

# Cloud Computing

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UvA-SURFsara

# What is Cloud Computing?



## Cloud Computing is an Evolution in IT

### Grid Computing

- Solving large problems with parallel computing
- Made mainstream by Globus Alliance



### Utility Computing

- Offering computing resources as a metered service
- Introduced in late 1990s



### Software as a Service

Network-based subscriptions to applications

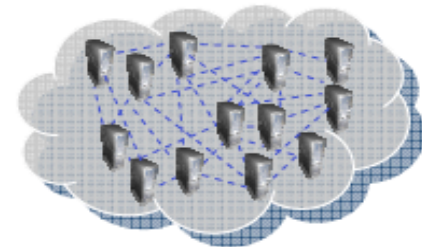
Gained momentum in 2001



### Cloud Computing

Next-Generation Internet computing

Next-Generation Data Centers



# What is the cloud

- IT as a service
- Cloud allows **access** to **services** without **user technical knowledge** or control of supporting infrastructure
- **Best describe in terms of what happened to electrical power over 100 years ago**
- Now computers are simple devices connected to the leader cloud

Data processing, storage and software application that used to run locally are now being supplied by big central computing station, They are becoming in essence **computing utilities**

# The Grid approach

- Urgent computing in Scientific computing and Business has pushed for **on-demand access** to **large amounts** of computational resources or need to tune their runtime demands.
- **Grid technology** enables resource sharing amongst various organizations.
  - **Grid resource management**, however, is optimized towards **fair usage**.
  - **On-demand access** to Grid resources is difficult to achieve in practice, even if multiple Grids are available.

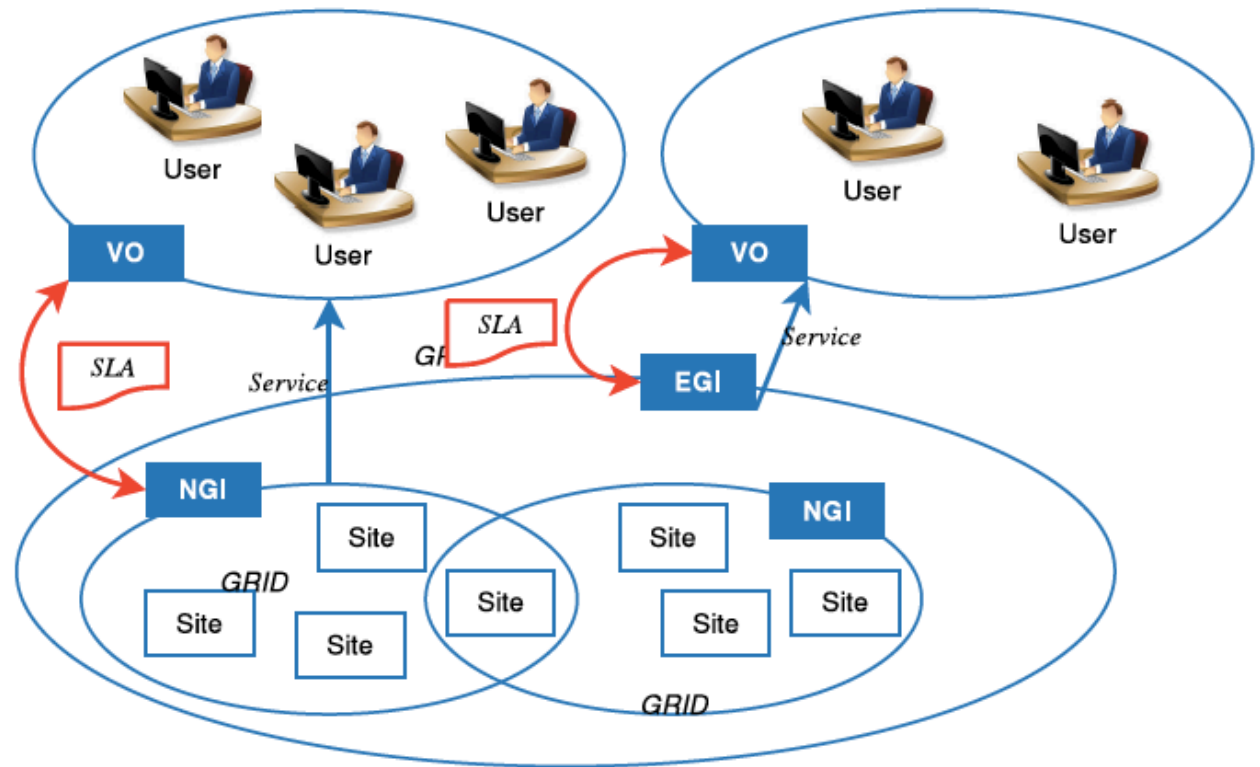
# Why Grid failed to provide on-demand access to computing resources

- Grid virtualization
  - Uniform **access** to computing and storage resources
  - **Discovery** of potential computing resources
  - Provide **security** mechanism (AAA)
- **But** did not address how computing is performed, it was left to the local resource managers (Grid design was suppose to be **not intrusive**)

# Why Grid failed to provide on-demand access to computing resources

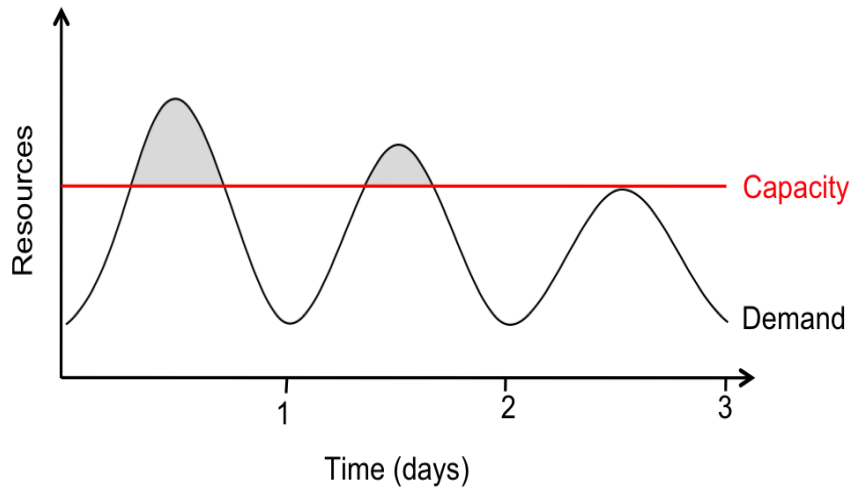
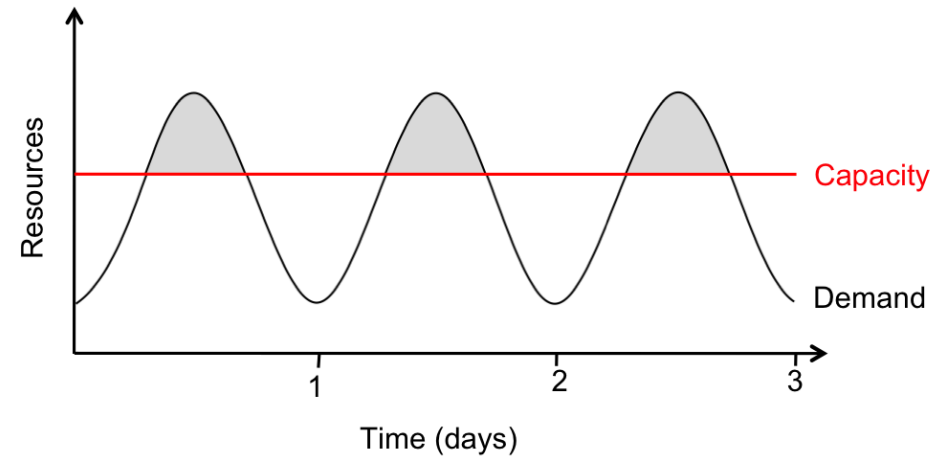
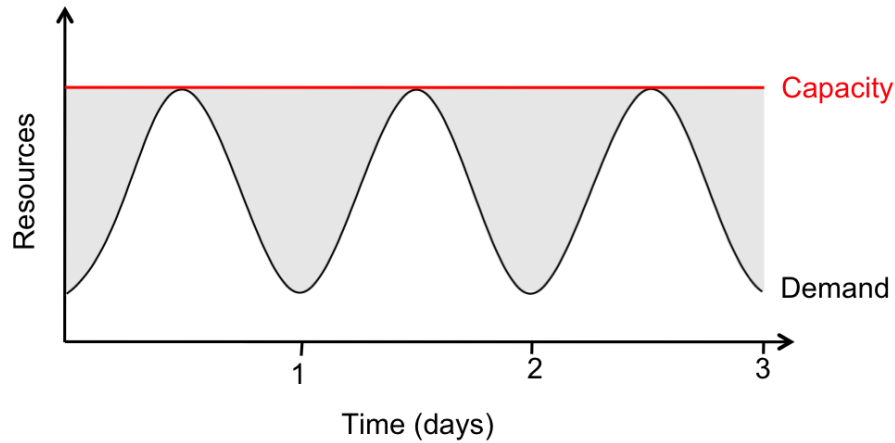
- Challenges
  - When a task end up on the Grid computing resource there is a fair chance for a failure to occur
    - missing lib
    - wrong version of the libs
    - different configuration
    - different OS version
    - ...

# How Grid approach delivers QoS



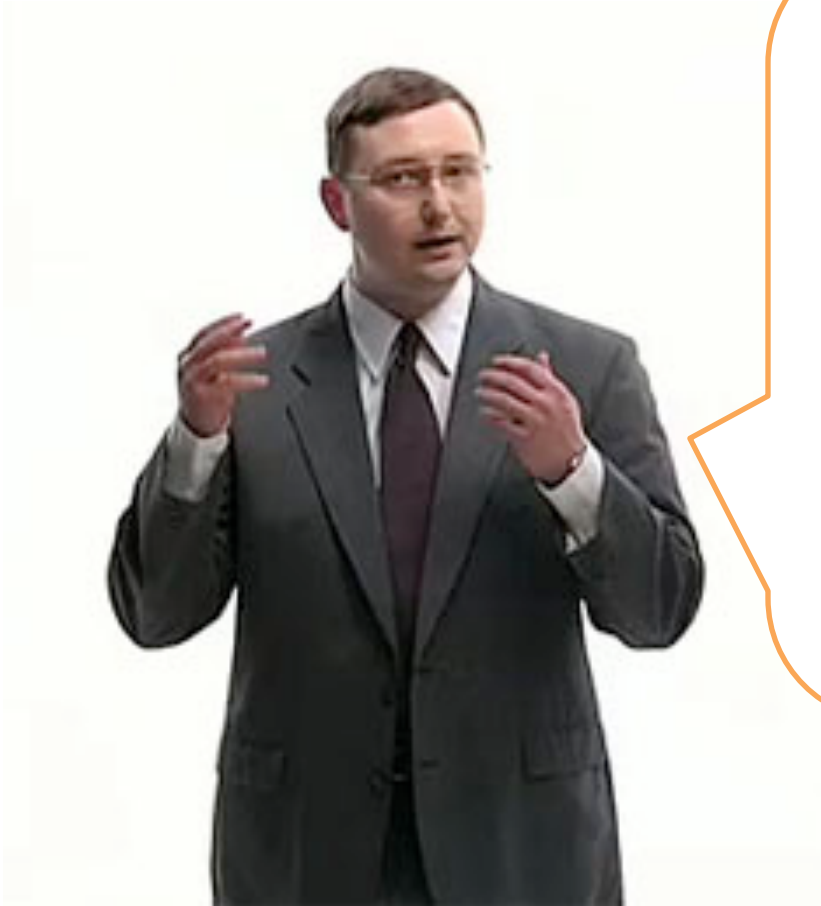
- Service Level Delivery not part of the original grid vision
  - Absence of central control
  - **No Easy** way to enforce SLM and SLD

# Traditional ways of provisioning resources





# Solution 1: Scale up



**Expand your Infrastructure!**  
Buy new servers, increase your  
software costs, provision more  
datacenter capacity!!



# Solution 2: Scale out

## **Look to the cloud!**

Pay for the bandwidth and  
server resources that you need.  
When your push is done then  
turn the whole thing off!



- **The Three Reasons to Cloud Compute :**

[http://www.youtube.com/watch?](http://www.youtube.com/watch?annotation_id=annotation_308603&feature=iv&src_vid=SgujaIzkwrE&v=OlbkMjrrdjQ)

[annotation\\_id=annotation\\_308603&feature=iv&src\\_vid=SgujaIzkwrE&v=OlbkMjrrdjQ](http://www.youtube.com/watch?annotation_id=annotation_308603&feature=iv&src_vid=SgujaIzkwrE&v=OlbkMjrrdjQ)



# Style of computing & usage model



## What is Cloud Computing?

A style of computing where massively scalable IT-enabled capabilities are provided "as a service" over the network



*Acquisition Model*  
**Service based**

"I only care about results, not how IT capabilities are implemented"

*Business Model*  
**Usage based**

"I want to pay for what I use, like a utility"

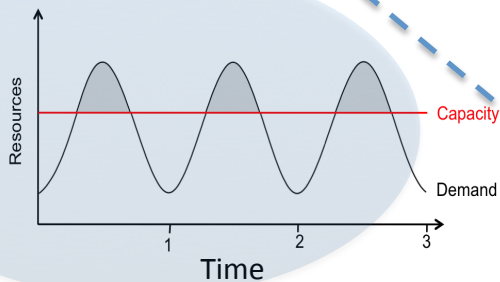
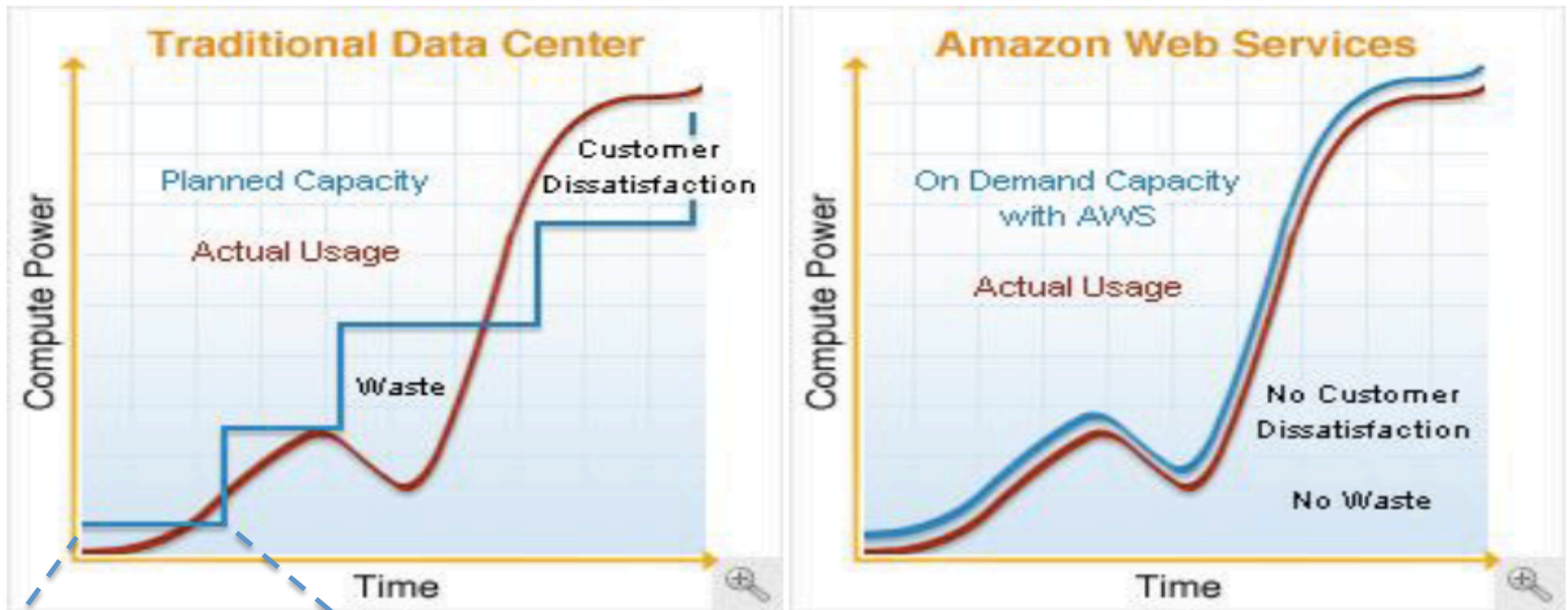
*Access Model*  
**Internet, Intranet**

"I can access services from anywhere, from any device"

*Technical Model*  
**Dynamic, flexible**

"I can scale up or down capacity, as needed"

# Elastic approach to resource provisioning





# Utility based usage metric



## Cloud Computing Characteristics

### Consumer Perspective

*Single Point of Access*

Self service with rich user experience

*Virtualization*

Increased system utilizations

*Automation*

Automated service request and fulfillment

*Agility*

Rapid service provisioning

*Flexibility*

Massive scaling of IT services as needed

*Usage Accounting*

Utility based usage metrics

*Service Management*

Modular services managed across infra/platform/application/business stacks.

*Security*

Shared services delivered across trusted domains

*Cost Efficiency*

Reduced CapEx with minimal to no asset ownership

# Delivery Models



## Cloud Delivery Models

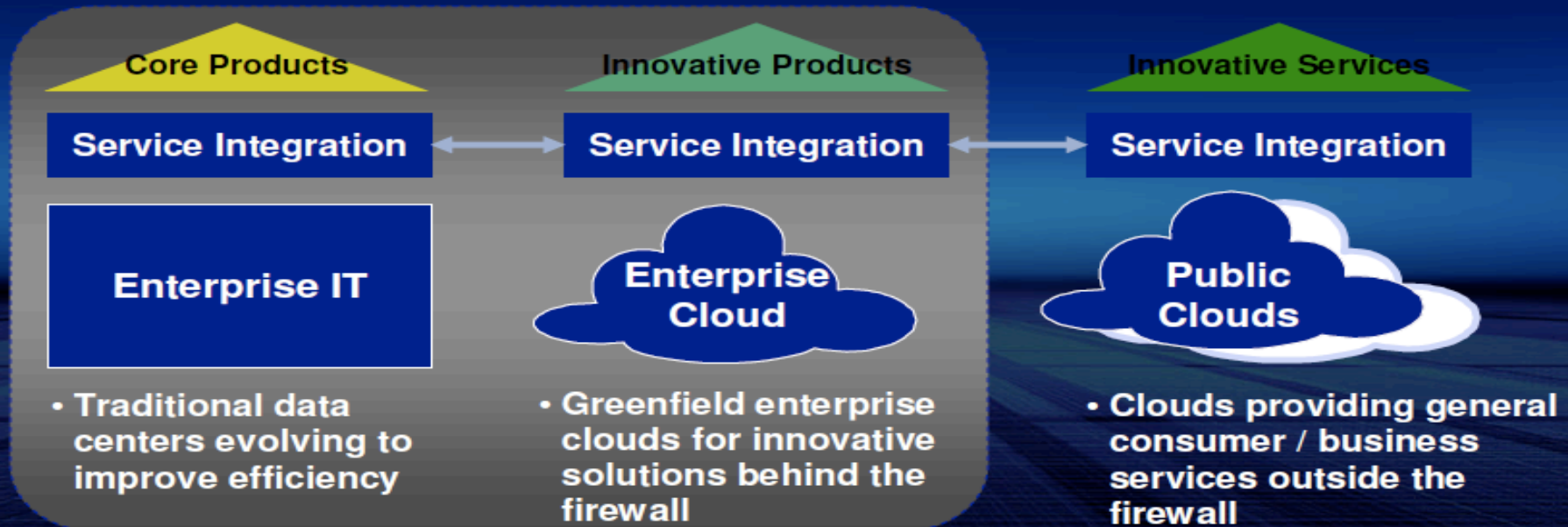
*Enterprise Internal Cloud – Security sensitive Cloud services delivered behind the firewall.*

*Public Cloud – General Cloud Services delivered over the Internet*

*Hybrid Cloud – Combination of internal and external cloud services.*

Clients and Customers

Innovative Business Models



# A new consumption Model for IT

*Self Service*

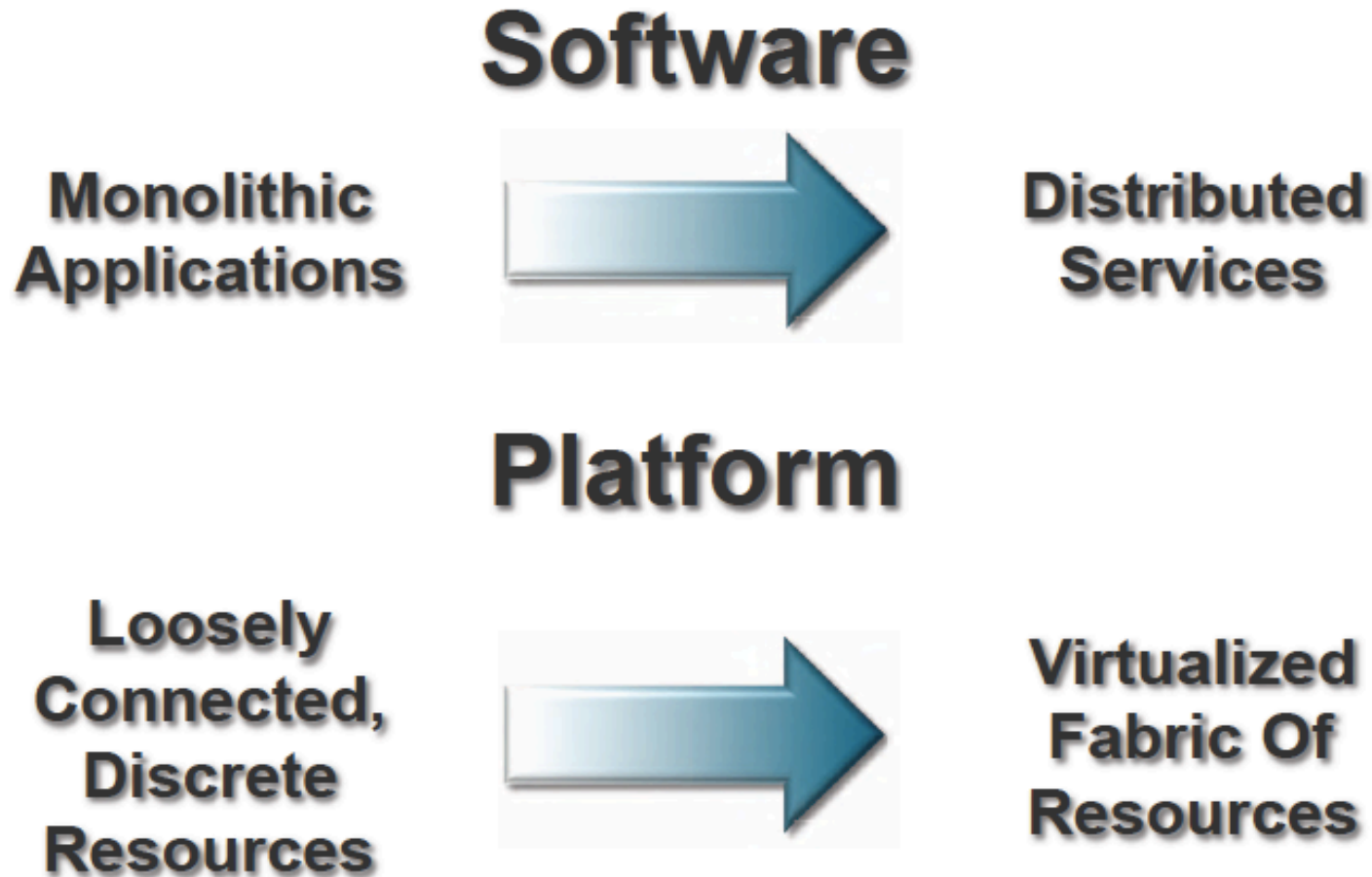
*Instantly Provisioned*

*Pay For Use*

*Efficient*

*Scale Up & Down*

# Enabling Cloud

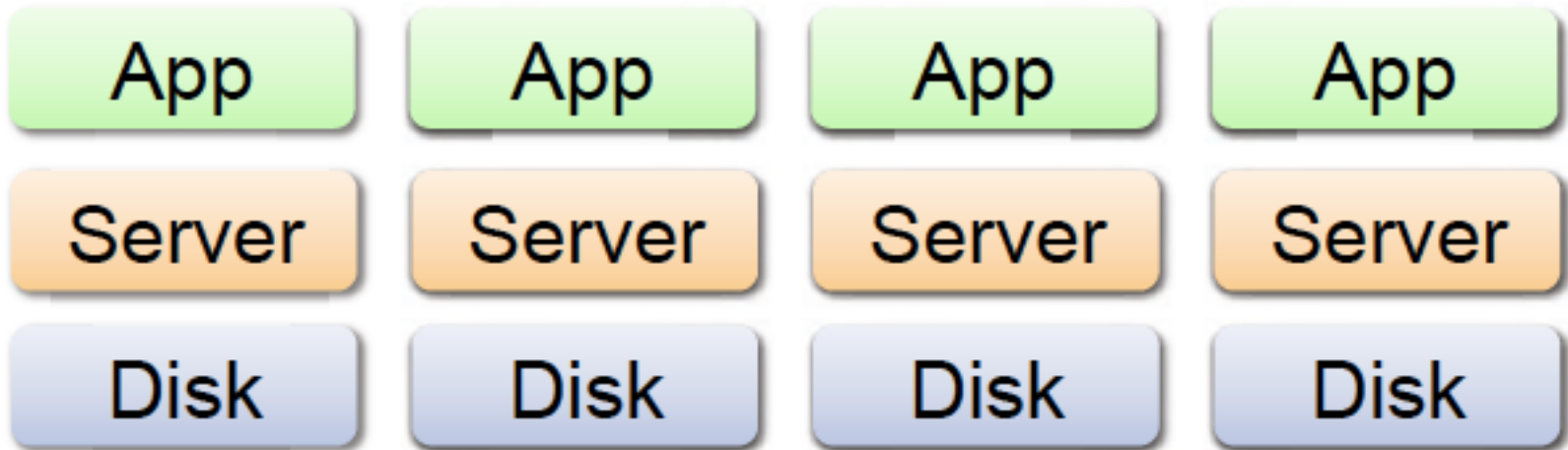


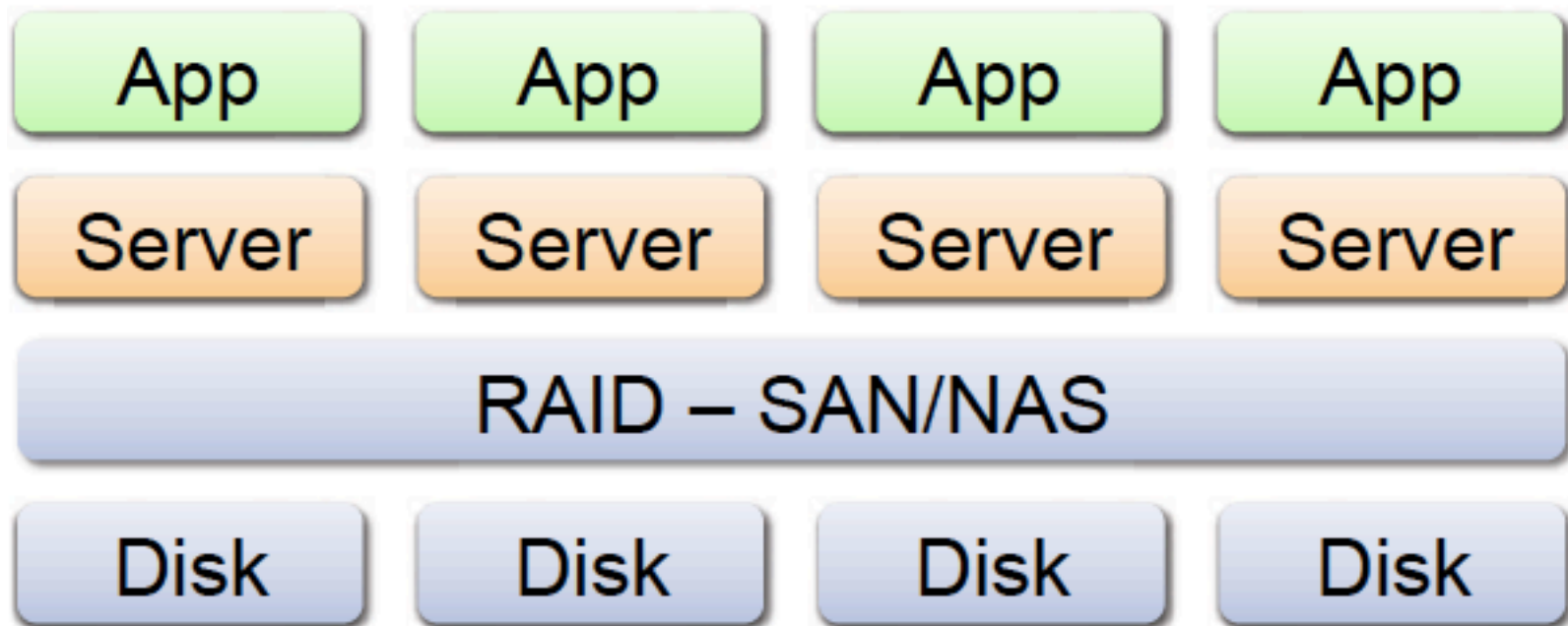


# Abstract Pool automate



# Abstract Pool automate





App

App

App

App

VM

VM

VM

VM

H/V – IaaS

Server

Server

Server

Server

RAID – SAN/NAS

Disk

Disk

Disk

Disk

App

App

App

App

PaaS

VM

VM

VM

VM

H/V – IaaS

Server

Server

Server

Server

RAID – SAN/NAS

Disk

Disk

Disk

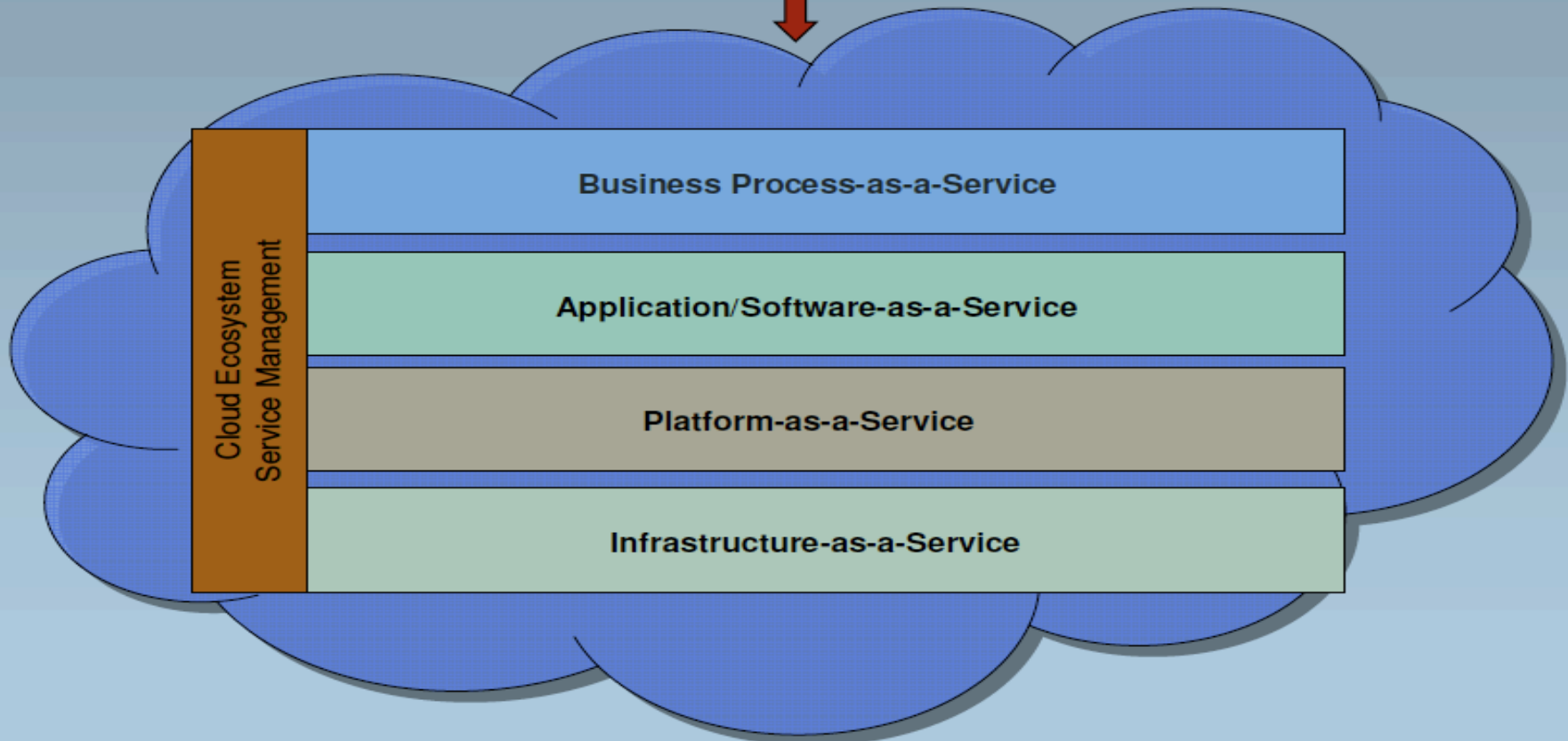
Disk

# Everything-as-a-Service

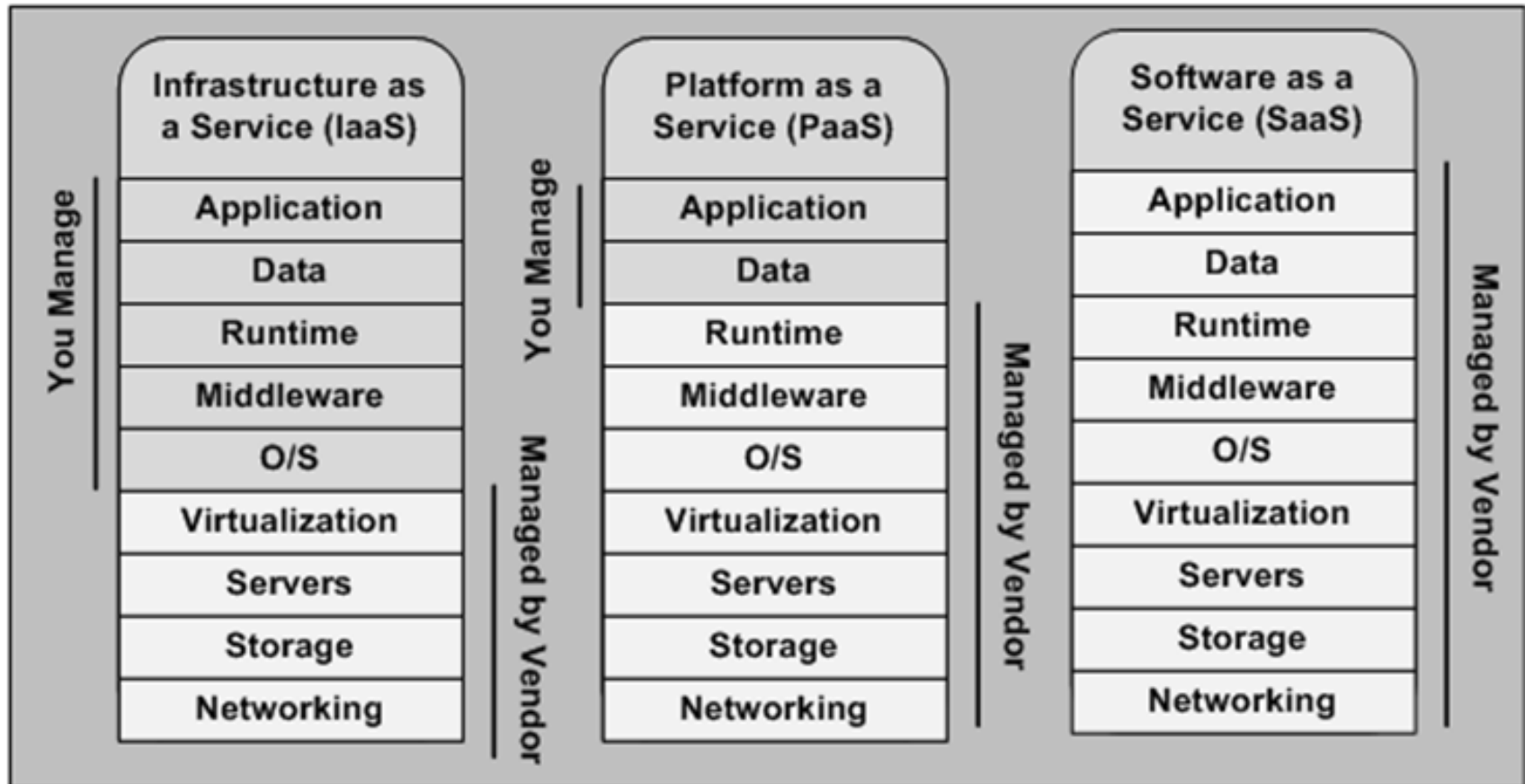
## A Cloud Framework



Service Consumers



# Interaction with Cloud systems



# Example of the elasticity and scalability (IaaS)

- To test the possibilities and performance of Grid on Demand a Biomedical Application and a workflow manager are used
- Biomedical Application: WAVE
  - Parallel (MonteCarlo simulation) application
- Workflow Manager
  - A (graphical) tool to assist complex e-Science application creation
  - Creates a series of jobsubmissions
  - WS-VLAM created by UvA SNE Group
  - Connects to Globus Grid Interface

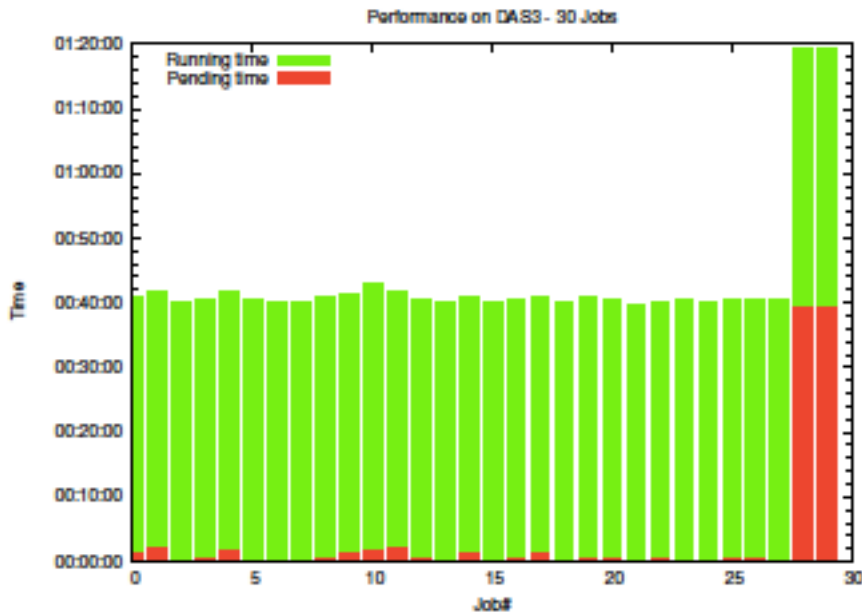


# Example of the elasticity and scalability (IaaS)

demand compared to a 32 node physical UvA cluster (DAS3)  
Globus Grid interface

Grid	Jobs	Total execution time
DAS3	28	00:42:58
Grid on Demand	28	00:46:22
DAS3	98	02:46:36
Grid on Demand	98	00:52:26

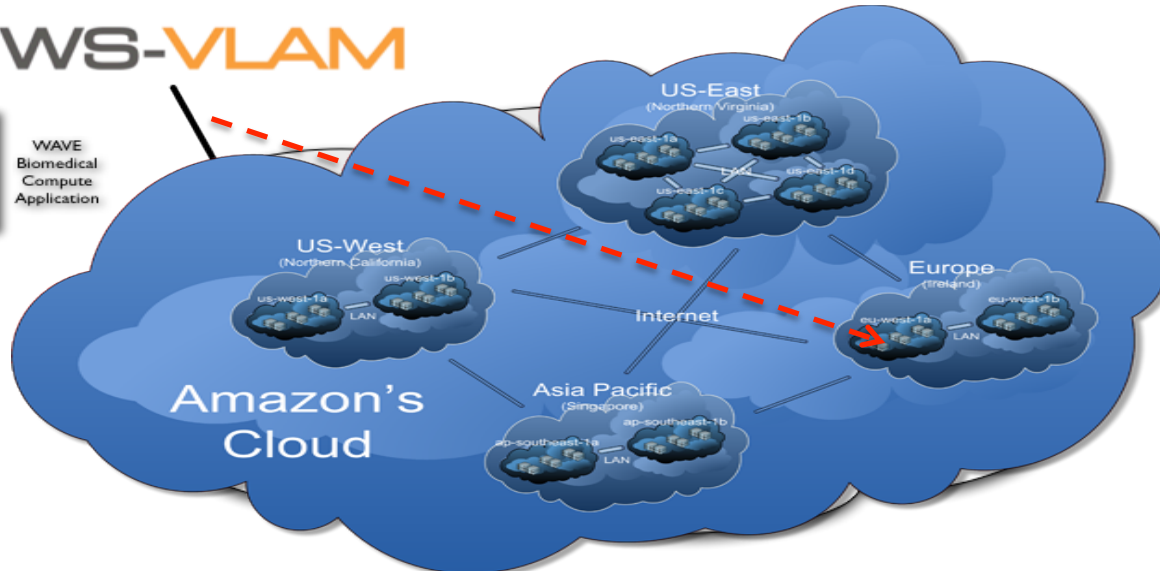
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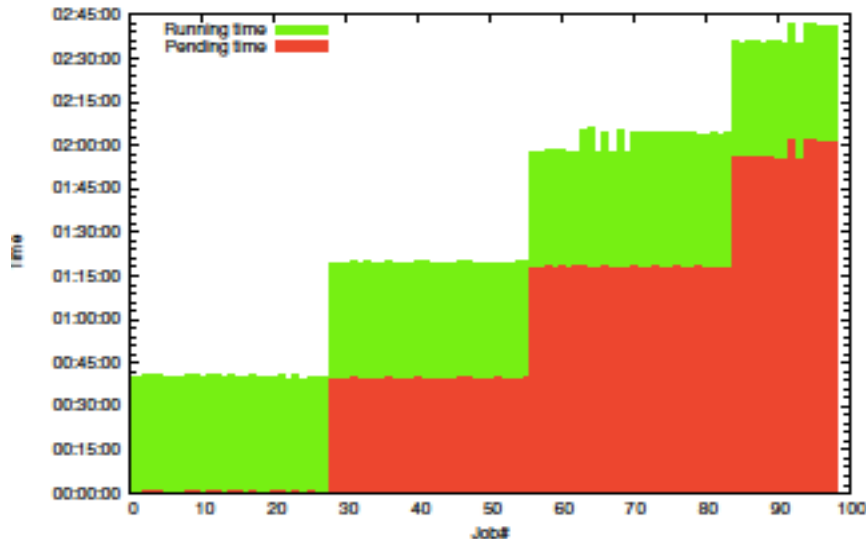
# Example of the elasticity and scalability



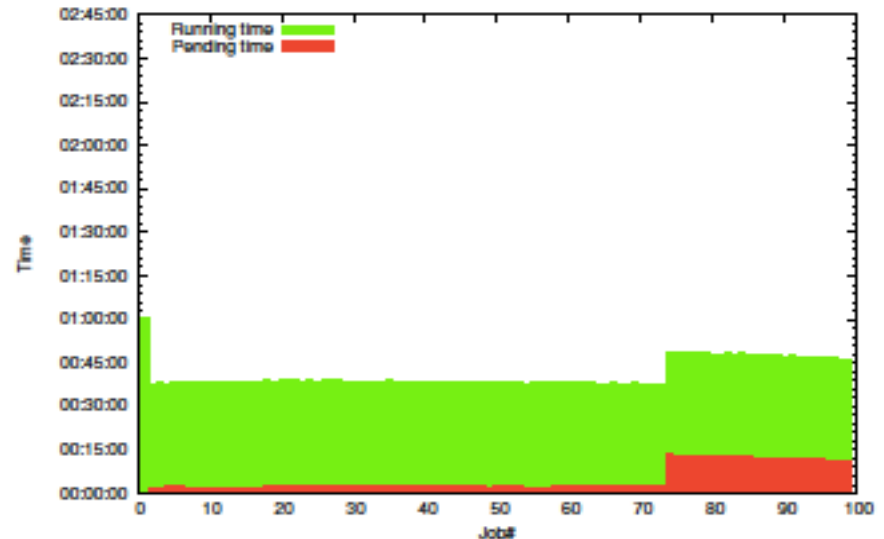
WAVE  
Biomedical  
Compute  
Application



Performance on DASS - 100 Jobs



Performance on Grid on Demand - 100 Jobs



# Infrastructure as a Service (IaaS).

Amazon	<b>S3</b> (Data storage/file system), <b>SimpleDB</b> (non-relational database) <b>EC2</b> (computing servers).
Rackspace	<b>Cloud Drive</b> (Data storage/file system), <b>Cloud Sites</b> (web site hosting on cloud) <b>Cloud Servers</b> (computing servers).
GoGrid	<b>Cloud Hosting</b> (web site hosting on cloud) <b>Cloud Storage</b> (Data storage/file system).
IBM	<b>Smart Business Storage Cloud</b> <b>Computing on Demand (CoD)</b>

# Platform as a Service (PaaS).

Googles	<b>AppEngine</b> is a development platform based upon Python and Java
force.com	<b>Apex</b> a development platform based upon a proprietary programming language
Microsoft	<b>Azure</b> provides a development platform based upon .Net.

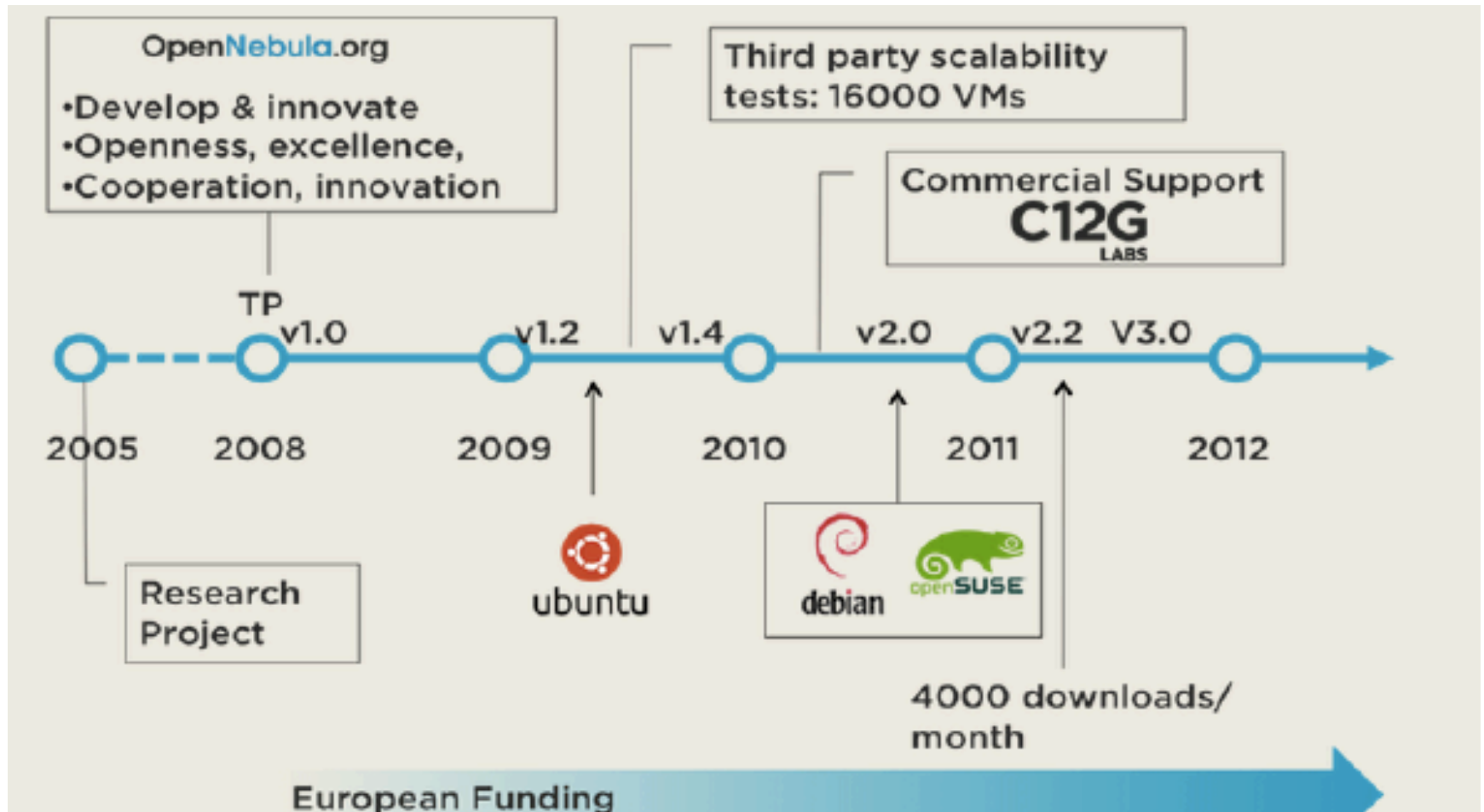
# Software as a Service (SaaS)

Google	Google Docs, GMail, Google Calendar and Picasa
IBM	<b>LotusLive iNotes</b> , a web based email service that provides messaging and calendaring capabilities to business users
Zoho	has vast suite of online products similar to Microsoft office suite.

# Software as a Service (SaaS) applications processing

- Photo editing software
- Online file storage
- Twitter related applications
- Digital Video
- Photo Album
- Editing documents, spreadsheets and powerpoints
- Navigation: google Maps, Yahoo maps, ...
- e-commerce software
- ...

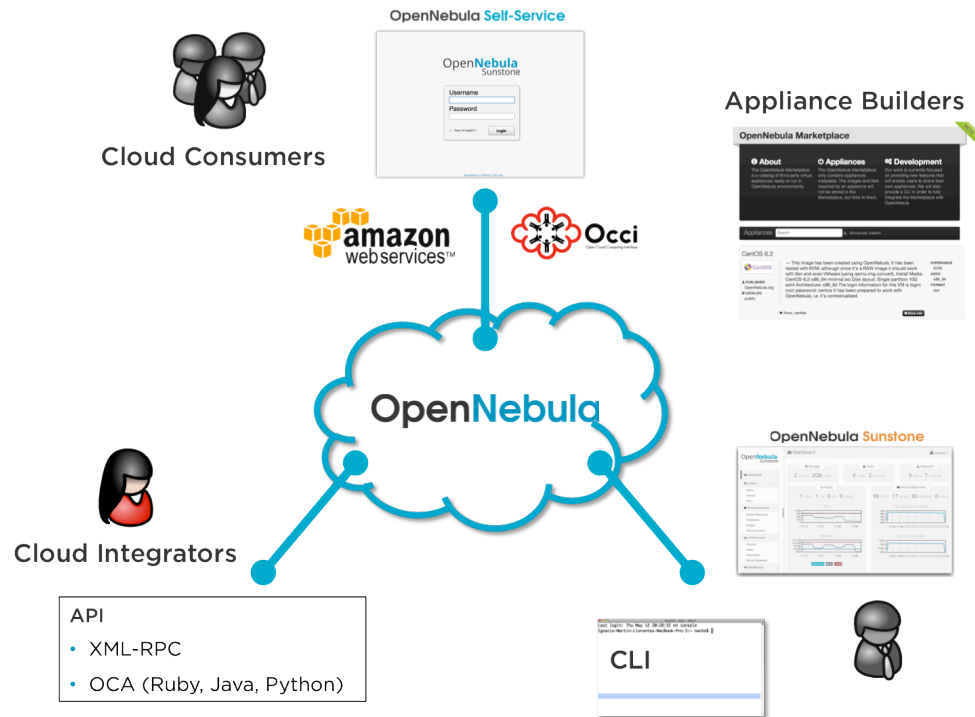
# Open Source Cloud Software: OpenNebula





# Open Source Cloud Software: OpenNebula

- OpenNebula provides different interfaces to interact and manage physical and virtual resources.



# Open Source Cloud Software: OpenStack

- The OpenStack Open Source Cloud Mission:  
“to produce the **ubiquitous** Open Source Cloud Computing platform that will meet the needs of **public** and **private** clouds regardless of size, by being simple to implement and massively scalable.”
- Originated by **Rackspace** and **NASA** In **2010**

# Further Reading ...

1. Ian Foster, ***Cloud Computing and Grid Computing 360-Degree Compared***  
<http://arxiv.org/pdf/0901.0131.pdf>
2. Luis Rodero-Merino et al., ***From infrastructure delivery to service management in clouds***, Future Generation Journal