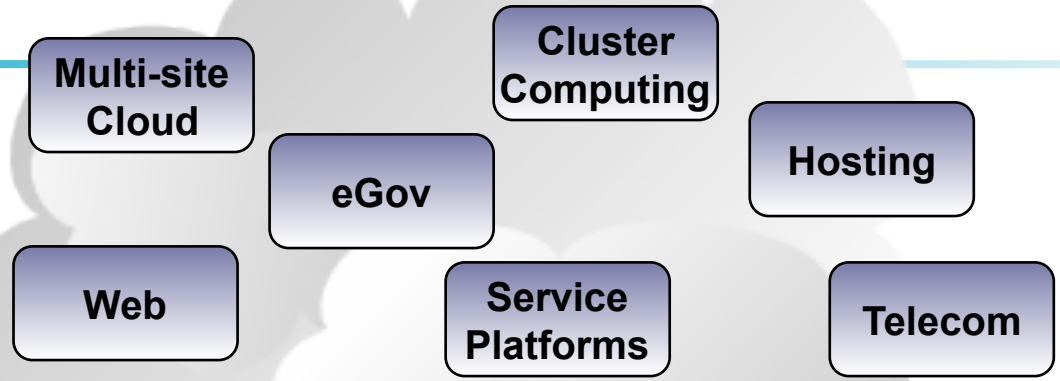
ISC Cloud 2010
Frankfurt, Germany
October 29th, 2010

OpenNebula
Cloud Case Studies

Ignacio M. Llorente
DSA-Research.org
Distributed Systems Architecture Research Group
Universidad Complutense de Madrid

Acknowledgments

The research leading to these results has received funding from the European Union's Seventh Framework Programme ([FP7/2007-2013]) under grant agreement n° 215605 (RESERVOIR Project)



Cloud as an Evolution of the Data Center

Addressing the constraints of your **infrastructure environment** and the requirements of your **business use cases**

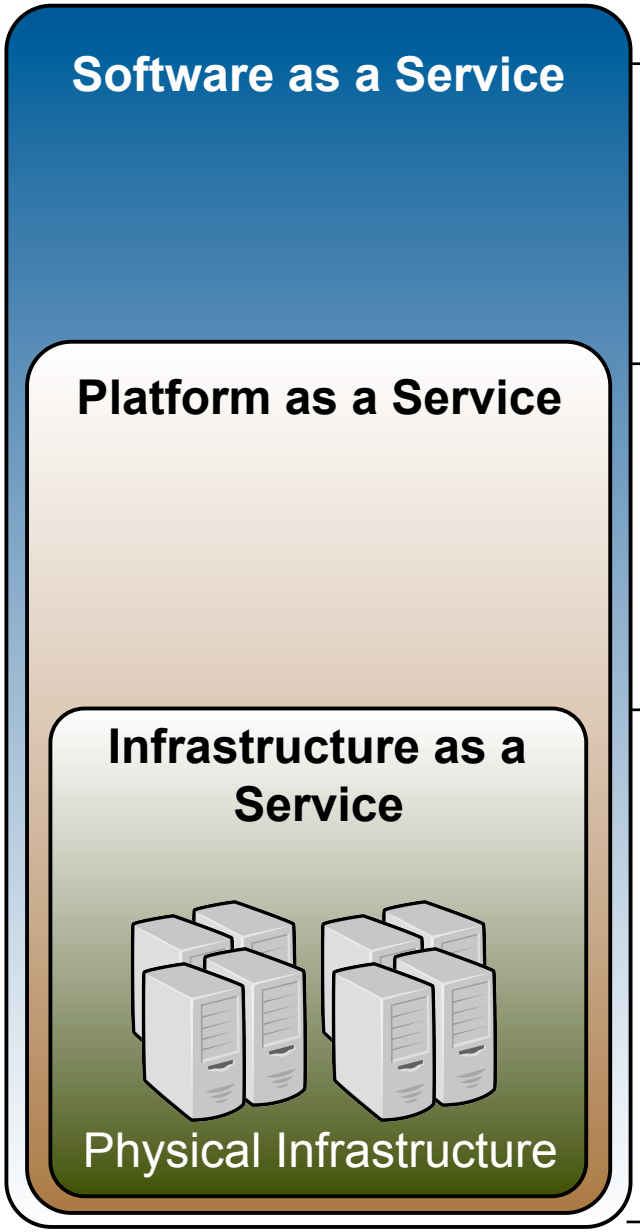
OpenNebula Toolkit

Fully open source, thoroughly **tested**, **flexible**, **extensible** and with excellent **performance** and **scalability** to manage tens of thousands of VMs

Cloud Computing Case Studies

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

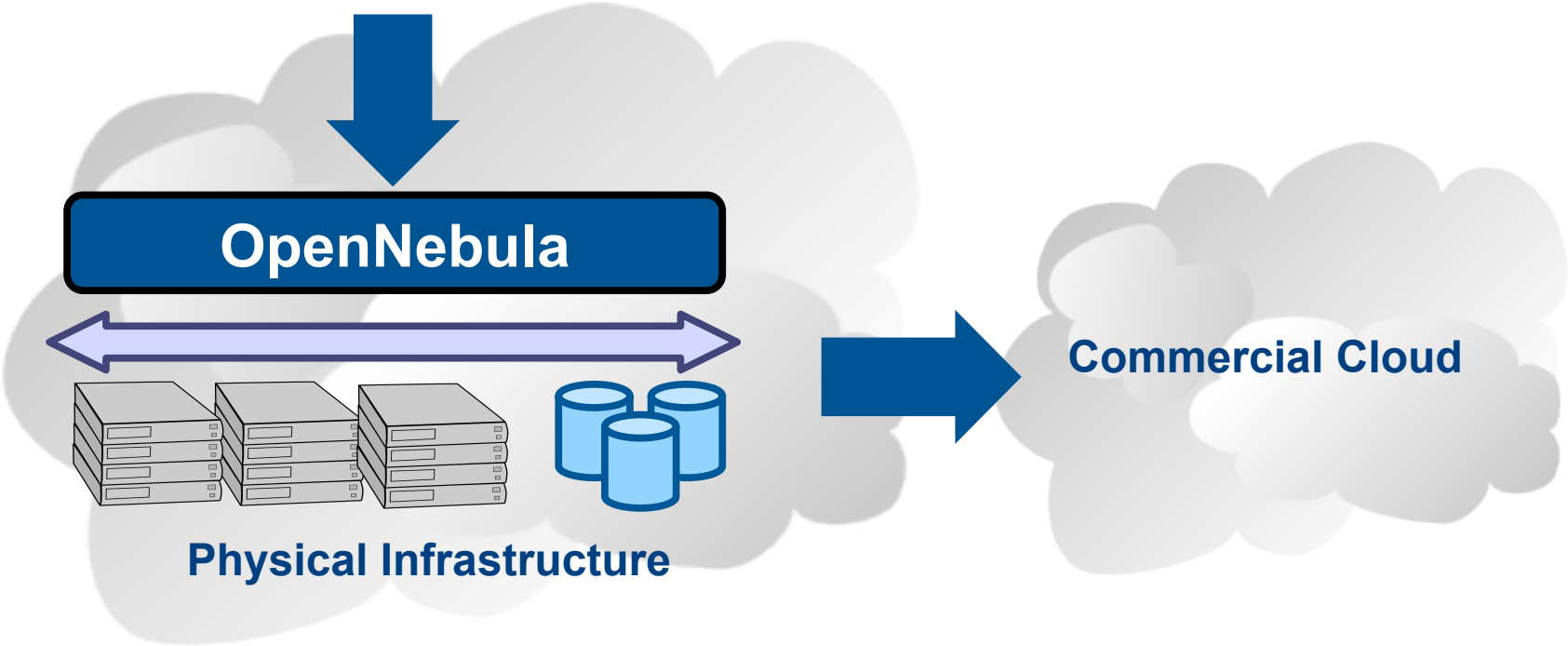
A Model for Delivering IT Capabilities



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)**

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

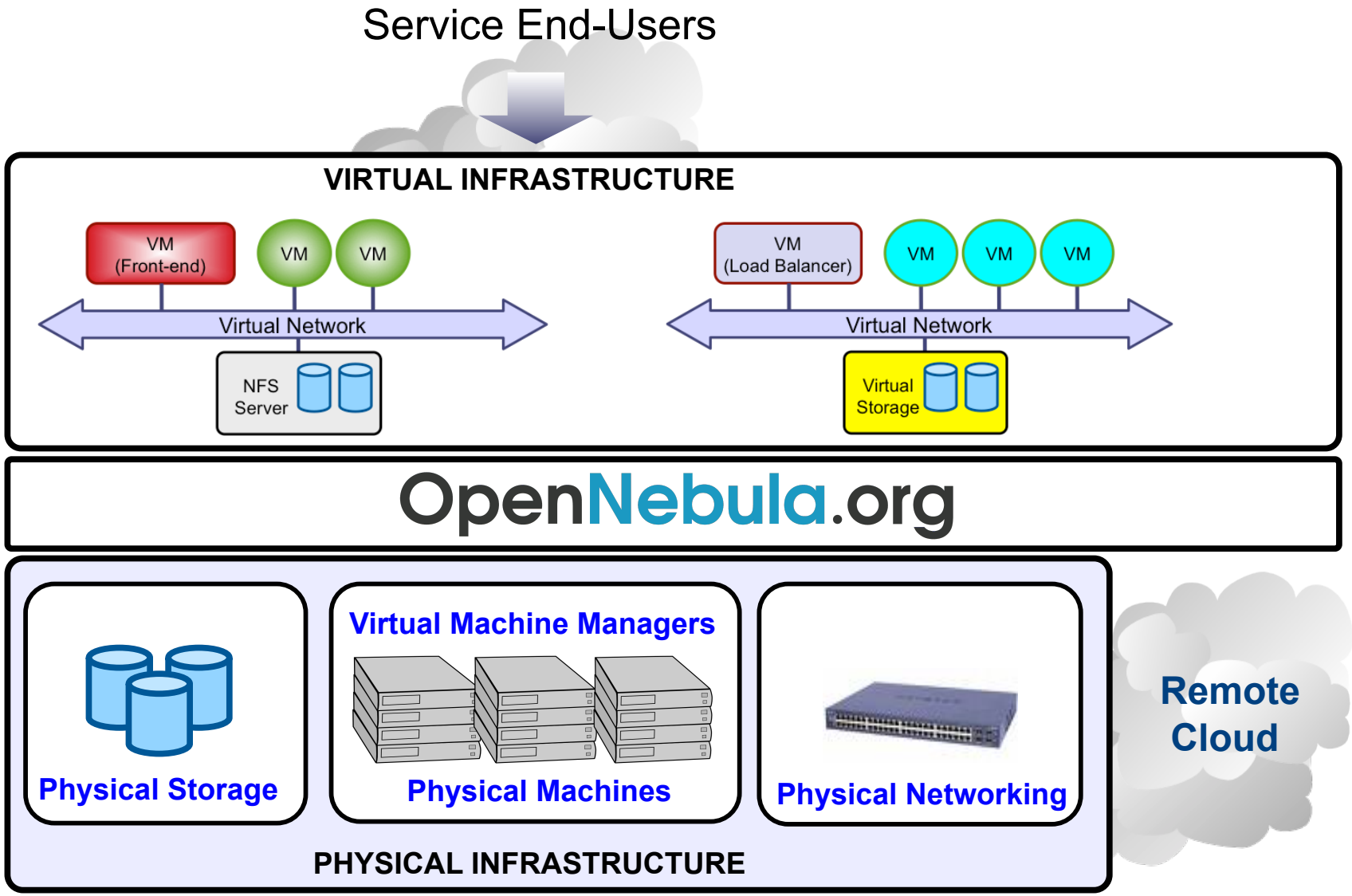
- Simplify and optimize internal operations
- Service flexibility and elasticity
- Higher utilization & operational savings
- Security concerns



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

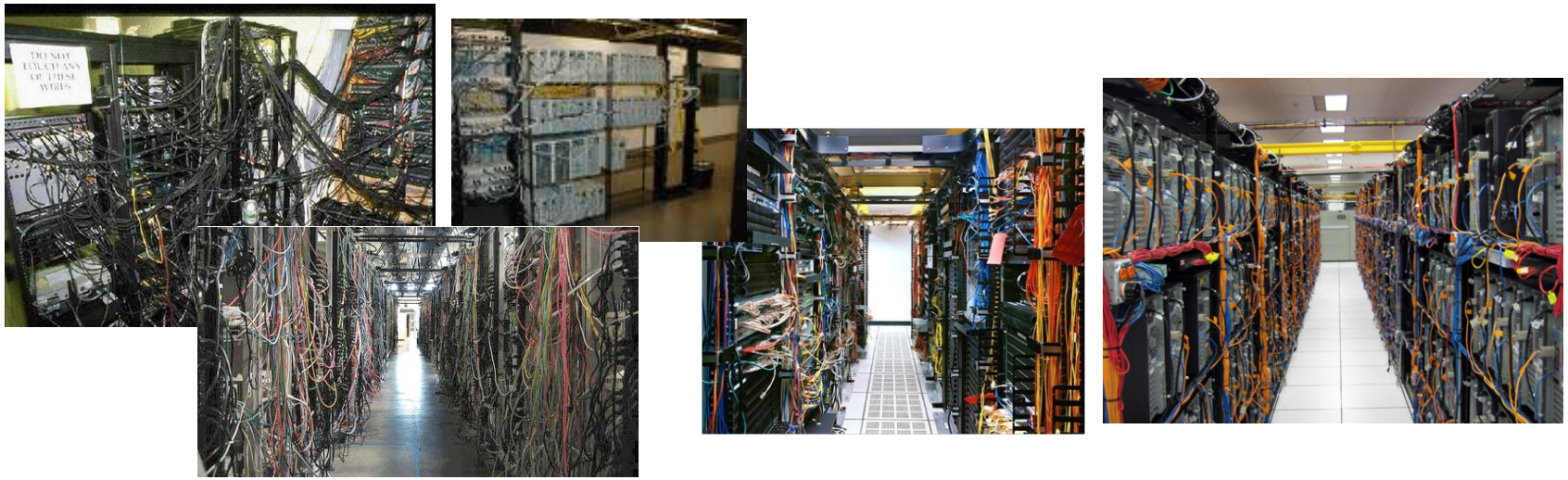
- Supplement the capacity of the Private Cloud

Cloud Manager to Orchestrate the Complexity of a Datacenter

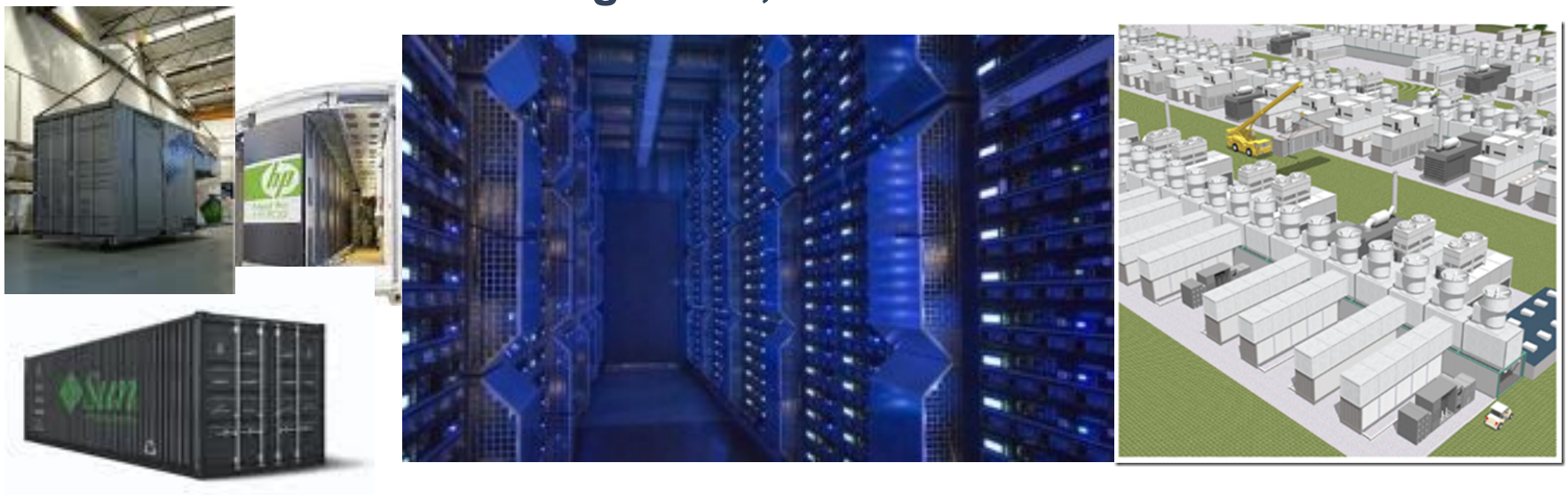


An Evolution of the Data Center

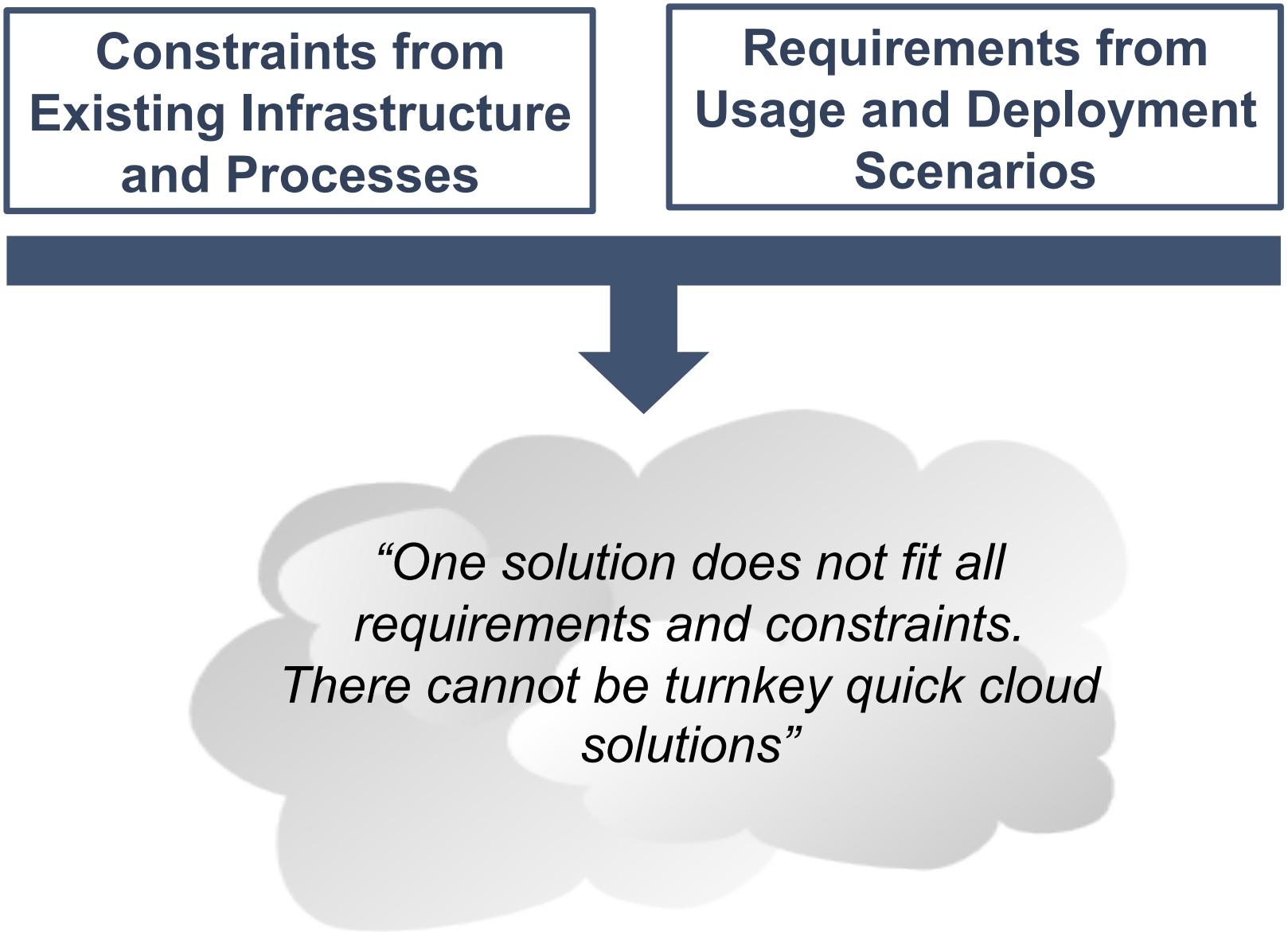
From Heterogeneous and Ugly Data Centers…



… To Homogenous, Modular and Beautiful Data Center



An Evolution of the Data Center



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 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

Business Use Cases from Leading Companies

Feature	Requirements of Enterprise Clouds
Workload Profile	Management of multi-tier services with security levels, placement constraints and automatic configuration
Administration Interface	Complete CLI to manage VMs, images, users, accounting, clusters, virtual networks, physical resources…
Cloud Interfaces	Support standard and most popular cloud interfaces
Cloudbursting	Combine local capacity with remote cloud resources
Adaptability	APIs and modular architecture to integrate with existing processes and management tools in the data center
Scalability	Efficient Management of hundreds of thousands of VMs and multiple physical clusters
Stability & Robustness	Production-ready thoroughly tested and mature technology
Security	Multi-tenancy, isolation and integration with security mechanisms and policies
Openness and Standards	Open interfaces and architecture, fully open-source code, and adopt and implement standards
Interoperability and Portability	Provide with choice across most popular cloud interfaces, hypervisors and public clouds and with a flexible software that can be installed in any hardware and software combination
Cloud Administration	Monitoring, accounting and logging
Site Policy Enforcement	Scheduling and user quota management

The OpenNebula Toolkit: 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

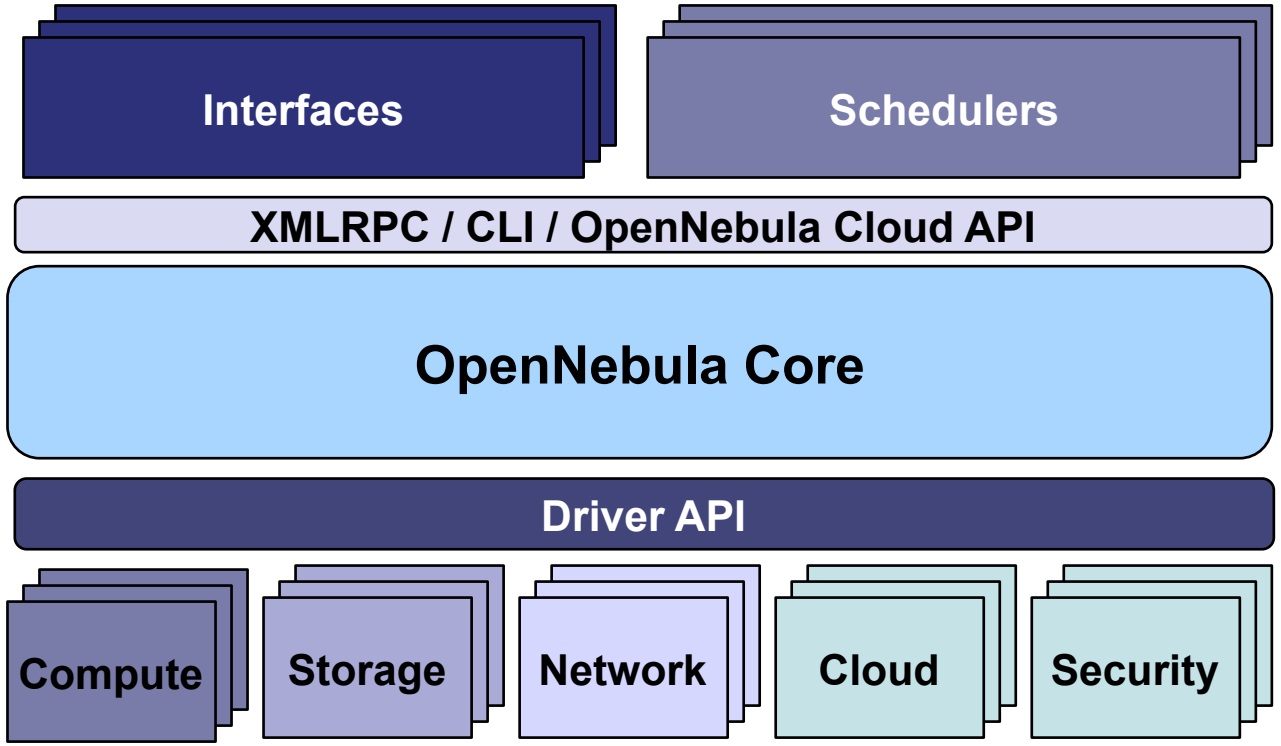
Fully Open Source Cloud Software

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

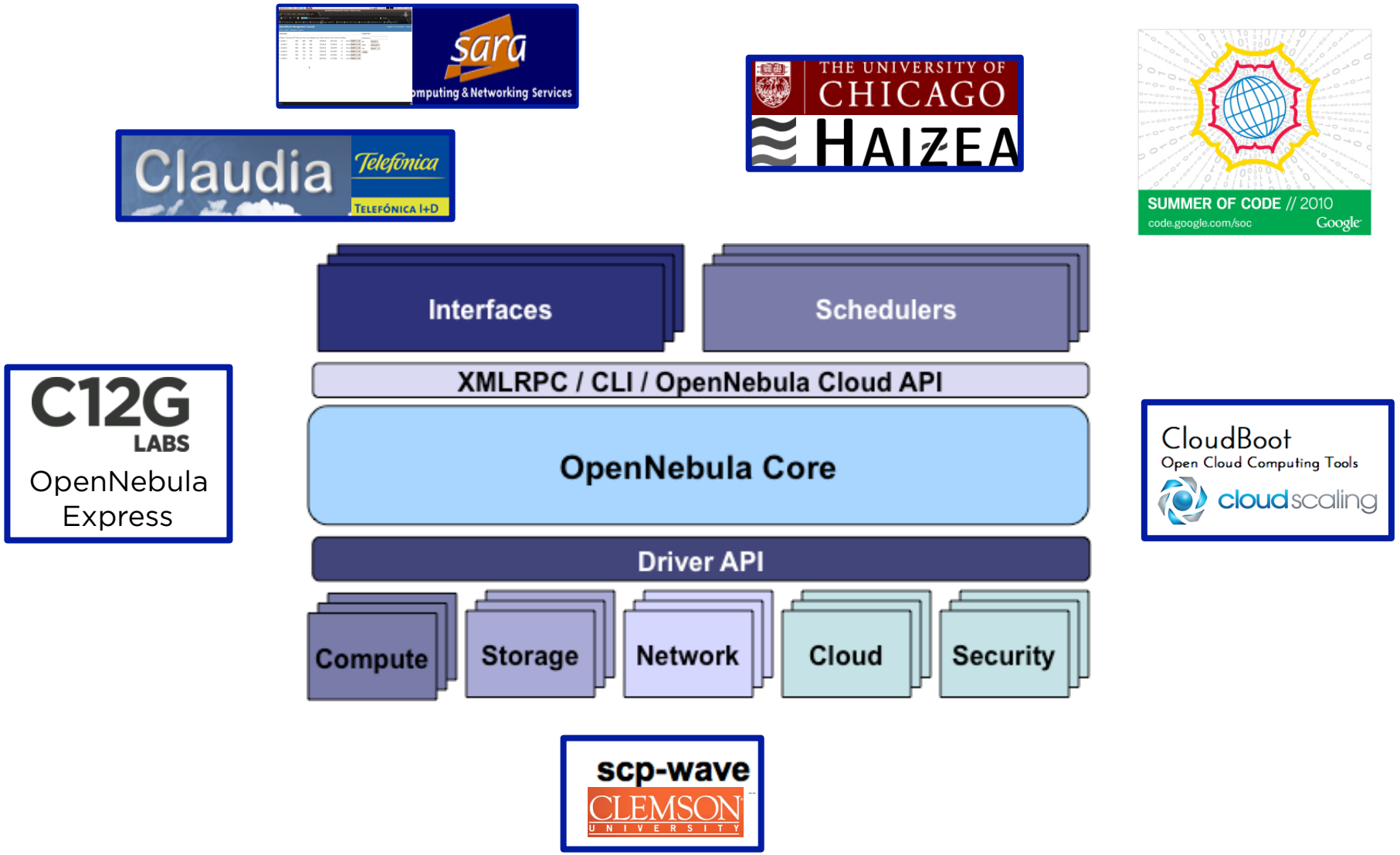
The OpenNebula Toolkit: Flexibility

A Highly Modular Architecture to Fit into any Existing Datacenter

- 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



Examples of Components in the Ecosystem



The OpenNebula Toolkit: Interoperability

Openness

- Open architectures
- Open interfaces
- Open code

Adaptability

- Modular architectures

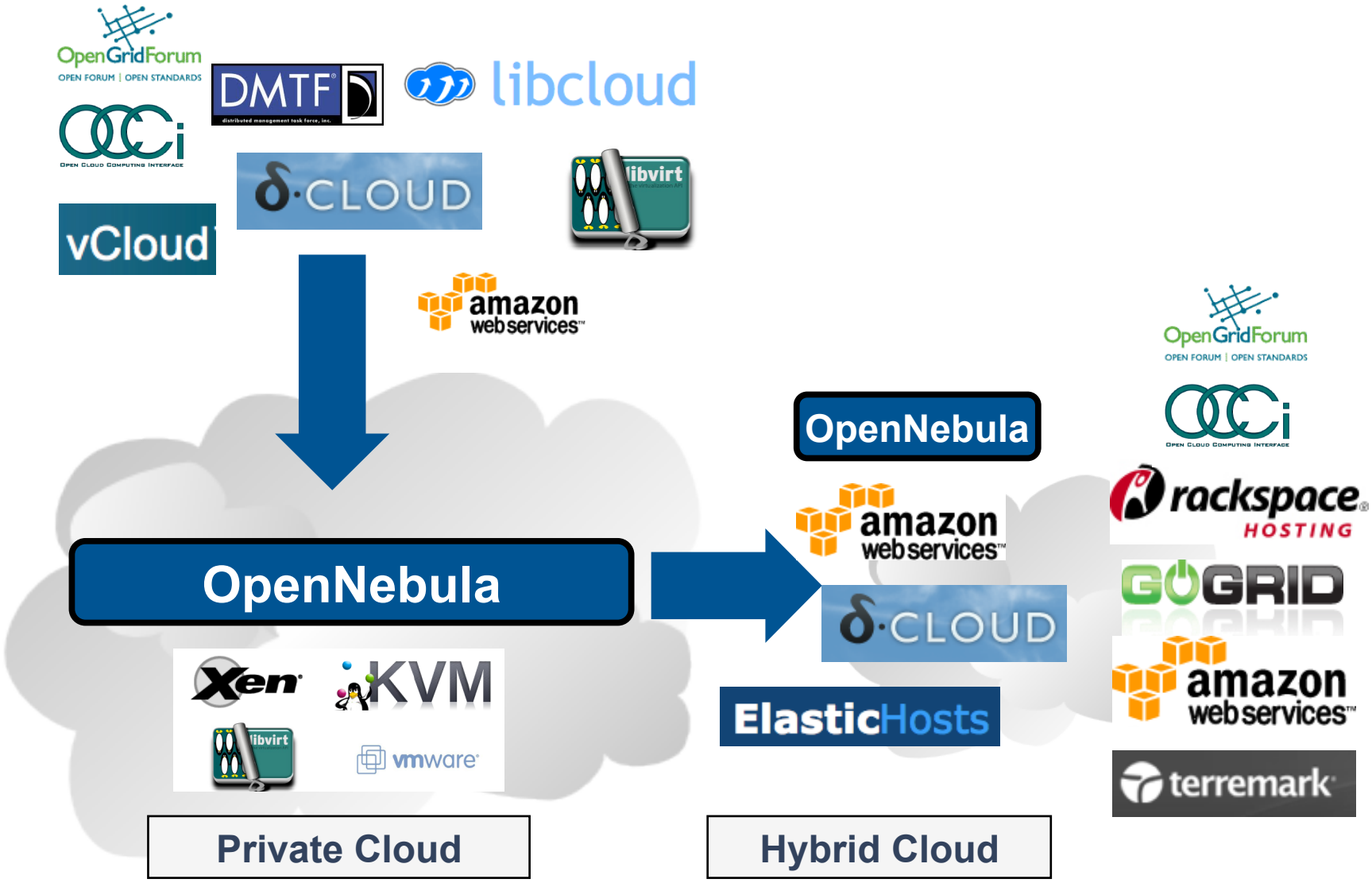
Standardization

- Use standards
- Implement standards

Portability

- It can be installed in any hardware and software

The OpenNebula Toolkit: Interoperability



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

GR-Grid

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

Private Cloud to Support Grid Site

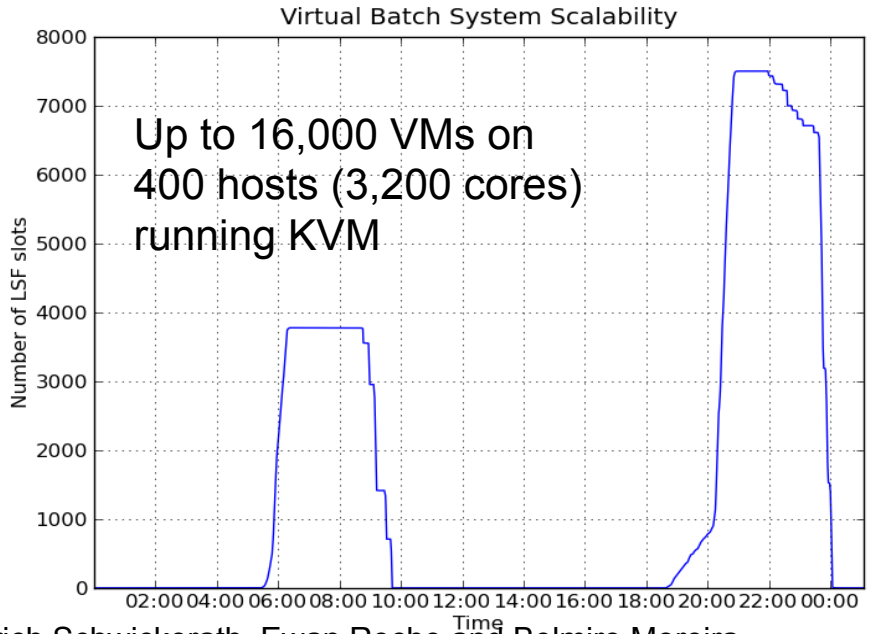
- **Goal**: Execution of a virtualized Grid site in D-Grid and EGEE
- **Details**: The D-Grid Resource Center Ruhr (DGRZR) runs an OpenNebula private cloud on 248 blades and 1,984 cores with Xen

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

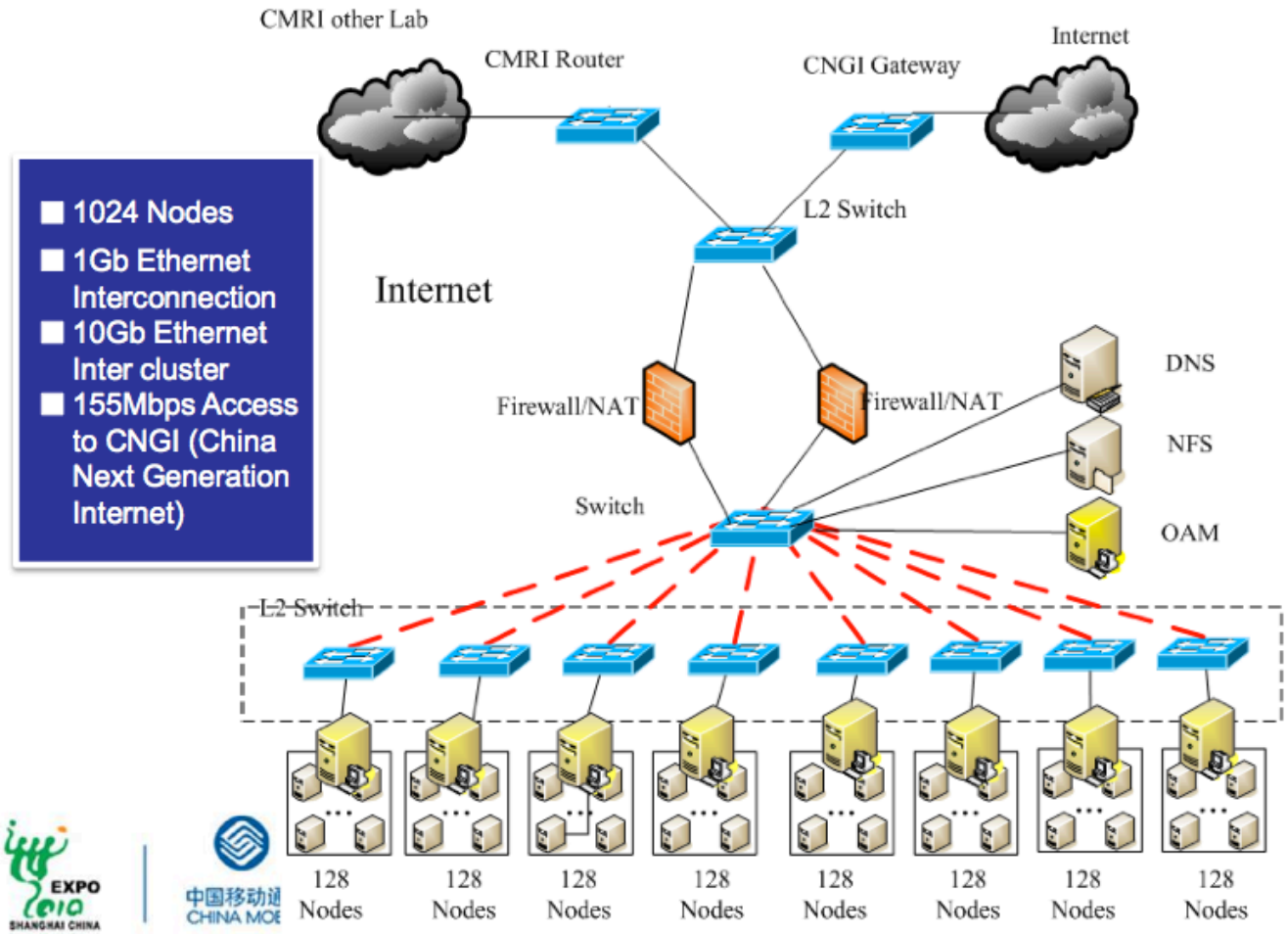


Source: CERN IT-PES/PS Group: Sebastien Goasguen, Ulrich Schwickerath, Ewan Roche and Belmiro Moreira

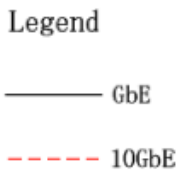
Cloud Case Studies: Telecom Provider

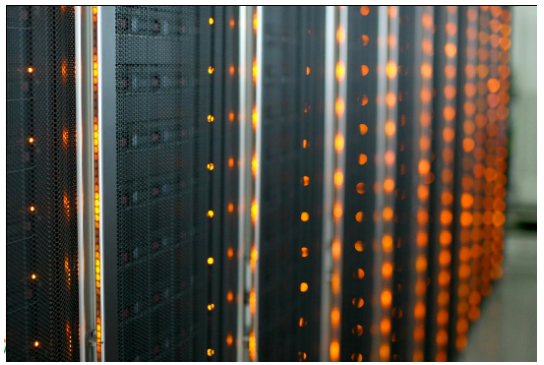
- **Goal:** Meet the growing demands for high performance, low cost, high scalability, high reliability of China Mobile IT Infrastructure (computing, storage); and the demands of China Mobile to deliver Internet business and services

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

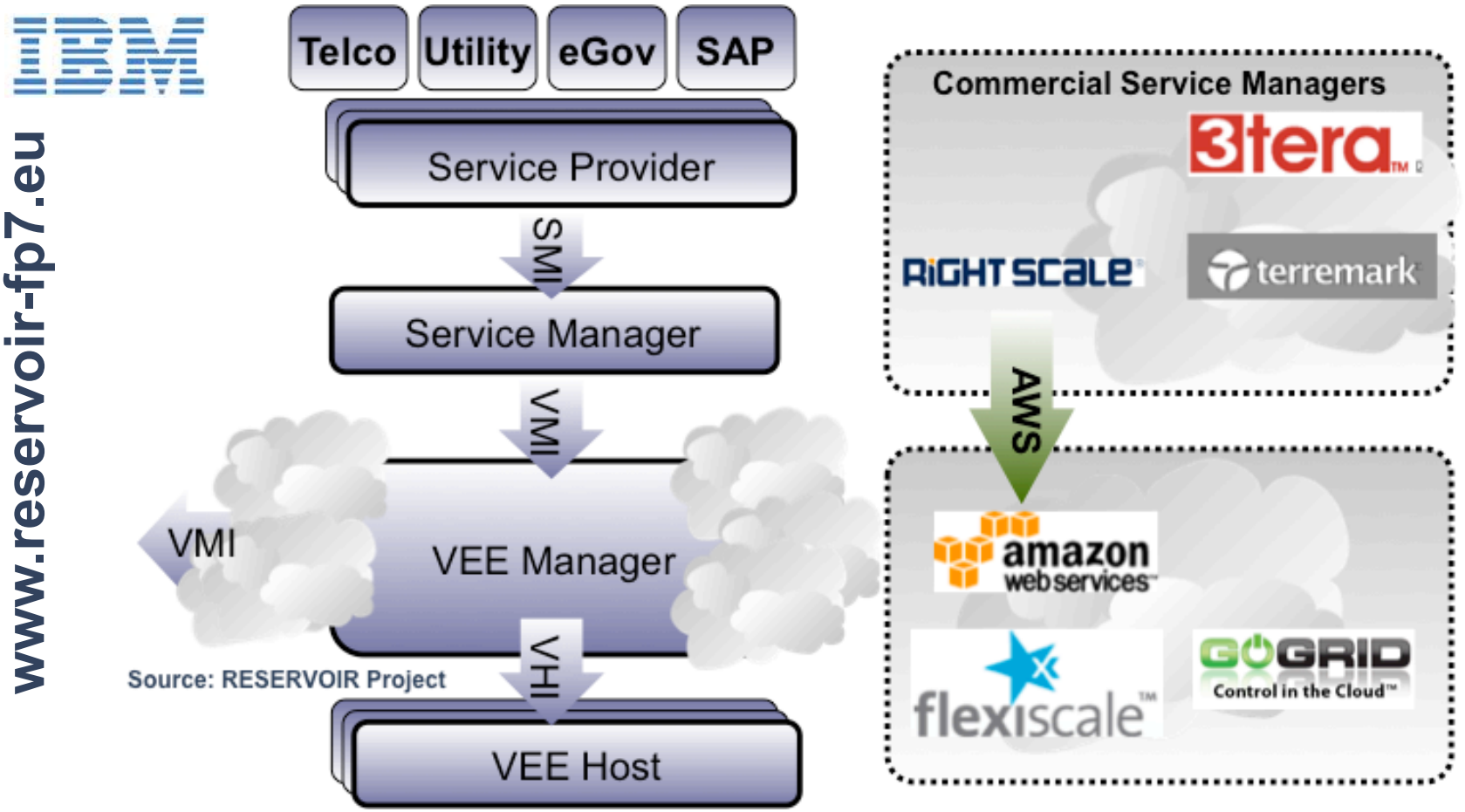
Cloud Case Studies: Tool for Innovation

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



Cloud Case Studies: Tool for Innovation

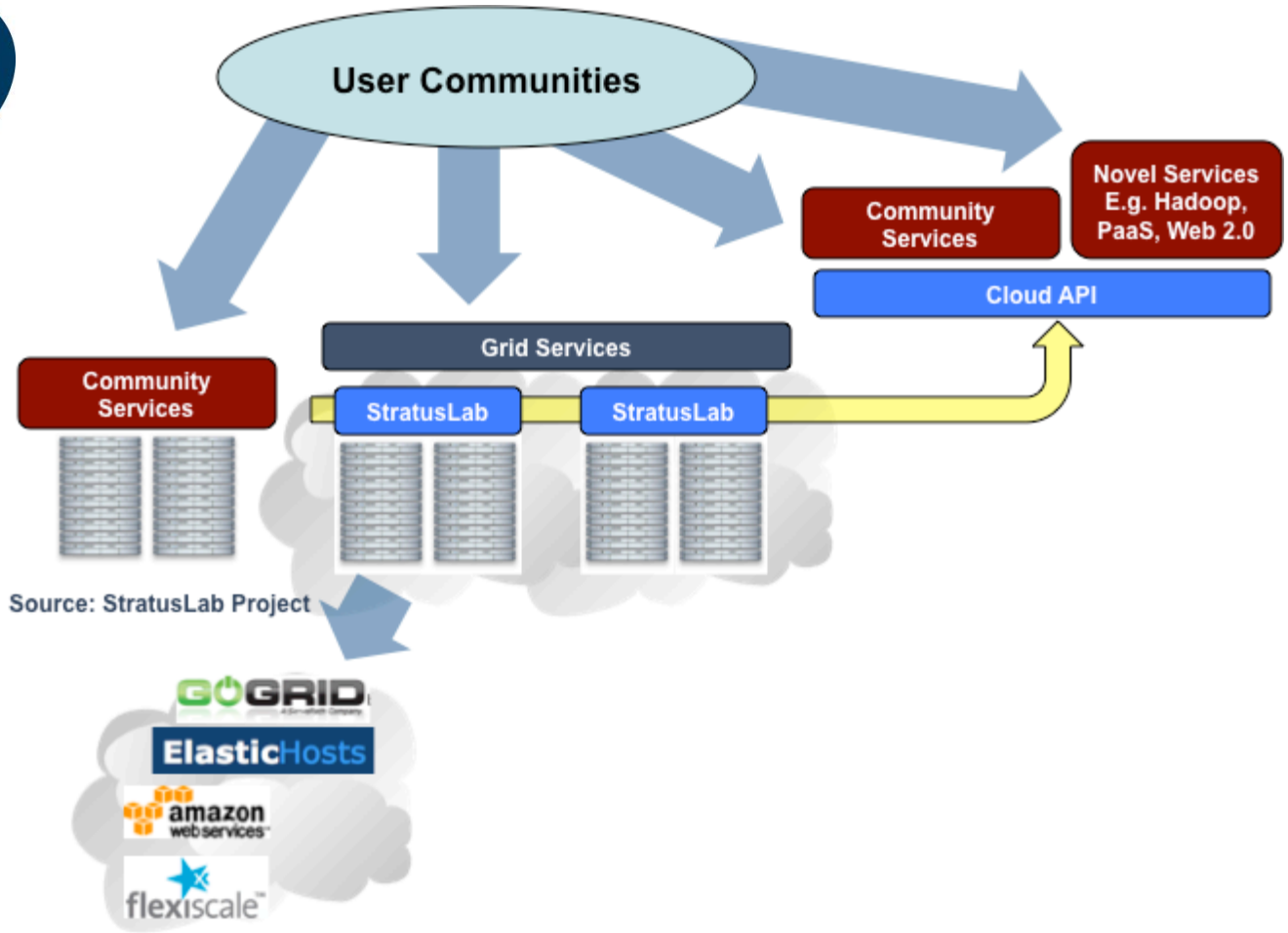
StratusLab

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



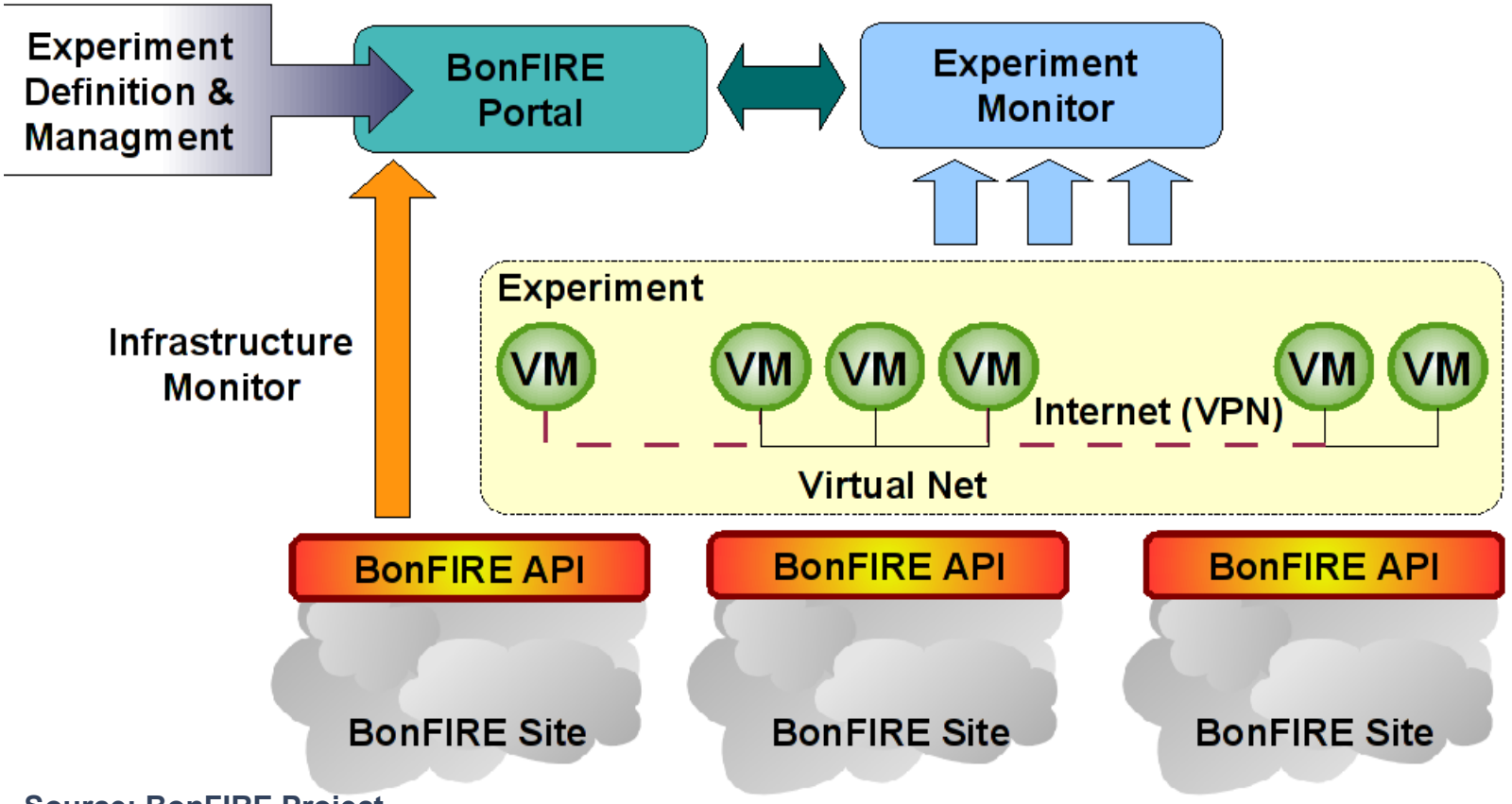
Agreement 257386 (2010-2013)
New Infrastructure Paradigms and Experimental Facilities

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

4CaaSt

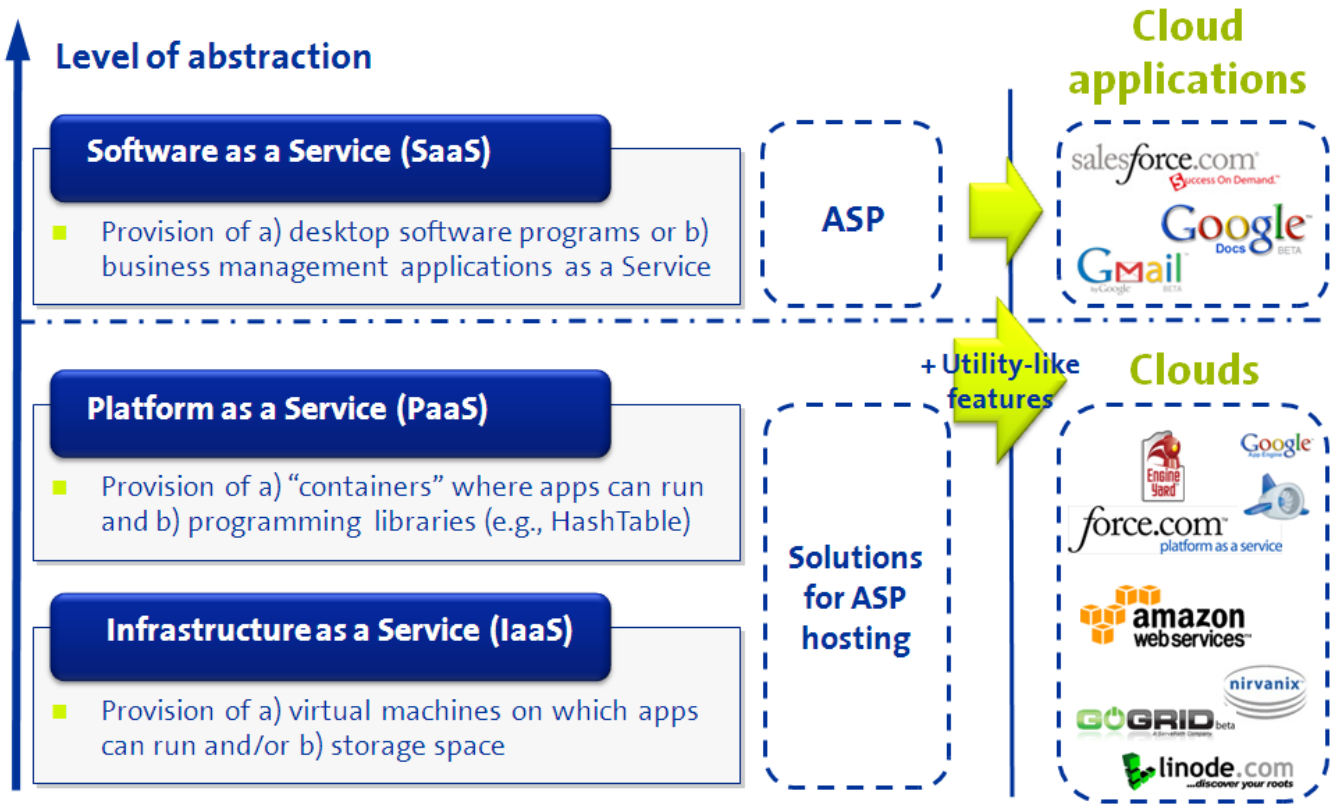
Agreement 258862 (2010-2013)
Service and Sw Architectures and Infrastructures

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

Get Involved in the OpenNebula Community!

Use the Technology and Give us Feedback

- Support through several mailing lists
- Report bugs and make feature requests
- Describe your use case in our blog
- Participate in the OpenNebula Technology Days

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 workshops or tutorials

Sponsors

dsa-research.org

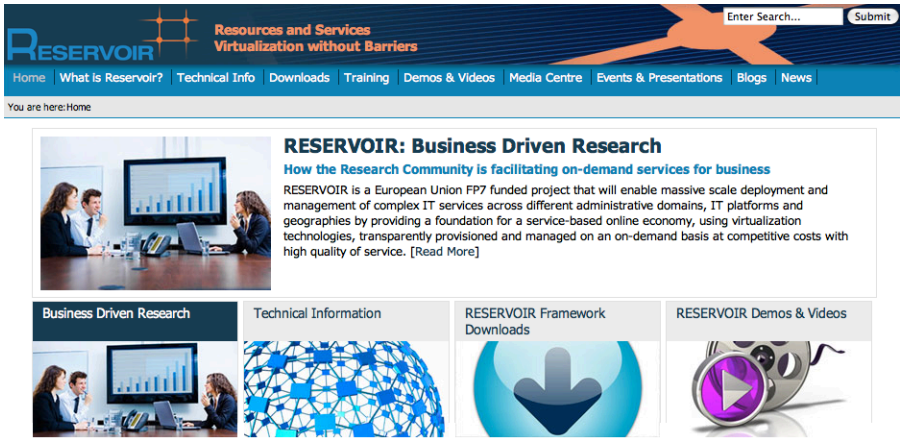
- **European Commission**: RESERVOIR (EU agreement 215605), StratusLab (EU agreement 261552), BonFIRE (EU agreement 257386) and 4CaaSt (EU agreement 258862).
- **Ministry Science & Innovation**: HPCcloud 2010-2012, MICINN TIN2009-07146
- **Community of Madrid**: MEADIANET 2010-2013 CAM S2009/TIC-1468
- **C12G Labs** dedicates an amount of its own engineering resources to support and develop OpenNebula

The OpenNebula Community

- **The OpenNebula Team**: Ignacio M. Llorente, Ruben S. Montero, Tino Vazquez, Javier Fontan, Jaime Melis, Carlos Martín, Rafael Moreno, Daniel Molina, Borja Sotomayor…
- … and many **value community contributors** from several organizations

Your support and contribution are very much appreciated!

More info, downloads, mailing lists at



Research References

- B. Rochwerger, J. Caceres, R.S. Montero, D. Breitgand, E. Elmroth, A. Galis, E. Levy,I.M. Llorente, K. Nagin, Y. Wolfsthal, *"The RESERVOIR Model and Architecture for Open Federated Cloud Computing"*, **IBM Systems Journal**, Vol. 53, No. 4. (2009)
- 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)

The research leading to these results has received funding from the European Union's Seventh Framework Programme ([FP7/2007-2013]) under grant agreement n° 215605 (RESERVOIR Project)