OpenNebula
Leading Innovation in Cloud Computing Management

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Acknowledgments

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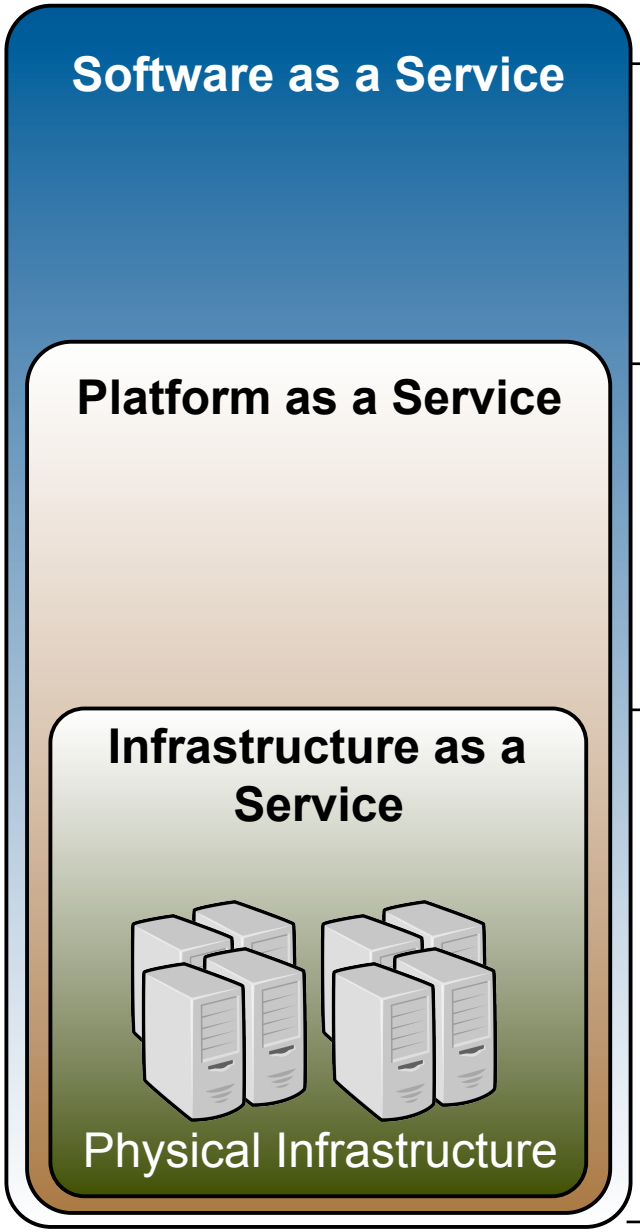
A Model for Delivering IT Capabilities

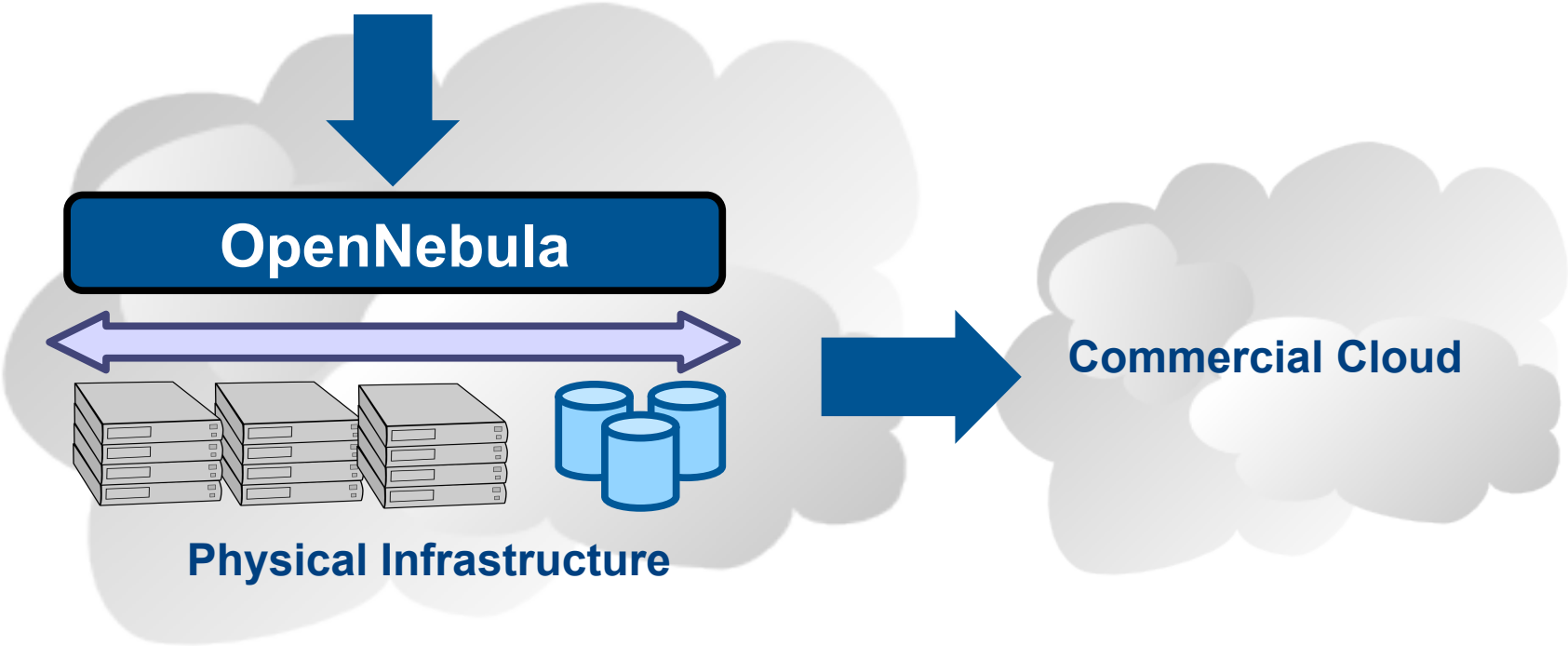


What	Who
On-demand access to any application	End-user **(does not care about hw or sw)**
Platform for building and delivering web applications	Developer **(no managing of the underlying hw & swlayers)**
***Raw* computer infrastructure**	System Administrator **(complete management of the computer infrastructure)**

IaaS Cloud Computing

Private Cloud Computing => A "Public Cloud behind the firewall"

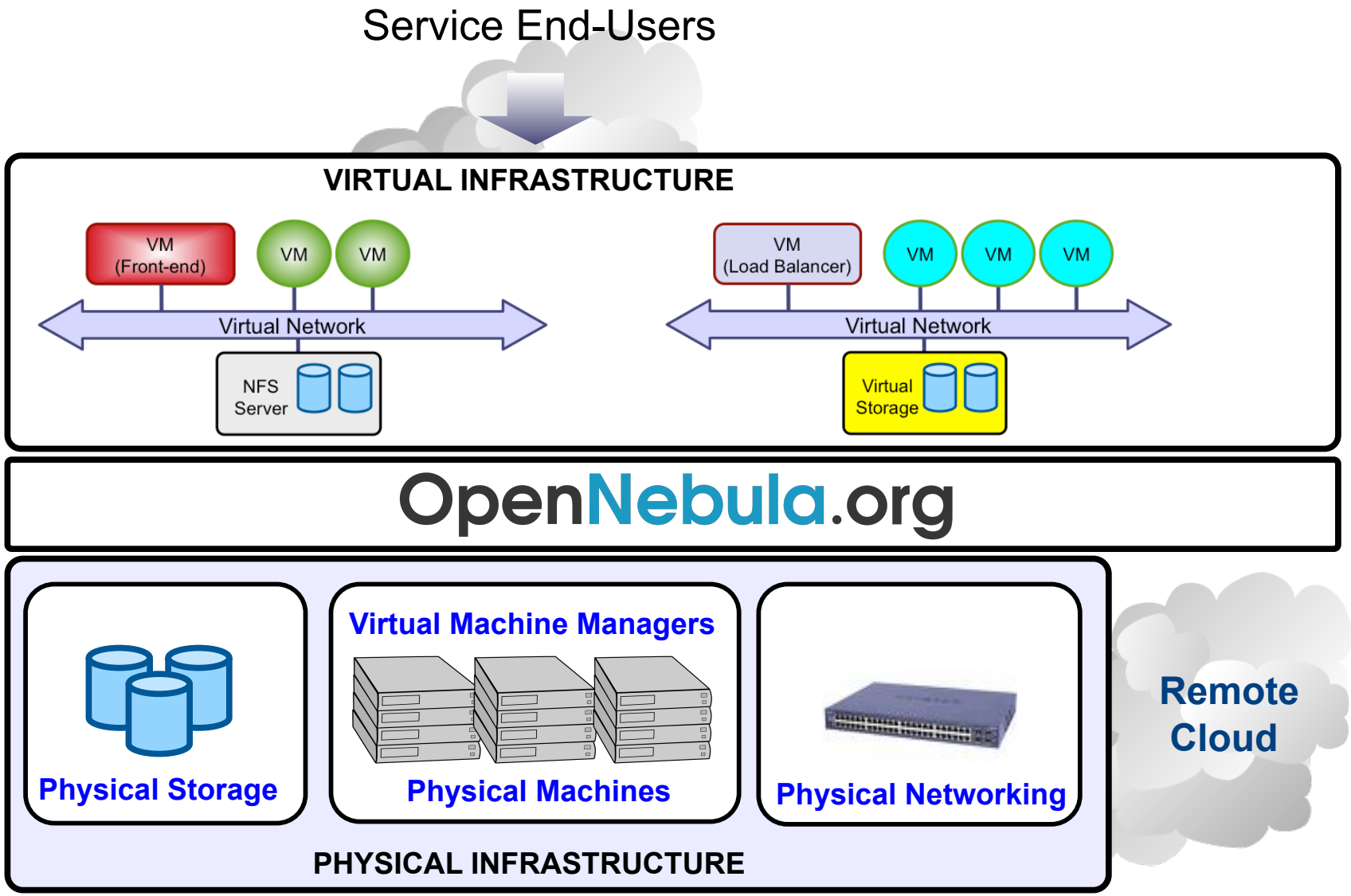
- Simplify and optimize internal operations
- Service flexibility and elasticity
- Higher utilization & operational savings
- Security concerns



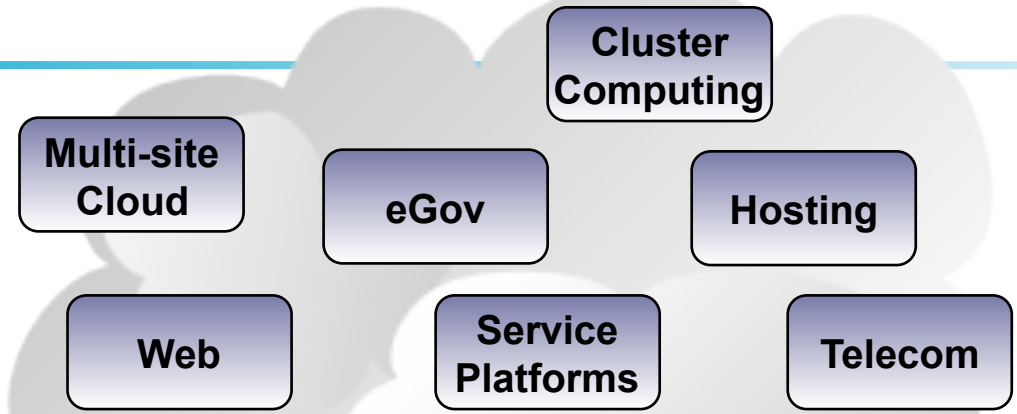
Hybrid Cloud Computing => Utility Computing dream made a reality!

- Supplement the capacity of the Private Cloud

The Data Center is the Computer



Contents



Innovation in Cloud Computing Management

Addressing the technology **challenges** in cloud computing management from **business use cases**

Building a Cloud Infrastructure

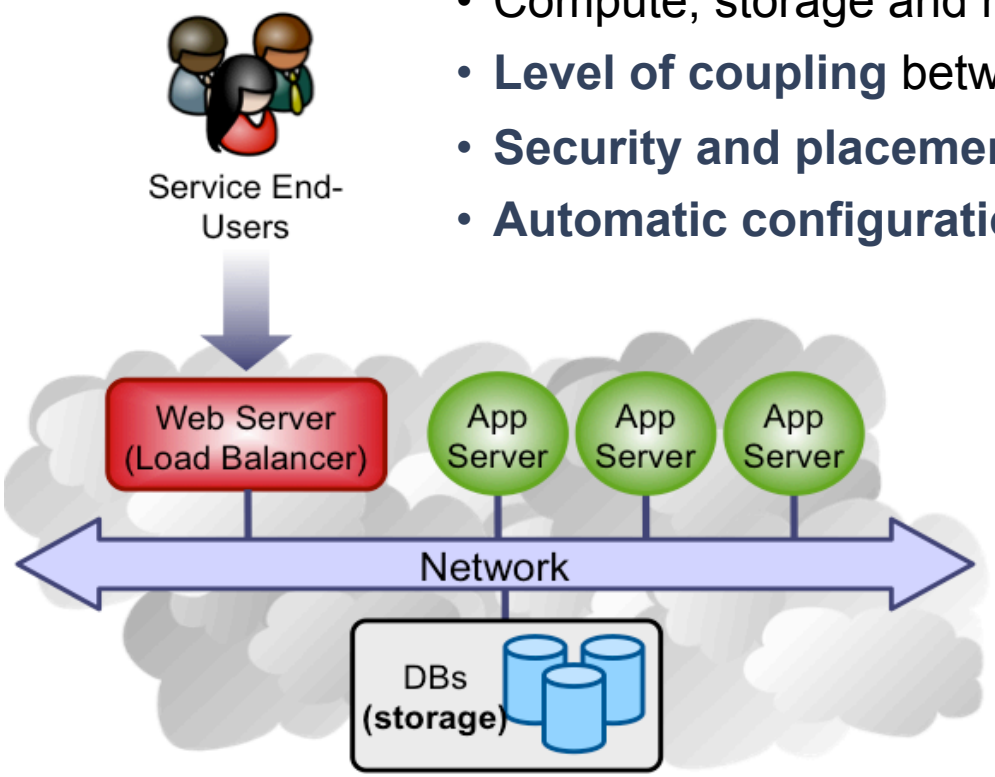
OpenNebula as **Cloud Enabling Technology**

Cloud Computing Case Studies

Examples of cloud infrastructures and large projects using **OpenNebula as cloud management tool**

Profile of Service Workloads

- Multi-tier service as **basic management entity**
  - Compute, storage and network **capacity**
  - **Level of coupling** between service instances
  - **Security and placement constraints**
  - **Automatic configuration** of service instances



Service as Groups of VMs

- Service **components** in VMs
- **Inter-connection** relationship
- **Placement** constraints

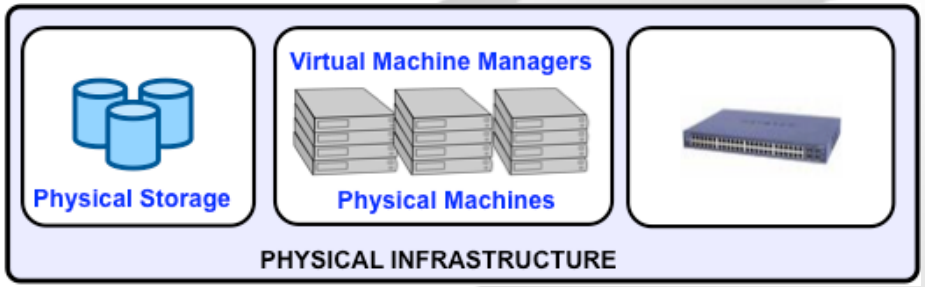
Cloud Interface

- Management of **VM images, VM instances,** and **virtual networks**
- Support for **standard and common interfaces** (OGF OCCI, Amazon EC2 and VMware vCloud)

Innovations: The Manager Perspective

Comprehensive Management of the Cloud

- **Administration interface** for the centralized management of the cloud
  - Physical infrastructure with hosts and clusters management
  - Users, and authorization and authentication
  - VM images, VM instances and virtual networks
- Definition of workload and resource-aware **allocation policies** such as energy efficiency, load balancing, affinity-aware, capacity reservation
- **Secure multi-tenancy** and isolation
- Site policy enforcement with user **quota management**
- **Accounting** to "charge" users based on usage or to guarantee fair share of resources among users
- **Highly reliable, efficient and scalable back-end**

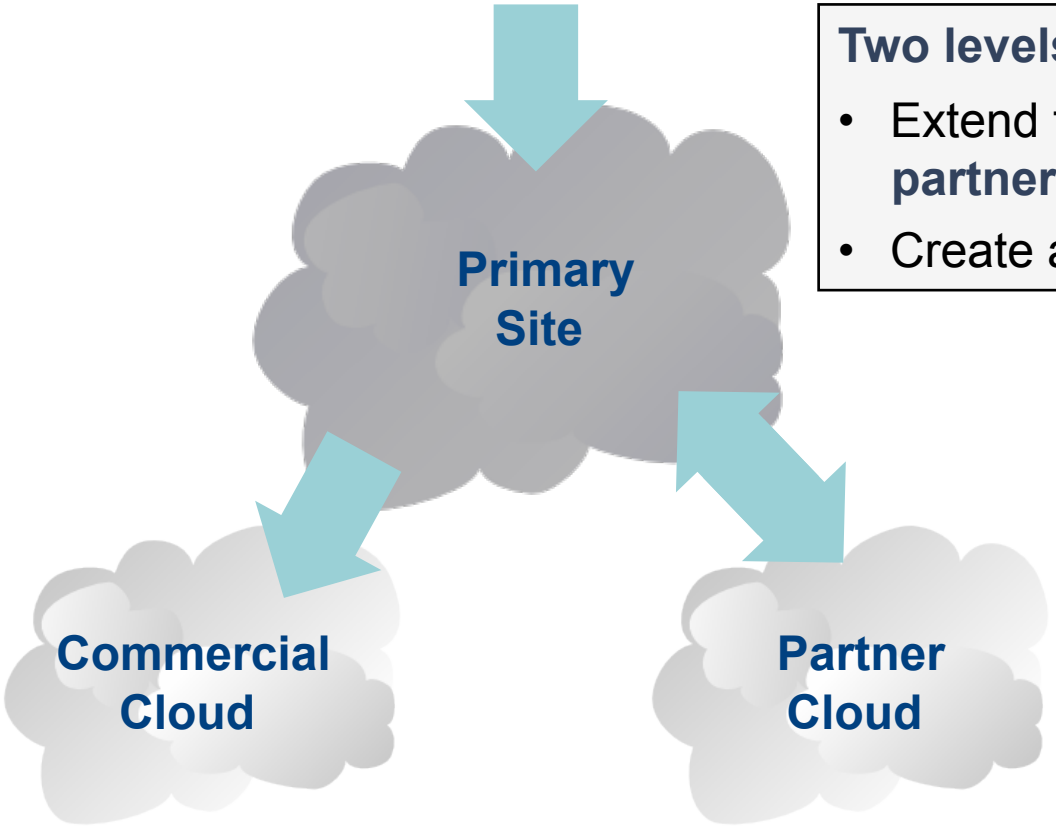


Scalable back-end

- Virtualization
- Storage
- Networking

Hybrid Cloud Computing and Federation

- ***Cloudbursting* at infrastructure layer**, fully transparent to users
- **Scale-out decisions are taken by infrastructure administrators** according to business policies



Two levels of Federation

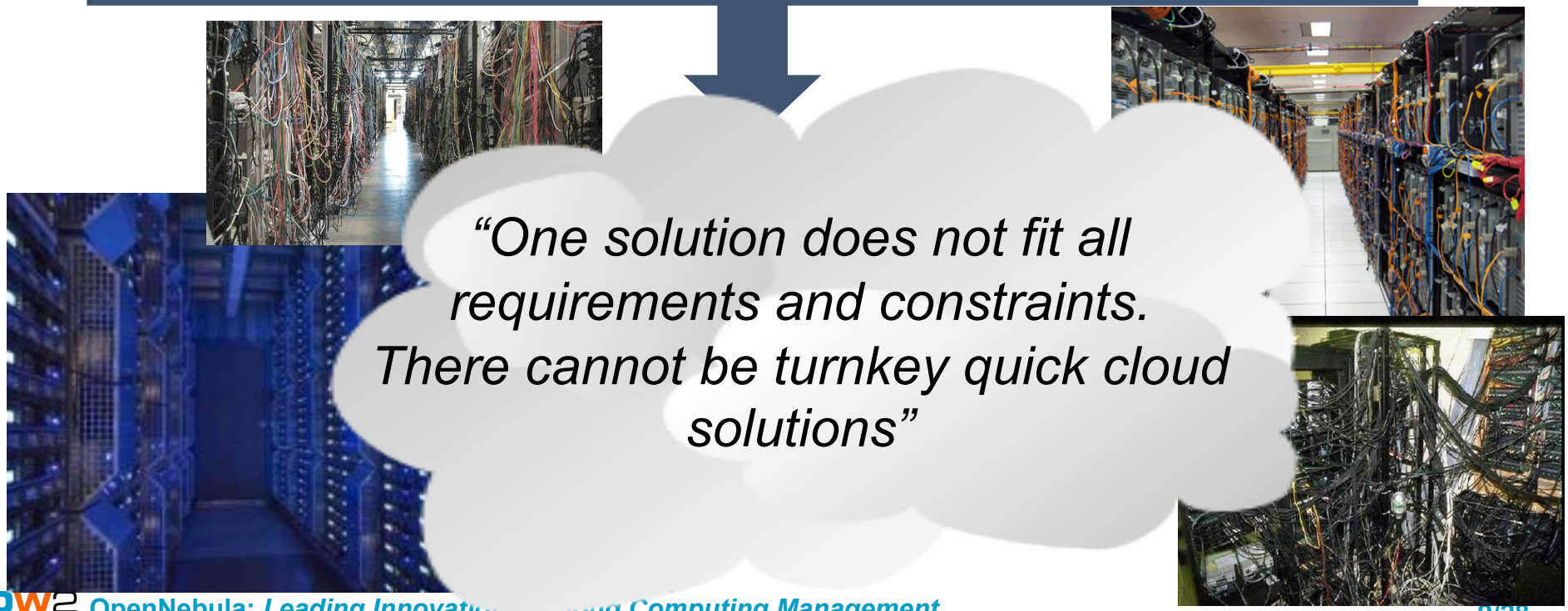
- Extend the private cloud using both **partner and commercial clouds**
- Create a **federation of clouds**

Innovations: The Integrator Perspective

- Cloud Computing is an **evolution of existing data centers**
- One solution can not fit all data-center and user requirements and constraints

Constraints from Existing Infrastructure and Processes

Requirements from Usage and Deployment Scenarios



Innovations: The Integrator Perspective

Open Architecture, Interfaces and Code

- **Integration** with existing **processes** and **management tools** in the data center
- Support any **security, monitoring**, **storage, networking and virtualization infrastructure service**
- **Integration with any product and service** in the virtualization/cloud ecosystem such as cloud providers, hypervisors, virtual image managers, service managers, management tools, schedulers…
- Support to **build any type of deployment**: private, public, hybrid and community clouds
- **Easy to extend** to support new functionality and **to embed** into other Cloud applications and platforms
- Based on **standards to** avoid vendor lock-in and to enable interoperability
- **Truly open-source**, not open core
- **Liberal open-source license**

Flagship International Projects in Cloud Computing

Result of many years of research and development in efficient and scalable management of virtual machines on large-scale distributed infrastructures.

Open-source Toolkit

Open platform for innovation to research the challenges that arise in **enterprise cloud management**, and **production-ready** tool in both academia and industry

- **Started in 2005, first release in march 2008, and ONE 2.0 just released**
- **Open-source** released under Apache v2.0, packaged for main Linux distributions
- Mailing lists for **best-effort support** and **open development framework**
- Development and roadmap definition **driven by the community and projects**
- Active and engaged **open community and ecosystem**
- > **3,000 downloads/month** (not including code repository and Ubuntu)
- Used in many **production environments**, distributed in **commercial solutions** and availability of **commercial professional support by C12G Labs**
- **Long-term sustainability** ensured by project funding and commercial sponsors

Building a Cloud: Why OpenNebula?

Capabilities for Cloud Management

Most advanced open-source toolkit offering unique features to administer the complexity of large-scale distributed infrastructures

Capabilities for Integration

Open, flexible and extensible architecture, interfaces and components that fit into any existing data center

Capabilities for Production Environments

Scalability and performance tested on very large-scale infrastructures consisting of thousands of cores, with the security and fault tolerance levels required in production

Leverage the Vibrant Cloud Ecosystems

Leverage the ecosystems being built around OpenNebula and the most common cloud interfaces, Amazon AWS, OGC OCCI and VMware vCloud

Fully Open Source Cloud Software

OpenNebula is NOT a feature or performance limited edition of an Enterprise version. OpenNebula is truly open, and not open core.

Building a Cloud: Interoperability

Openness

- Open architectures
- Open interfaces
- Open code

Adaptability

- Modular architectures

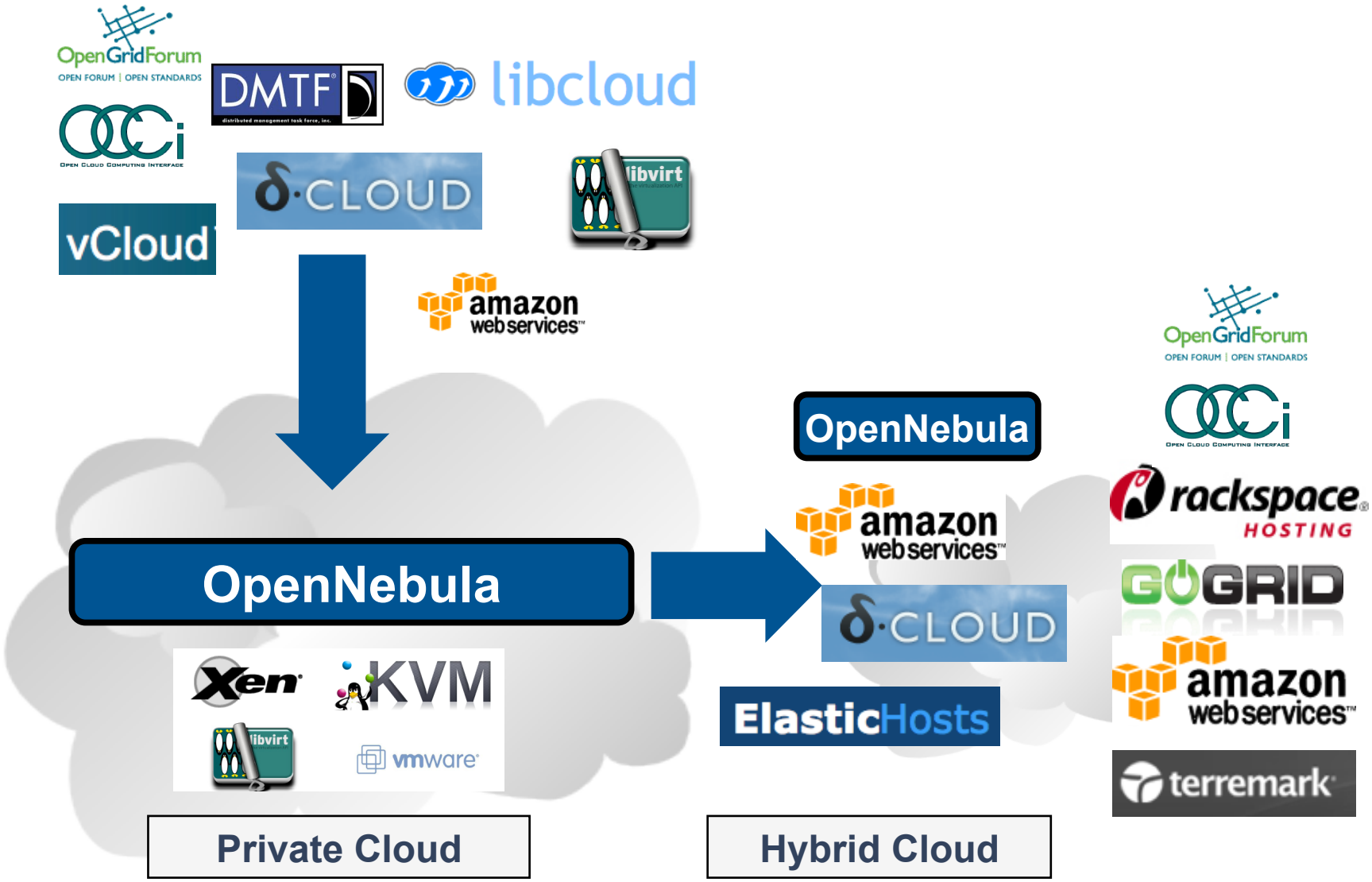
Standardization

- Use standards
- Implement standards

Portability

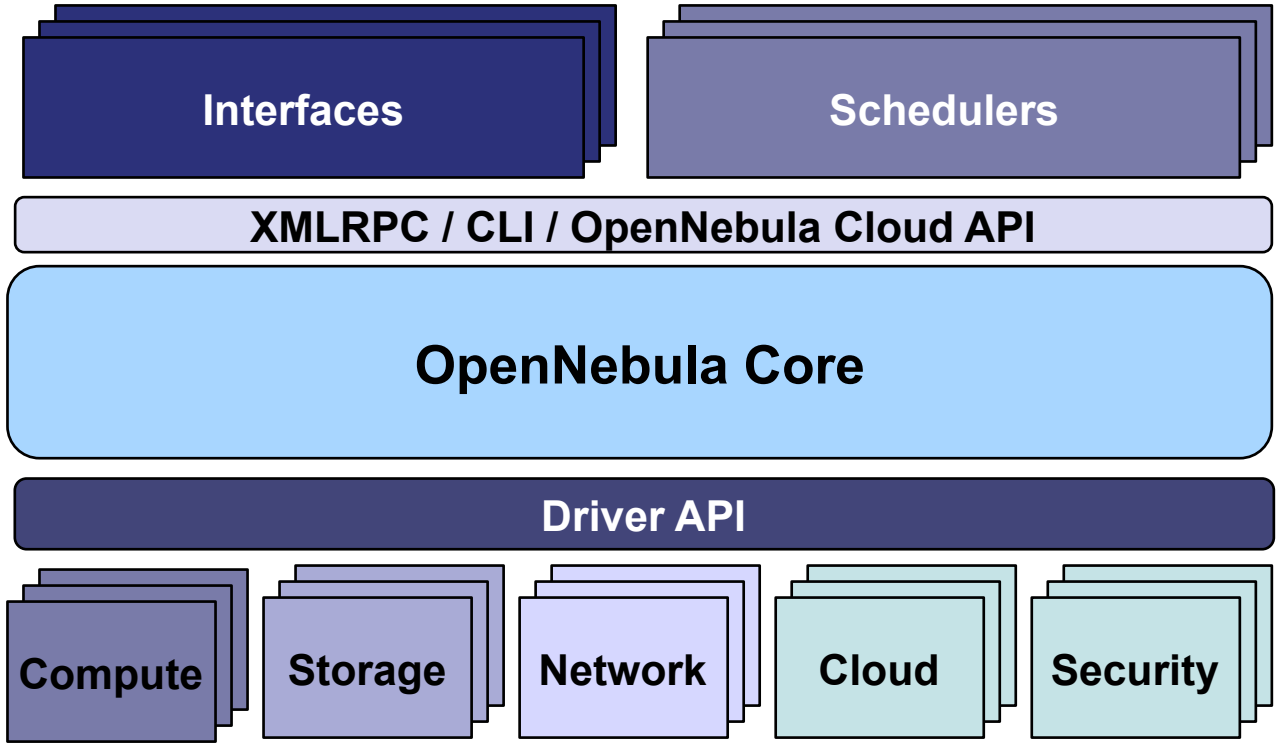
- It can be installed in any hardware and software

Building a Cloud: Interfaces and Standards

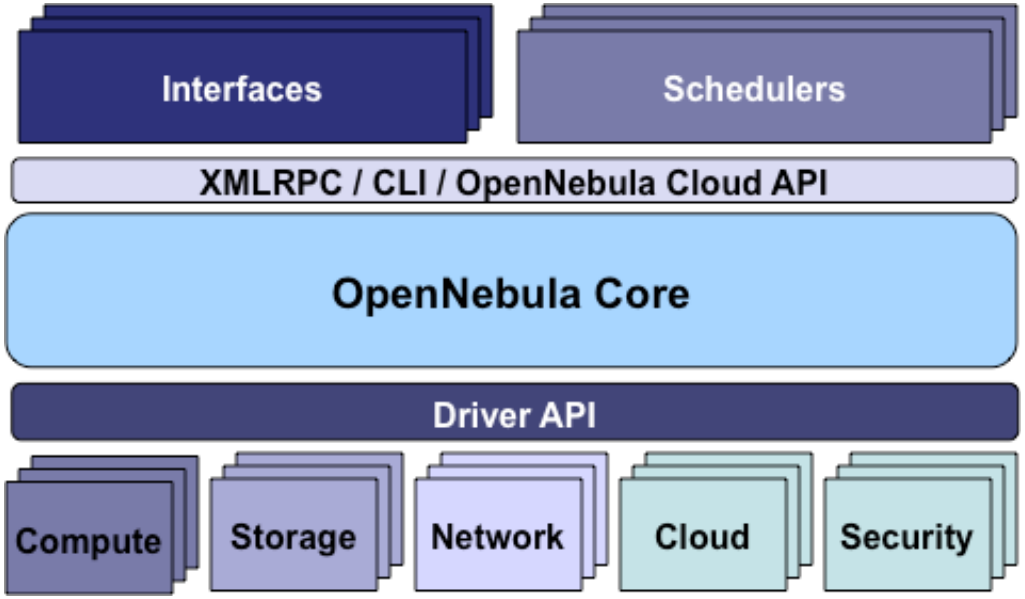


Building a Cloud: Adaptability

- Cloud Computing is an **evolution of existing data centers**
- One solution can not fit all data-center and user requirements and constraints
- Open, flexible and extensible architecture
- Provide basic components, but allow them to be easily replaceble by others



Building a Cloud: An Open Cloud Ecosystem



C12G LABS
OpenNebula Express

CloudBoot
Open Cloud Computing Tools
cloudscaling

scp-wave
CLEMSON UNIVERSITY

Cloud Case Studies: Enabling your Cloud

OpenNebula.org

Adopt Standards

OCCI Open Cloud Computing Interface

OpenGridForum Open Forum | Open Standards

DMTF distributed management task force, inc.

libvirt

Open Source Community

- Open architecture and interfaces
- Open code abd liberal license
- Open community and ecosystem

OpenNebula.org

Management Tool

Orion VM .com.au

esa esac european space astronomy centre

SURFNET

CERN

CESCA Centre de Supercomputació de Catalunya

CESGA

NIKHEF

Telefónica Telefónica Investigación y Desarrollo

sara Computing & Networking Services

CR 54

NCHC

中国移动通信 CHINA MOBILE

Innovation Tool

StratusLab

4CaaSt

RESERVOIR

BonFIRE

eGee Enabling Grids for E-sciencE

D-GRID

Cloud Case Studies: Deployment Models

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	• **Commercial cloud providers** • **Science public clouds** by ICT service centers to enable scientific and educational projects to experiment with cloud computing • **Special purpose clouds** with dedicated capabilities (HPC Clouds..)
Hybrid	Infrastructure is a composition of two or more clouds	• **Cloudbursting** to address peak demands • **Cloud Federation** to share infrastructure with partners • **Cloud Aggregation** to provide a larger resource infrastructure

Cloud Case Studies: Computing Provider

Private Cloud to Support Grid Site

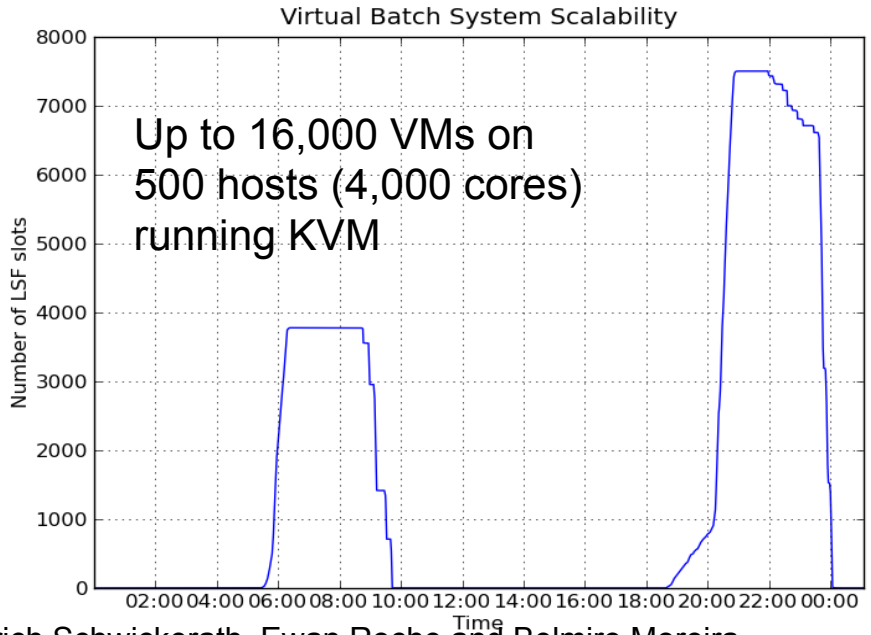
- **Goal**: Execution of virtualized Grid sites in D-Grid and EGEE
- **Details**: The D-Grid Resource Center Ruhr (DGRZR) runs an OpenNebula private cloud on 248 blades and 1,984 cores with Xen

Public HPC Cloud

- **Goal**: OpenNebula is used to support the execution of virtual clusters and HPC applications
- **Details**: SARA High Performance Computing Center uses OpenNebula in its new HPC Cloud service

Cloud Case Studies: Computing Provider

- **Goal:** Easier management and new computing models in the batch farm
- **Example of Integration with Existing Infrastructure Environment**
  - **Configuration Management**: Quattor with lifecycle management and “self -notification” in OpenNebula
  - **Network Management**: Adapted to address network infrastructure requirements regarding fixed IP/MAC leases in each box
  - **Storage Management**: New LVM transfer scripts and a very fast parallel scp to push images to all the hosts

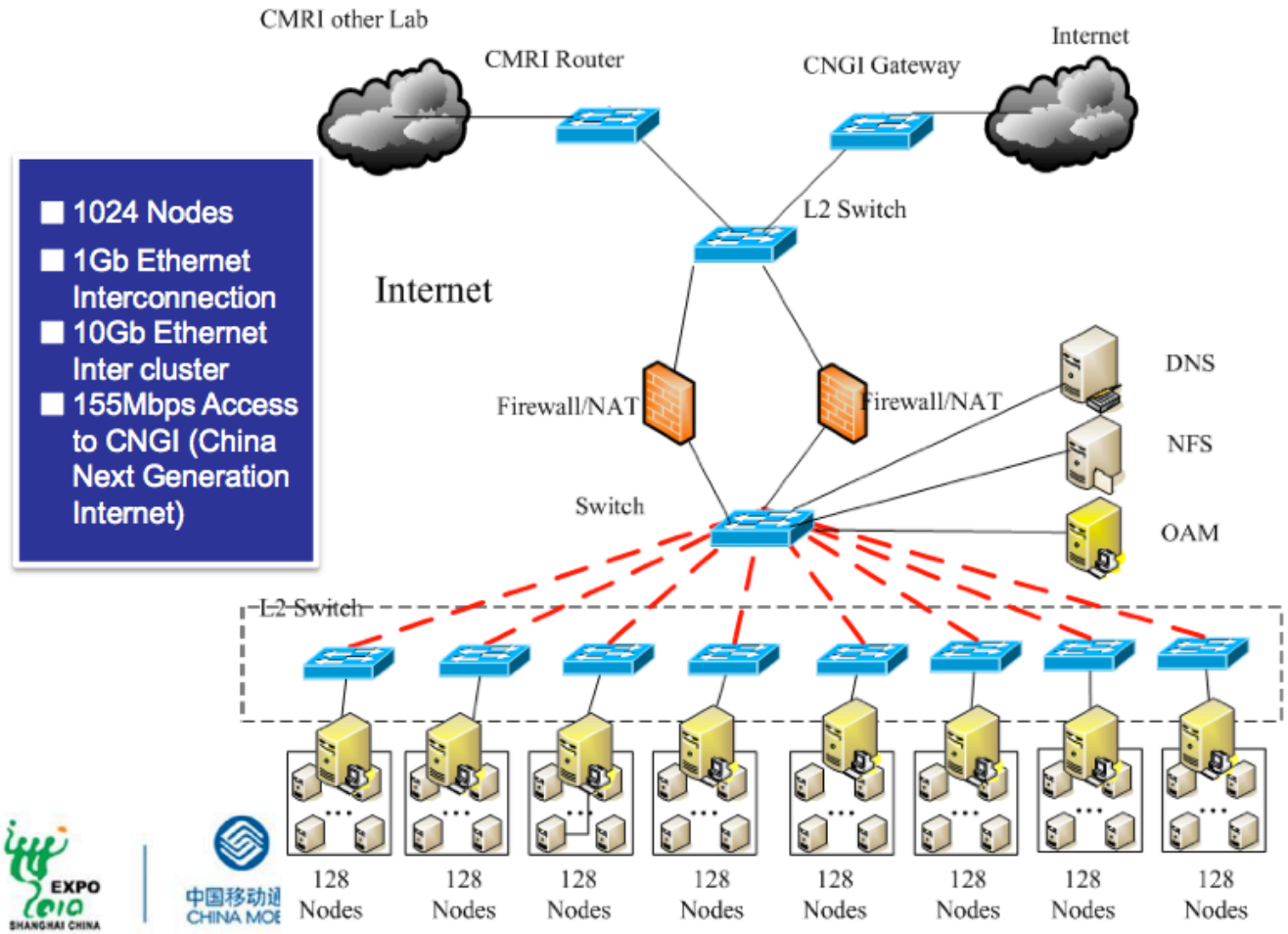


Source: CERN IT-PES/PS Group: Sebastien Goasguen, Ulrich Schwickerath, Ewan Roche and Belmiro Moreira

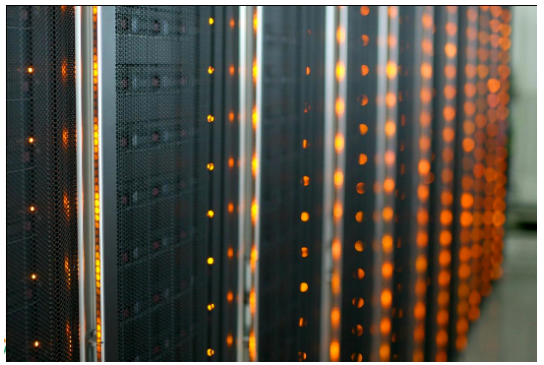
Cloud Case Studies: Telecom Provider

- **Goal:** Meet the growing demands for high performance, low cost, high scalability, high reliability of China Mobile IT Infrastructure (computing, storage); and the demands of China Mobile to deliver Internet business and services

中國移動有限公司 CHINA MOBILE LIMITED



- **Details**: 4,096 cores, Xen, Ganglia, and Hadoop



Source: China Mobile's Presentation at OpenCirrus Meeeting

Cloud Case Studies: Tool for Innovation

RESERVOIR

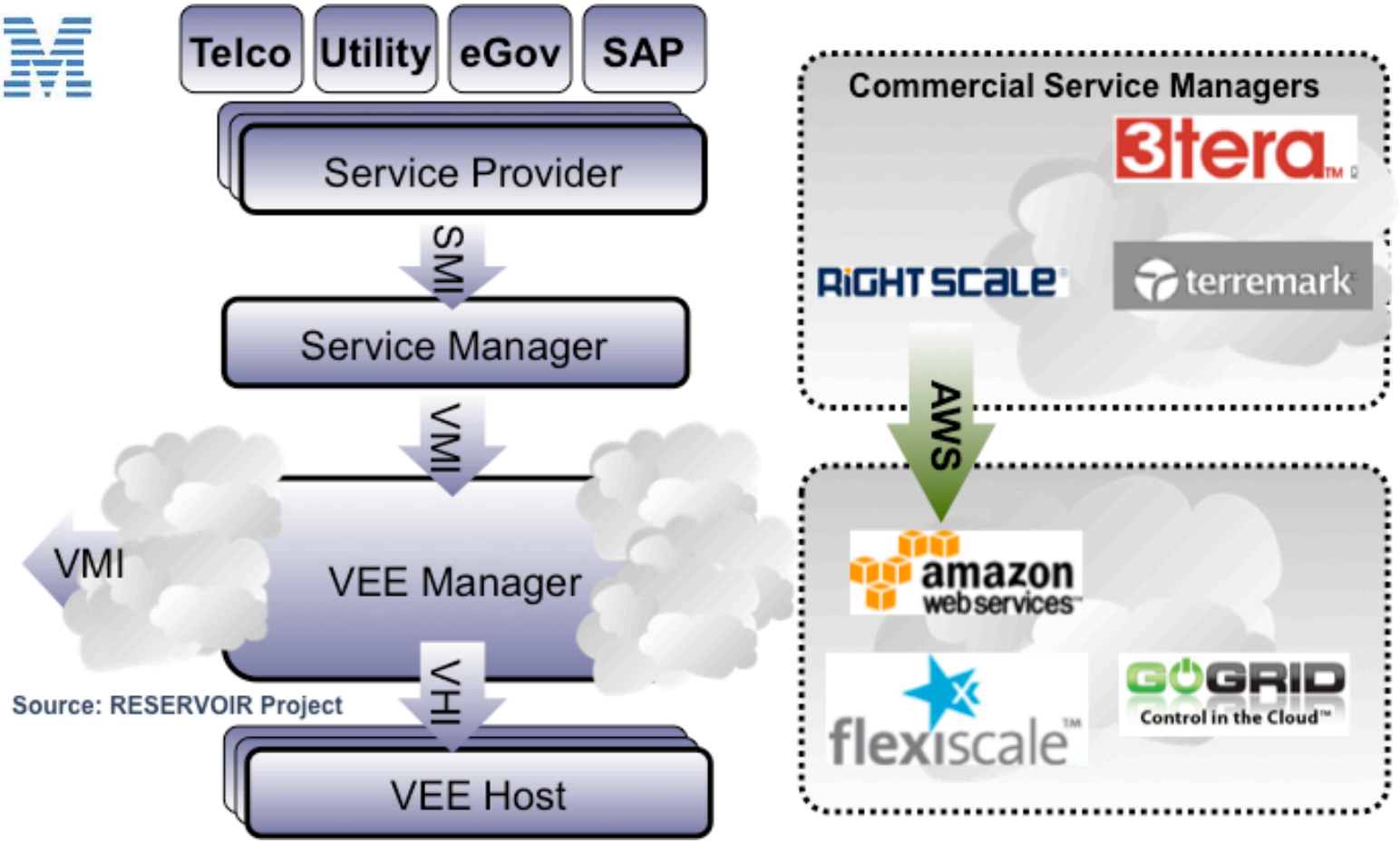
Agreement 215605 (2008-2011)
Service and Sw Architectures and Infrastructures

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



Cloud Case Studies: Tool for Innovation

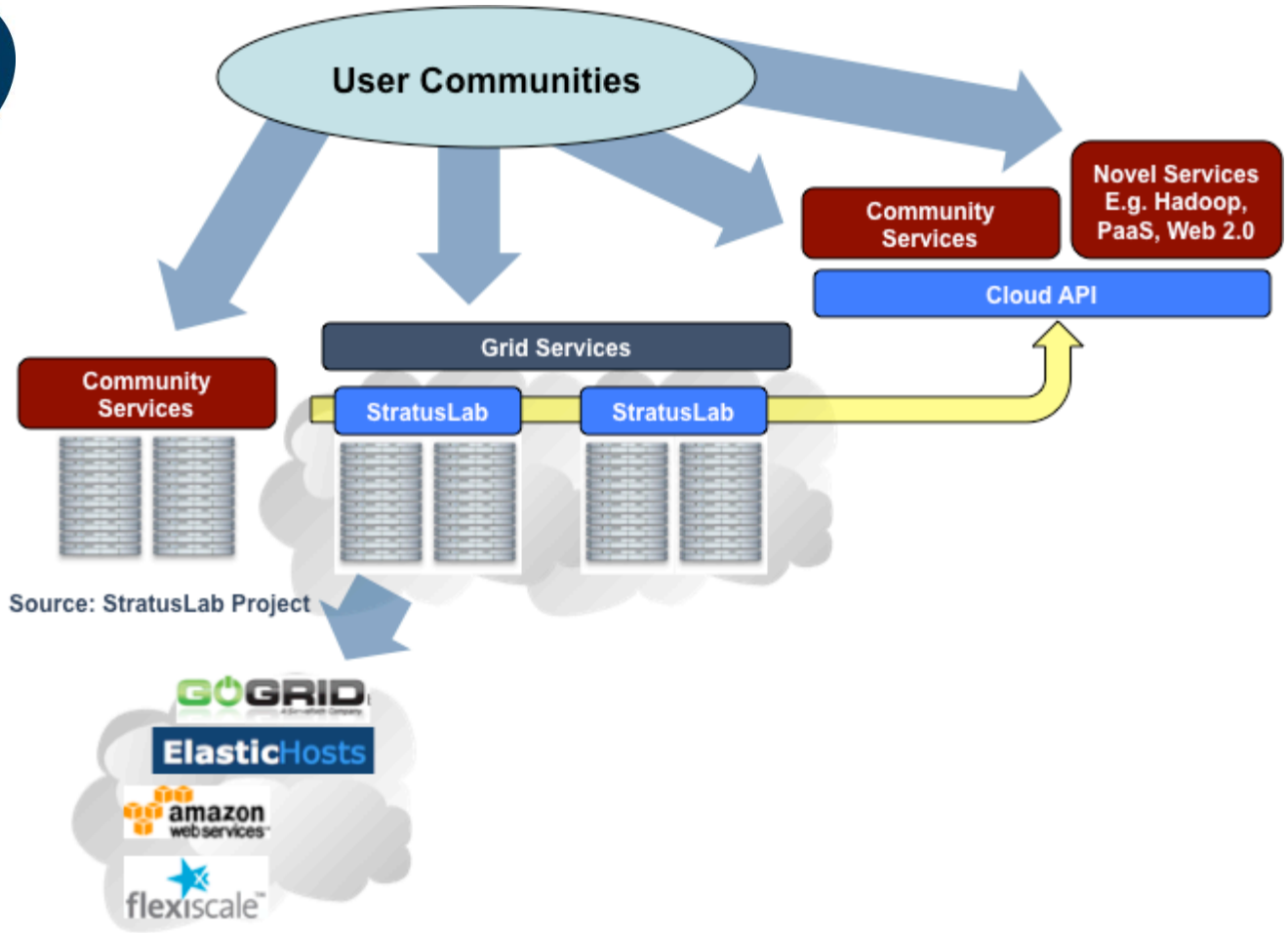
StratusLab

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

Enhancing Grid Infrastructures with Cloud Computing

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

www.StratusLab.eu



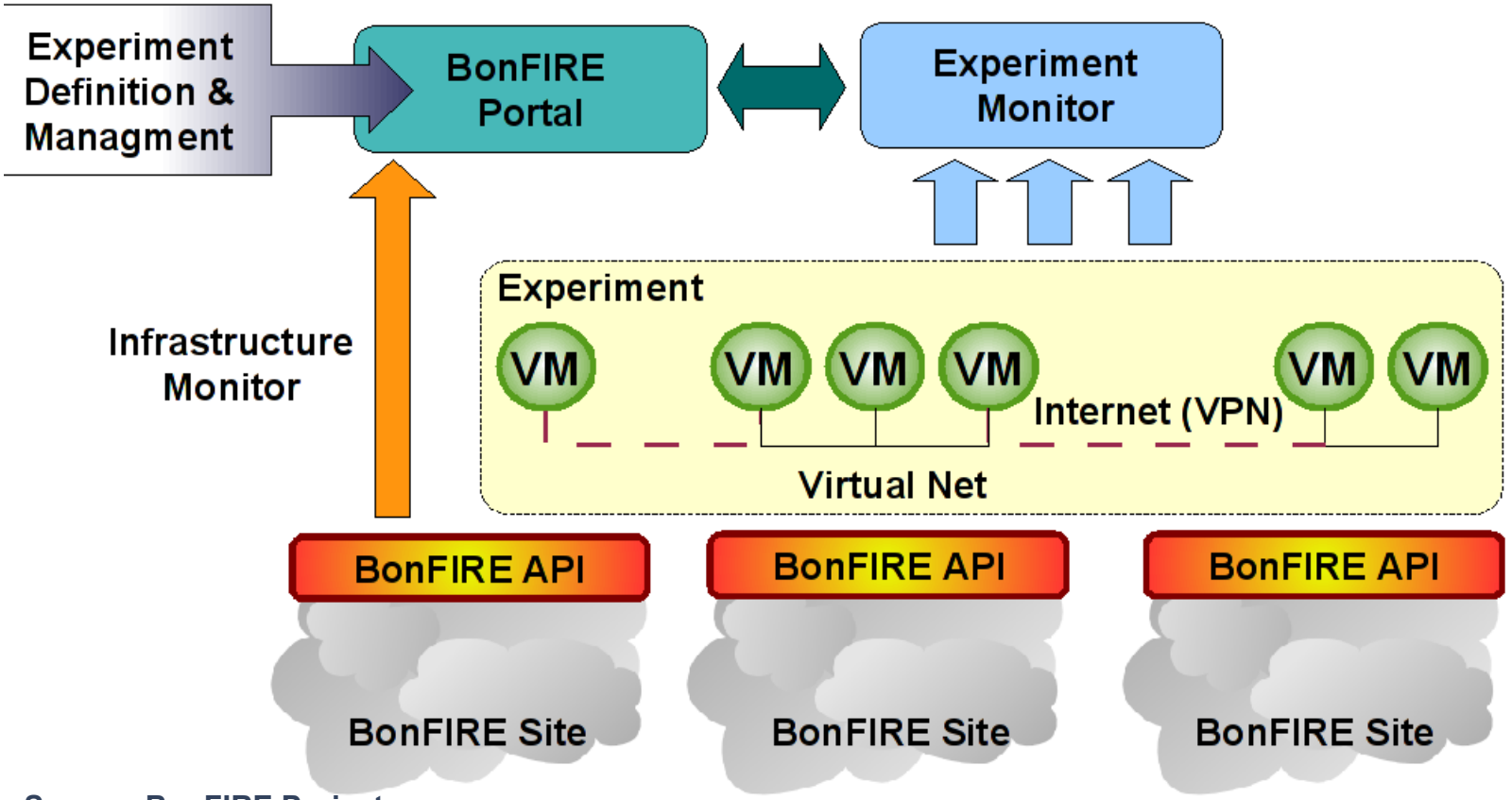
Agreement 257386 (2010-2013)
New Infrastructure Paradigms and Experimental Facilities

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

Atos Origin

www.BonFIRE-Project.eu



Source: BonFIRE Project

Cloud Case Studies: Tool for Innovation

4CaaSt

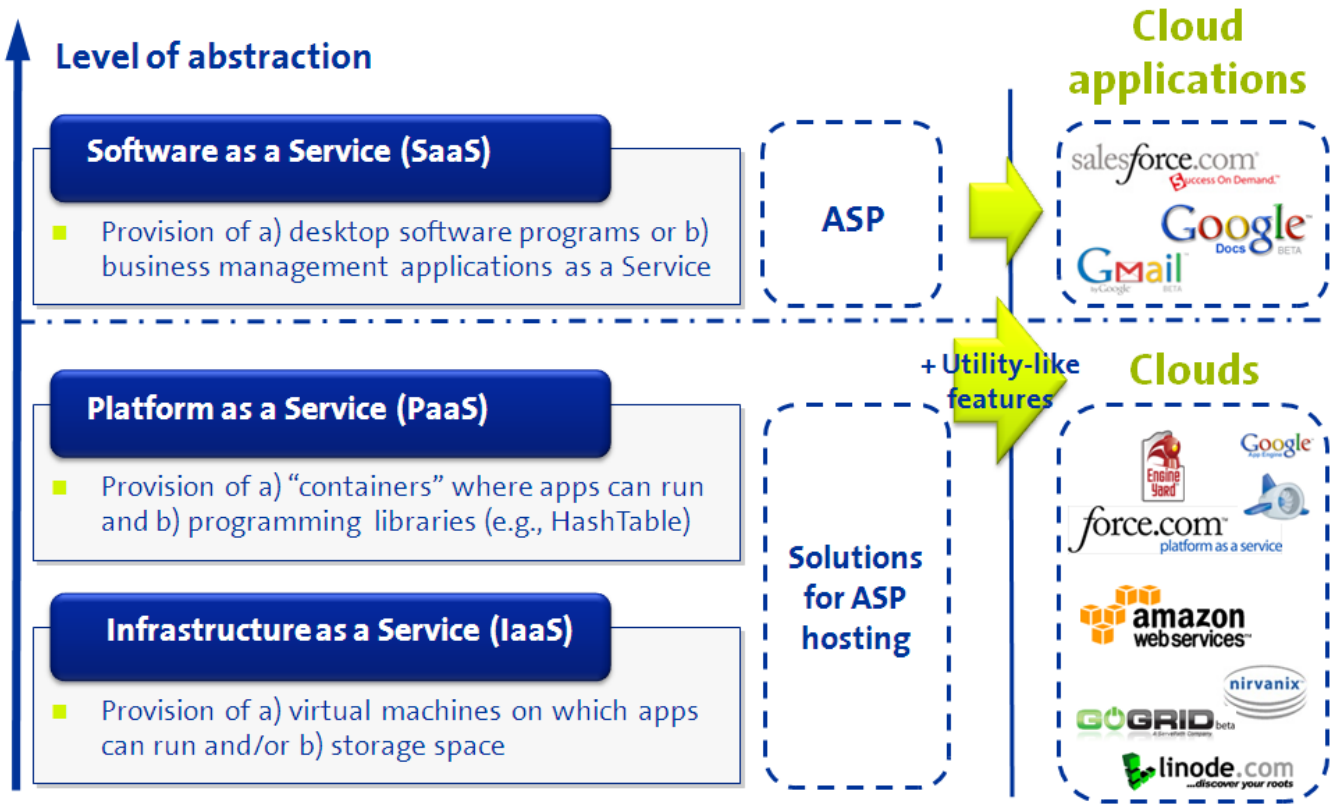
Agreement 258862 (2010-2013)
Service and Sw Architectures and Infrastructures

Telefónica Investigación y Desarrollo

4caast.morfeo-project.org

Building the PaaS Cloud of the Future

- Create an advanced PaaS Cloud platform which supports the optimized and elastic hosting of Internet-scale multi-tier applications

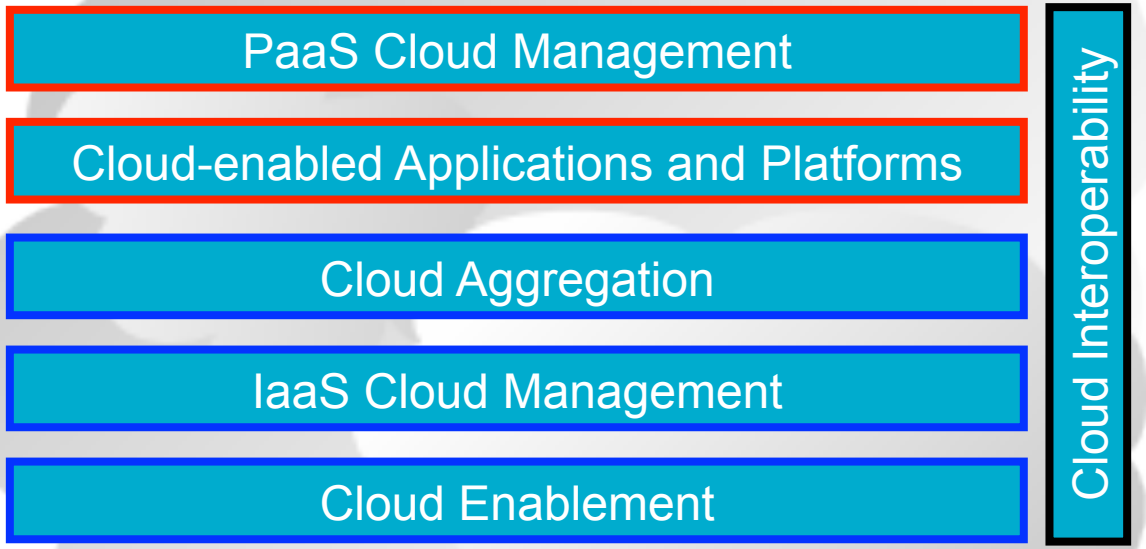


Source: 4CaaSt Project

Outlook – The Data Center is the Computer

IT Resources will be the Next Utility

- **Future enterprise datacenters will operate like hybrid Clouds** combining local with public Cloud-based infrastructure to enable highly scalable hosting environments
- **Public Clouds will be supported by a network of geographically distributed datacenters** for high availability, end-user service proximity, legal and policy issues…
- **Growing number of domain specific and regional Cloud providers** implementing a utility computing business model



Involvement in the OpenNebula Community

Use the Technology and Give us Feedback

- Support through several mailing lists or describe your use case in our blog
- Report bugs and make feature requests

Spread our Word

- Spread the word about OpenNebula and open source cloud computing

Contribute to the Development

- Open development infrastructure
- Provide patches for bug fixes or enhancements

Contribute to the Quickly Growing Ecosystem

- Submit a new tool or extension to the OpenNebula ecosystem

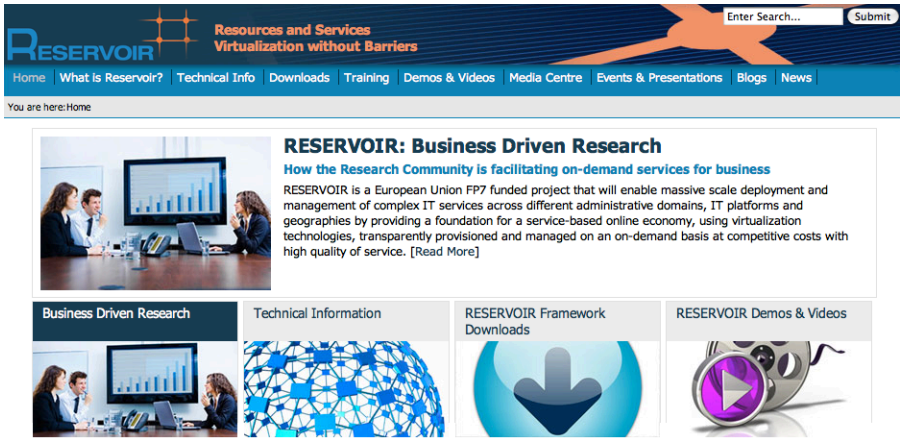
Sponsor the Community

- Provide funds or resources to support development or to organize events

Innovation Alliance

- Collaboration in open-source and innovation in cloud computing management

More info, downloads, mailing lists at



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- B. Sotomayor, R. S. Montero, I. M. Llorente and I. Foster, *"Virtual Infrastructure Management in Private and Hybrid Clouds"*, **IEEE Internet Computing**, September/ October 2009 (vol. 13 no. 5)

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