Cloud Day 2011

KTH-SICS Cloud Innovation Center and **EIT ICT Labs**

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Challenges in Hybrid and Federated Cloud Computing

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OpenNebula.org

Acknowledgments

The research leading to these results has received funding from the *Ministerio de Ciencia e Innovación* of Spain through research grant TIN2009-07146.

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Challenges in Hybrid and Federated Cloud Computing

- IaaS Cloud Computing
- OpenNebula Cloud Management
- Cloud Federation
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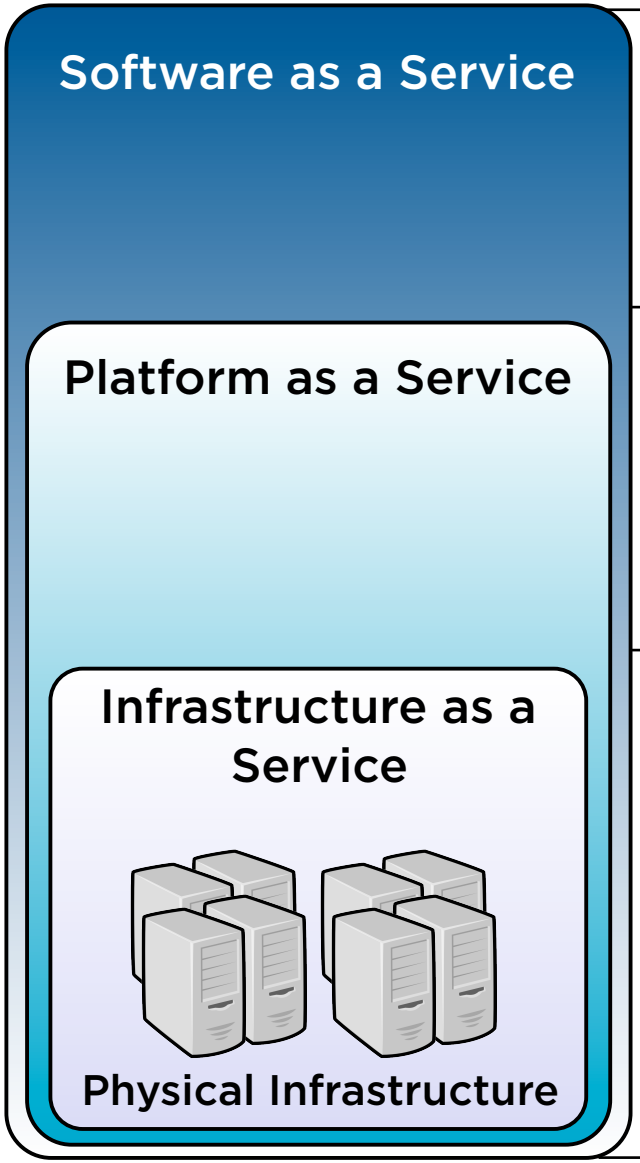
- Common Architectures for Federation
- Challenges for Interoperability and Portability

Types of Cloud Services for Provision of IT Capabilities as a Service



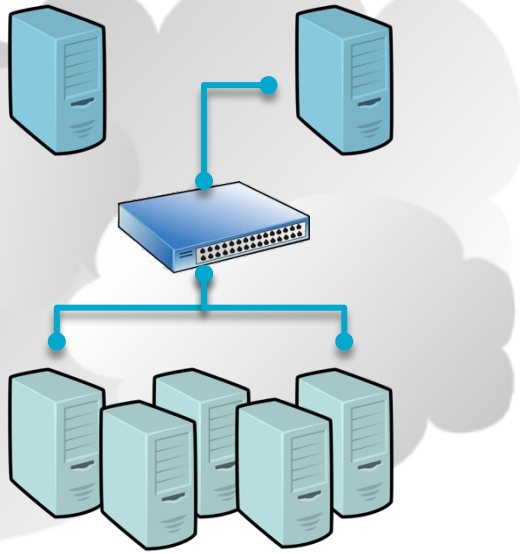
What	Who
On-demand access to any application	End-user (does not care about hw or sw)
Platform for building and delivering web applications	Developer (no managing of the underlying hw & swlayers)
Raw computer infrastructure	System Administrator (complete management of the computer infrastructure)

Provision of Virtualized Resources as a Service

- Management Console
- Simple **REST** API's

- Raw infrastructure resources

Manage Instances



- Pay-as-you-go & elastic capacity

OpenNebula Cloud Management

OpenNebula.org

IaaS Cloud Computing Tool for Managing a Data Center's Virtual Infrastructure

Adaptable

- Customizable and Extensible

Proven

- Many Massive Scale Production Deployments

Powerful and Innovative

- Advanced Enterprise-class Functionality

No Lock-in

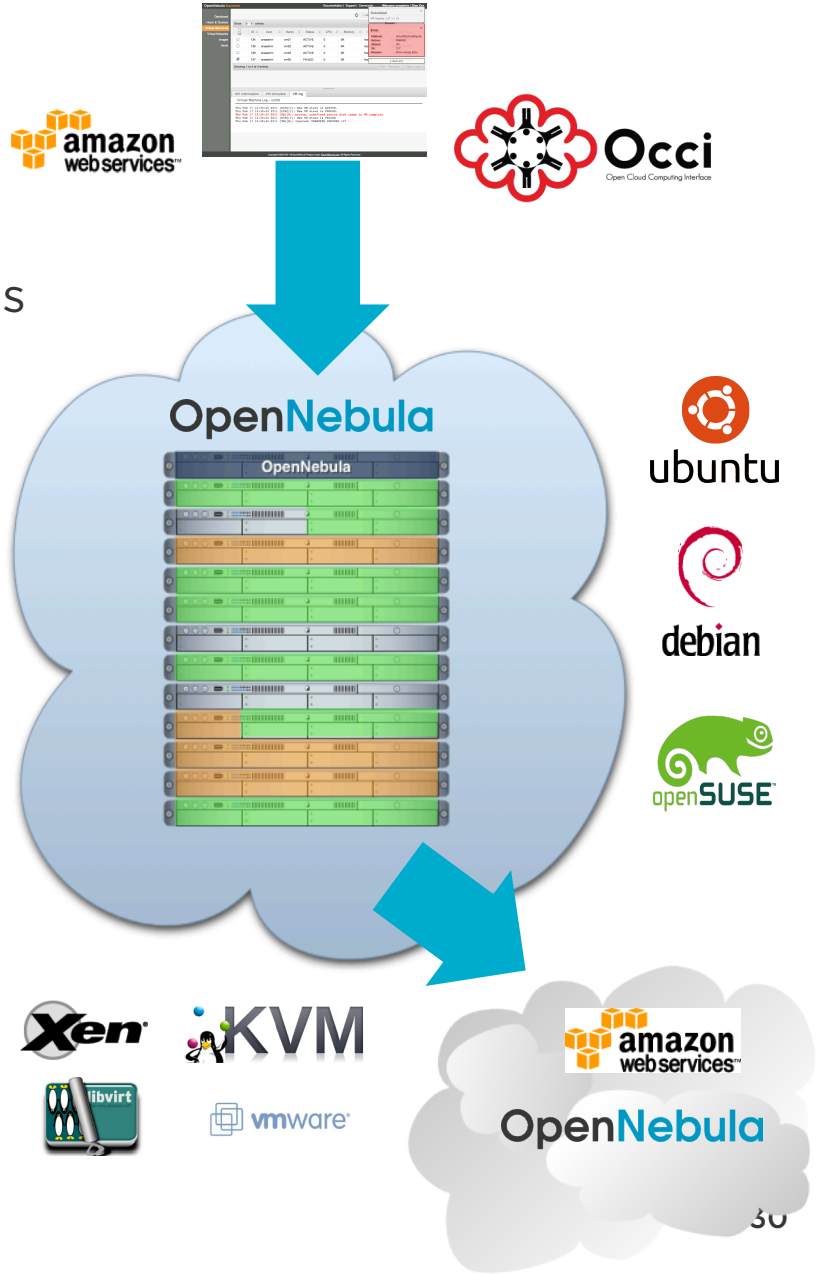
- Platform Independent and Interoperable

Interoperable

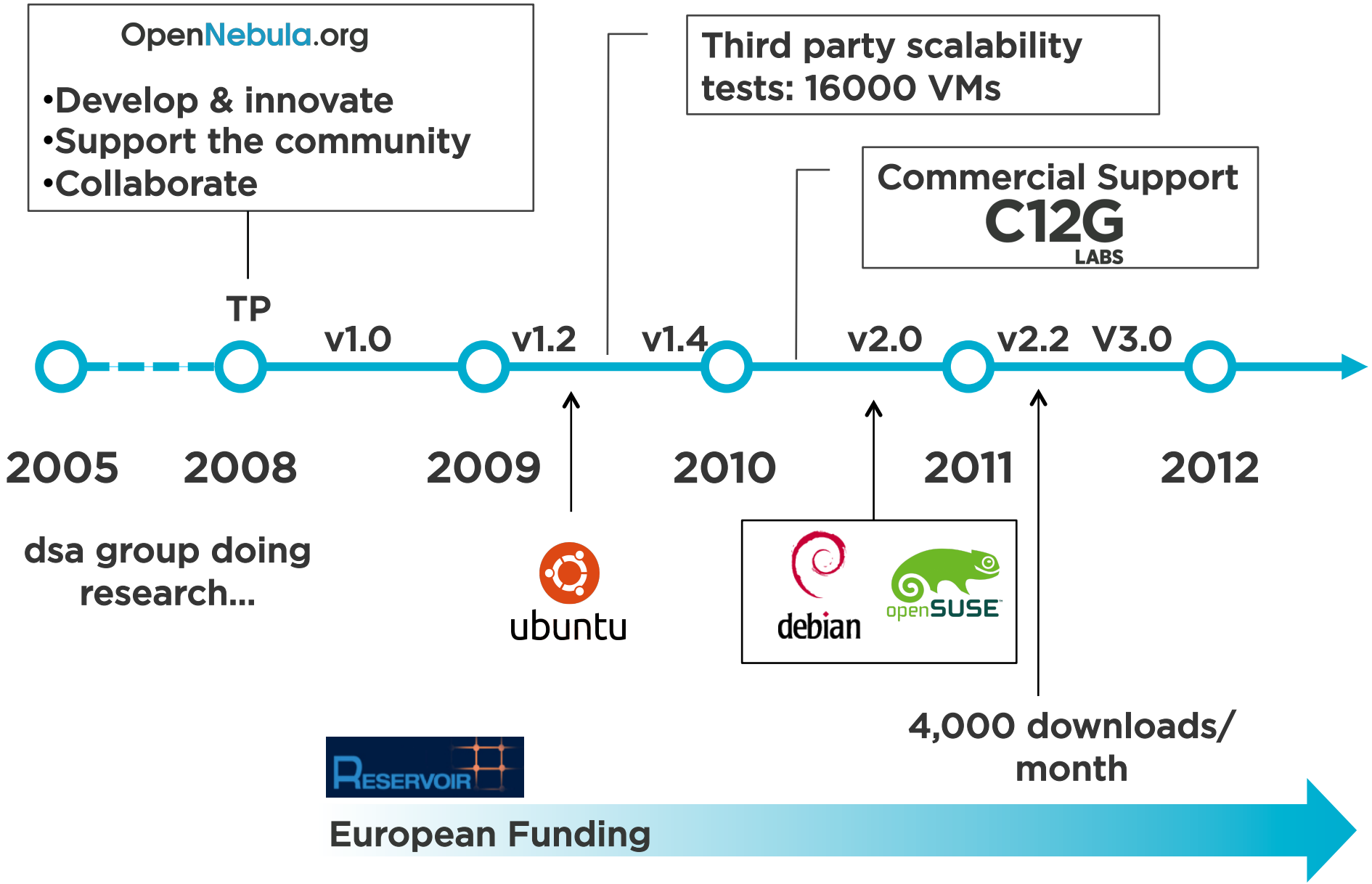
- Popular cloud APIs and standard based

Openness

- Fully open-source
- Apache license



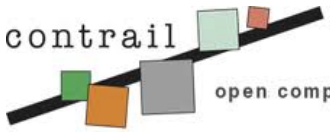
Building the Industry Standard Open Source Cloud Computing Tool



Organizations Building Clouds and Innovative Projects

Organizations Building Clouds for Development, Testing and Production

Projects Building an Open Cloud Ecosystem Around OpenNebula



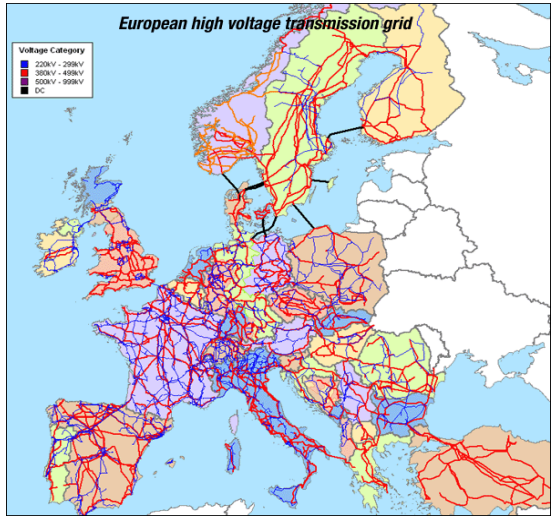
Different Models of Deployment

Model	Definition	Cloud Cases
Private	Infrastructure is owned by a single organization and made available only to the organization	• Optimize and simplify **internal operation** • **SaaS**/**PaaS** support • IT consolidation within **large organizations** (**Goverment** Clouds, University Clouds...)
Public	Infrastructure is owned by a single organization and made available to other organizations over the Internet	• **Commercial cloud providers,** mostly hosting providers to offer low cost solutions with limited control/configuration and security/reliability good enough • **Science public clouds** to enable scientific and educational projects or to experiment with cloud computing
Virtual Private	Infrastructure is owned by a single organization and made available to other organization over a dedicated private network	• **Telecom cloud providers** to offer premium solutions with additional control/ configuration and security/reliability

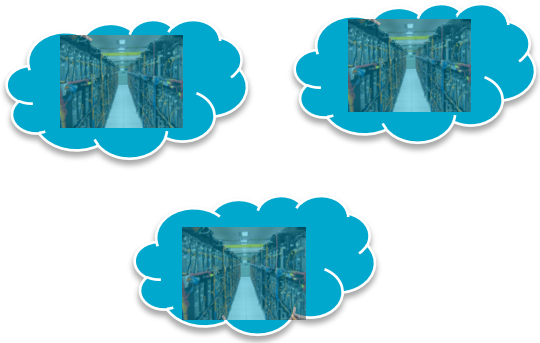
Next Step in the Evolution of an Utility

Utility Generation

Utility Distribution



Utility Grid



Benefits of Federation

Scalability

- Cloudbursting to address peak demands

Collaboration

- Sharing of infrastructure between partners

Multi-site Deployments

- Infrastructure aggregation across distributed data centers

Reliability

- Fault tolerance architectures across sites

Performance

- Deployment of services closer to end users

Cost

- Dynamic placement to reduce the overall infrastructure cost

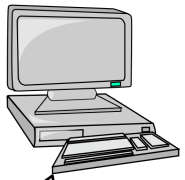
Energy Consumption

- Minimize energy consumption

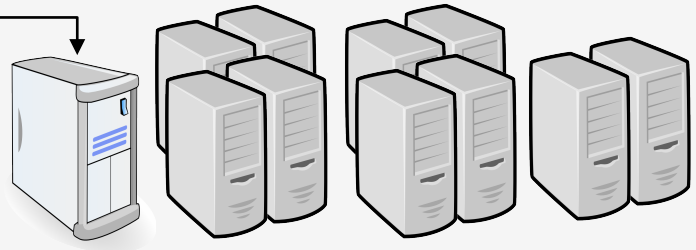
The Multi-tier Cluster Use Case

Virtual Cluster Flexibility
- Dynamic elasticity rules
- Dynamic provision of cluster configurations

Cluster Users



Application Servers

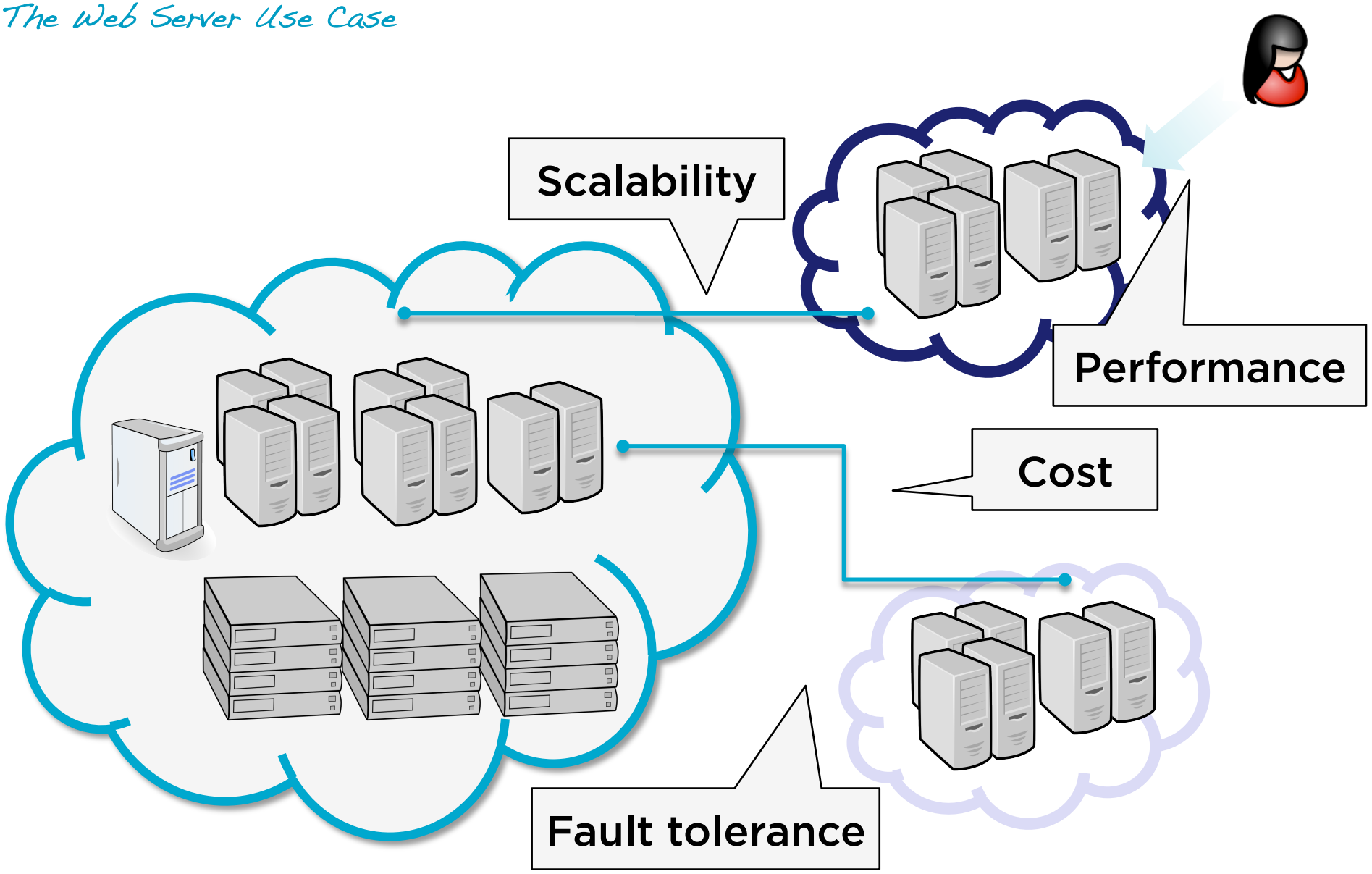


Front-end

Completely Transparent
- Service interface

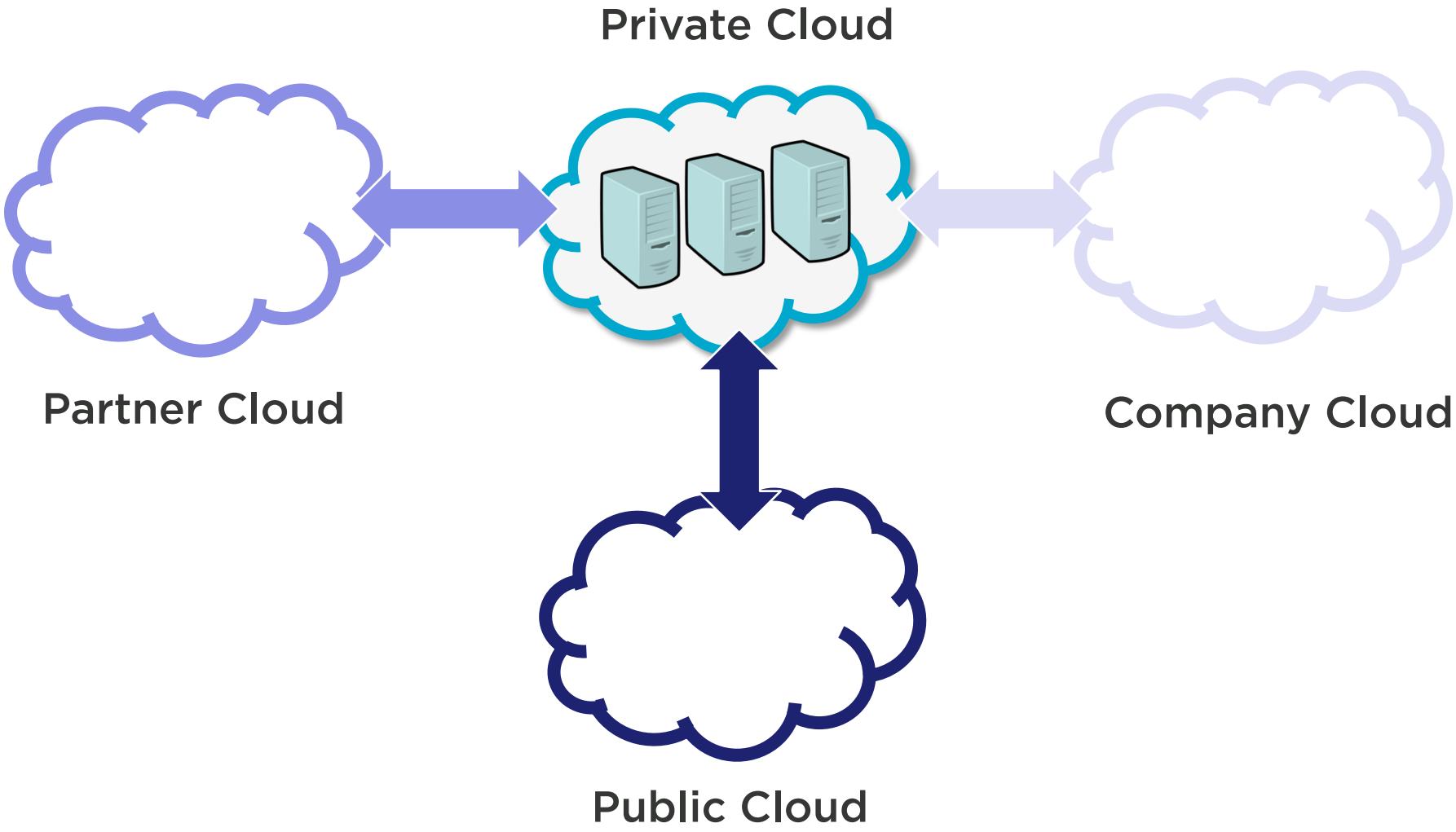
Simplify and Optimize Internal Operations
- Dynamic performance partitioning
- Consolidation
- Faster upgrades
- Maintenance

The Web Server Use Case



Coupling Levels for Federation

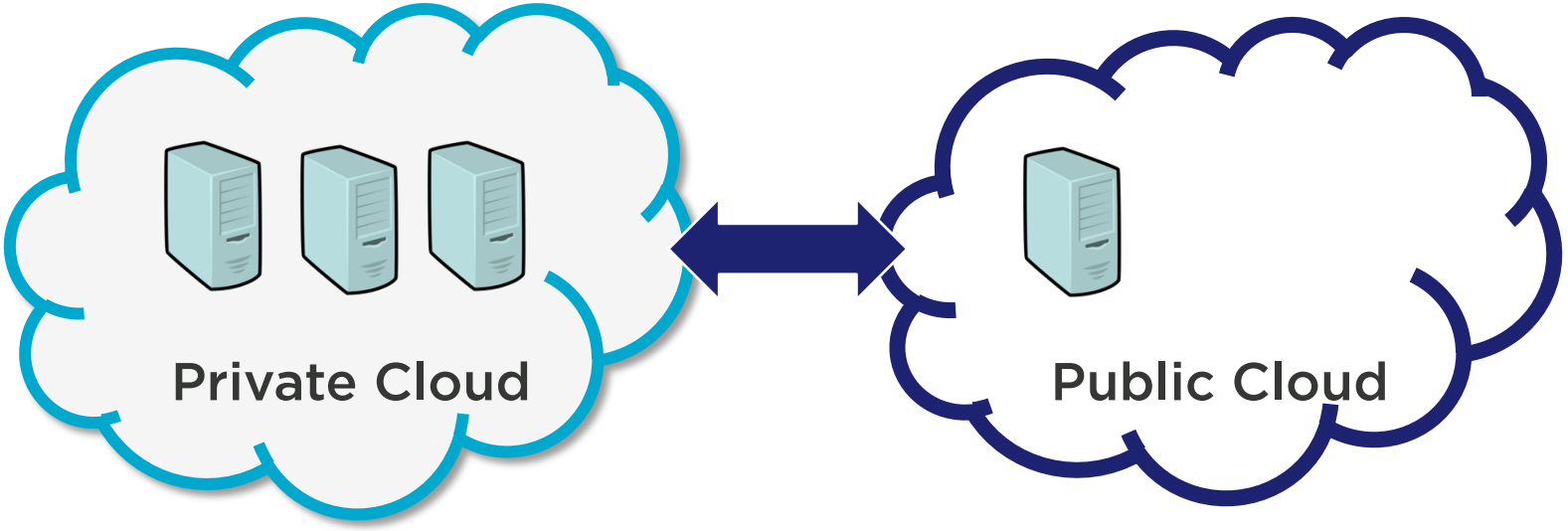
Different Levels of Control, Monitoring, Cross-site Functionality and Security



Coupling Levels for Federation

Loosely Coupled Federation

Federation with a Cloud without Interoperation Support

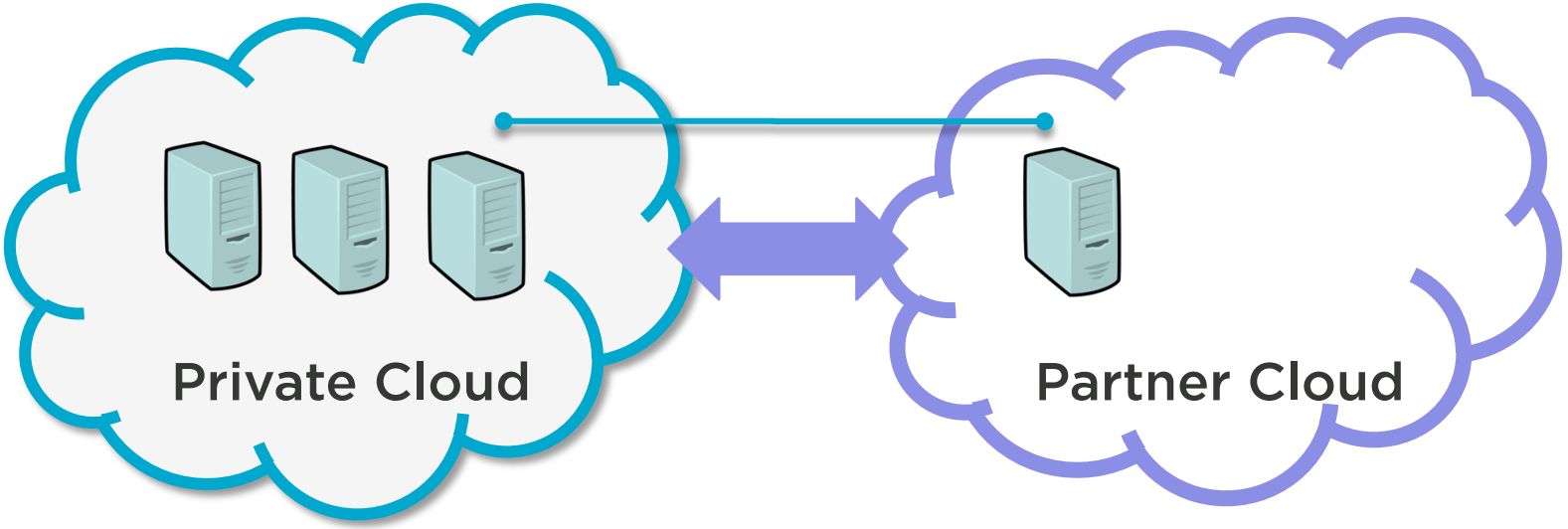


Control	• Basic operations over VMs (start, shutdown, restart...) • Different instance types
Monitoring & Accounting	• Basic virtual resource monitoring (resource consumption...)
Cross-site	• None
Security	• Single account representing the organization

Coupling Levels for Federation

Partially Coupled Federation

Federation with a Cloud with Partial Interoperation Support

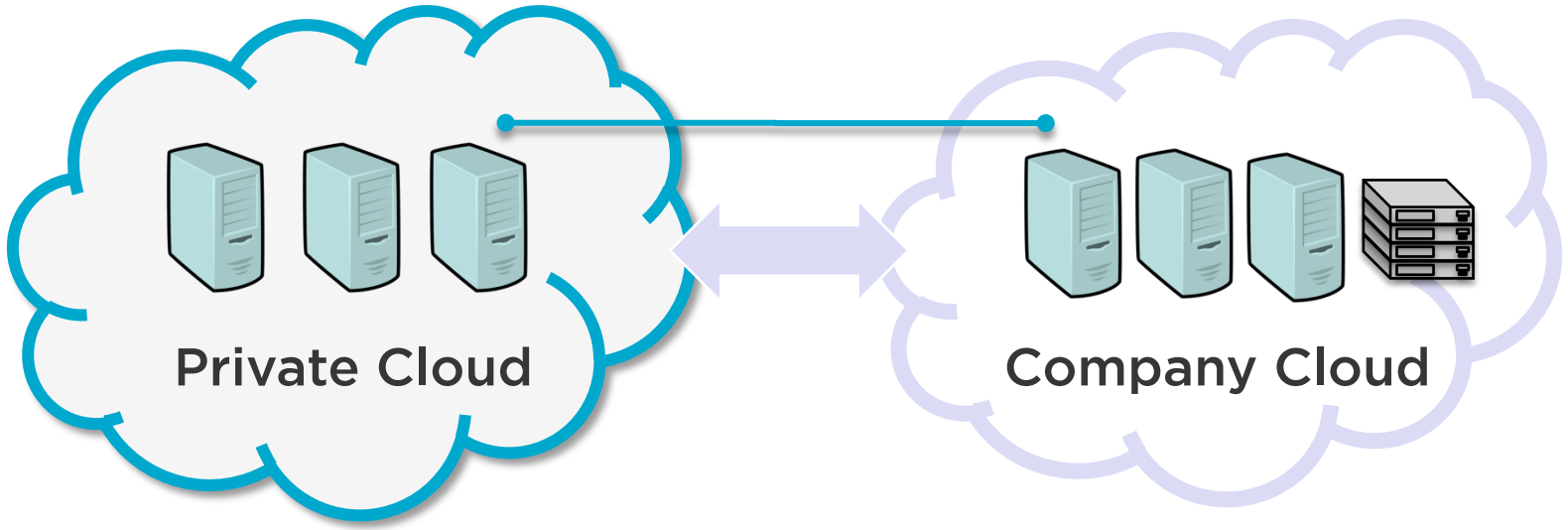


Control	• Advanced operations over VMs (live migration...) • VM location and affinity constraints
Monitoring & Accounting	• Advanced virtual resource monitoring (energy consumption, VM placement...)
Cross-site	• Virtual networks • Virtual storage
Security	• Framework agreement

Coupling Levels for Federation

Tightly Coupled Federation

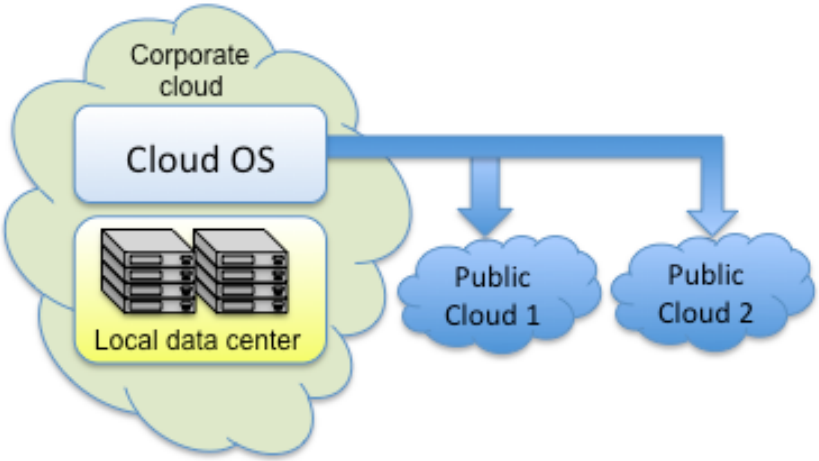
Federation with a Cloud with Advanced Interoperation Support

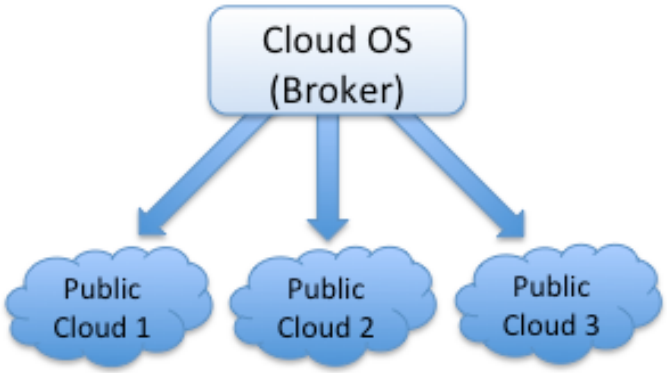


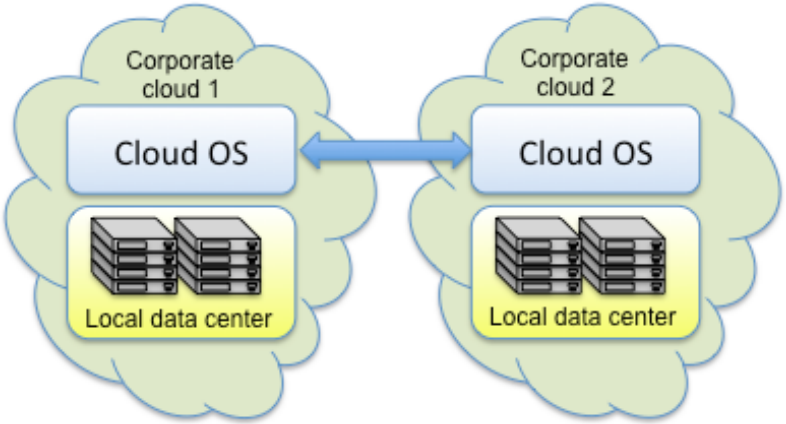
Control	• Placement on specific physical resources • Same instance types
Monitoring & Accounting	• Physical resource consumption
Cross-site	• Live migration • High availability
Security	• User space sharing

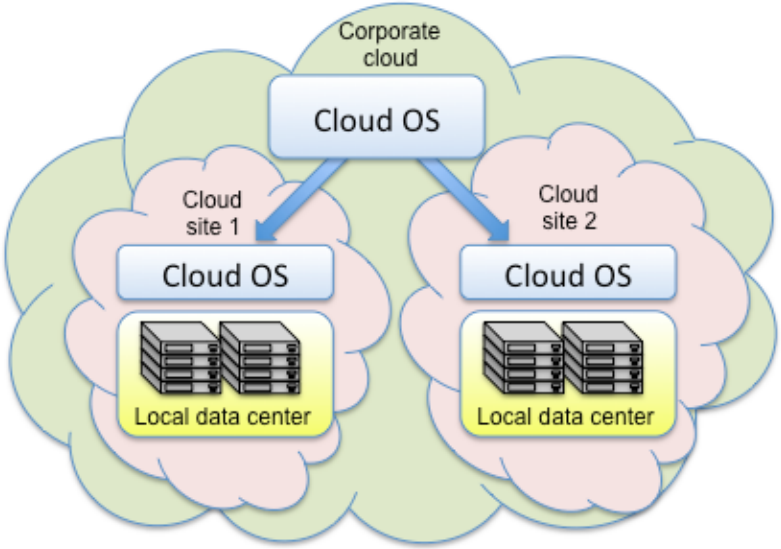
Common Architectures for Cloud Federation

Organization of Multi-site Cloud Environments



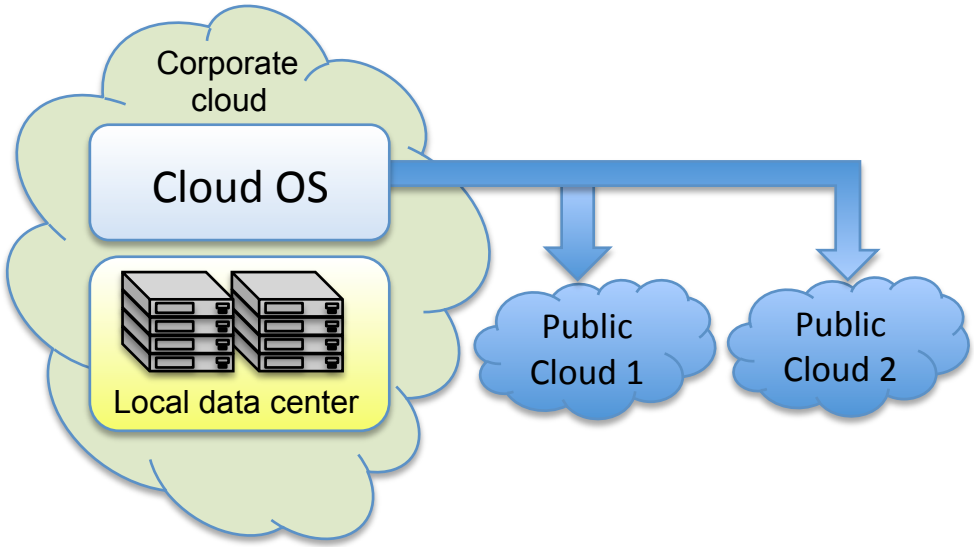






Common Architectures for Cloud Federation

Cloudbursting Architecture



Cloud Type	• Private cloud to scale out with public or virtual private cloud resources
Aim	• Meet peak demands
Coupling	• Loosely and partially coupled

Cloudbursting Architecture

StratusLab

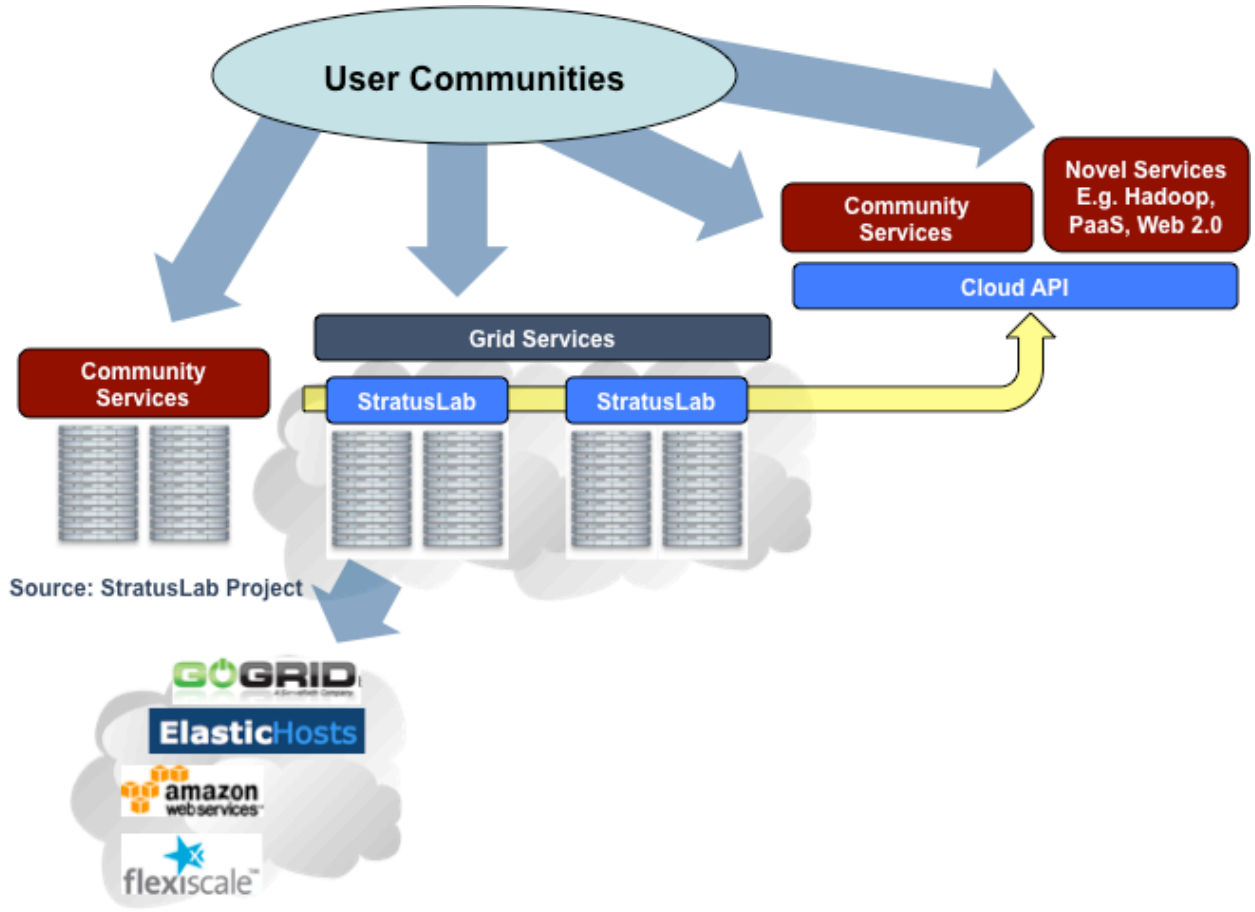
EU grant agreement RI-261552
(2010-2012)
e-Infrastructure

cnrs

www.StratusLab.eu

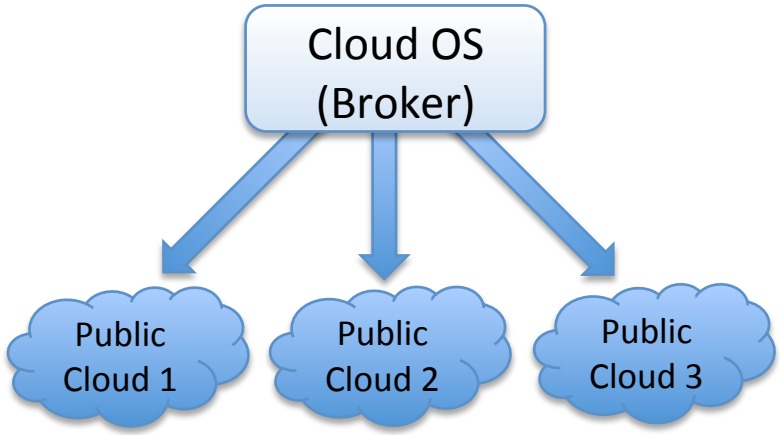
Enhancing Grid Infrastructures with Cloud Computing

Simplify and optimize its use and operation, providing a more flexible, dynamic environment for scientists; and enhance existing computing infrastructures with "IaaS" paradigms



Common Architectures for Cloud Federation

Cloud Broker Architecture



Cloud Type	• User of several public clouds
Aim	• Cost, performance and reliability optimization
Coupling	• Loosely coupled

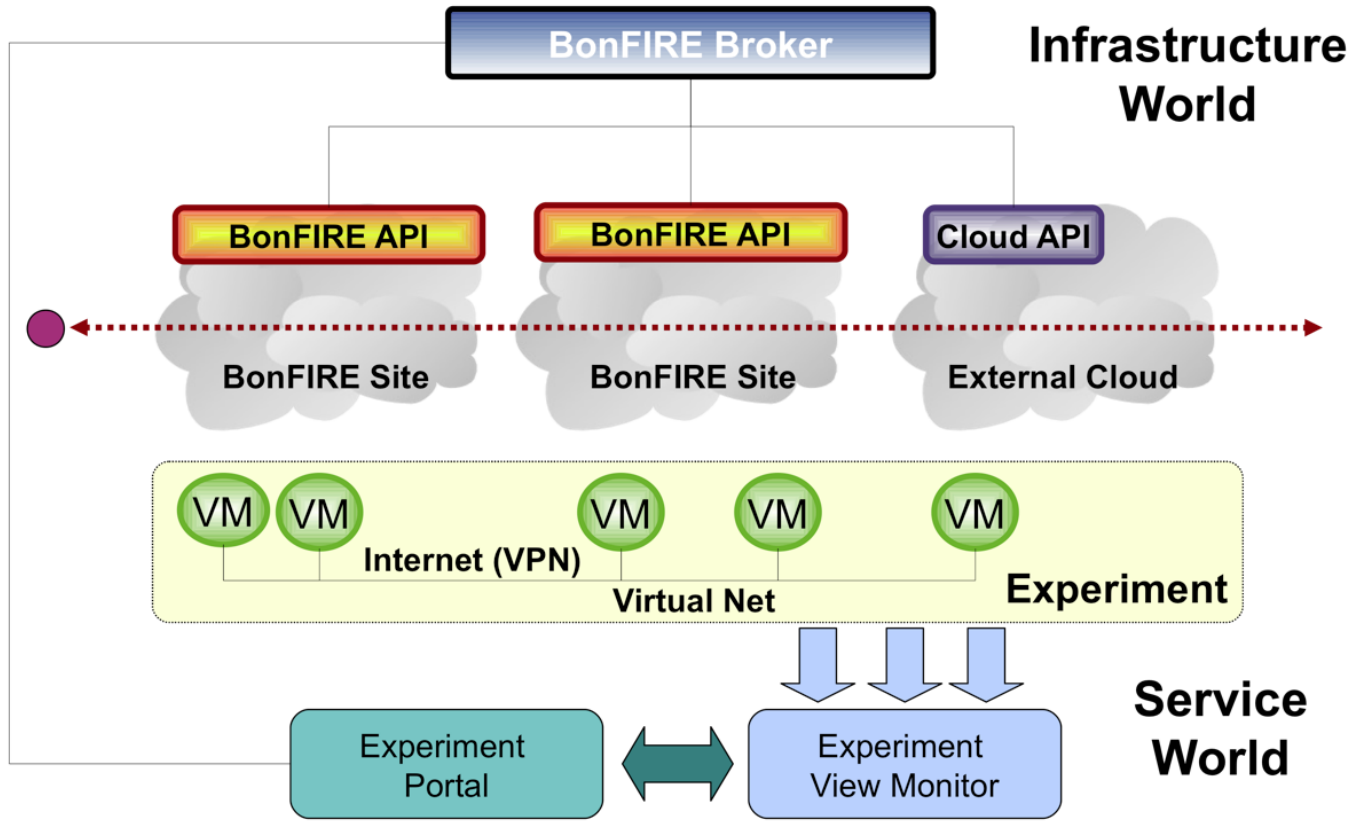
Cloud Broker Architecture

Agreement 257386 (2010-2013)
New Infrastructure Paradigms and Experimental Facilities

Building Service Testbeds on FIRE

Design, build and operate a multi-site cloud-based facility to support research across applications, services and systems targeting services research community on Future Internet

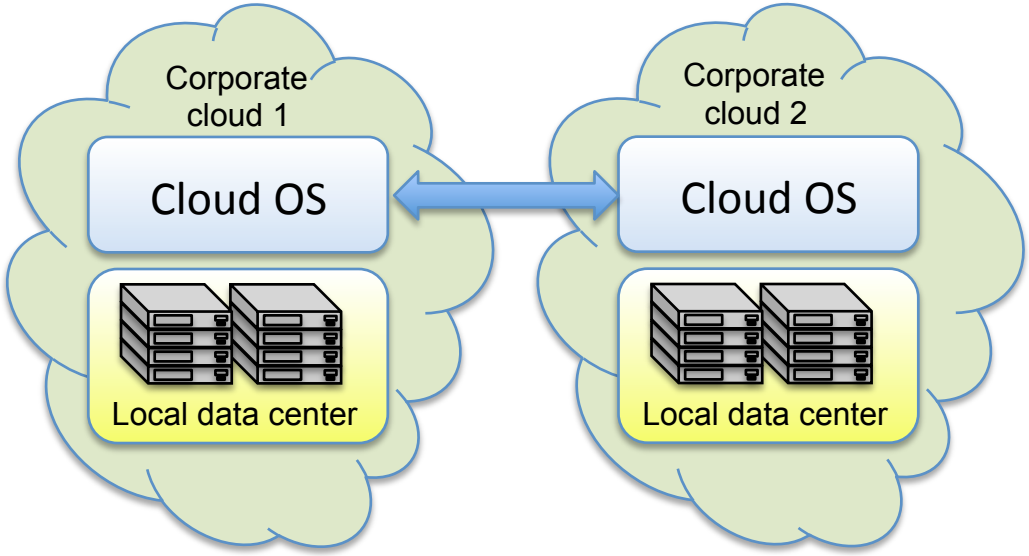
www.BonFIRE-Project.eu



Source: BonFIRE Project

Common Architectures for Cloud Federation

Aggregated Cloud Architecture



Cloud Type	• Aggregation of different private clouds
Aim	• Sharing of resources between partners to meet peak demands
Coupling	• Partially or tightly coupled

Aggregated Cloud Architecture

RESERVOIR

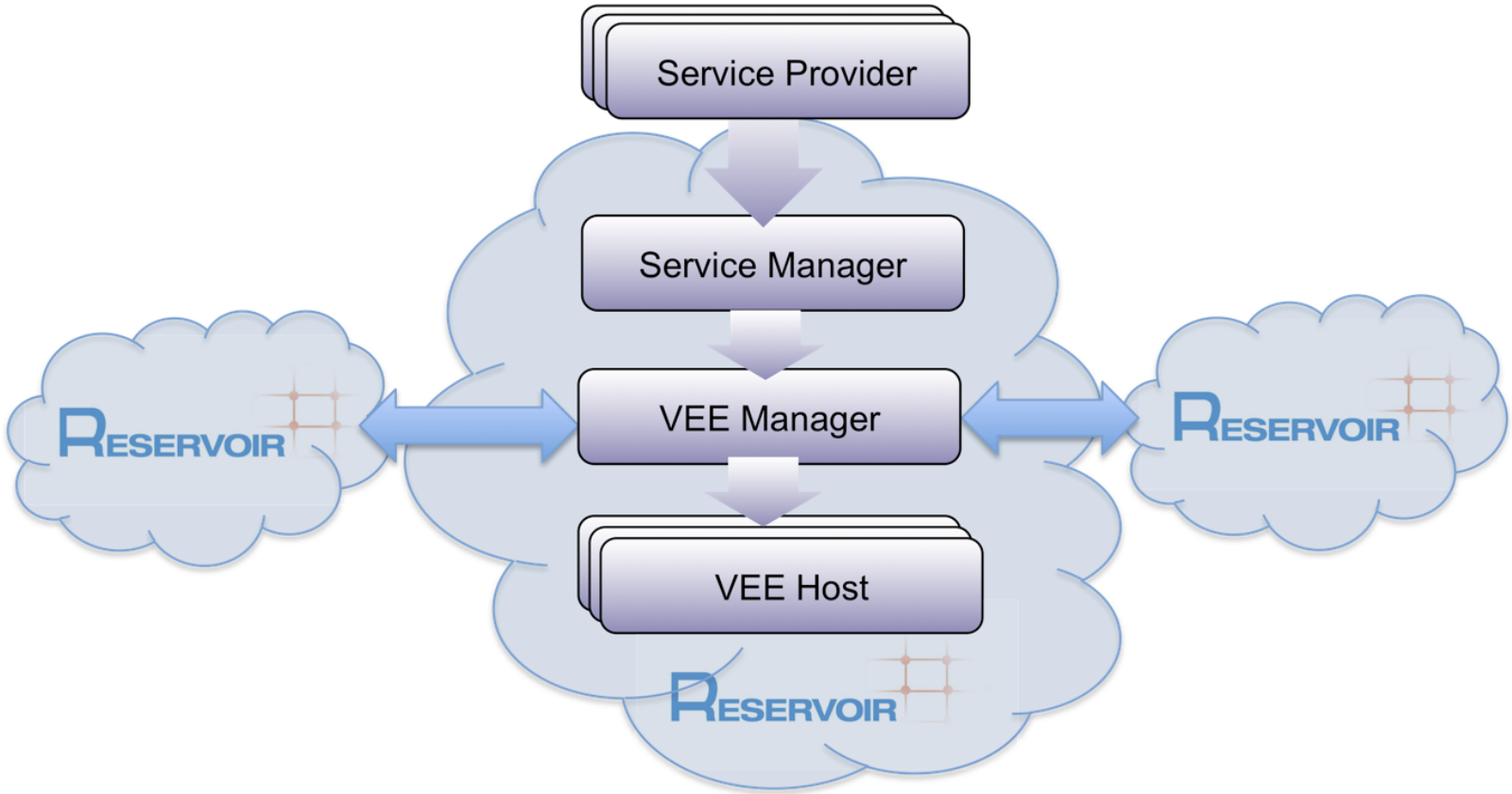
Agreement 215605 (2008-2011)
Service and Sw Architectures and Infrastructures

Resources and Services Virtualization without Barriers

Open source technology to enable deployment and management of complex IT services across different administrative domains

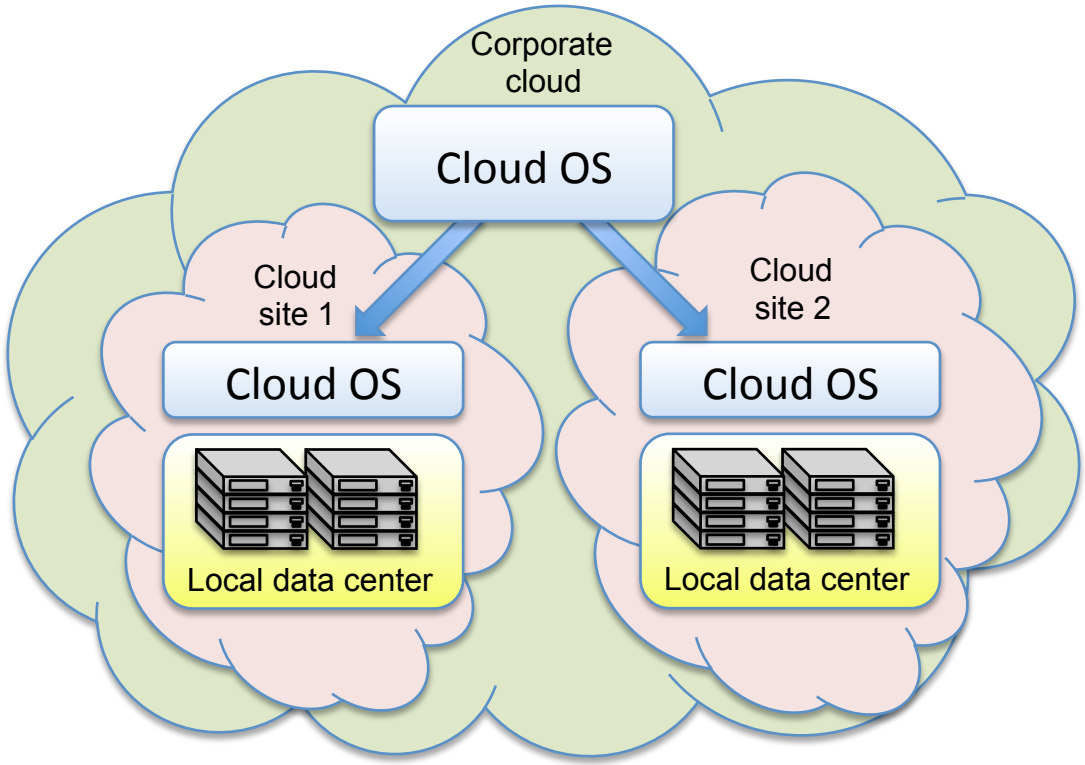
IBM

www.reservoir-fp7.eu



Common Architectures for Cloud Federation

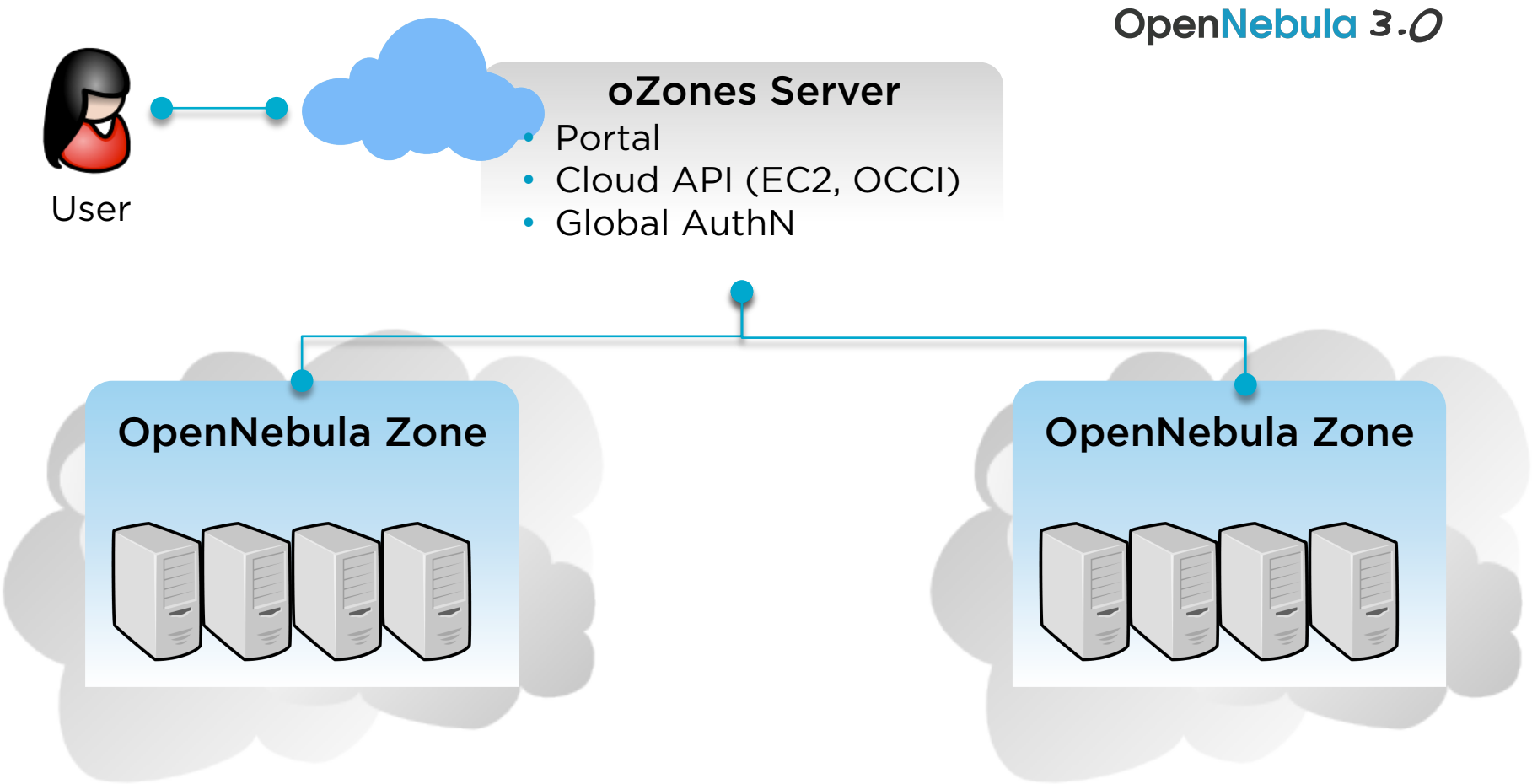
Multi-tier Cloud Architecture



Cloud Type	• Very large corporate clouds (private, public or virtual private) with several instances
Aim	• Scalability, isolation or multiple-site support
Coupling	• Tightly coupled

Common Architectures for Cloud Federation

Multi-tier Cloud Architecture

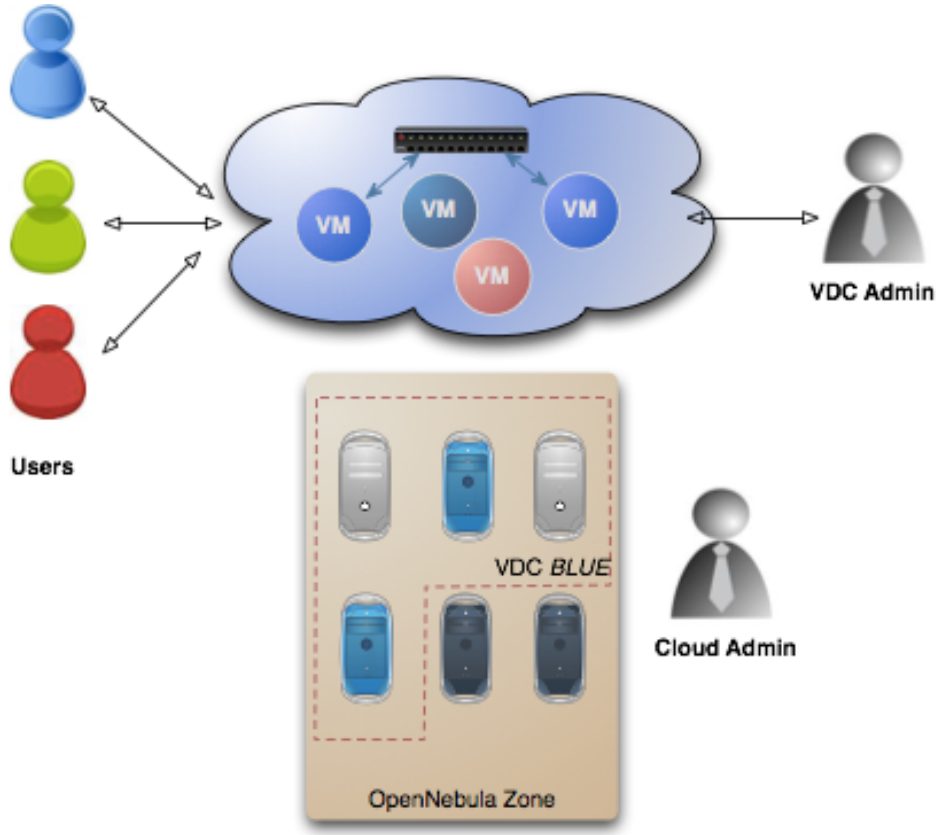


Multi-tier Cloud Architecture

Advanced Multi-Tenancy within each Zone

OpenNebula 3.0

- Typical scenario in large organizations and cloud providers
- On-demand provision of fully-configurable and isolated VDC with full control and capacity to administer its users and resources



Challenges for Interoperability and Portability

Transparent Combination of Local Resources with Cloud Resources with No Changes

1. Management Interfaces for Virtual Workloads

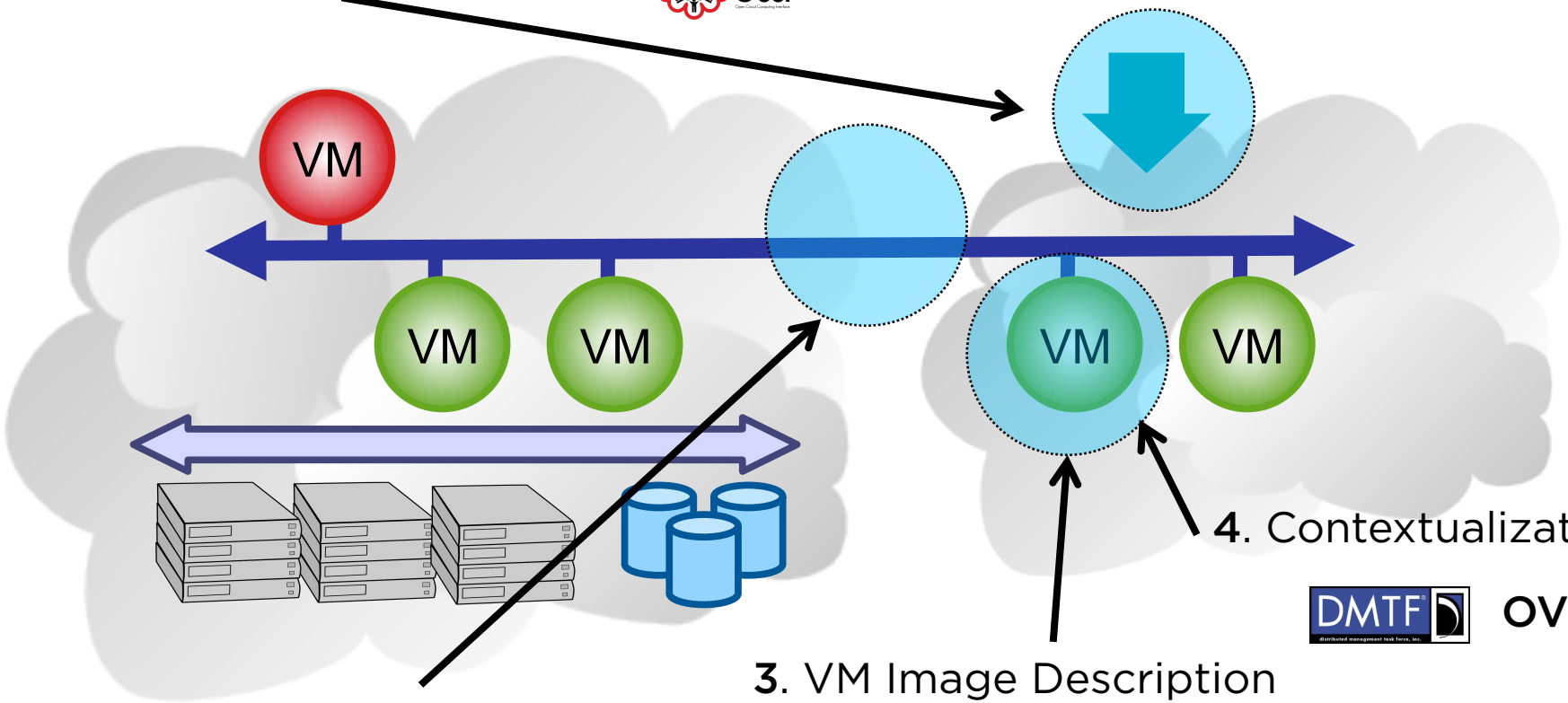
OpenGridForum OPEN FORUM | OPEN STANDARDS

Occi

2. Management Interfaces for Data Elements

SNIA

CDMI



4. Contextualization

DMTF OVF

3. VM Image Description

DMTF OVF

5. Management of Cross-site Networking

6. Common Execution Framework (Instance Type, QoS and Security)

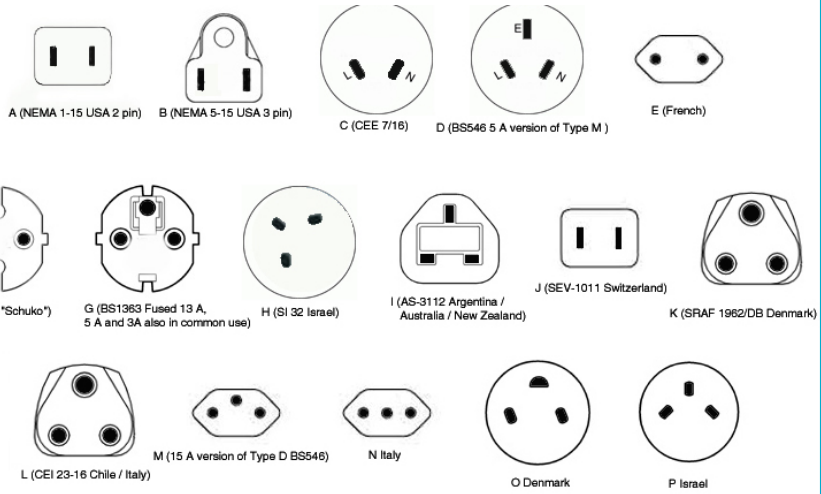
Leveraging Existing Standards and Implementing Interoperation

Standardization

- Implement standards
- Integrate with standards

Which Standard?

- Different *de jure* standards
- Several *de facto* standards

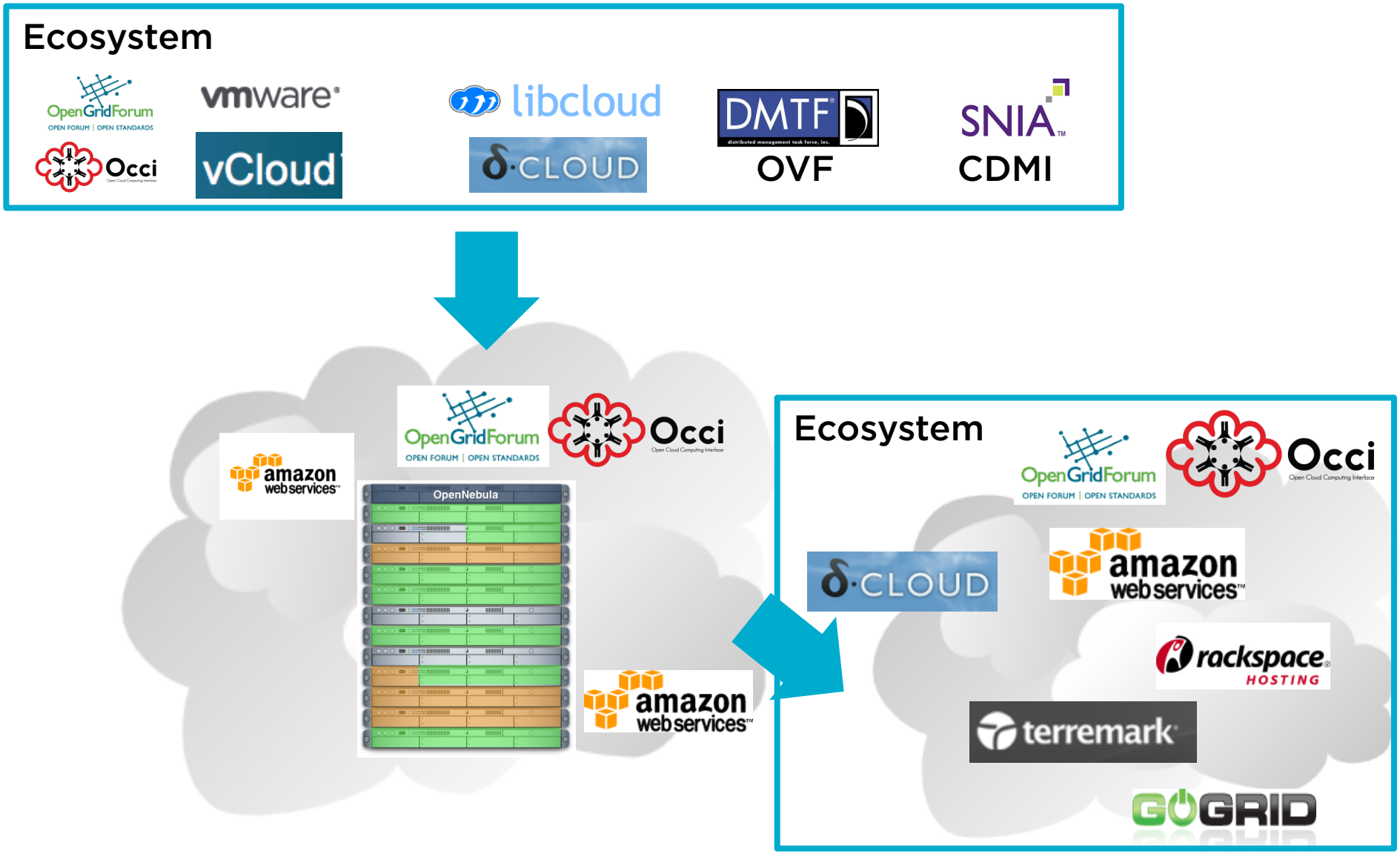


Interoperation

- Implement adaptors
- Use transformers

Challenges for Interoperability and Portability

Implementation of Common APIs and Adaptors



Questions?

We Will Be Happy to Answer Any Question

CloudPlan.org @imllorente

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