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Design and Building of IaaS Clouds

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dsa-research.org

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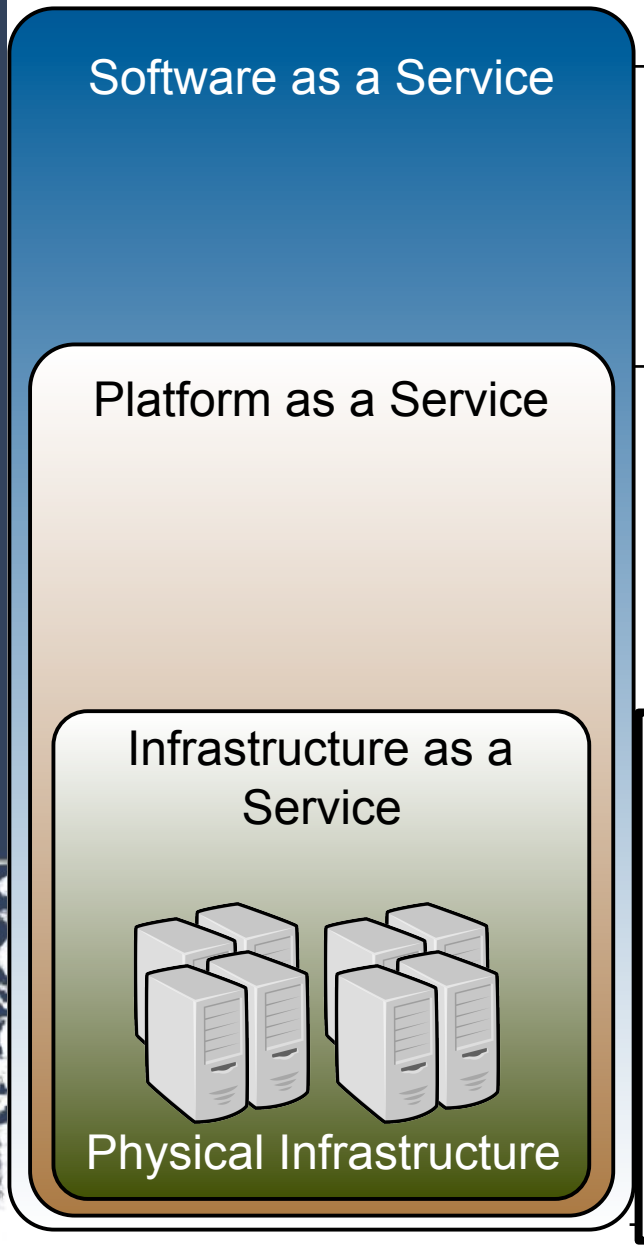
Position in the Cloud Ecosystem

Design and Building of IaaS Clouds



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)**

OpenNebula.org

Innovative open, flexible and scalable technology to configure your own IT resources into a IaaS cloud

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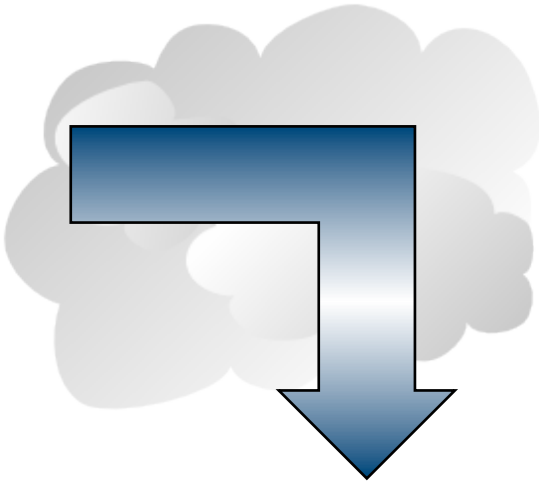
Transforming your IT Infrastructure into a Cloud

Design and Building of IaaS Clouds

Commercial Cloud Provider

- **Flexible** and **elastic capacity** to meet dynamic demands of service
- **Ubiquitous network access**
- **Pay per use** and on-demand access



Building your Own Cloud

- **Optimize and Simplify Internal Operations**
  - **Centralized management** of all servers and services with dynamic resizing of infrastructure and dynamic allocation of capacity
  - **Higher utilization** and **operational saving** of existing resources with server consolidation and removal of application silos
  - **Lower infrastructure expenses** with combination of local and remote Cloud resources
- **Support new IT, scientific, or business Cloud services**

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Deployment Models

Design and Building of IaaS Clouds

Model	Definition	Examples of Deployment
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** • **Community public clouds** by ICT service centers to enable scientific and educational projects to experiment with cloud computing • **Special purpose clouds** with dedicated capabilities (Science Clouds, HPC Clouds..) • **Regional clouds** to address regulatory or latency issues
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

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Contents

Design and Building of IaaS Clouds

Designing a Cloud Infrastructure
Addressing challenges from **Deployment and Usage Scenarios**

Building a Cloud Infrastructure
OpenNebula as Cloud Enabler

Experiences and Innovative Projects in Cloud Computing Infrastructures
RESERVOIR, StratusLab and **BonFIRE**

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Designing a Cloud: A Design Driven by Requirements

Design and Building of IaaS Clouds

Requirements from Usage and Deployment Scenarios

- **Users:** Functionality exposed and workload profile
- **Managers:** Flexible, efficient and scalable management of the Cloud
- **Business:** Hybrid cloud computing and federation
- **Integrators:** Open architecture, interfaces and code

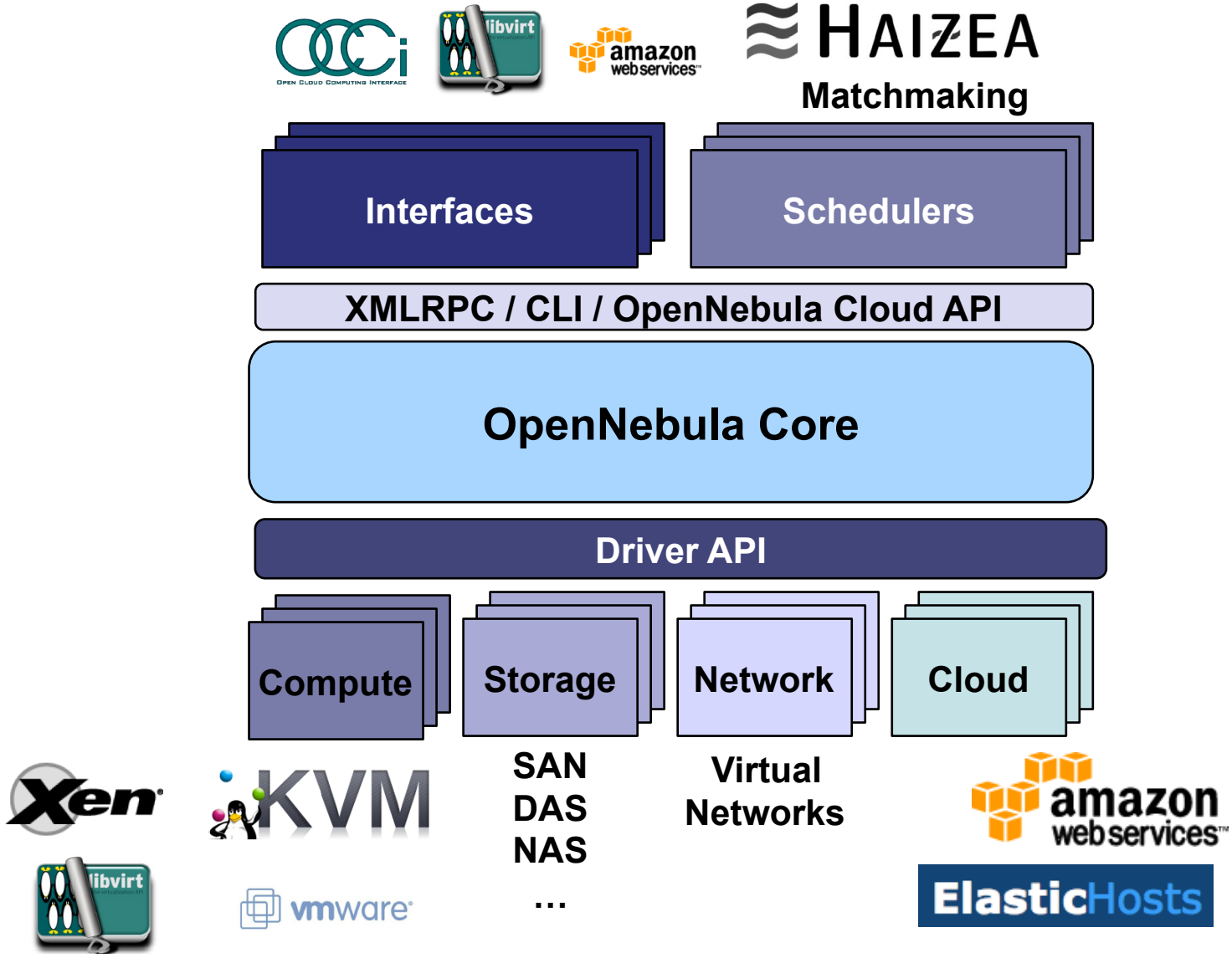
"One solution does not fit all requirements and constraints, a properly architectured solution should fully align with your Cloud strategy"

Constraints from Existing Infrastructure and Processes in the Organization

Designing a Cloud: Flexible Cloud Manager

Design and Building of IaaS Clouds

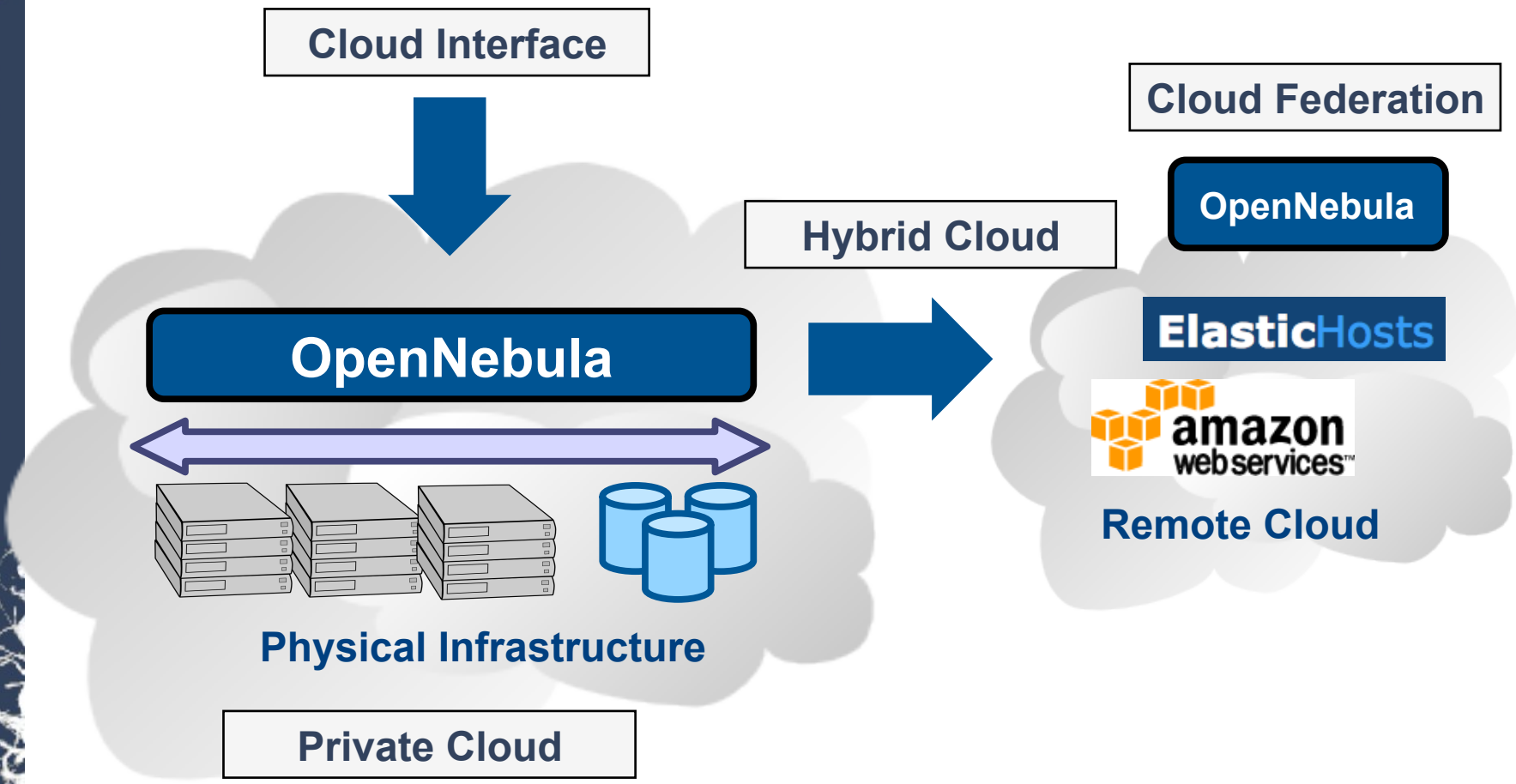
Cloud Manager as Enabler to Build Your Own Cloud



Designing a Cloud: Interoperability

Design and Building of IaaS Clouds

Interoperation from Different Perspectives



Building a Cloud: OpenNebula as Cloud Enabler

Design and Building of IaaS Clouds

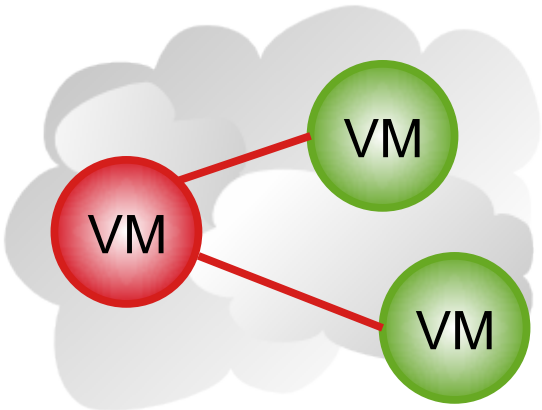
RESERVOIR

Innovations

Technology **challenges** in cloud computing management from **business use cases**

Open-source Toolkit

OpenNebula v1.4



- **Open and flexible tool** to fit into any datacenter and integrate with any ecosystem component
- **Open-source** released under Apache v2.0, and distributed in Ubuntu
- **Most advanced solution** to build private, public, federated and hybrid clouds
- Based on and implements **standards to** avoid vendor lock-in and to enable interoperability
- **Efficient and scalable management** of the cloud

Building a Cloud: Experiences

Design and Building of IaaS Clouds

Different Levels of Use: From Experimental to Production

esa esac european space astronomy centre

CERN

NIKHEF

NCHC

CRS4

VSTORM the ViRtual STORM is here… are you ready?

CENTRE DE SUPERCOMPUTACIÓ DE CATALUNYA CESCA

MindTree

Telefónica Telefónica Investigación y Desarrollo

MPS CONSORZIO OPERATIVO GRUPPOMONTEPASCHI

CESGA

sara Computing & Networking Services

Building a Cloud: Experiences

Design and Building of IaaS Clouds

Deployment Cases

- A team at Clemson University and CERN has used OpenNebula to deploy thousands of VMs on 400 hosts (3,200 cores) running Xen
- OpenNebula was integrated in internal network and configuration management
- Contributed drivers for using LVM based disk images

- The Dgrid Resource Center Ruhr (DGRZR) has used OpenNebula to manage 248 Blades with a total of 1,984 cores.
- OpenNebula is used to support the execution of a virtualized Grid site in D-Grid and EGEE

- SARA High Performance Computing Center uses OpenNebula in its new HPC Cloud service on 128 cores across 16servers with KVM
- OpenNebula is used to support the execution of virtual clusters and HPC applications
- Authors of the OpenNebula Management Console

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Building a Cloud: OpenNebula Ecosystem

Design and Building of IaaS Clouds

Open Community for Cloud Computing

- **Haizea Lease Manager (University of Chicago):** Advance reservation of capacity and queuing of best effort requests
- **Cloud Management Console (SARA Computing and Networking Services):** Web interface for OpenNebula
- **Virtual Cluster Tool (CRS4 Distributed Computing Group):** Atomic virtual cluster management with versioning and multiple transport protocols.
- **DeltaCloud Driver (DSA-Research@UCM)**
- **RESERVOIR Policy Engine (IBM Haifa/Elsag Datamat):** Policy-driven probabilistic admission control and dynamic placement optimization to satisfy site level management policies
- **VM Consolidation Scheduler (DSA-Research@UCM):** Periodic re-placement of VMs for server consolidation and suspension/resume of physical resources
- **Claudia (Telefonica I+D):** SLA-driven automatic service management
- **Under Development:** SUN Cloud API, vCloud API, VirtualBox plugin, dashboard for infrastructure management, new schedulers, SLA and security framework, Grid service manager, LVM and SAN support,…

Building a Cloud: Innovative Projects

Design and Building of IaaS Clouds

European Projects on Cloud Computing Infrastructures

EU grant agreement 215605
Service and Sw Architectures and Infrastructures
(2008-2011)

Resources and Services Virtualization without Barriers

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

Proposal in negotiation
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.
- Enhance existing computing infrastructures with “IaaS” paradigms

Proposal in negotiation
New Infrastructure Paradigms and Experimental Facilities
(2010-2013)

Building Service Testbeds on FIRE

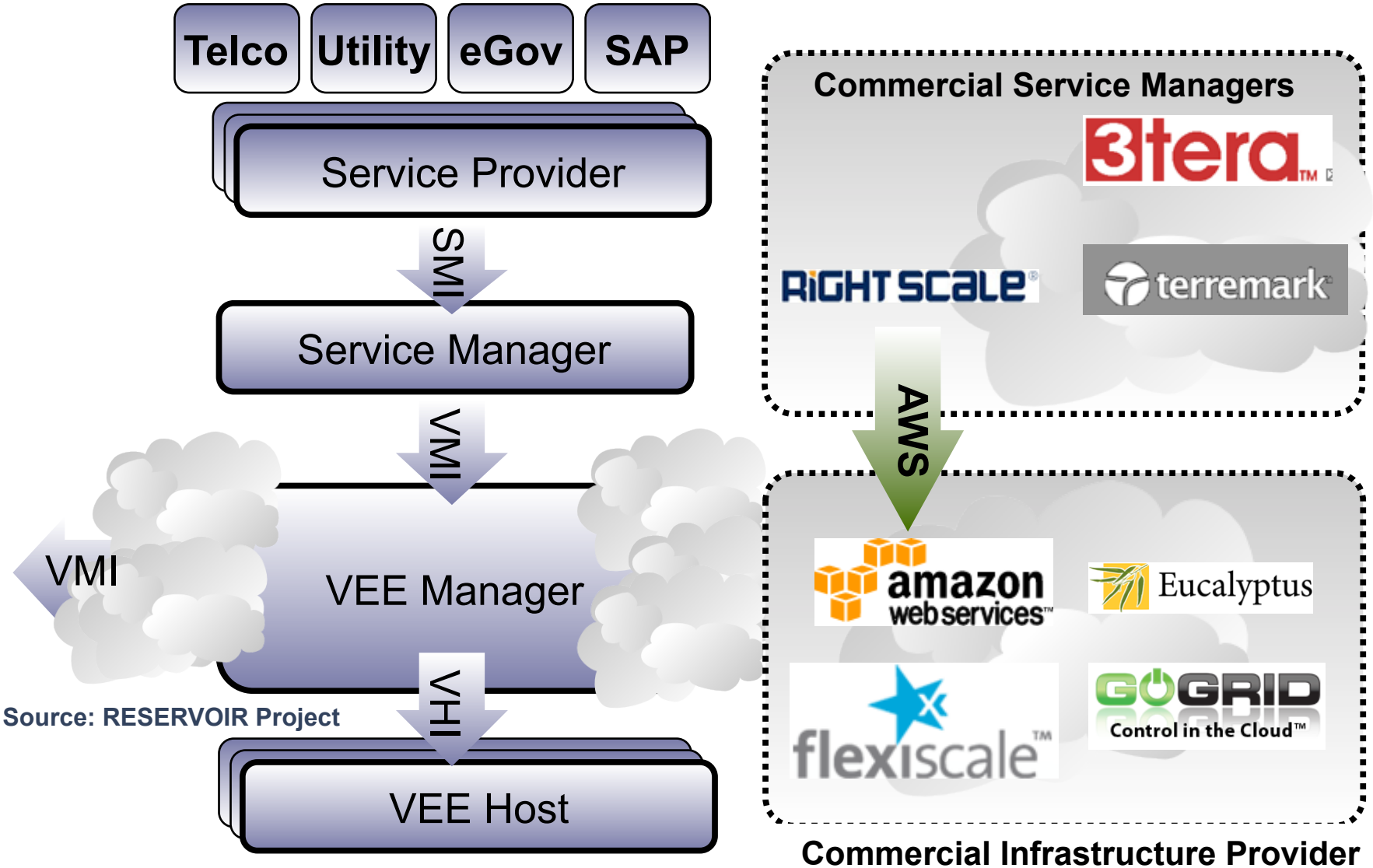
- Design, build and operate a multi-site cloud-based facility to support research across applications, services and systems targeting services research community on Future Internet

Innovative Projects: The Enabling Software Artefacts

Design and Building of IaaS Clouds

RESERVOIR

www.reservoir-fp7.eu

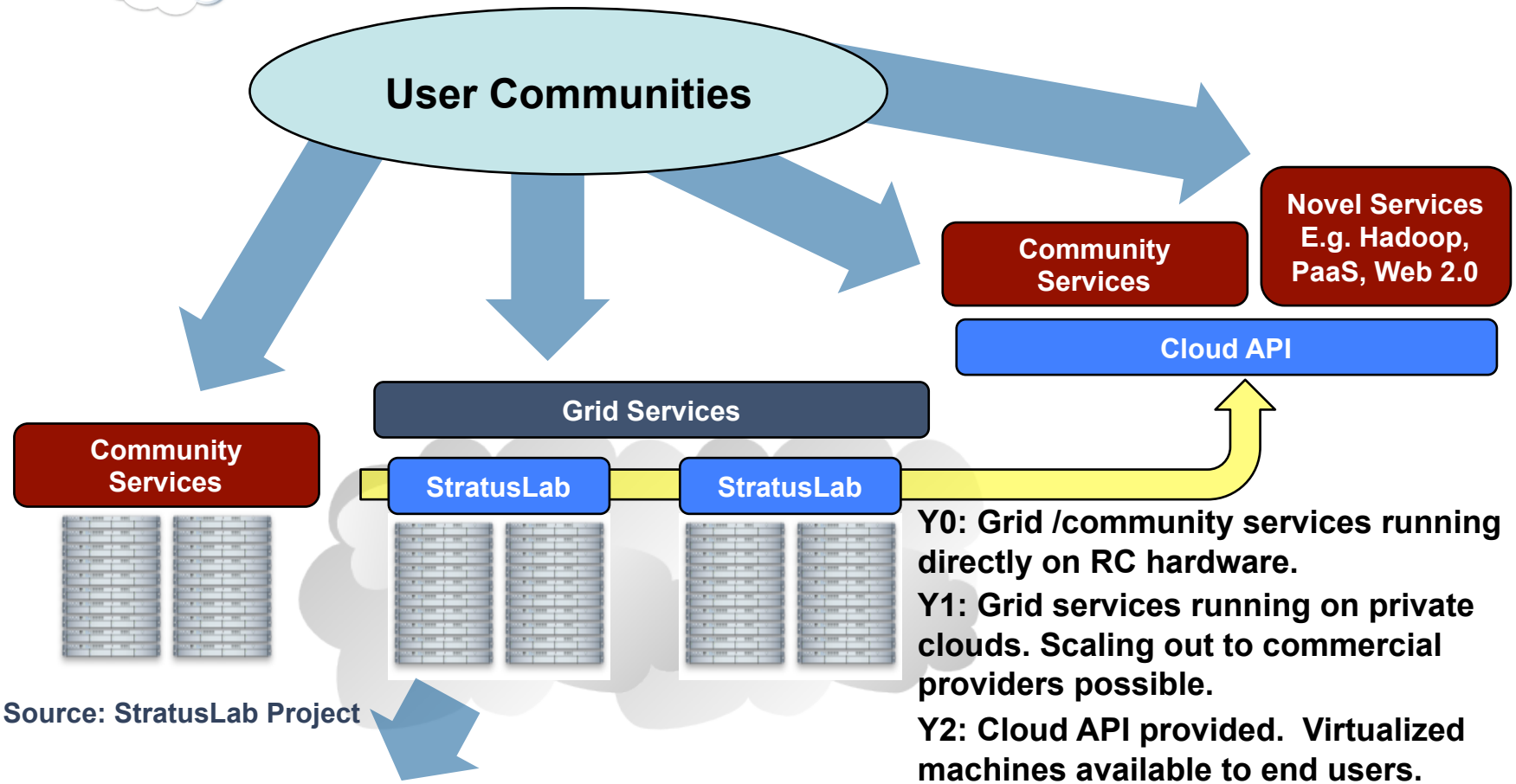


Source: RESERVOIR Project

Innovative Projects: Enhancing Grid with Cloud

Design and Building of IaaS Clouds

StratusLab **www.stratuslab.org**



Source: StratusLab Project

Y0: Grid /community services running directly on RC hardware.

Y1: Grid services running on private clouds. Scaling out to commercial providers possible.

Y2: Cloud API provided. Virtualized machines available to end users.

Y3: Community services run on standard resources via StratusLab cloud API.

Y4: Additional community services and novel services built on top of cloud API.

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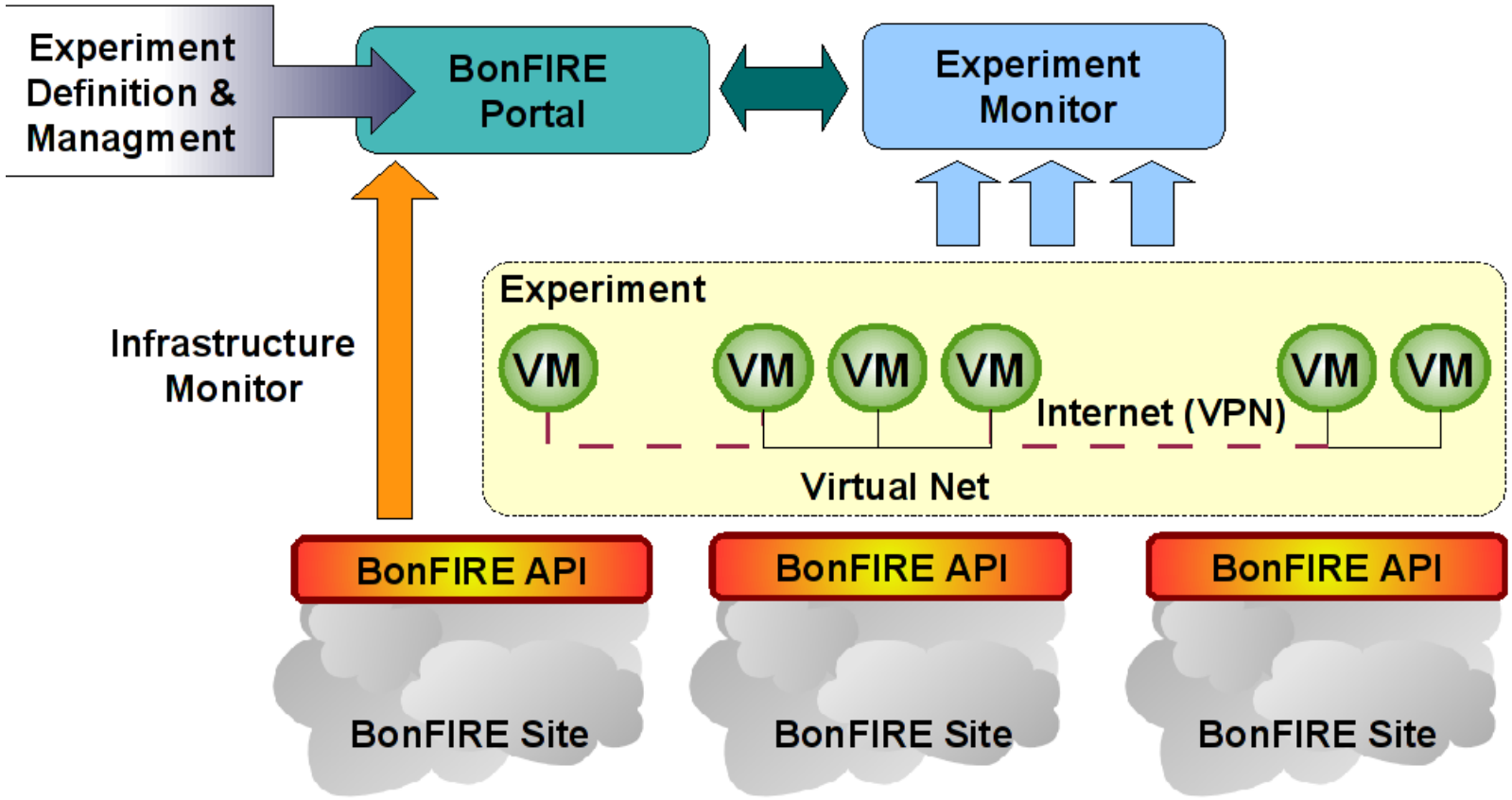
Building Service Testbeds on FIRE



Source: BonFIRE Project

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Outlook

Design and Building of IaaS Clouds

About the Short-term Roadmap (2 months): v1.6

Feature	New Function
Scalability, Reliability and High Availability	• Support fro MySQL in the back-end • Unit-testing of the core • HTTP back-end
Functionality	• Image repository • Support for multiple clusters • CLI for accounting and billing support
Cloud Interfaces	• Improve compatibility with EC2 ecosystem

About the Medium-term Roadmap

- **Projects** funding OpenNebula
- **Community**

Funding

- New European Projects ensure the development and maintenance of OpenNebula until end of 2013
- C12G Labs also contributes to the sustainability of the open-source community

Long-term Sustainability and Commercial Support

Design and Building of IaaS Clouds

C12G.com

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Thanks

Funding Agencies

- **European Commission**: RESERVOIR 2008-2011, EU agreement 215605
- **Ministry Science&Innovation**: HPCcloud 2010-2012, MICINN TIN2009-07146
- **Community of Madrid**: MEADIANET 2010-2013 CAM S2009/TIC-1468

Other Sponsors

- **C12G Labs** dedicates an amount of its own engineering resources to support and develop OpenNebula

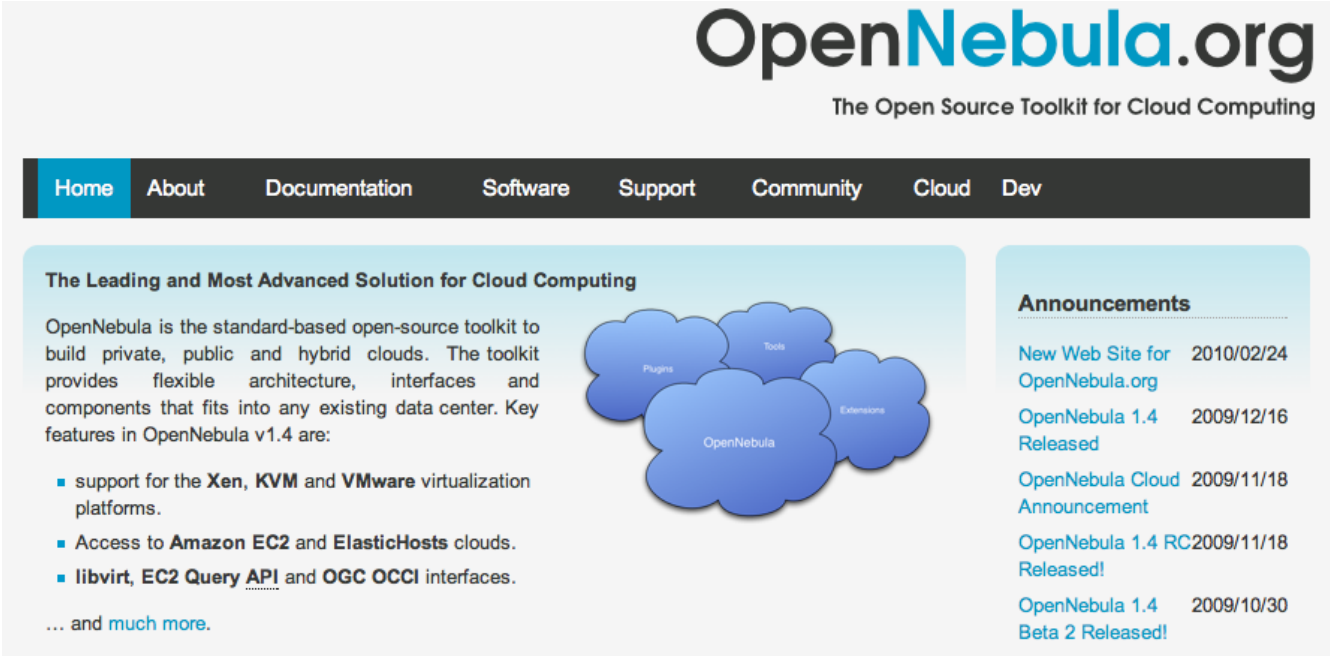
The OpenNebula Community

- **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 Information

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)