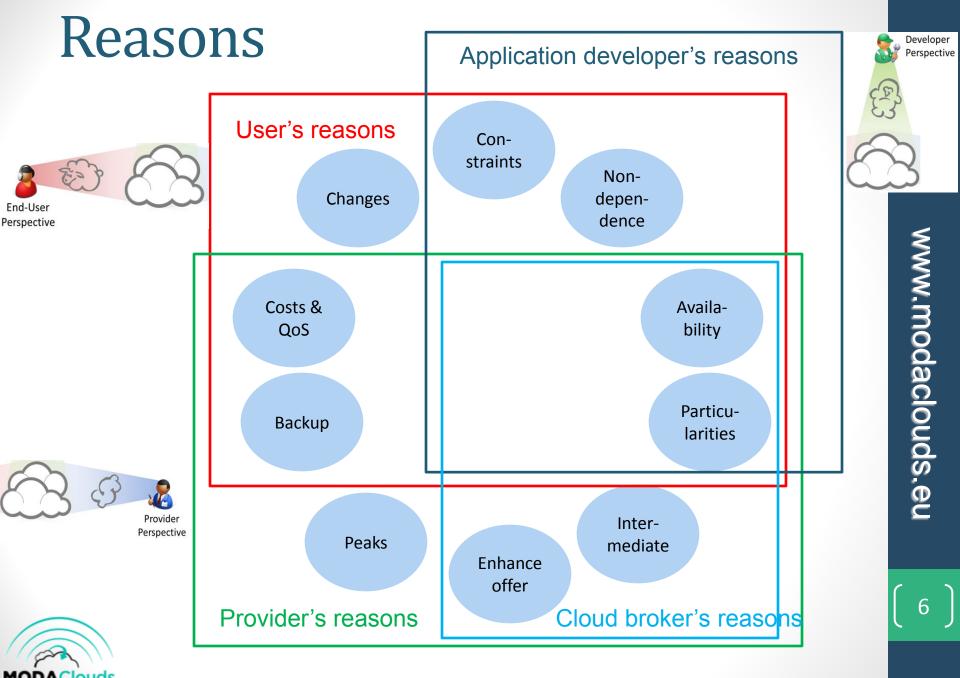
- [serial] migration from a Private Cloud to a Public Cloud
- 2. [simultaneous] Hybrid Cloud, when some services are lying on the Private Cloud, while other services are lying on a Public Cloud



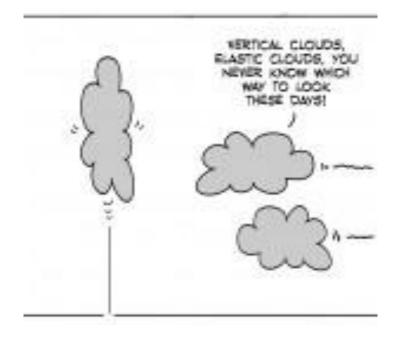
Top 10 Reasons for Multiple Clouds

- deal with the peaks in service & 6. 1. resource requests using external ones, on demand basis;
- optimize costs or improve 2. quality of services;
- react to changes of the offerts 3. of the providers;
- follow the constraints, like new 4. locations or laws;
- 5. replicate the applications or services from different Cloud providers to ensure their high availability;

- avoid the dependence on only one external provider;
- 7. ensure backup-ups to deal with disasters or scheduled inactivity;
- act as intermediary; 8.
- enhance own Cloud resource 9 and service offers, based on agreements with other providers;
- services consuming resources or 10. consume different services for their particularities not provided elsewhere.



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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

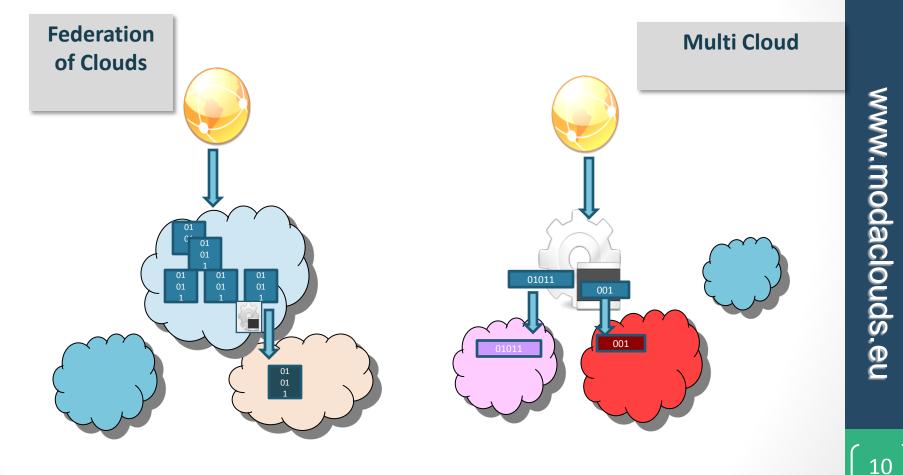
- assumes
 - <u>a formal agreement between the Cloud providers</u>
- service providers
 - are sub-contract capacity from other service providers
 - offer spare capacity to the federated group of providers.
- the consumer of the service
 - is not aware of the fact that the Cloud provider he or she pays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



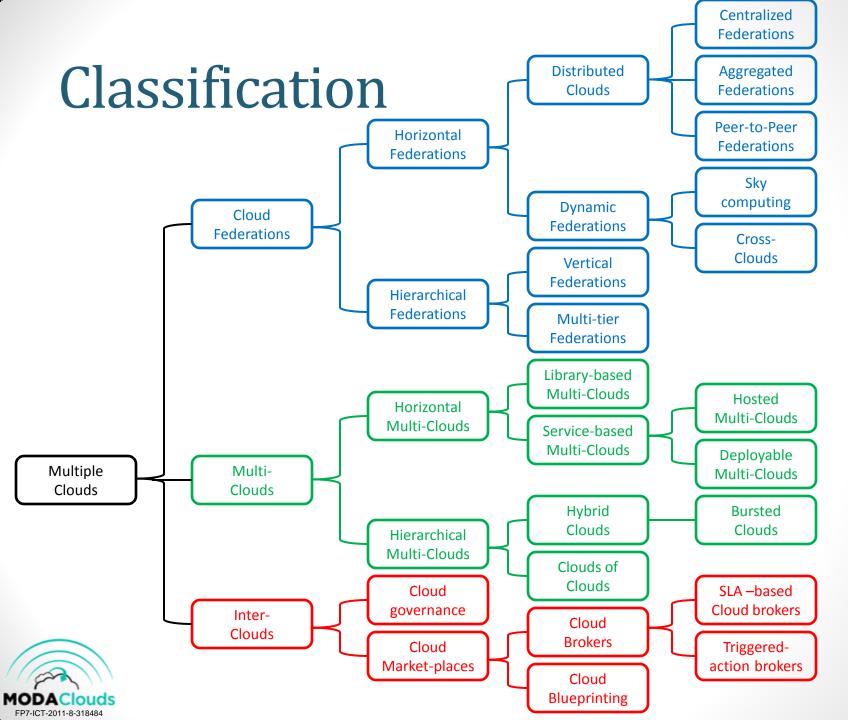


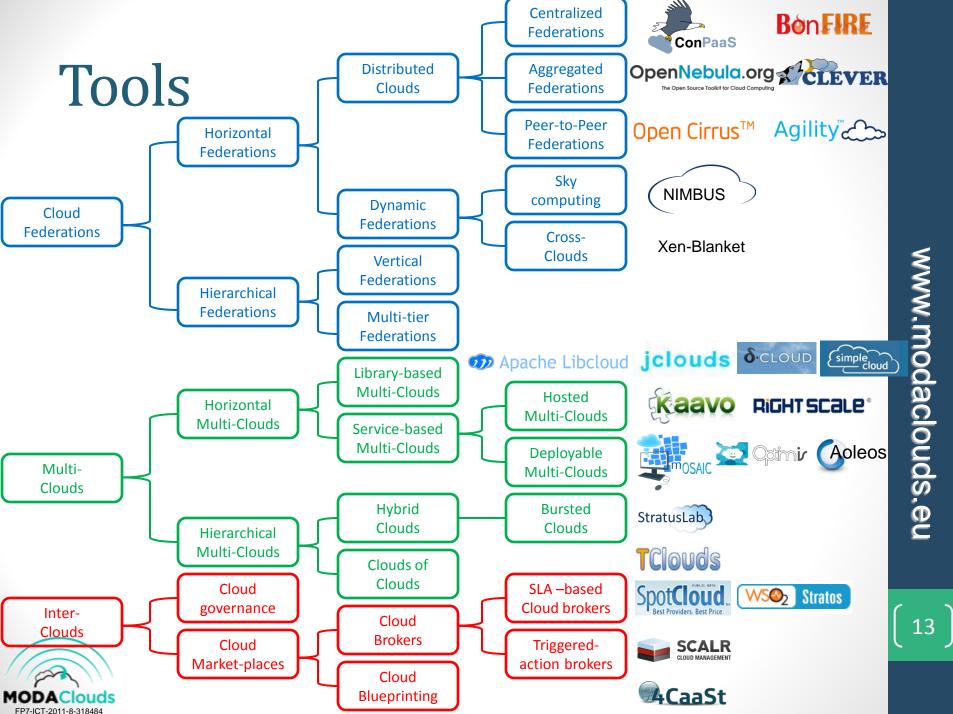
InterCloud & Cloud Broker

- 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









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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

| Leveis | - | lechs | |
|------------------|------------------------------------------------------|-----------------------|----------------------------------------|
| | E.g. | | E.g. |
| Business | Strategies, regulations, mode of use | Domain specific lang. | Automated translation in code |
| Semantic | Function calls and responses | Semantic repositories | UCI |
| Appl & service | Automation, configuration Standards in deployment | Abstraction layers | Mediators, frame- works (SLA@SOI) |
| Management | & migration Protocols for | Standards | OVF/DMTF, CDMI/SNIA |
| Techs & infrastr | requests/responses Pre-deployment, | Open APIs & protocols | jClouds, libcloud, OpenStack, OCCI, |
| Image & data | work-loads Allocation, | | DeltaCloud |
| Network | admission | | |



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Barriers

- 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

- 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 trustfullness in Hybrid Clouds as the simple example of Multi-Clouds





Model-Driven Engineering of Clouds





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MODAClouds (www.modaclouds.eu)

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



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MODAClouds objective

To provide

<u>Methods +decision support system +</u> <u>+ IDE + runtime environment</u>

to support

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

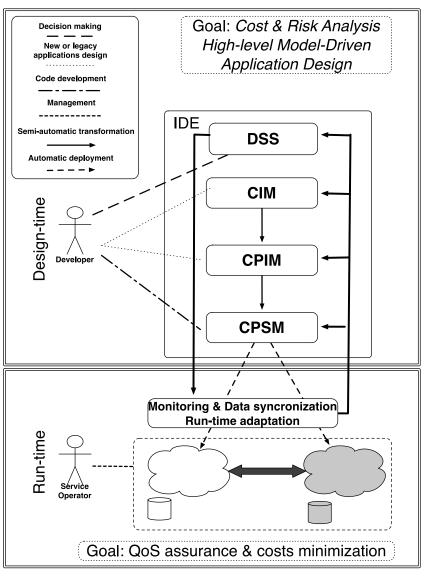
of applications on Multi-Clouds

with <u>guaranteed QoS</u>

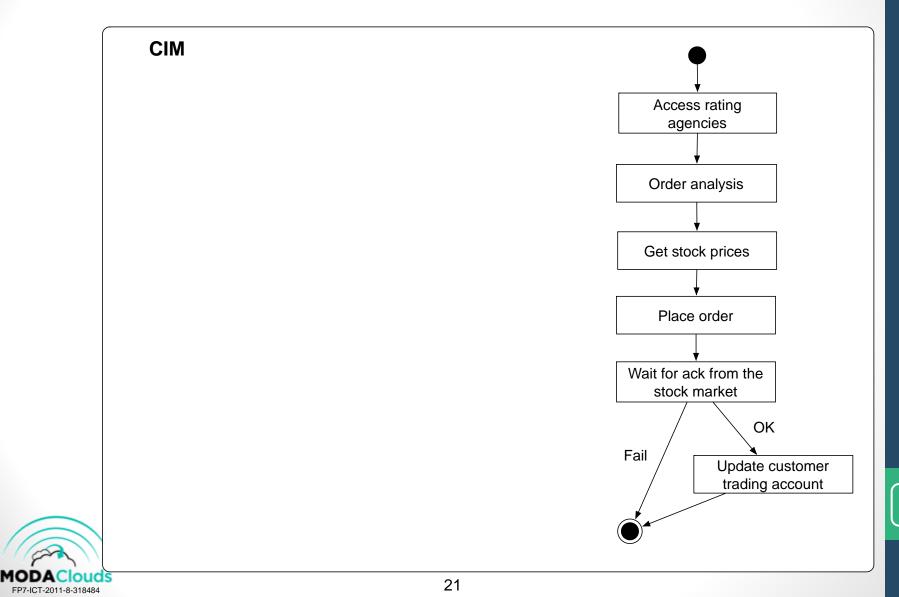


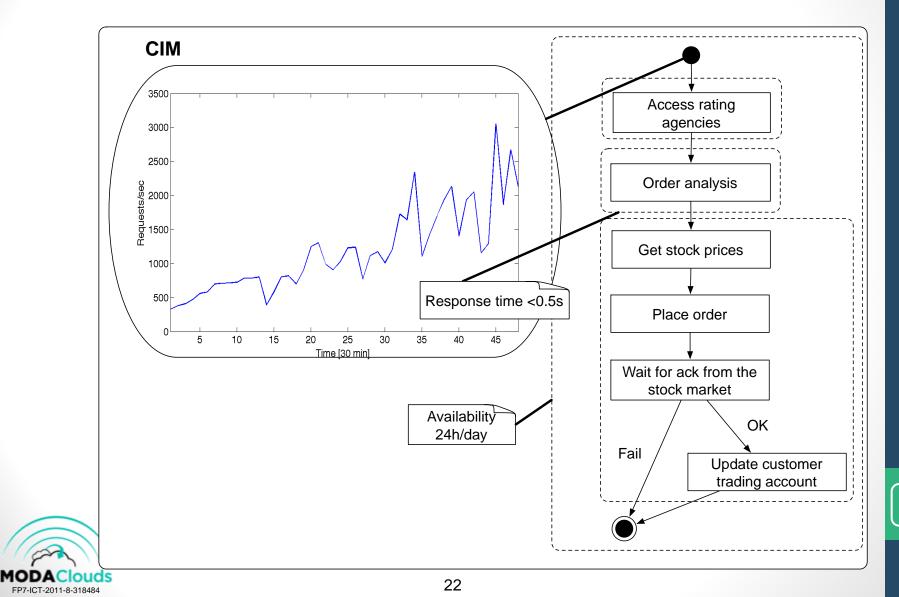


MODAClouds Vision

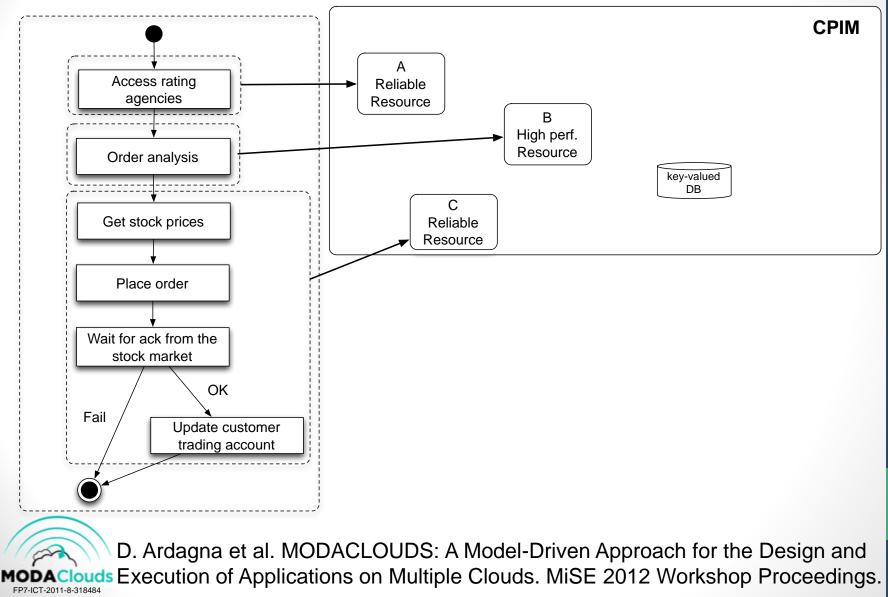






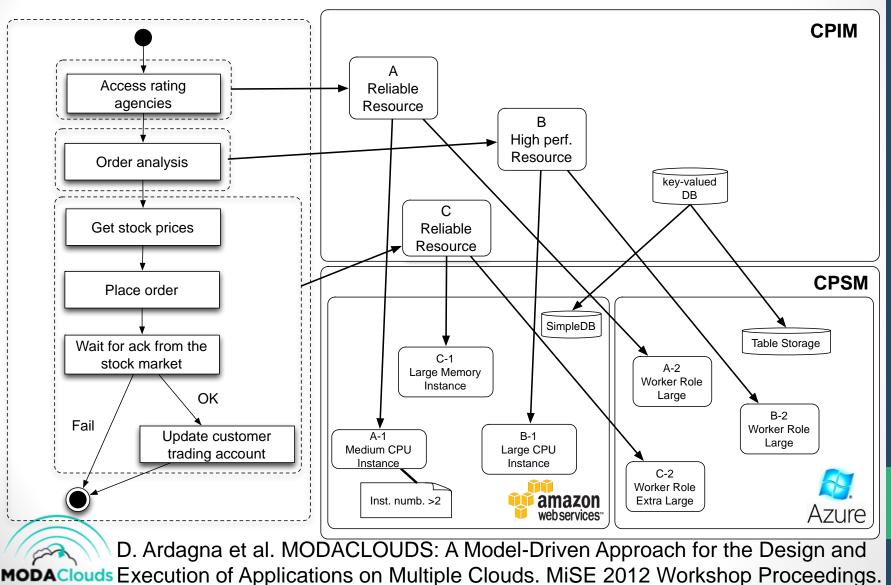


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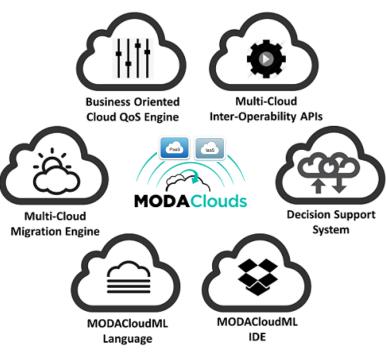
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Outputs

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 (laaS /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

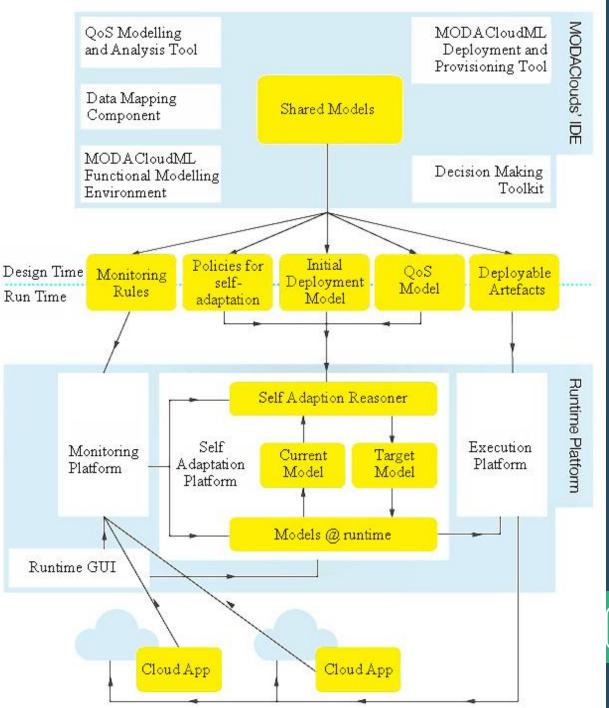
or in combination with third parties to extend their value proposition



Concepts & components maps

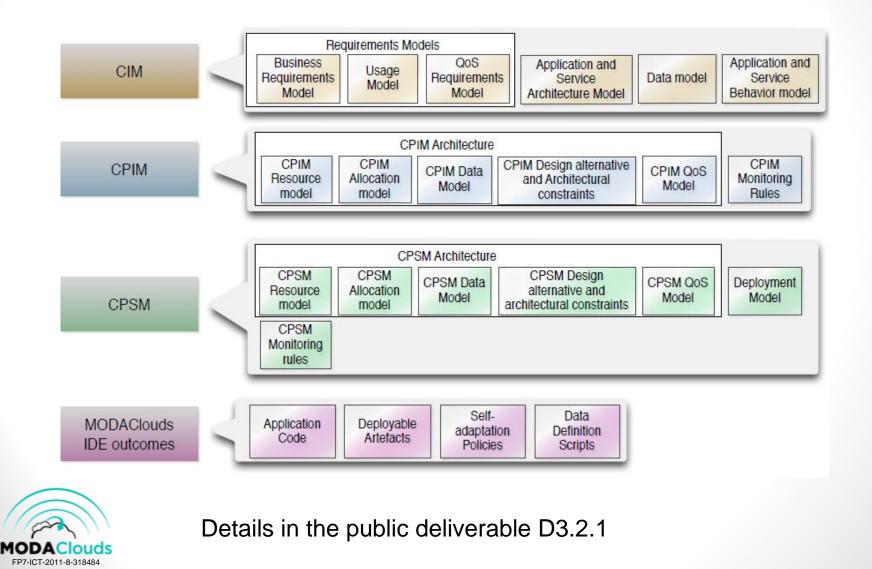
Details in the public deliverable D3.2.1

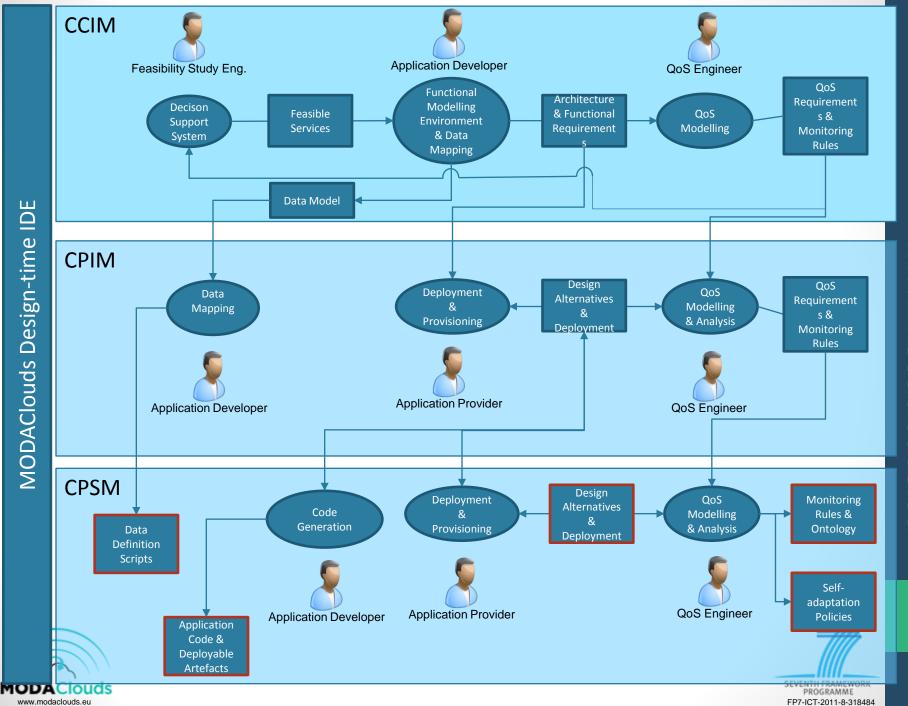




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Shared models





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www.modelio.org/quick-start-pages/19-general-user-interface.html Modelio as IDE modelio Requirement & Vision Analyst Solution integrated requirements and the open source modeling environment goal analysis About Modelio Downloads Community Documentation Home | Quick start pages | General user interface Quick start guide a subscription 12. · # | * * * * * * *

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LINE: Performance analyzer

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| Project Information Project feeds Code license New BSD License Labels Modeling, Performance, Queueing | Line is a solver for queueing network models based on ordinary differential equations. It leverages the concept of mean-field theory, in which the interactions among a large population of entities are approximated by a single averaged effect. Line can be integrated with the Palladio Bench suite used for performance analysis of Palladio Component Models (PCM). Compared to existing PCM performance analysers, Line can compute analytically percentiles of response times, which are important for SLA assessment. Furthermore, it can describe uncertainty about an operational environment using a modelling abstraction known as random environment. Releases | |
| Members <u>cg02@gmail.com</u> juanfern@gmail.com | The last and previous releases of LINE can be found <u>here</u> . Documentation All the documentation of Line can be found on <u>this</u> page. How to cite Line To cite Line, please refer to the following article: J. F. Perez and G. Casale, "Assessing SLA compliance from Palladio component models", in <i>Proceedings of the 2nd MICAS</i> , 2013. | |

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System PerformAnce and Cost Evaluation on Cloud

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CloudML

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





mOSAIC:

Run-time platform for Multi-Clouds

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Portable Testbed Cluster - Co...

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Testing cloudlets on PTC

Mosaic/Notes/Platform/Tutori...

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Case studies

| Case study | MODACloud Challenges |
|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Software development company/Project management server (SOFTEAM) | Deploy legacy applications laaS to laaS migration Run-time monitoring effective resource scaling |
| Software development company/Business Process Modelling System (BOC) | Migration of legacy application re-deployed as a SaaS DSS, risk, and utility analysis to select the best laaS laaS to laaS migration Parallel execution of long- running activities |
| Services for citizens in the health sector/ <i>Palliative care</i> <i>application</i> (ATOS) | Develop new application services Data managed on a private laaS Heterogeneous environments: virtual desktops, application logic; hybrid Clouds (private laaS, multiple public PaaS) Validate activities for filling the gap between runtime and design time |
| IoT in crisis management/ <i>Smart City Urban Safety</i> <i>Planner</i> | 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

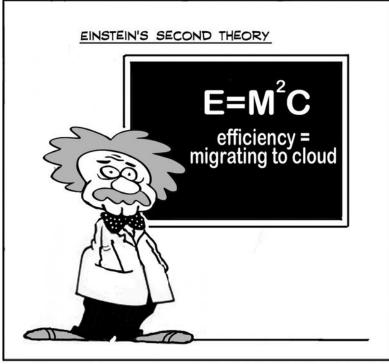
• Multi-Clouds:

 D. Petcu, <u>Consuming Resources and Services from Multiple</u> <u>Clouds. From Terminology to Cloudware Support</u>, Journal of Grid Computing, January 2014, doi: <u>10.1007/s10723-013-9290-3</u>

• MODAClouds:

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





From Cloud humor site

Q&A?



