

Multi-Clouds: challenges, achievements and opportunities

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EC FP7/H2020-ICT actions on Clouds: mOSAIC, MODAClouds, SPECS, DICE, CloudLightning
Cluster of EC H2020-ICT projects on Infrastructure Services

Cloud heterogeneity

- ▶ Manifested in the ...
 - ▶ set of interfaces of the services from different Public Clouds
 - ▶ set of services from the same provider
 - ▶ software stacks
 - ▶ hardware
 - ▶ terms of performance or user quality of experience
- ▶ Favoring
 - ▶ the Cloud service providers
 - ▶ allowing them to be competitive in a very dynamic market especially by exposing unique solutions
- ▶ Hindering the ...
 - ▶ interoperability between these services
 - ▶ portability of the applications consuming the services
 - ▶ seamless migration of legacy applications towards Cloud environments

Types of solutions

1. adoption of standards
 - ▶ existing standards
 - ▶ emerging standards
2. usage of intermediary layers
 - ▶ libraries for major programming languages
 - ▶ tools and services
3. adoption of high abstraction levels
 - ▶ semantics
 - ▶ model-driven engineering

E.g. Model-driven engineering

Type	Examples
Model-driven	MODAClouds, ARTIST, PaaSage

Advantages	Disadvantages
Enhance the abstraction layers with an automation process	Available tools are not yet generating code for various Clouds
Allow a feedback from operational modules to the design modules	The models that are used potentially omit special features of the services

Research agenda – short term

Approach	To Do
Standards	Enhance the number of standard implementations Establish standards for metrics, monitoring, accounting, security Establish standards for machine-readable representations of services, quality, negotiations, processes
Design	Support for decision making for Cloud migration Introduce Modelling-as-a-Service Mechanism for service compositions Build use cases and benchmarks for Cloud portability and interop Define the portability degree
Runtime	Adopt open-source platforms Increase the use of empirical evidence of portability and interop Automate re-deployments

Research agenda – long term

Approach	To Do
Standards	<ul style="list-style-type: none">Unified policy of SLAsEstablish standards for workload and data migrationReference architecture for basic components of software consuming Cloud services
Design	<ul style="list-style-type: none">Define re-engineering process for CloudMechanisms for code inspections and rewritingFollow a structural approach in the design of the supporting toolsEnsure the portability of elasticity rule enginesCombine automation with customization
Runtime	<ul style="list-style-type: none">Mechanisms for real-time migrationTools for the full service cycle, including Cloud governanceOpen-source platforms ensuring automated portability or encompassing various approaches

Delivery models for Multiple Clouds

1. Federated Clouds

- ▶ assumes
 - ▶ a formal agreement between the Cloud providers

2. Multi-Cloud

- ▶ assumes that
 - ▶ there is no priori agreement between the Cloud providers
- ▶ a 3rd party (even the consumer) is responsible for the services
 - ▶ contacts the service providers,
 - ▶ negotiates the terms of service consumption,
 - ▶ monitors the fulfillment of SLAs
 - ▶ triggers codes, data, networking migration from one provider to another

To solve in Multi-Clouds

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

EC FP7/H2020-ICT projects related to Multi-Clouds

▶ *Finished:*

- ▶ *mOSAIC*
- ▶ Cloud4SOA
- ▶ OPTIMIS

▶ *Ongoing:*

- ▶ *MODAClouds*
- ▶ SeaClouds
- ▶ Broker@Cloud

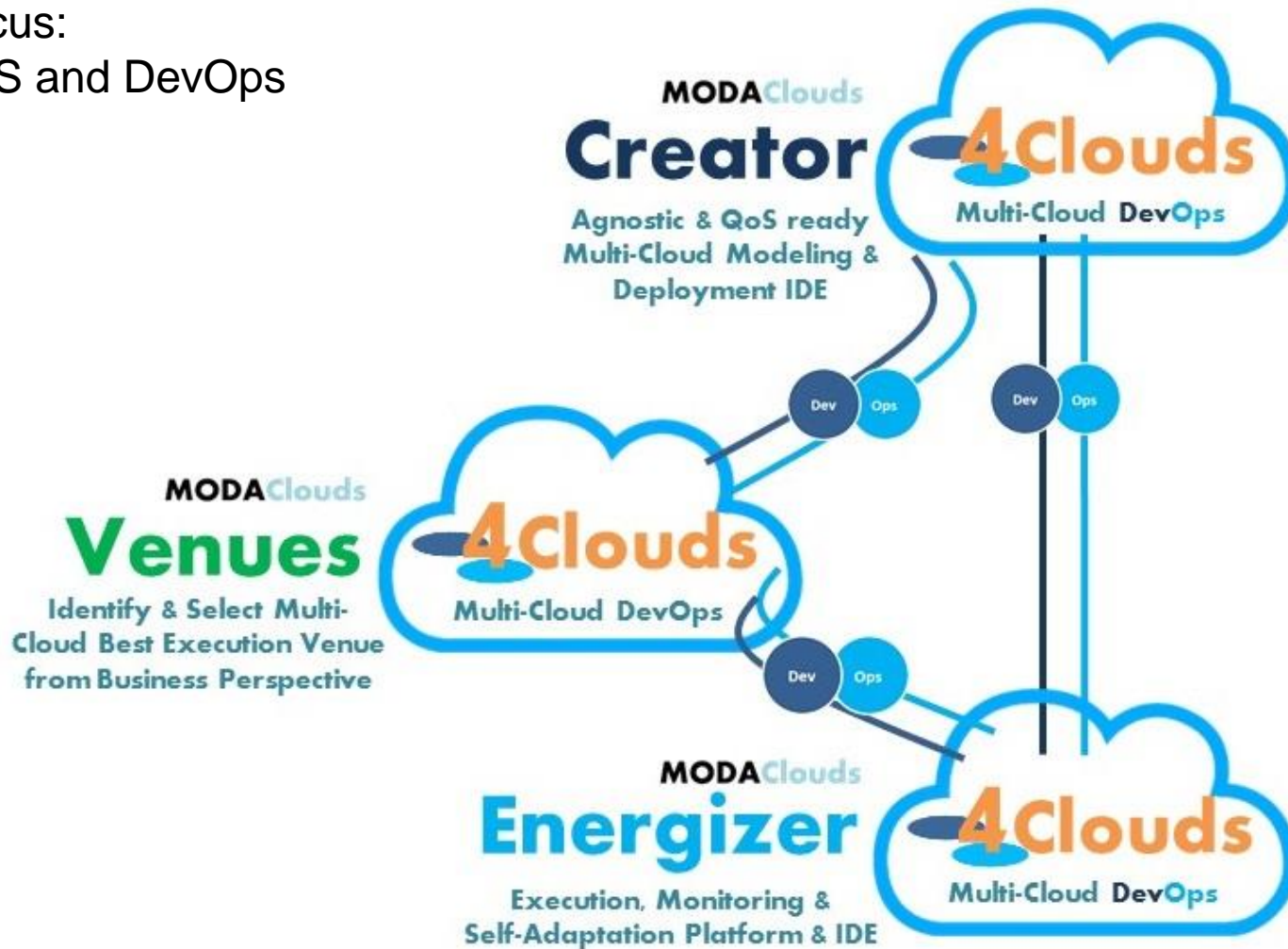
▶ *New:*

- ▶ MUSE,
- ▶ SuperCloud,
- ▶ CYCLONE

Tools

Delivery model	Organization	Type	Architecture	Middleware examples
Federation	Horizontal	Distributed	Centralized	<u>BonFIRE</u> , <u>ConPaaS</u>
		Dynamic	Aggregated	<u>OpenNebula</u>
			Peer-to-Peer	<u>OpenCirrus</u>
			Sky computing	Nimbus
			Cross-Clouds	Xen-Blanket
	Hierarchical	Vertical		
		Multi-tier		
Multi-Cloud	Horizontal	Library-based		jclouds, Libcloud, δ -Cloud, SimpleCloud, SAGA
		Service-based	Hosted	RightScale, Kaavo
			Deployable	<u>mOSAIC</u> , <u>Cloud4SOA</u> , <u>Optimis</u> , <u>Aoleus</u> , <u>MODAClouds</u>
	Hierarchical	Hybrid Cloud	Bursting Cloud	<u>StratusLab</u> , <u>Agility</u>
		Clouds of Clouds		<u>TClouds</u>
Inter-Cloud	Governance			Enstratus
	Marketplace	Cloud brokers	SLA-based	SpotCloud, Stratos, CloudBroker
			Triggerred-action	Scalr
		Blueprint		<u>4CaaS</u>

Focus:
QoS and DevOps



Main Topics to Address

Source: <http://cordis.europa.eu/fp7/ict/ssai/docs/cloud-expert-group/roadmap-dec2012-vfinal.pdf>

1. *Data Management*
2. Communication & Network
3. Resource Description & Usage
4. Resource Management
5. *Programmability and Usability*
6. *Federation, Interoperability, Portability*
7. Multiple Tenants
8. Political & Legislative
9. Security
10. Business & Cost Models

