

CLOSER 2014

4th INTERNATIONAL CONFERENCE ON CLOUD COMPUTING AND SERVICES SCIENCE

3 - 5, APRIL 2014

BARCELONA, SPAIN

OpenNebula *Latest Innovations in Private Cloud Computing*

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OpenNebula Project Director

OpenNebula.org

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This presentation is about innovation

... in cloud provisioning

... in cloud consumption

and in two cloud use cases

... HPC and science applications

... Pro-active autonomic applications

What is OpenNebula?

OpenNebula.org

Simple but feature-rich, production-ready, customizable solution to build clouds



SIMPLE

Easy to operate, install and upgrade, with packages for the main Linux distributions



FLEXIBLE

Really open-source and customizable to fit into any data center and policies



ROBUST

Production-ready, mature, reliable and commercially supported



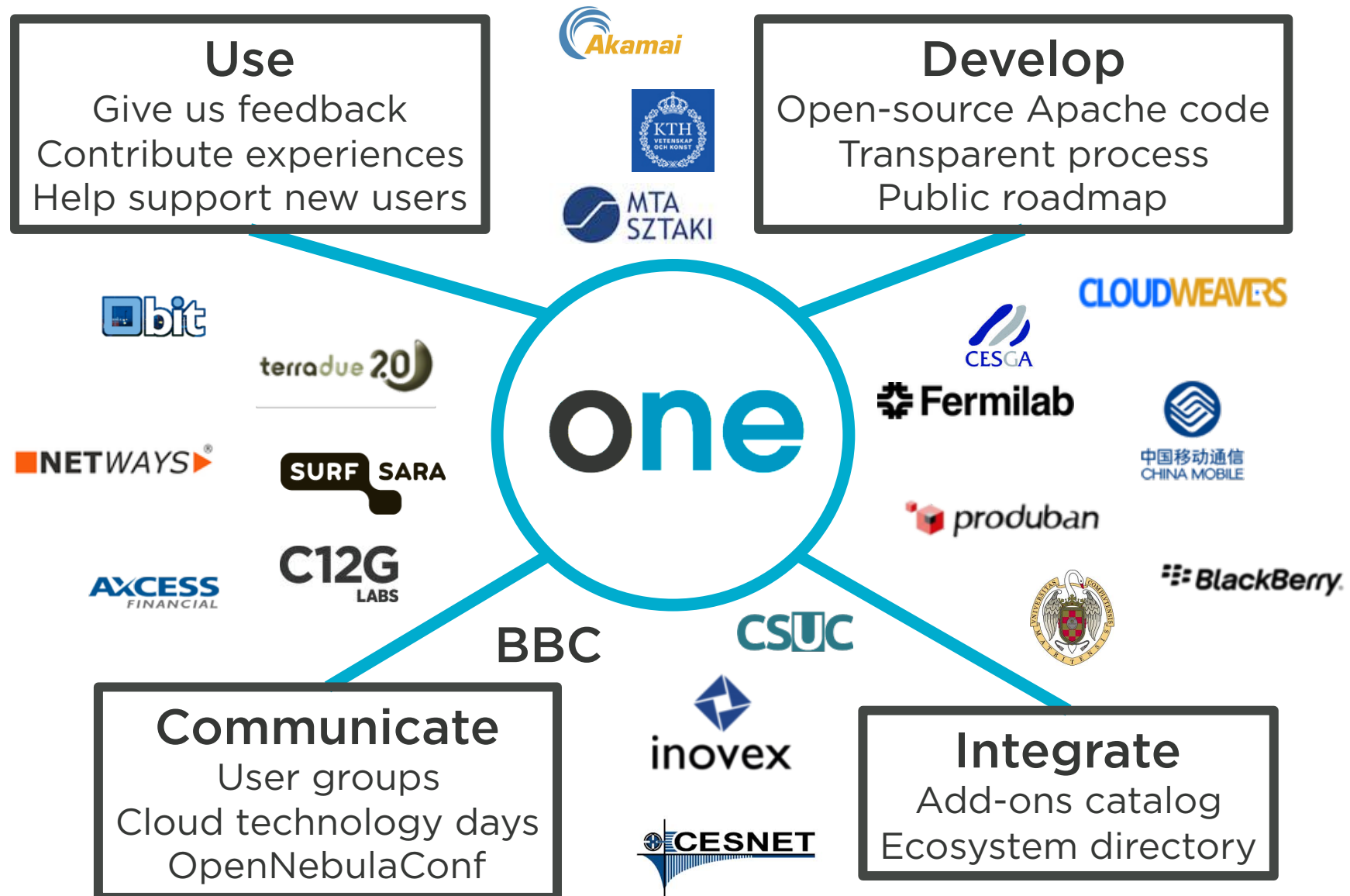
POWERFUL

Innovative functionality for enterprise clouds and data center virtualization

What is OpenNebula?

OpenNebula.org

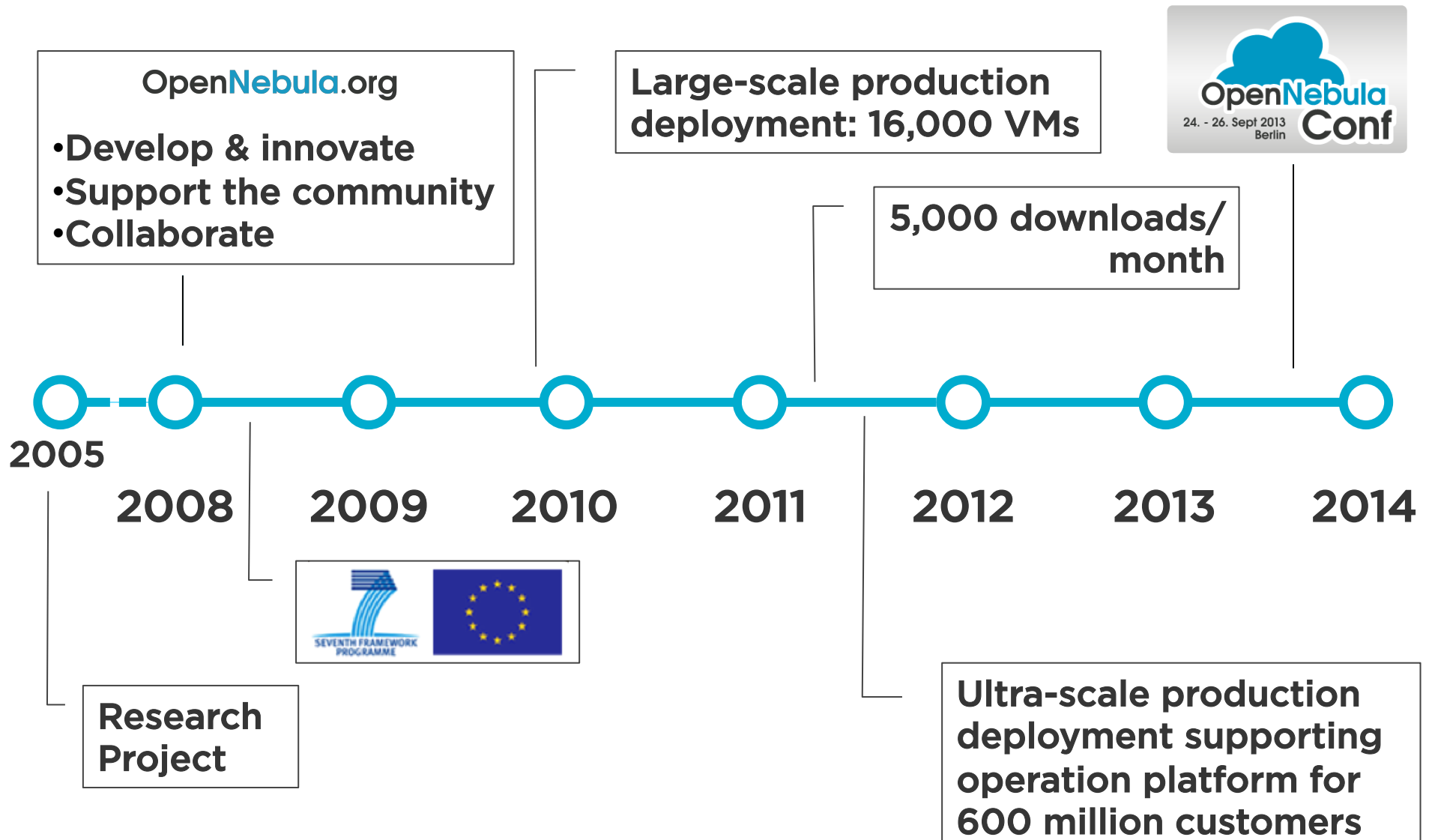
An Open Community Driven by Users



What is OpenNebula?

OpenNebula.org

From Research Project to Open-source Project for Enterprise



What is OpenNebula?

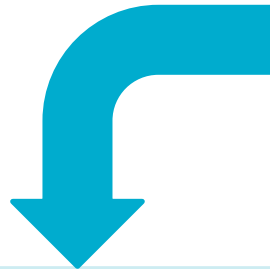
OpenNebula.org

EU Success Story in Cloud Computing Research and Innovation

Flagship EU Project on
Cloud Computing Research



Innovative
Technology Spin-off
OpenNebula.org



Business Platform



Innovation Platform



OpenNebula - Latest Innovations in Private Cloud Computing

European Commission

DIGITAL AGENDA FOR EUROPE

A Europe 2020 Initiative

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[Cloud Computing](#)

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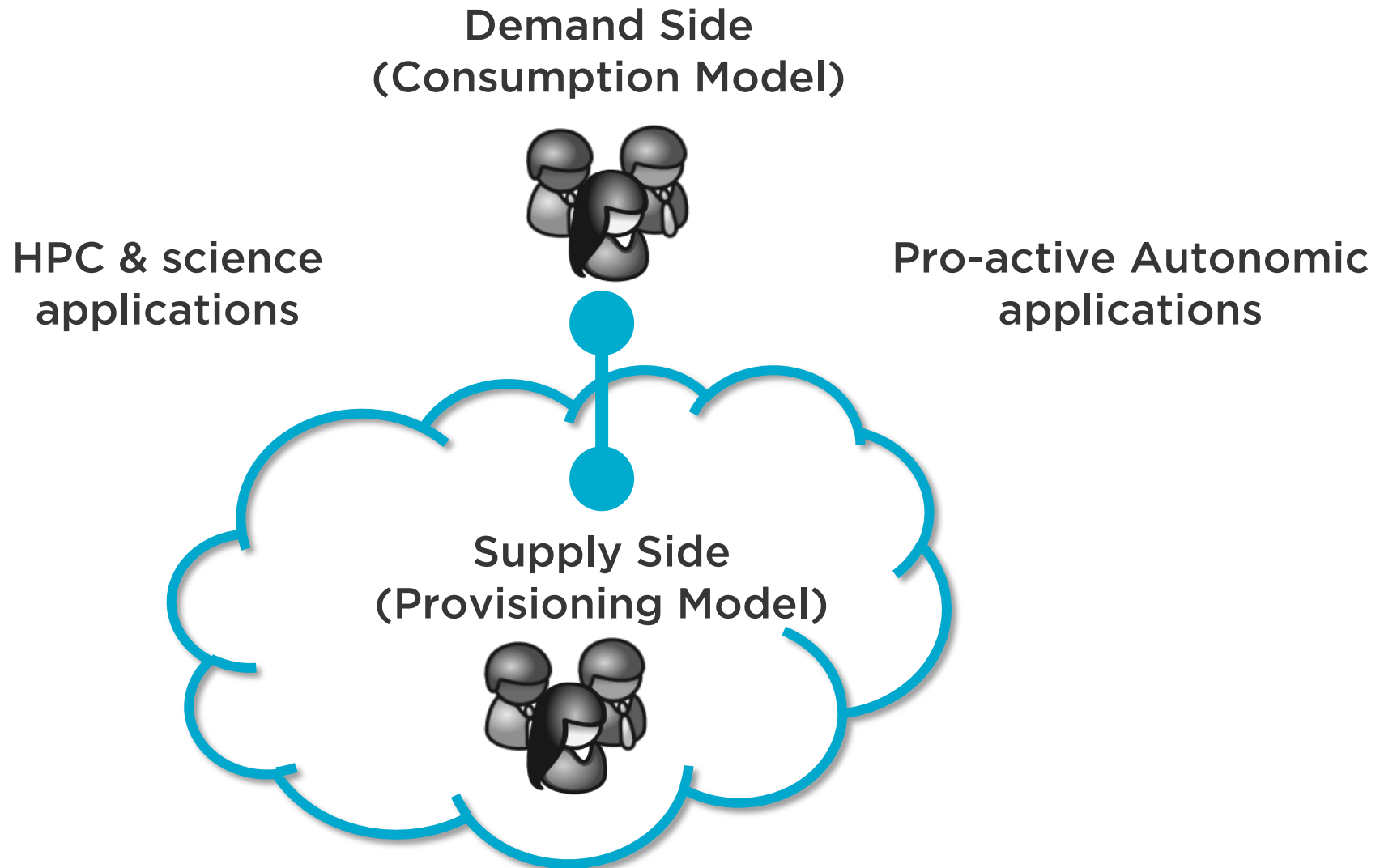
[Telecoms & the Internet](#)

OpenNebula: the only European open-source management platform to build IaaS clouds! A success story in exploitation of FP7 research results

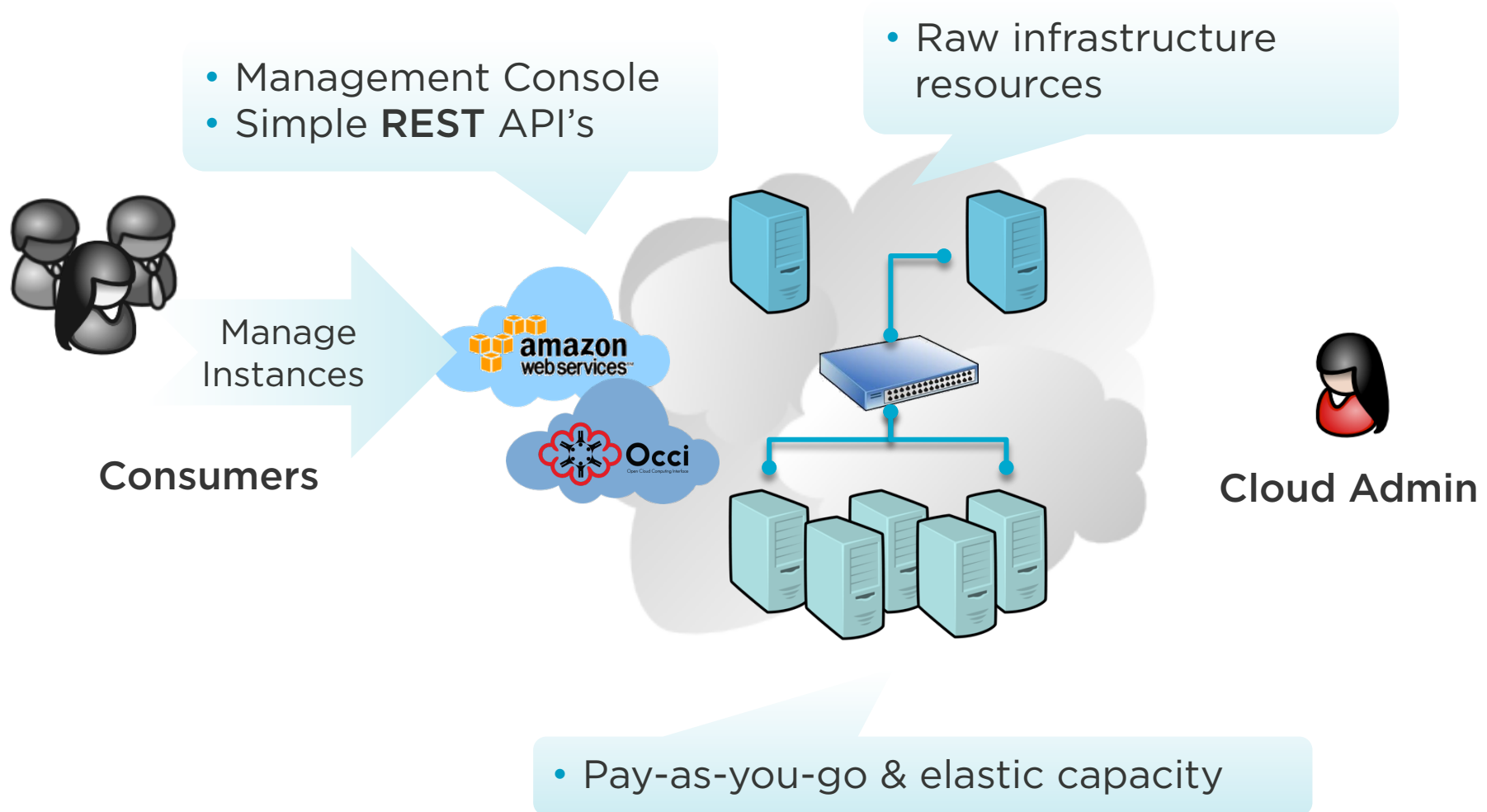
published by [Maria TSAKALI](#) on Thu, 12/09/2013 - 15:36

OpenNebula has played an important role in driving and supporting the transition to cloud computing and thus accelerating the pace of innovation in Europe.

Different Perspectives to Present Innovations in Cloud Computing



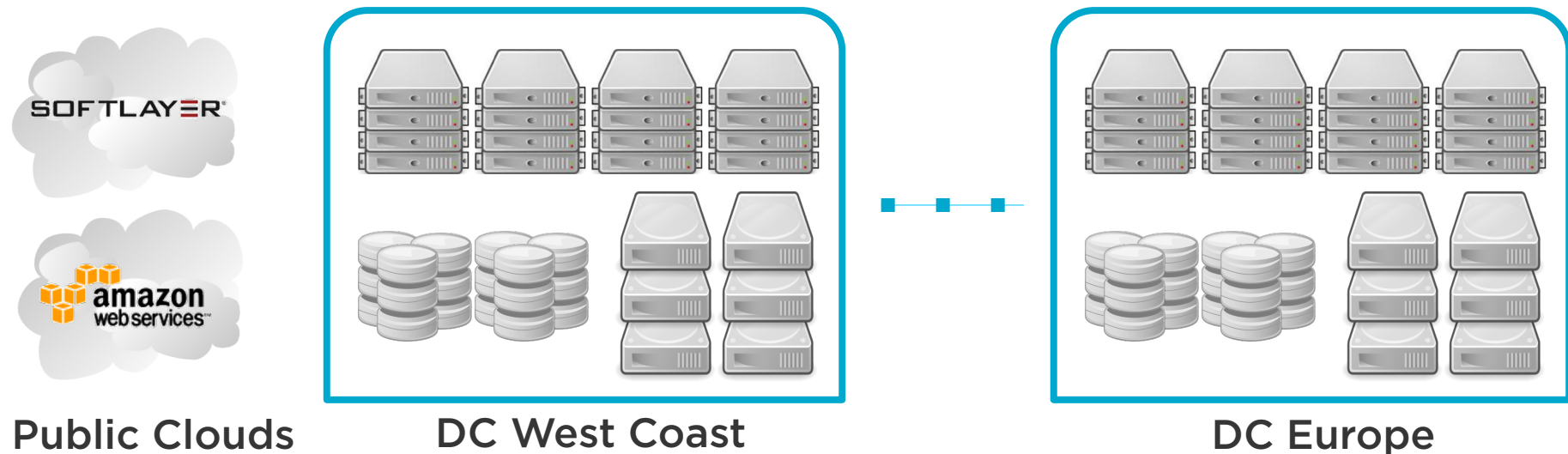
Existing Amazon-like Provisioning Model



Challenges from the Infrastructure Perspective

Comprehensive Framework to Manage Infrastructure Resources

- **Scalability:** Several DCs with multiple clusters
- **Outsourcing:** Access to several clouds for cloudbursting
- **Heterogeneity:** Different hardware for specific workload profiles

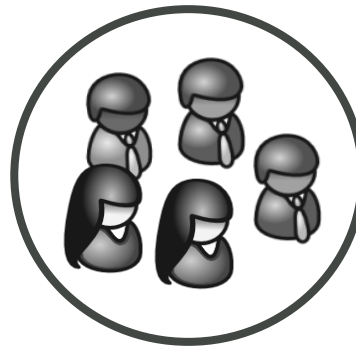


Challenges from the Organizational Perspective

Web Development



HPC Simulations



Big Data Analysis



Comprehensive Framework to Manage User Groups

- Several divisions, units, organizations...
- Different performance and security requirements
- Dynamic groups that require admin privileges

The OpenNebula Provisioning Model

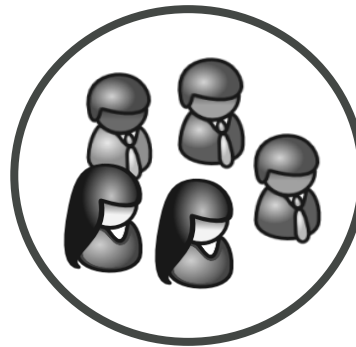
OpenNebula.org

The Goal: Dynamic Allocation of Private and Public Resources to Groups of Users

Web Development



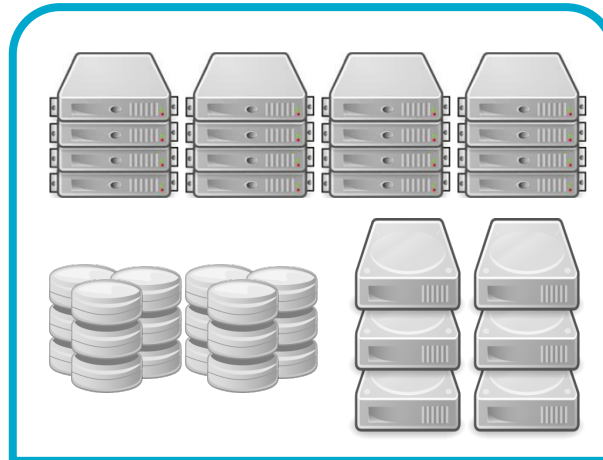
HPC Simulations



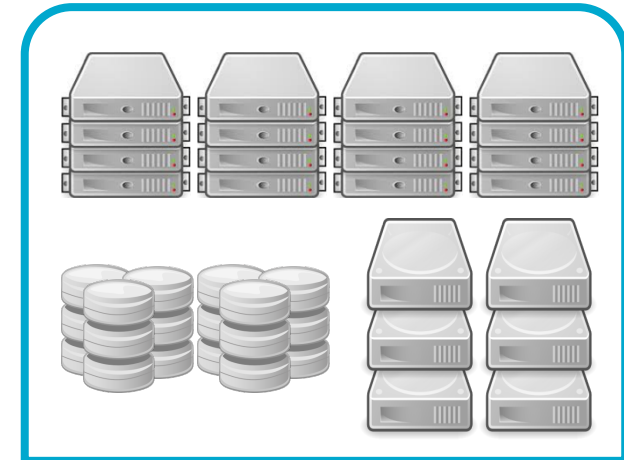
Big Data Analysis



Public Clouds



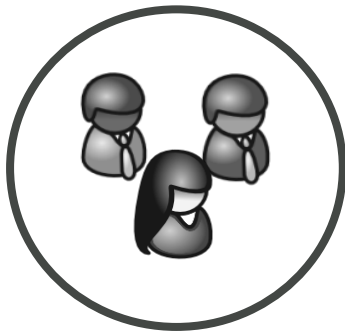
DC West Coast



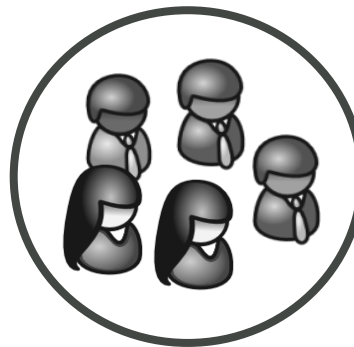
DC Europe

Definition of Clusters (Resource Providers)

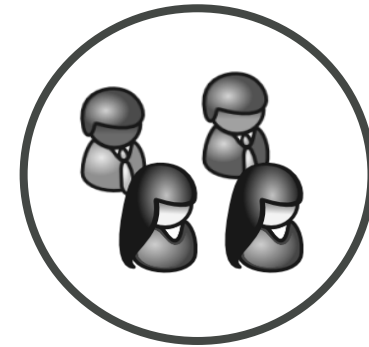
Web Development



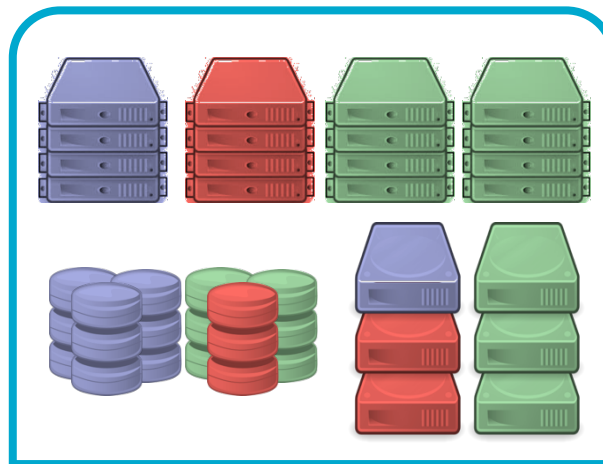
HPC Simulations



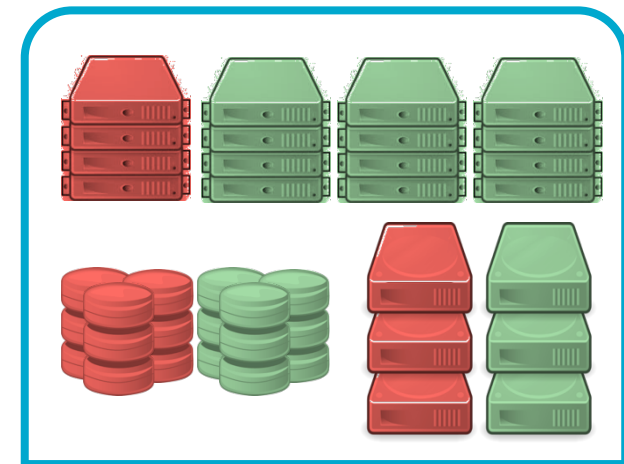
Big Data Analysis



Public Clouds



DC West Coast



DC Europe

Definition of vDCs

Web Development



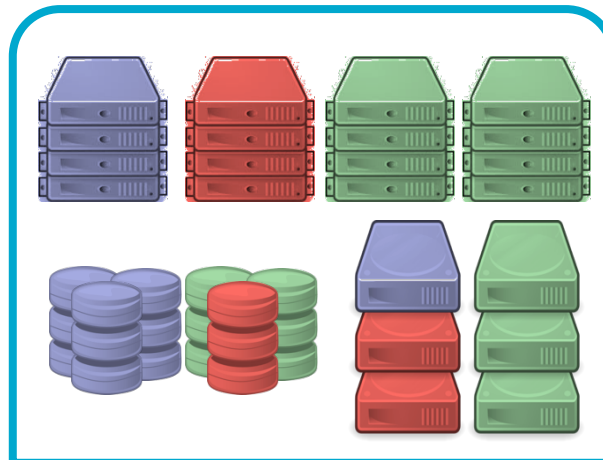
HPC Simulations



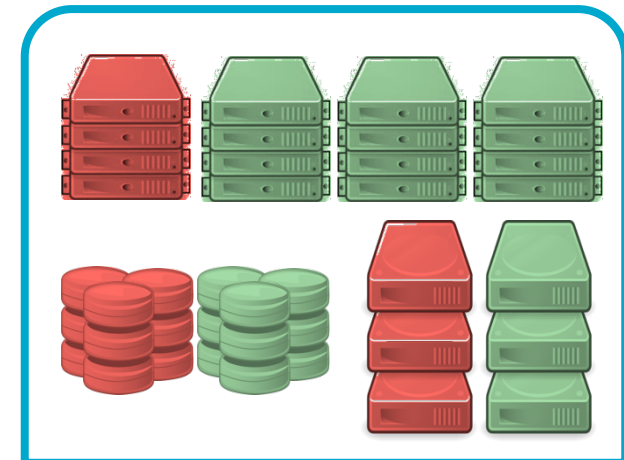
Big Data Analysis



Public Clouds



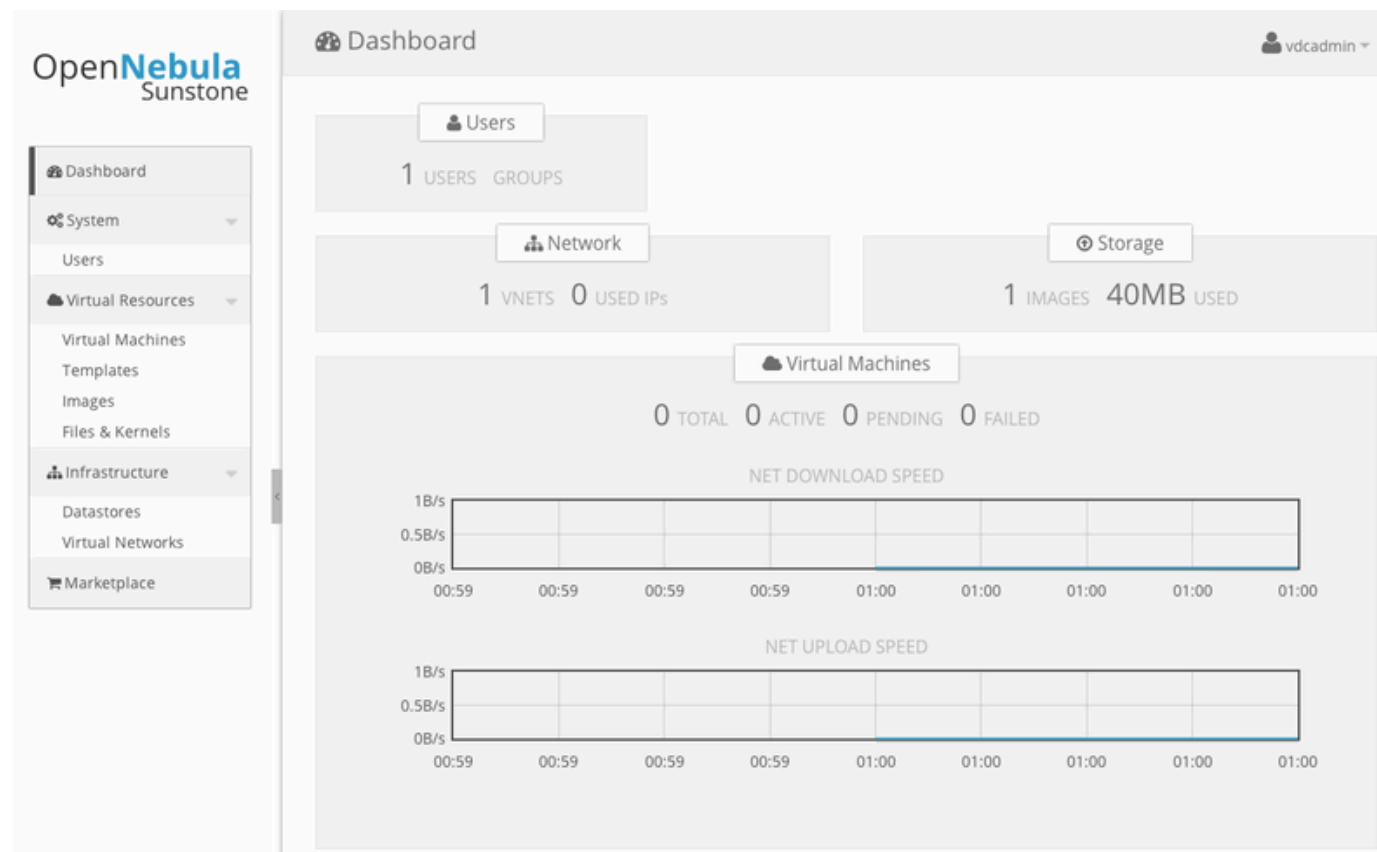
DC West Coast



DC Europe

Admins in each Group/vDC Manage to its Own Virtual Private Cloud

- Each vDC has an **admin**
- **Delegation of management** in the VDC
- Only **virtual resources**, not the underlying physical infrastructure



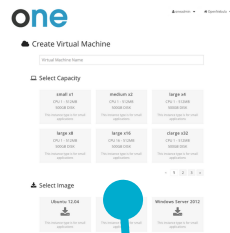
vDC Admin View

The OpenNebula Provisioning Model

OpenNebula.org

Users in each Group/VDC Access to its Own Virtual Private Cloud

Cloud API



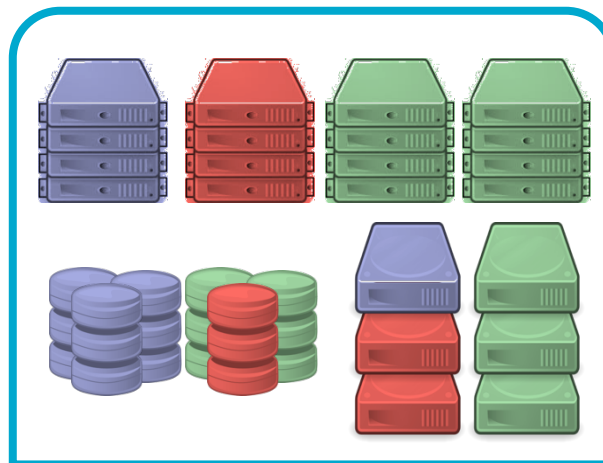
Web
Development

HPC
Simulations

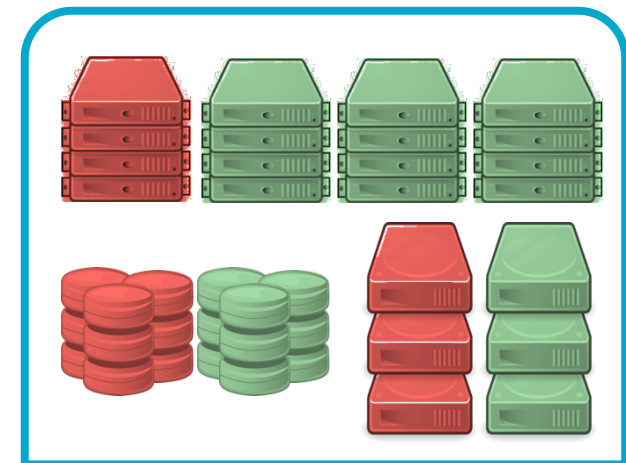
Big Data
Analysis



Public Clouds



DC West Coast



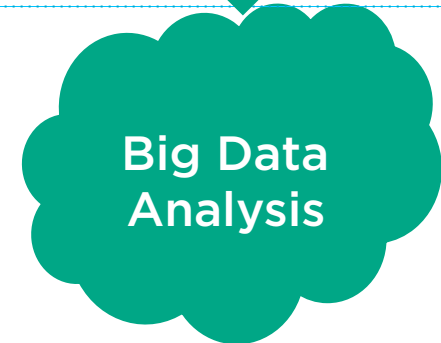
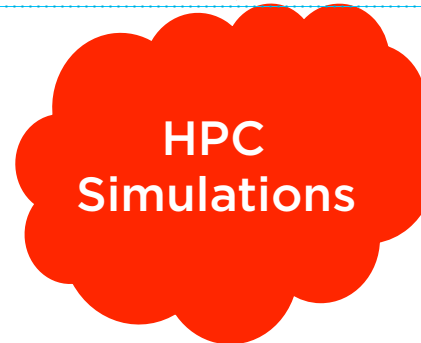
DC Europe

New Level of Provisioning: IaaS as a Service

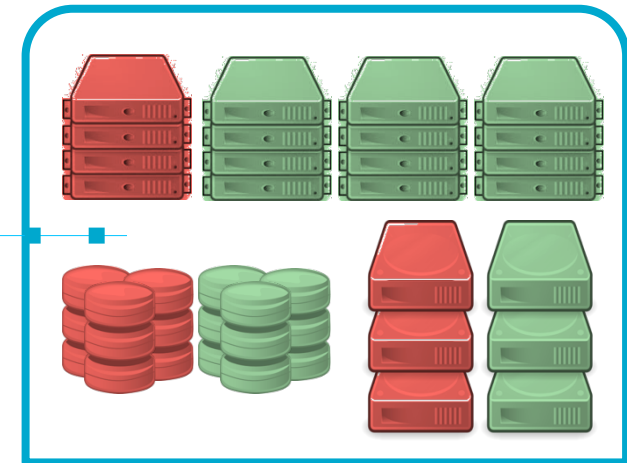
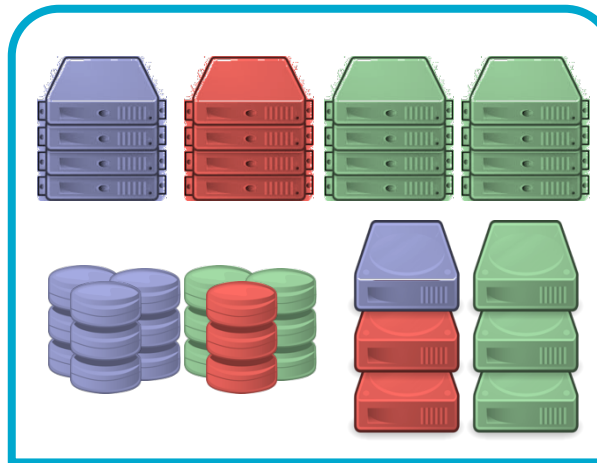
Consumers



vDC Admins



Cloud Admins



Public Clouds

DC West Coast

DC Europe

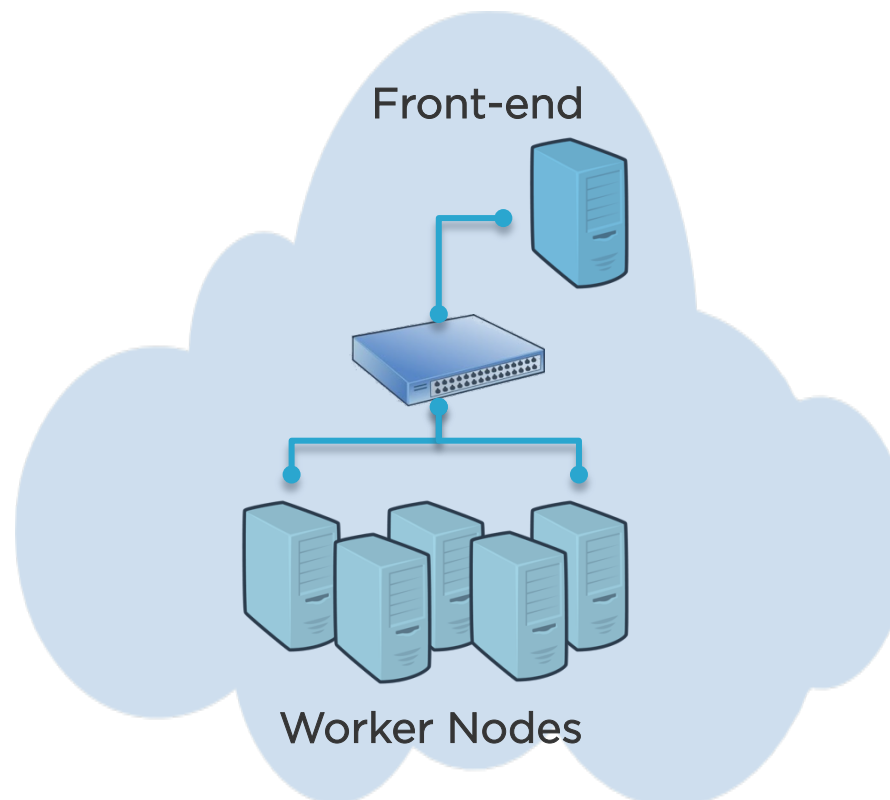
Benefits

- **Partition of cloud resources**
- Complete **isolation** of users, organizations or workloads
- Allocation of Clusters with different levels of **security, performance** or **high availability** to different groups with different workload profiles
- **Containers** for the execution of virtual appliances (SDDCs)
- Way of **hiding physical resources** from Group members
- Simple **federation** and **scalability** of cloud infrastructures beyond a single cloud instance and data center

How Do I Manage a Multi-tier Service?

A Comprehensive Framework to Manage Complex Applications

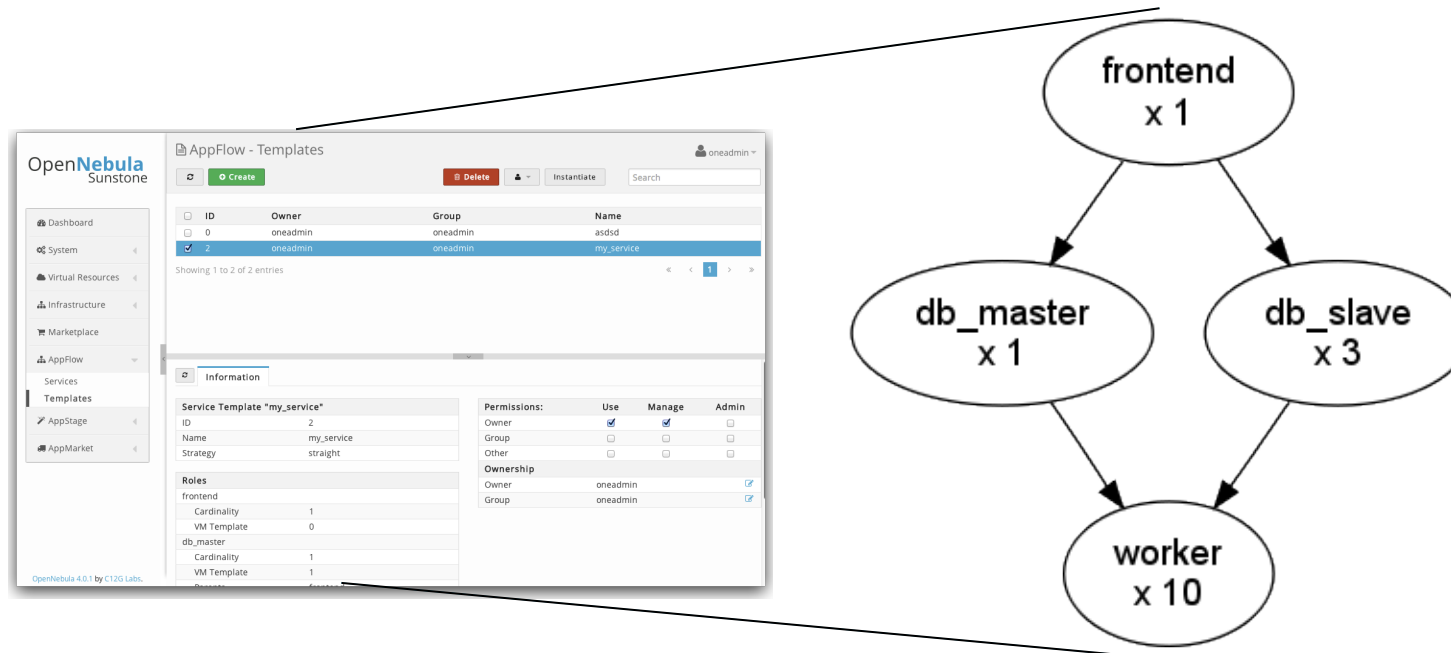
- Several tiers
- Deployment dependencies between components
- Each tier has its own cardinality and elasticity rules
- ...



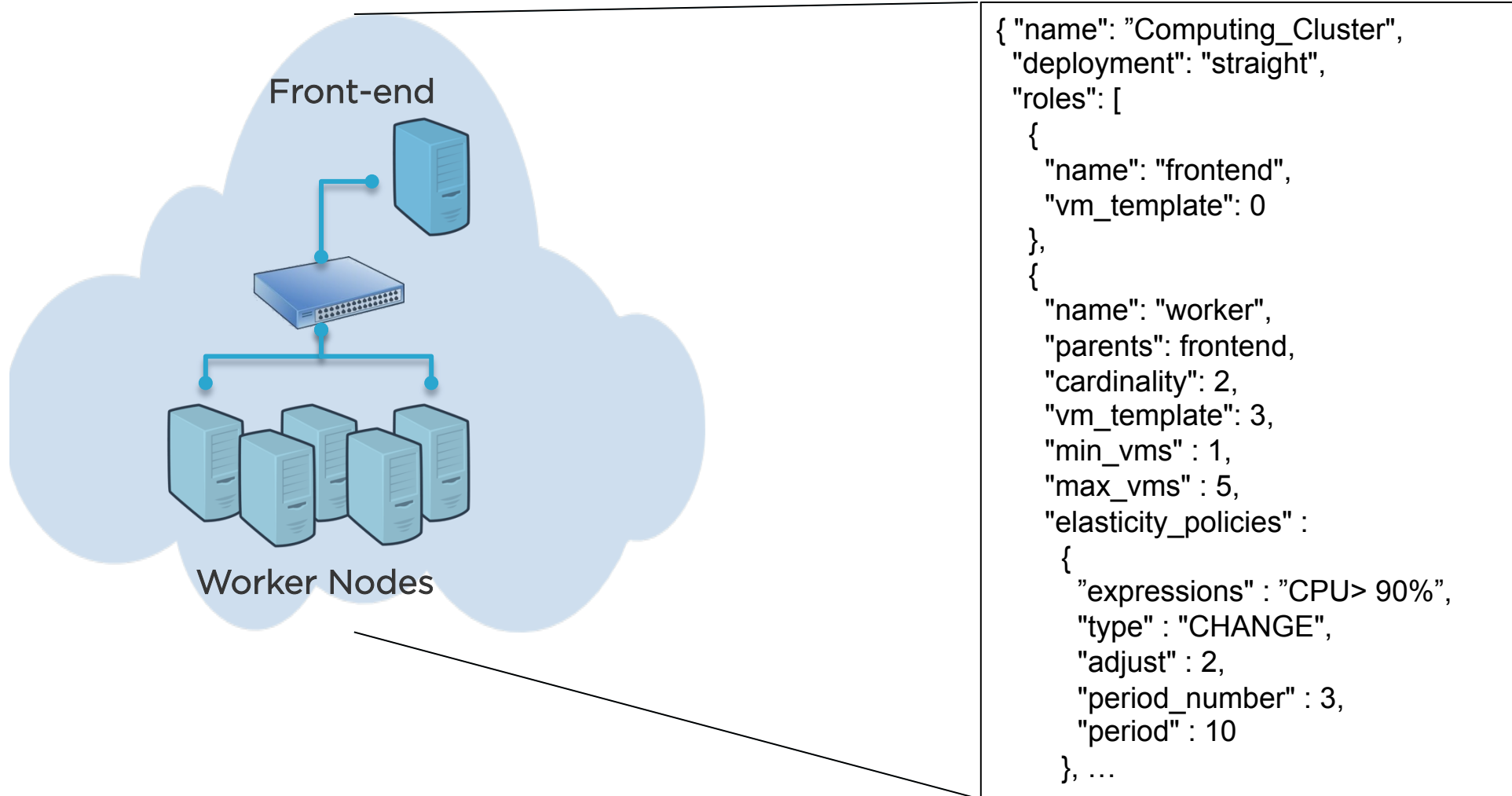
Multi-tier Application Management and Catalog

Management of interconnected multi-VM applications:

- Definition of **application flows**
- **Catalog** with pre-defined applications
- **Sharing** between users and groups
- Management of **persistent scientific data**
- Automatic **elasticity**



An Example of Flow



Let us Talk in Services Terms

Types of Elasticity Rules

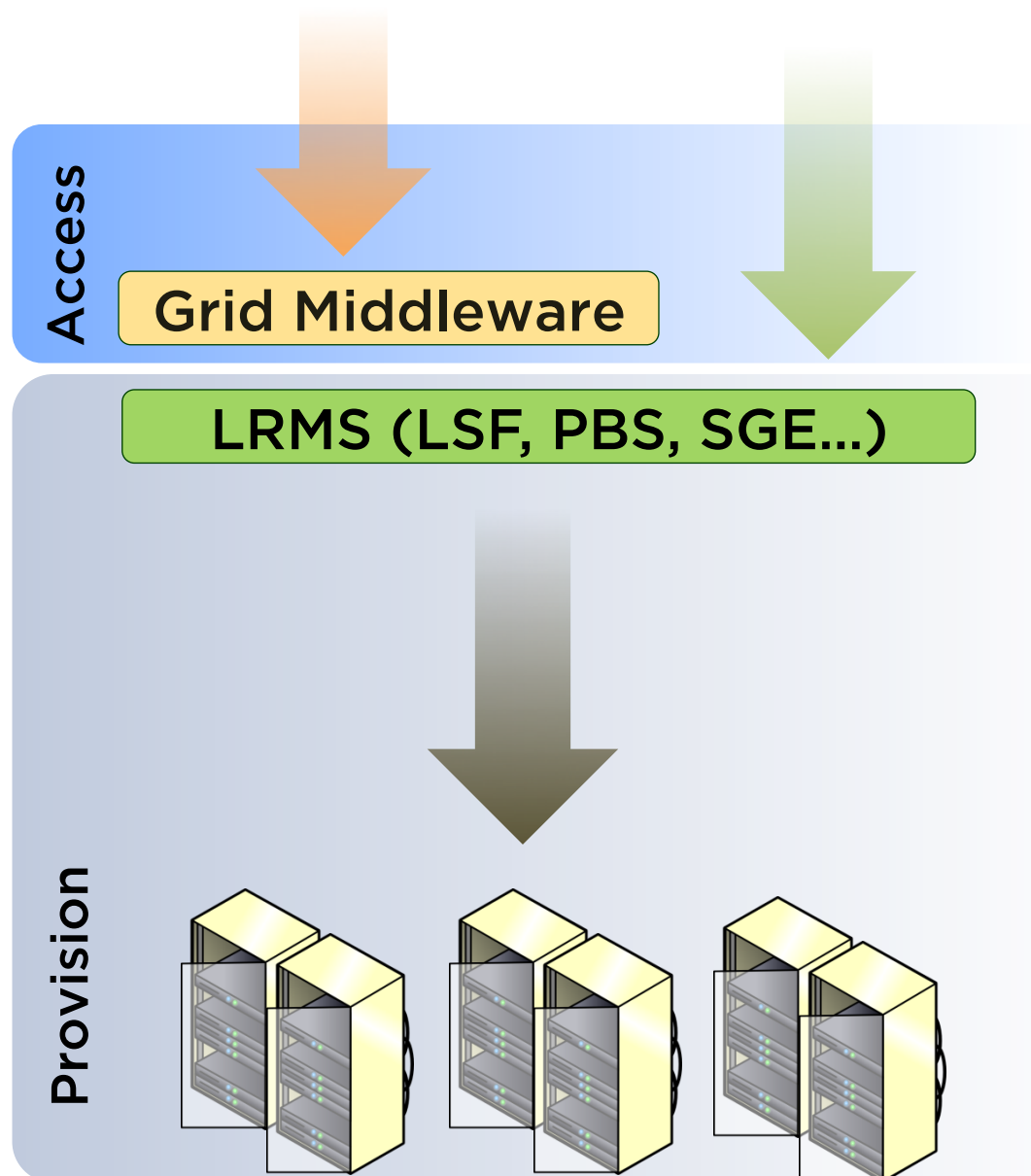
- Auto-scaling Based on Metrics

```
"elasticity_policies" : [  
  {  
    "expression" : "ATT > 50",  
    "type" : "CHANGE",  
    "adjust" : 2,  
  
    "period_number" : 3,  
    "period" : 10  
  },  
  ...  
]
```

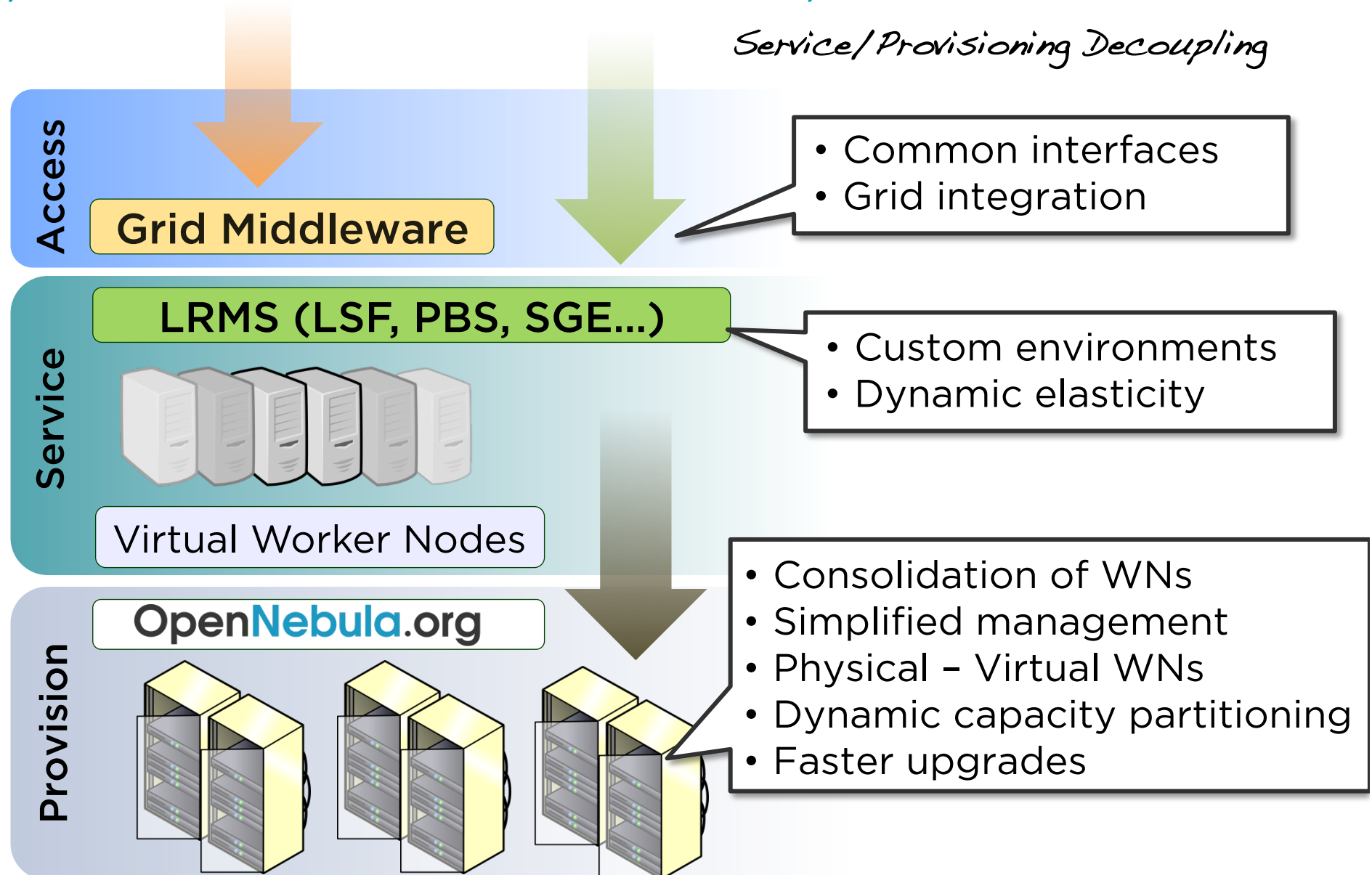
- Auto-scaling Based on a Schedule

```
"scheduled_policies" : [  
  {  
    // Set cardinality to 2 each 10 minutes  
    "recurrence" : "*/10 * * * *",  
  
    "type" : "CARDINALITY",  
    "adjust" : 2  
  },  
  {  
    // +10 percent at the given date and time  
    "start_time" : "2nd oct 2013 15:45",  
  
    "type" : "PERCENTAGE_CHANGE",  
    "adjust" : 10  
  }  
]
```

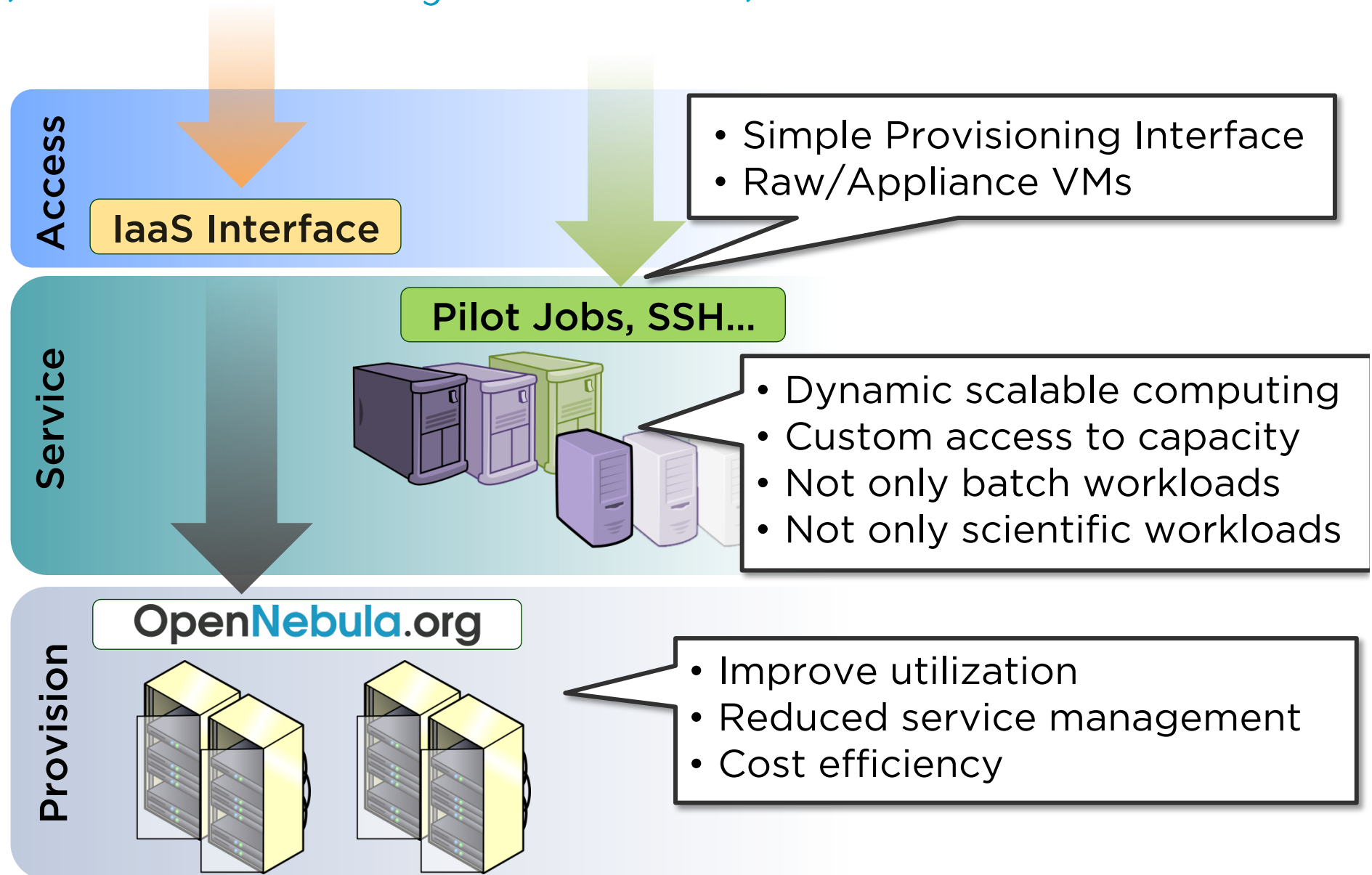
The Pre-cloud Era



OpenNebula as an Infrastructure Tool - Enhanced Capabilities



OpenNebula as an Provisioning Tool - Enhanced Capabilities



Using the Cloud - Performance Penalty as a Small Tax You Have to Pay

Overhead in Virtualization

- Single processor performance penalty between **1% and 5%**
- NASA has reported an overhead between **9% and 25%** (HPCC and NPB)¹
- Growing number of users demanding containers (**OpenVZ** and **LXC**)

Overhead in Input/Output

- Growing number of **Big Data** apps
- Support for **multiple datastores** including automatic scheduling

Need for Low-Latency High-Bandwidth Interconnection

- Lower performance, **10 GigE** typically, used in clouds has a significant negative (**x2-x10**, especially latency) impact on HPC applications¹
- FermiCloud has reported MPI performance (HPL benchmark) on VMs and SR-IOV/**Infiniband** with **only a 4%** overhead²
- The Center for HPC at CSR has contributed the **KVM SR-IOV Drivers for Infiniband**³

(1) An Application-Based Performance Evaluation of Cloud Computing, NASA Ames, 2013

(2) FermiCloud Update, Keith Chadwick!, Fermilab, HePIX Spring Workshop 2013

(3) http://wiki.chpc.ac.za/acelab:opennebula_sr-iov_vmm_driver , 2013

Operating the Cloud - Innovations in Resource Management

Optimal Placement of Virtual Machines

- Automatic placement of VM near input data
- Striping policy to maximize the resources available to VMs

Fair Share of Resources

- Resource quota management to allocate, track and limit resource utilization

Isolated Execution of Applications

- Full Isolation of performance-sensitive applications

Management of Different Hardware Profiles

- Resource pools (physical clusters) with specific Hw and Sw profiles, or security levels for different workload profiles (HPC and HTC)

Hybrid Cloud Computing

- Cloudbursting to address peak or fluctuating demands for non critical and HTC workloads

Provide VOs with Isolated Cloud Environ

- Automatic provision of Virtual Data Centers

One of Our Main User Communities

Supercomputing Centers



SURF SARA



Industry



Research Centers



Distributed Computing Infrastructures



Nodes	KVM on 29 nodes (2 TB RAM – 608 cores) Koi Computer
Network	Gigabit and Infiniband
Storage	CLVM+ GFS2 on shared 120TB NexSAN SataBeats
AuthN	X509
Linux	Scientific Linux
Interface	Sunstone Self-service and EC2 API
App Profile	Legacy, HTC and MPI HPC



Typical Workloads

- Production VM-based batch system via the "econe" EC2 emulation
- Scientific stakeholders get access to on-demand VMs
- Developers & integrators of new Grid applications

CESGA Cloud



<http://cloud.cesga.es/>

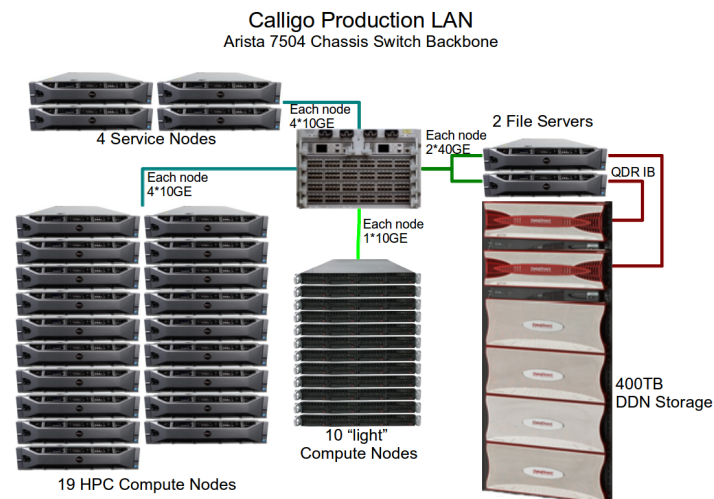
Nodes	KVM on 35 nodes (0.6 TB RAM – 280 cores) HP ProLiant
Network	2 x Gigabit (1G and 10G)
Storage	ssh from remote EMC storage server
AuthN	X509 and core password
Linux	Scientific Linux 6.4
Interface	Sunstone Self-service and OCCI
App Profile	Individual VMs and virtualised computing clusters



Typical Workloads

- 160 users
- Genomic, rendering...
- Grid services on production at CESGA
- Node at FedCloud project
- UMD middleware testing

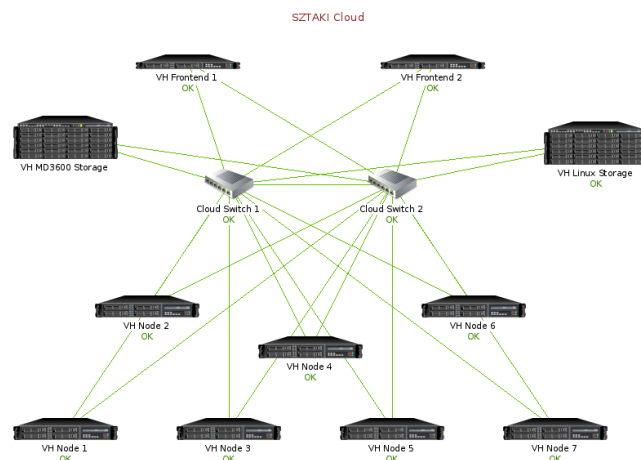
Nodes	KVM on 30 HPC nodes (256 GB RAM 960 cores + 2 TB High-memory node) Dell PowerEdge and 10 “light” nodes (64 GB RAM 80 cores) Supermicro
Network	2 x Gigabit (10G) with Arista switch
Storage	NFS on 500 TB NAS for HPC and ssh for “light”
AuthN	Core password
Linux	CentOS
Interface	Sunstone and OCCI
App Profile	MPI clusters, windows clusters and independent VMs



Typical Workloads

- Ad-hoc clusters with MPI and pilot jobs
- Windows clusters for Windows-bound software
- Single VMs, sometimes acting as web servers to disseminate results

Nodes	KVM on 8 nodes (2 TB RAM – 512 cores) DELL PowerEdge
Network	Redundant 10Gb
Storage	Dell storage servers: iSCSI (36TB) and CEPH (288 TB)
AuthN	X509
Linux	CentOS 6.5
Interface	Sunstone Self-service, EC2 and OCCI
App Profile	Individual VMs and virtualised computing cluster



Typical Workloads

- Run standard and grid services (e.g.:web servers, grid middlewares...)
- Development and testing of new codes
- Research on performance and opportunistic computing

KTh Cloud



<http://www.pdc.kth.se/>

Nodes	KVM on 768 cores (768 GB RAM) HP ProLiant
Network	Infiniband and Gigabit
Storage	NFS and LVM
AuthN	X509 and core password
Linux	Ubuntu
Interface	Sunstone self-service, OCCI and EC2
App Profile	Individual VMs and virtualised computing cluster

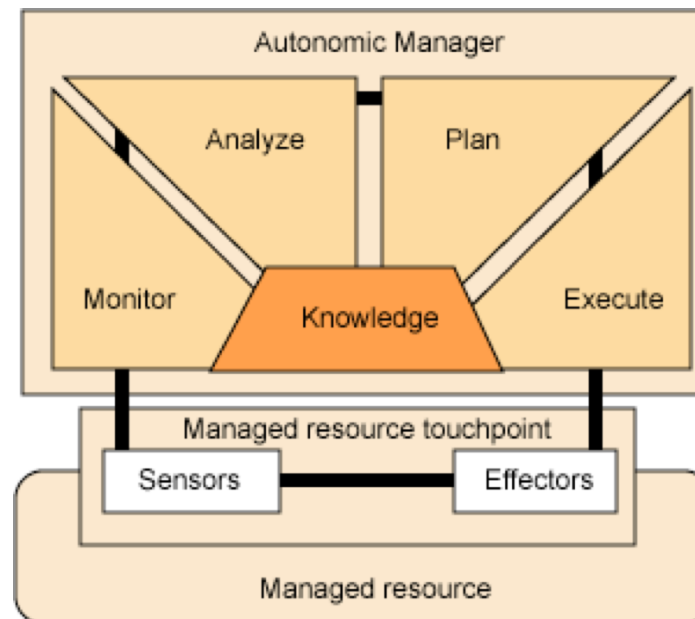
Typical Workloads

- Mainly BIO
- Hadoop, Spark, Galaxy, Cloud Bio Linux...

Autonomic Management Properties

Properties of Autonomic Systems:

- **Self-configuring:** Ability to define themselves “on-the-fly”
- **Self-healing:** Discover, diagnose, and react to disruptions
- **Self-optimizing** (self-adapting): Monitor and tune resources automatically
- **Self-protecting:** Detect, identify and protect themselves against threats



IBM architecture for autonomic computing

Upcoming Innovations in Automatic Management Support

Configure	Systems can change parameters (capacity, placement,...) at runtime
	Systems can connect new devices at runtime (hot plugging)
Healing	Systems can detect faults and recover from them
	Systems can perform software rejuvenation
	Systems can manage spares for application live migration
Optimizing	Systems can get information of the environment at runtime and adapt to it
	Systems can manage elasticity
Protecting	Systems can define and manage user access
	Systems can perform backup and recovery

The PANACEA FP7 Project: <http://panacea-cloud.eu>

PANACEA will propose innovative solutions for proactive autonomic management of cloud resources, based on machine learning, overlay networks, pervasive monitoring and the OpenNebula cloud manager. By predicting anomalies (like time to failure of cloud applications and DDoS attacks) before they occur, PANACEA will provide the following autonomic functionalities:



self-healing
against anomalies by recovering from multiple node and link failures, and using proactive rejuvenation of applications and servers for preventing crashes and increasing the availability, predicting the threshold violation of response time of servers,



self-optimizing
using proactive migration of virtual machines among cloud resources, maintaining the quality of service of end-to-end flows,



self-configuring
by efficiently mapping user's requirements onto distributed clouds and dynamically reconfiguring in the presence of anomalies,



self-protecting
using proactive reconfiguration of overlay networks to protect against DDoS attacks.



The PANACEA Poster at CLOSER 2014

**Dimiter Avresky will talk about PANACEA today at 16:45
Session about EU Projects (MR09)**

panacea Proactive Autonomic Management of Cloud Resources

PANACEA will propose innovative solutions for proactive autonomic management of cloud resources, based on machine learning, overlay networks, pervasive monitoring and the OpenNebula cloud manager. By predicting anomalies (like time to failure of cloud applications and DDoS attacks) before they occur, PANACEA will provide the following autonomic functionalities:

- self-healing**
against anomalies by recovering from multiple node and link failures, and using proactive rejuvenation of applications and servers for preventing crashes and increasing the availability, predicting the threshold violation of response time of servers,
- self-optimizing**
using proactive migration of virtual machines among cloud resources, maintaining the quality of service of end-to-end flows,
- self-configuring**
by efficiently mapping user's requirements onto distributed clouds and dynamically reconfiguring in the presence of anomalies,
- self-protecting**
using proactive reconfiguration of overlay networks to protect against DDoS attacks.

Project coordinator:
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Scientific director:
Dimiter Avresky
(autonomic@iriacn.com) IRIANC

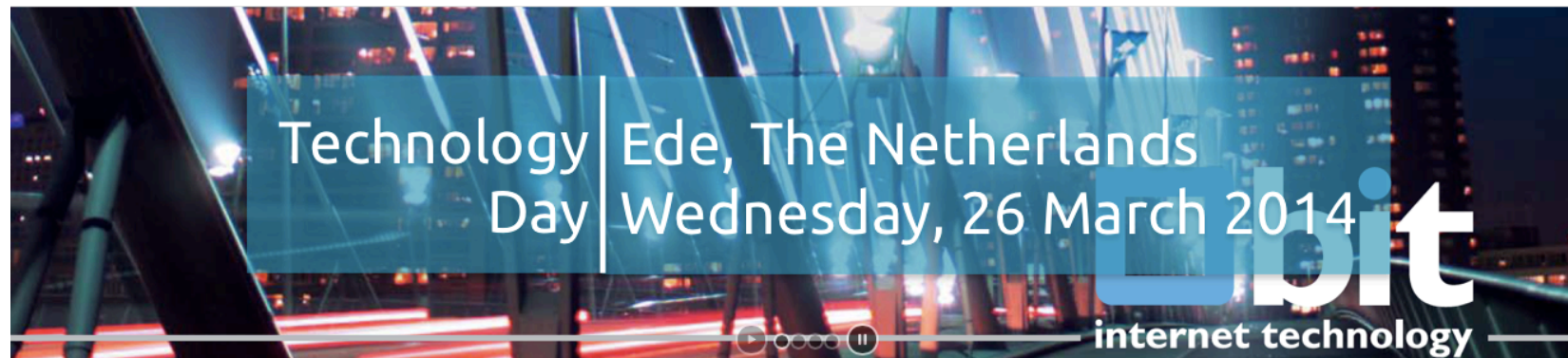
Partners: Atos, LAAS-CNRS, IRIANC, Imperial College London, IBM, UDS, UNIVERSITAT COMPLUTENSE MADRID

Contact: www.panacea-cloud.eu, @PANACEA_EU



This is a Research Event...

Innovation in Cloud Architecture

- 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)
- Rafael Moreno-Vozmediano, Ruben S. Montero, Ignacio M. Llorente, “Multi-Cloud Deployment of Computing Clusters for Loosely-Coupled MTC Applications”, **IEEE Transactions on Parallel and Distributed Systems**, 22(6): 924-930, April 2011
- Rafael Moreno-Vozmediano, Ruben S. Montero, Ignacio M. Llorente, “IaaS Cloud Architecture: From Virtualized Data Centers to Federated Cloud Infrastructures”, **IEEE Computer**, 45(12):65-72, December 2012
- Rafael Moreno-Vozmediano, Ruben S. Montero, Ignacio M. Llorente, “Key Challenges in Cloud Computing to Enable the Future Internet of Services”, **IEEE Internet Computing**, 17(4):18-25, 2012.




Other Cloud TechDays scheduled in Florida, Bay Area, Berlin, Aveiro, Chicago...




Save the date for 2014!

Dec 2 - 4 2014 in Berlin


The [OpenNebula Project](#) will follow up with the second OpenNebula Global Conference in December 2014. The Conference will serve as a meeting point for OpenNebula cloud users, developers, administrators, builders, integrators and researchers and a unique opportunity for discussion and collaboration with other projects. See you again in [Berlin](#)!



**Dec 2 - 4, 2014**
Starting at 02:00 pm

 **Berlin**

tickets from € 595
STARTING IN 2014 >

MAIN SPEAKERS 2013

 **POSTBRIEF**

Find out more about our speakers [here](#).

LATEST NEWS


- Providing the Foundation of the Cloud
- Shaping the Future of Cloud Computing
- Hacking Session
- OpenNebula Conf 2013: the Evening Event
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- **Free workshop** on the first day of the conference
- Amazing **evening event** on the second day
- Free Wi-Fi during the conference
- **Two nights accommodation** (GOLD)
- Additional dinner on the first day (GOLD)

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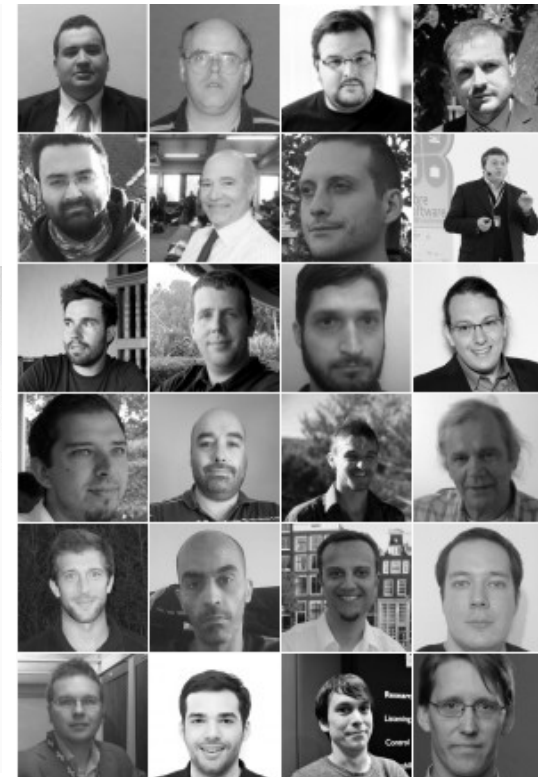


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Questions?

OpenNebula.org

We Will Be Happy to Answer Your Questions



OpenNebula.org



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The screenshot shows the OpenNebula.org website homepage. At the top, the OpenNebula.org logo is displayed with the tagline "Flexible Enterprise Cloud Made Simple". To the right of the logo are social media icons for Facebook, Twitter, LinkedIn, RSS, Google+, YouTube, and Email. Below the header is a navigation menu with links: About, Documentation, Software, Support, Community, Add-ons, Try-out, Users, and Blog. A search icon is located on the far right of the menu. The main banner features a blue background with a bridge and the text "New User Story | OpenNebula at BIT.nl". Below the banner, the heading "OPEN-SOURCE ENTERPRISE CLOUD SIMPLIFIED" is followed by the subtitle "An user-driven cloud management platform for sysadmins and devops". Four feature boxes are presented: "SIMPLE" (Easy to operate, install and upgrade, with packages for the main Linux distributions), "FLEXIBLE" (Really open-source and customizable to fit into any data center and policies), "ROBUST" (Production-ready, mature, reliable and commercially supported), and "POWERFUL" (Innovative functionality for enterprise clouds and data center virtualization). A "Why OpenNebula?" button is located at the bottom center.