Grid y Computación
de Altas Prestaciones
GRyCAP

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# ON DEMAND REPLICATION OF WSRF-BASED GRID SERVICES VIA CLOUD COMPUTING

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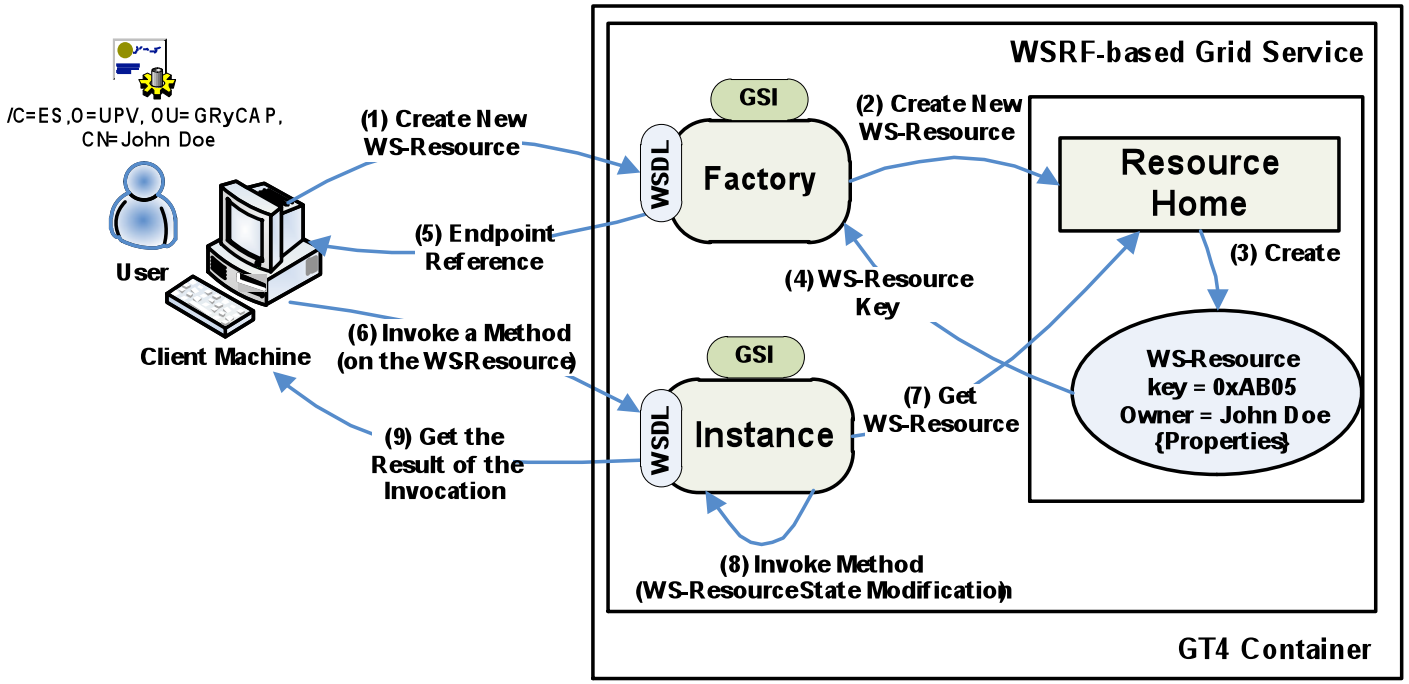
# OUTLINE OF THE TALK

- Outline
  1. Introduction
  2. The Grid Service Replication Library
  3. Cloud Computing: Contextualization and Cataloging
  4. A Cloud back-end for the Replication Library
  5. Results and Discussion
  6. Conclusions and Future Works

# INTRODUCTION (I)

## Anatomy of a GT4-based Grid Service

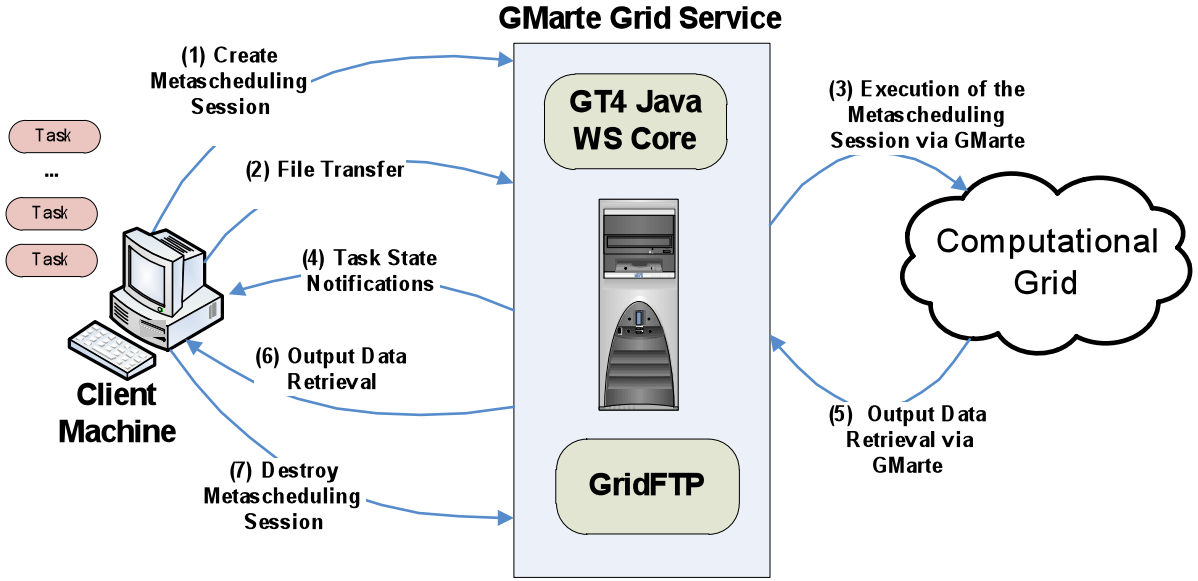
- The Globus Toolkit 4 (GT4) allows developers to create service-oriented components for the Grid
  - Loosely coupled, interoperable Grid services.
- WSRF-based Grid service = Web service + WS-Resource



# INTRODUCTION (II)

## A Sample GT4-based Grid Service

- Service-Oriented Metascheduling on Computational Grids



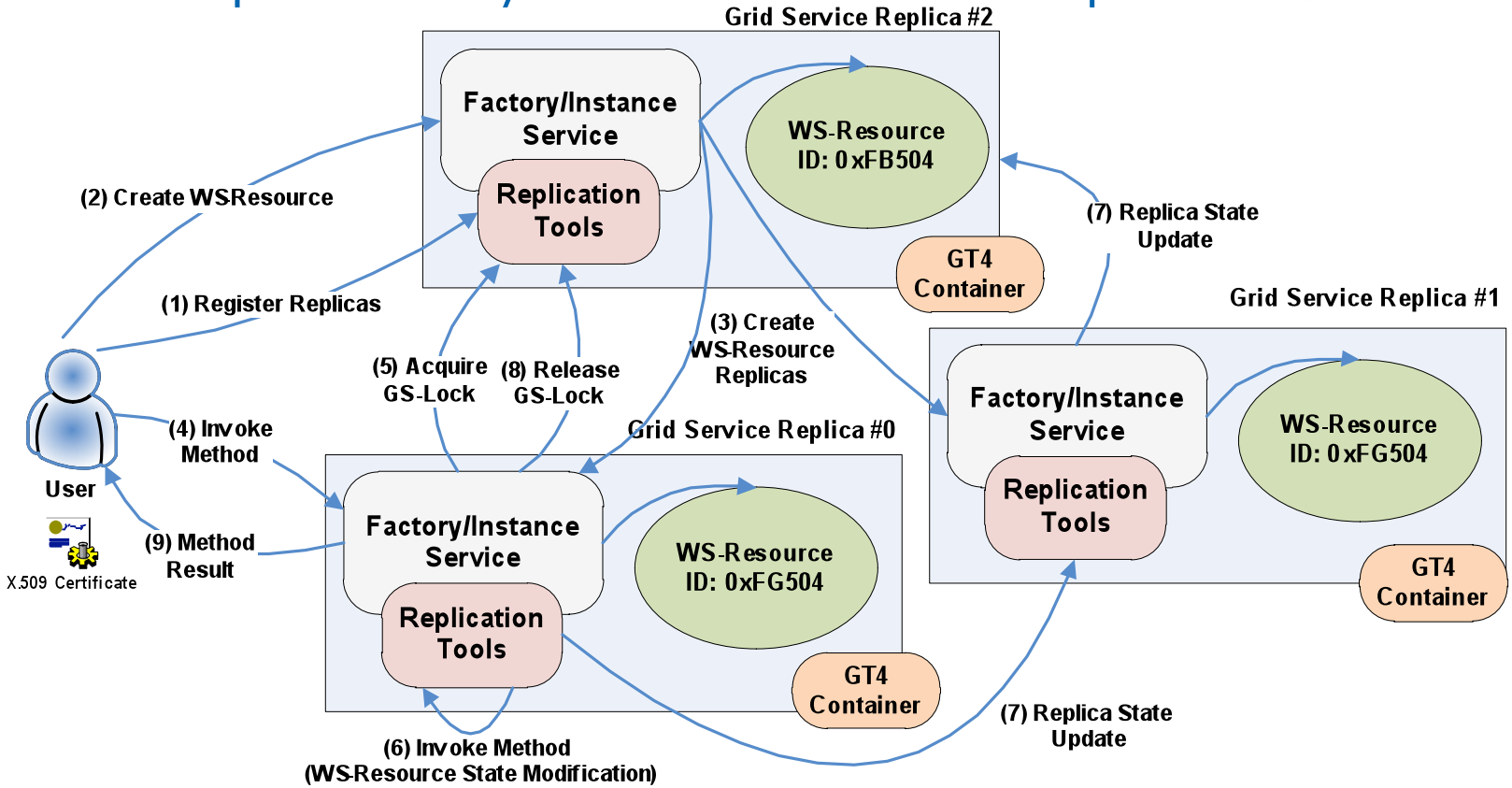

- Multi-user support accesible via the Internet.
- Metascheduling sessions (stored as WS-Resources)
- Hide the details when interacting with a Grid.
- GUI, CLI


G. Moltó, V. Hernández, and J. M. Alonso. **A Service-Oriented WSRF-based Architecture for Metascheduling on Computational Grids**. Future Generation Computer Systems (International Journal of Grid Computing), 24(4):317–328, 2008.

# INTRODUCTION (III)

## The WSRF-based Grid Service Replication Library

- In a previous work, we developed a library for GT4-based Grid service replication by WS-Resource state replication.



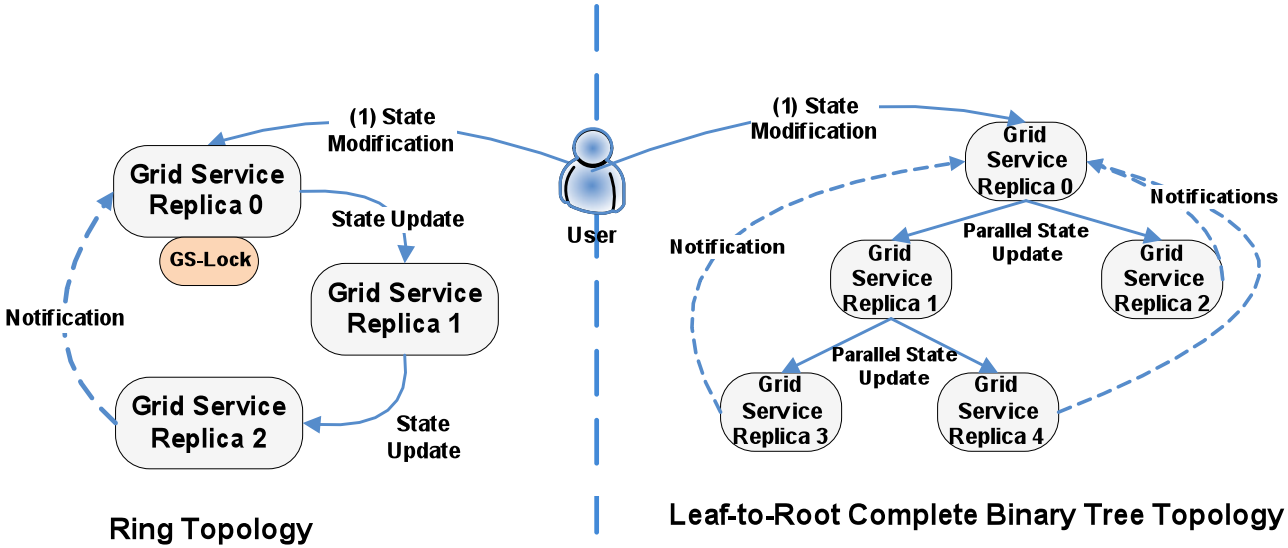

G. Moltó, V. Hernández, and J. M. Alonso. **Automatic Replication of WSRF-based Grid Services via Operation Providers**. Future Generation Computer Systems (International Journal of Grid Computing), 25(8):876–883, 2009

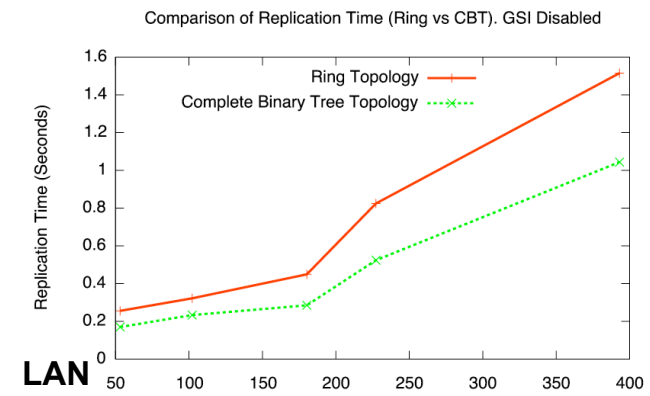
# INTRODUCTION (IV)

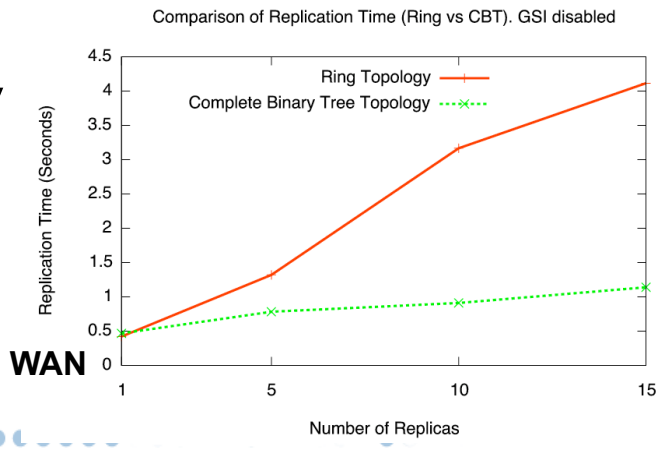




- Different topologies supported:
  - Ring-based: O(N) replication time (N = number of replicas).
  - Complete Binary Tree: $O(\log_2(N))$ replication time.




- Transparent replication of Grid Services via pluggable mechanisms.

# INTRODUCTION (V)

## Dynamic Scaling the Number of Replicas



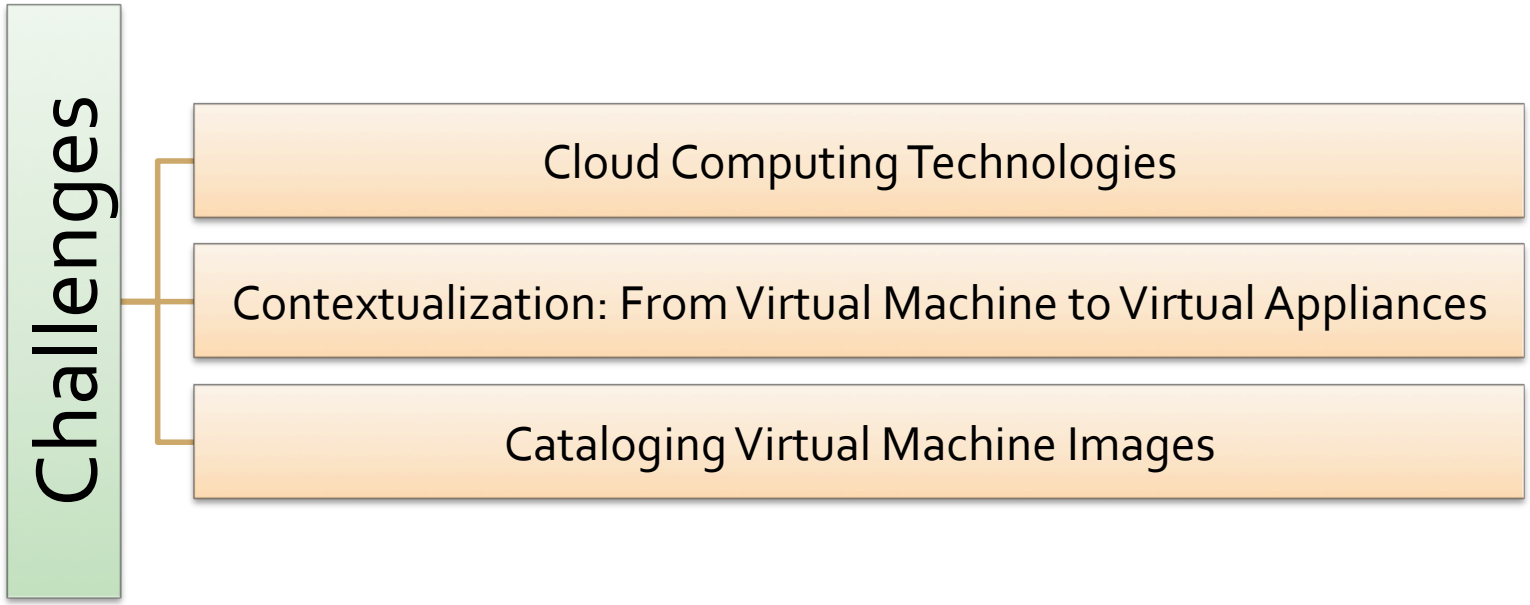
- The dynamic management of the number of replicas allows to:
  - Increase the size of the group of replicas to augment service availability.
  - Decrease the size of the group of replicas to release resources when they are no longer needed.
  - Replace the failed replicas with new ones.
- But:
  - Creating a new replica involves installing and configuring the Globus Toolkit (not trivial) as well as deploying the Grid service to be replicated and the replication library.

# PURPOSE OF THIS WORK





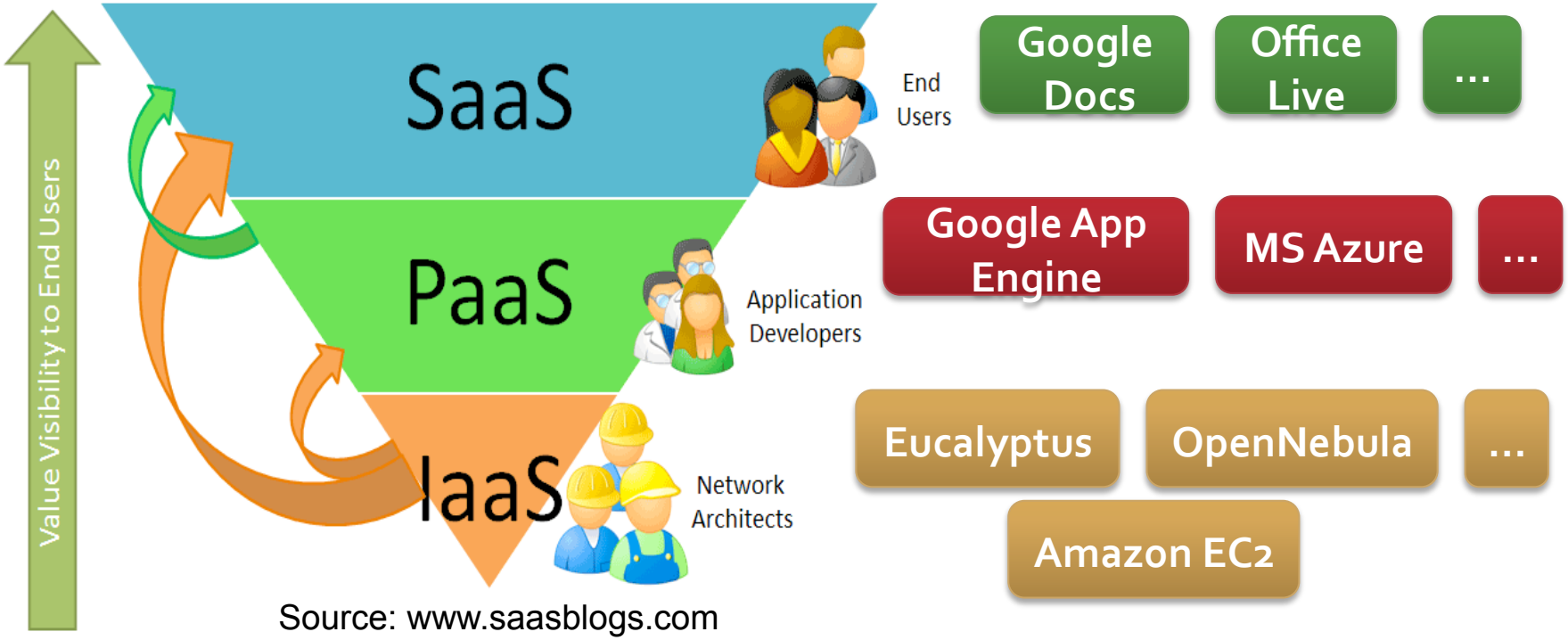
- Goal:
  - Dynamically provision new Grid service replicas from a Cloud infrastructure and integrate them into an already existing replication group.



# CLOUD APPROACHES

One of the many classifications …

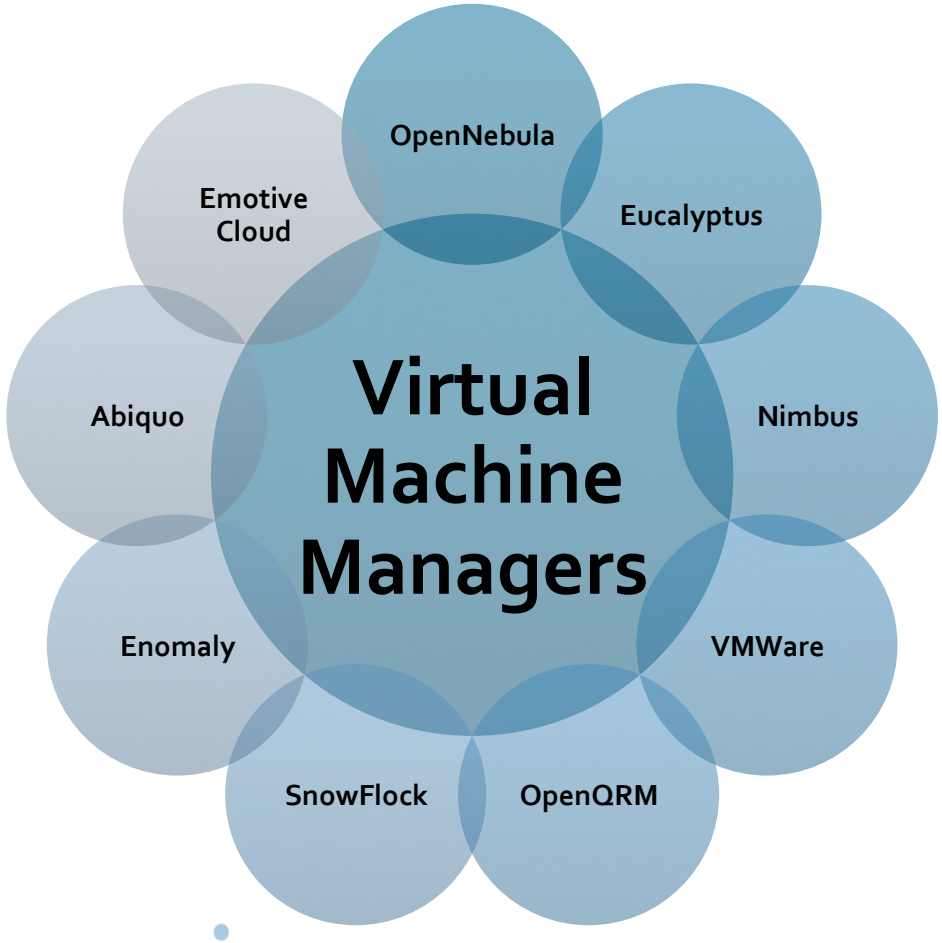
- In this work we focus on IaaS Cloud systems.
  - Enables deploying Virtual Machines on a physical infrastructure.

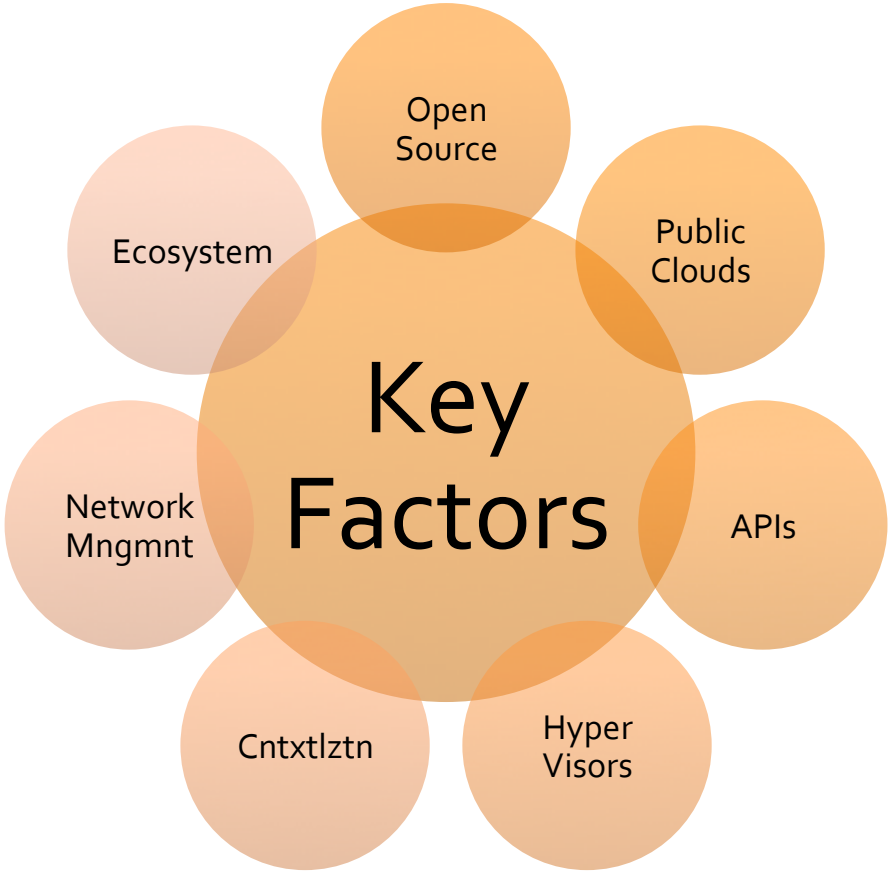



Source: www.saasblogs.com

# VIRTUAL MACHINE MANAGERS

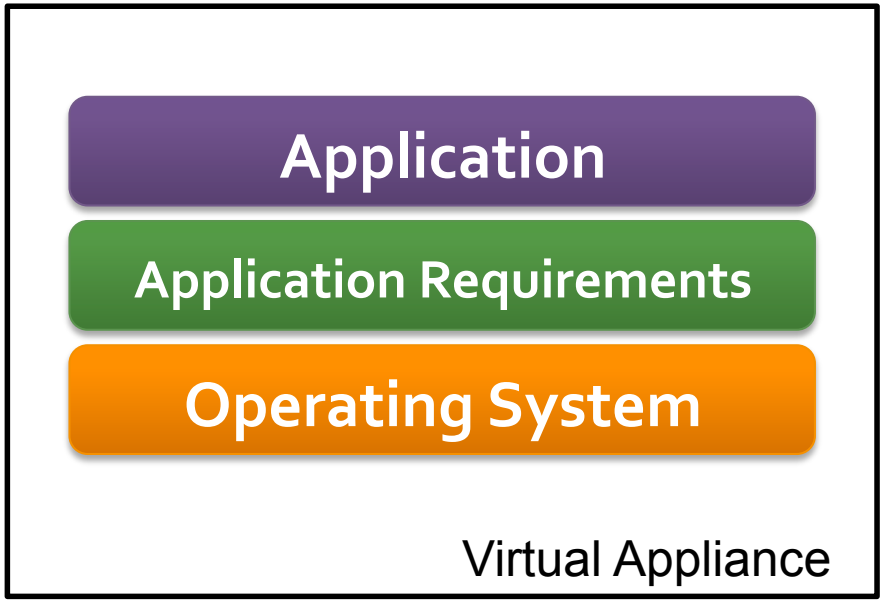
- VMMs provide the basic tools to build an IaaS Cloud
  - Different tools in the cloud arena for VM management.

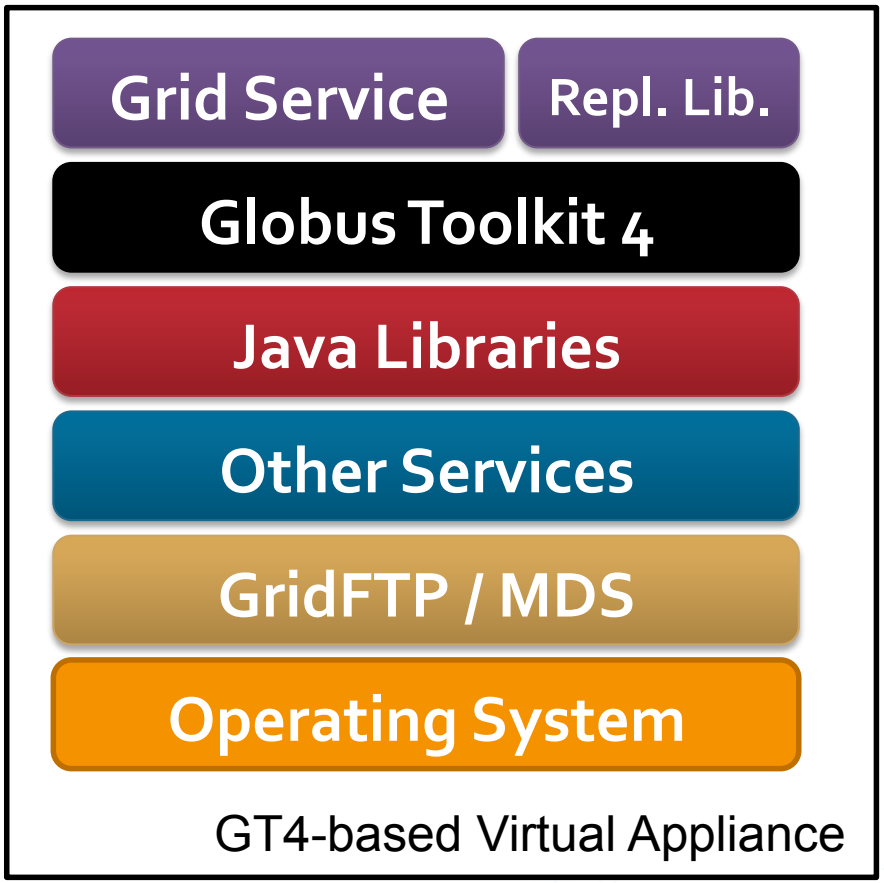


# VIRTUAL APPLIANCES

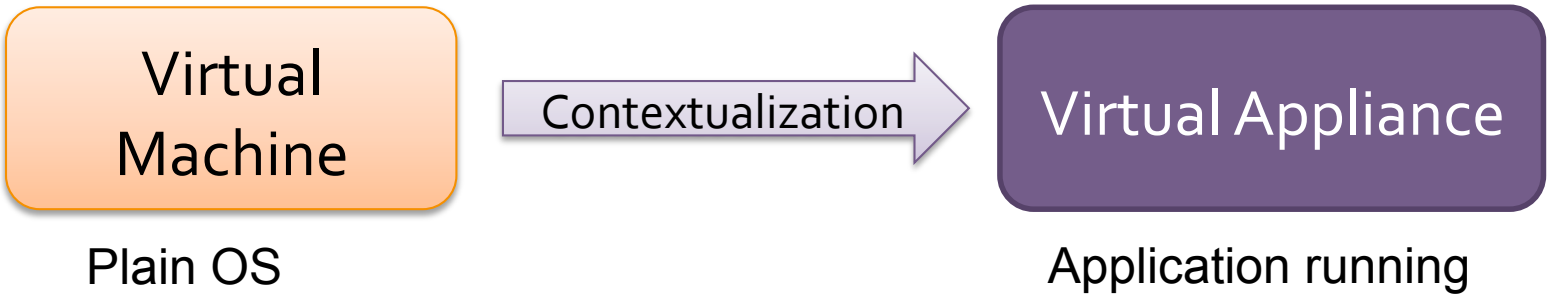
- A Virtual Appliance (VA) consists of a Virtual Machine specially configured for an Application.



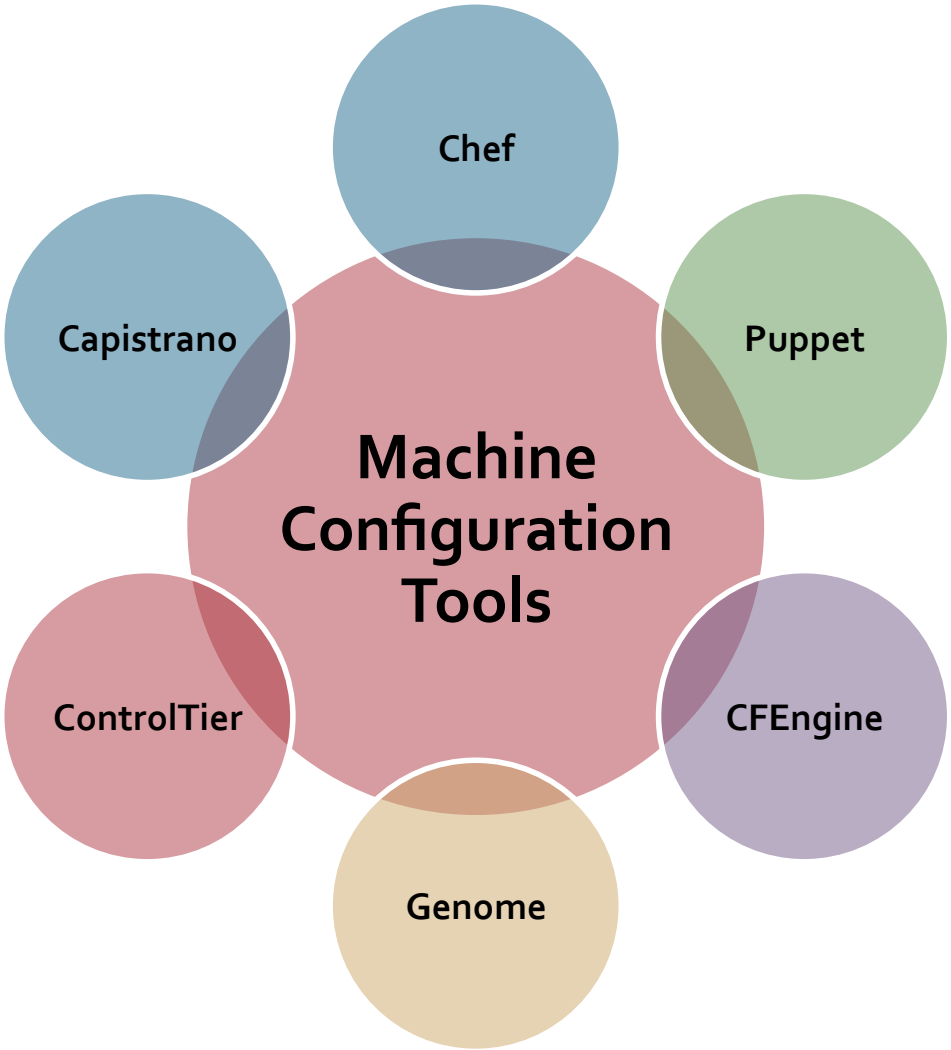
# CONTEXTUALIZING VIRTUAL APPLIANCES

- From VMs to production SVAs …




- Contextualization means creating the appropriate SW/HW environment for the successful execution of an application (GT4 + Grid Service).
  - Virtual Machines need to be contextualized (IP, DNS, etc.).
    - Support typically provided by the VMMs.
  - Applications need to be contextualized.
    - Deployed, configured, built, executed.

# SOFTWARE CONFIGURATION TOOLS




- Many machine configuration tools.
- Focus on automating the:
  - Machine configuration
    - DNS, Config files, etc.
  - Installation of commonly used packages:
    - Web Servers, Application Servers, etc.
- Client-Service tools.

# DEPLOYING SCIENTIFIC APPLICATIONS



- Many scientific applications follow the same patterns …

**Packages**

- Resolve dependencies (related packages or system packages)
- Install dependencies first

**Configuration**

- Common actions:
  - Copy files, change properties in configuration files, declare Environment Variables, etc.

**Build**

- Common build approaches:
  - Configure + make, Apache ant, SCons, globus-deploy-gar, etc.

**Execution**

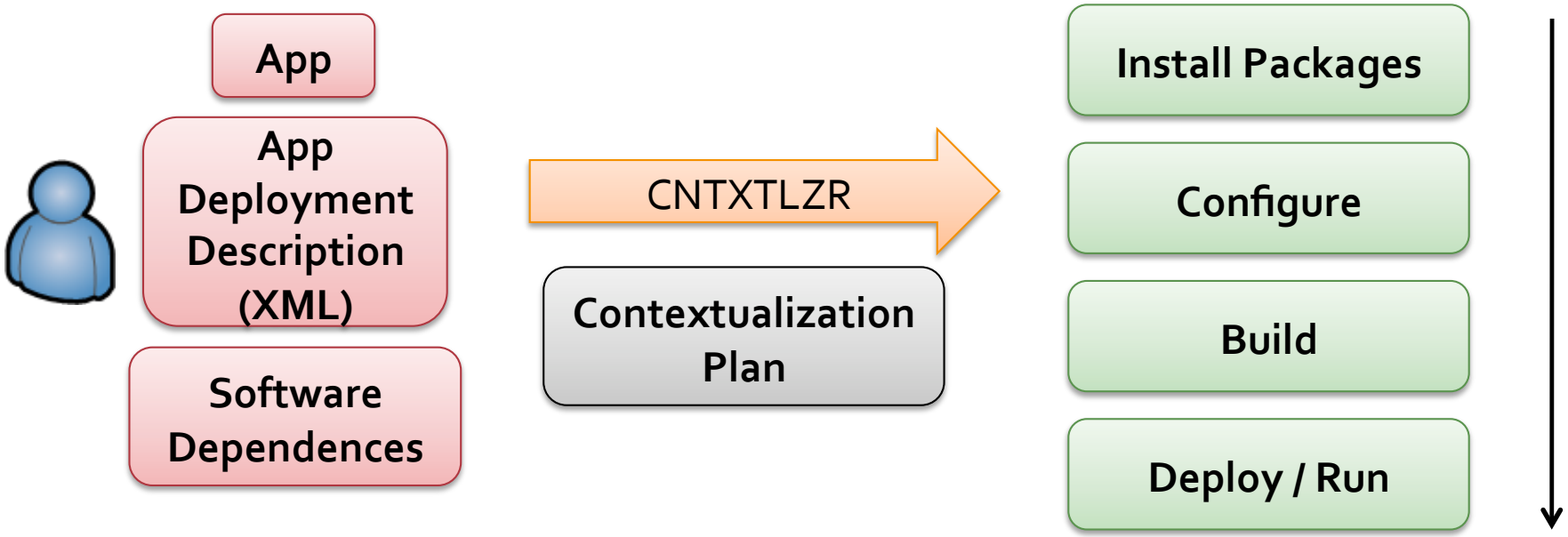
- Start the application
  - Invoke a script, start an application, parallel execution, delegated execution, etc.

# AUTOMATING APPLICATION CONTEXTUALIZATION (I)

For Scientific Applications



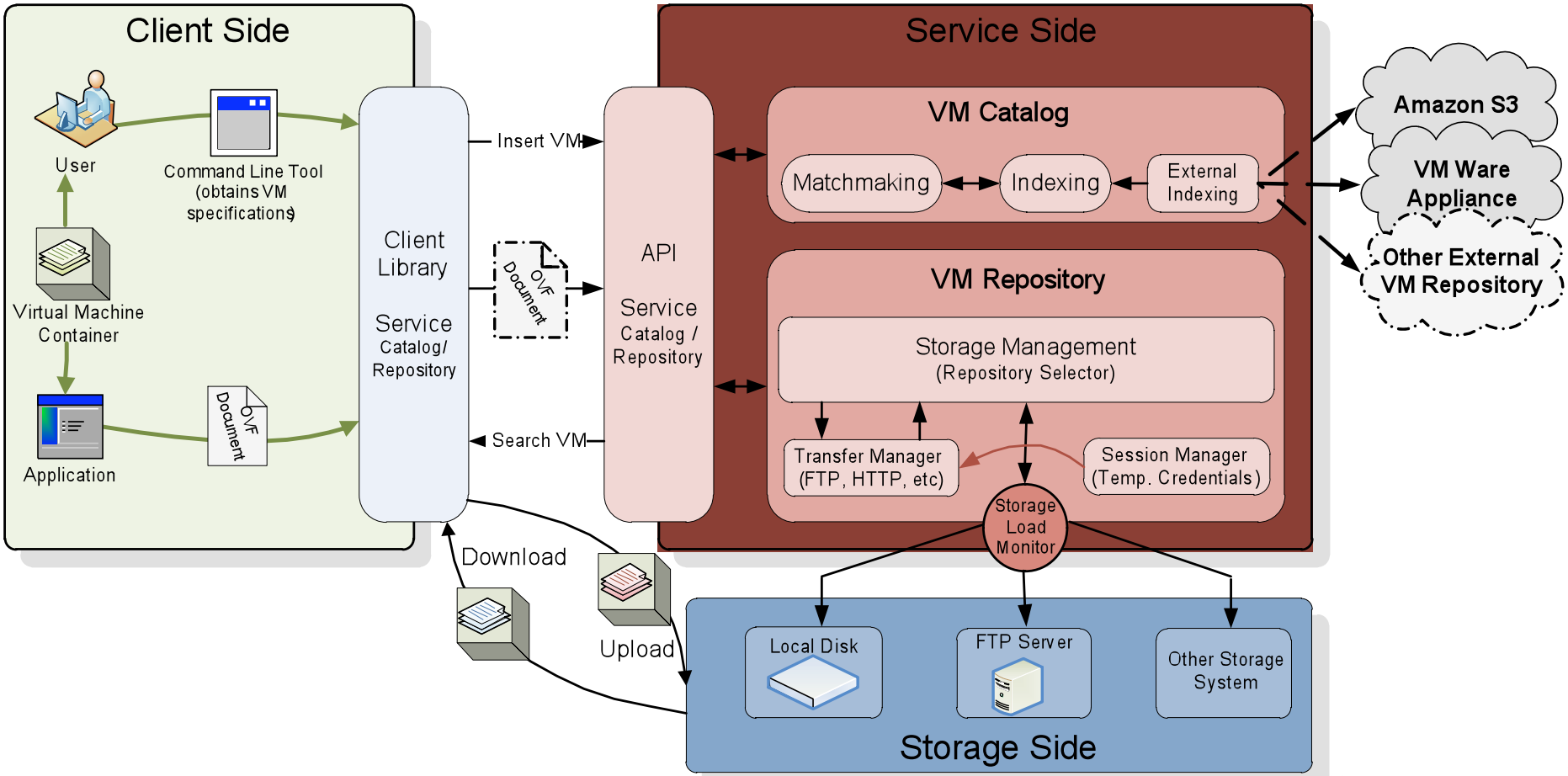
- We are working on software for (scientific) application contextualization.
  - Goal: Software inoculation and configuration into the VM with minimum user intervention (Staged into the VM via the VMM).
  - Automation vs SSH-based Manual Installation



# CATALOG AND REPOSITORY OF VIRTUAL MACHINE IMAGES

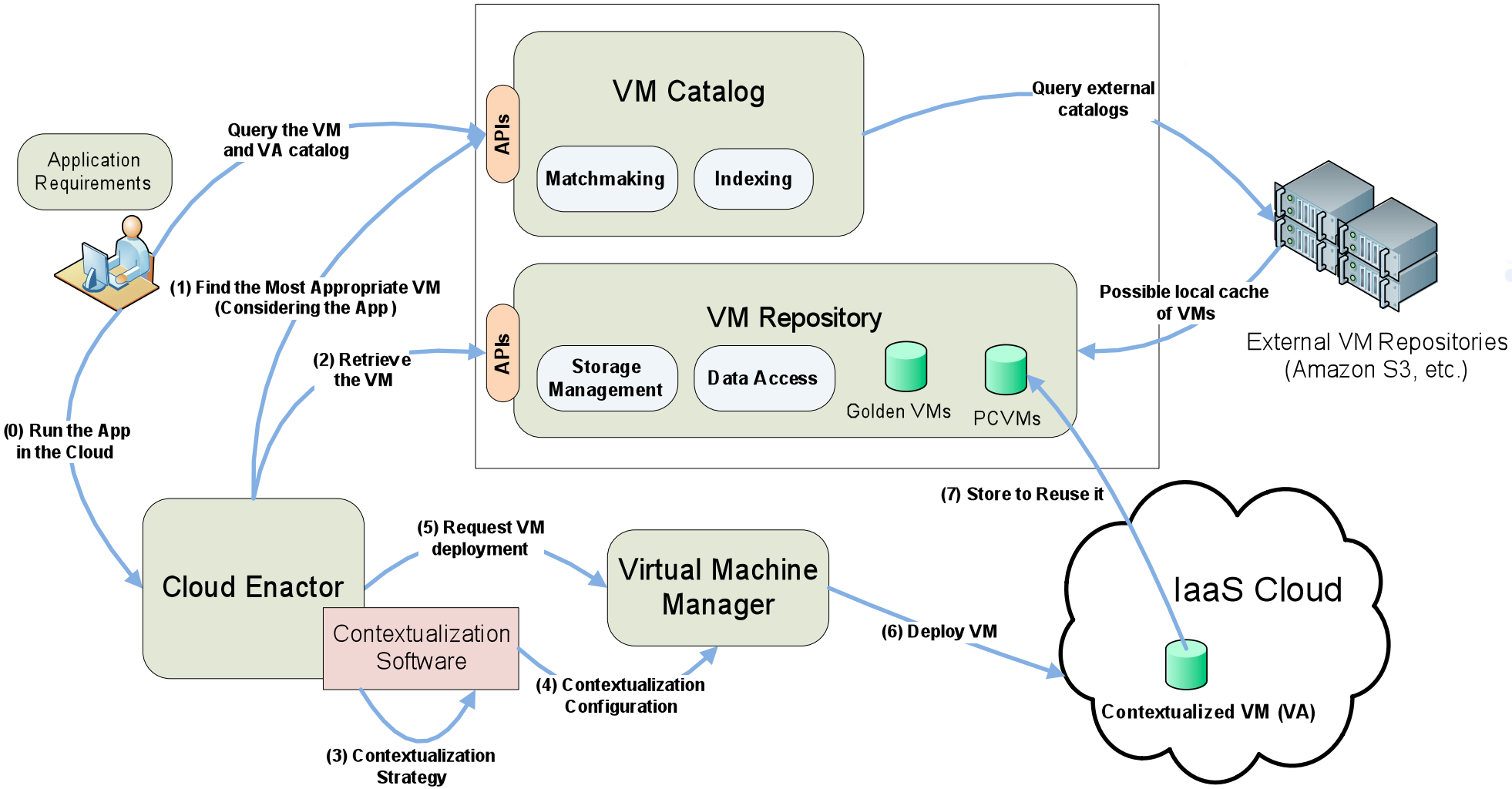
## Leverage VMI reuse and sharing

- A Generic VMI catalog based on standards, such as the Open Virtualization Format (OVF).



# THE BIG PICTURE

## Catalogs, Repositories and Contextualization



# A CLOUD BACK-END FOR THE GRID SERVICE REPLICATION LIBRARY

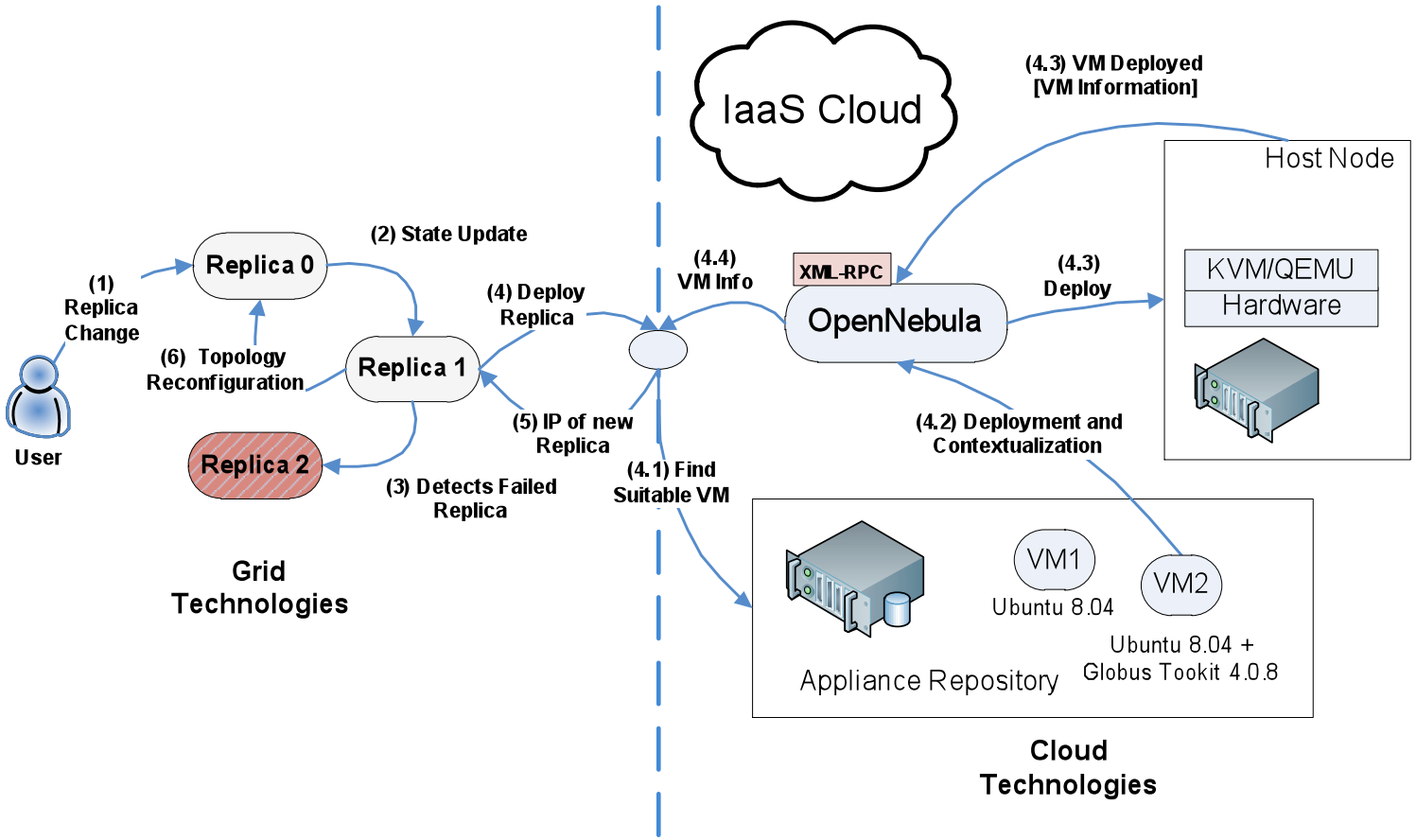


- Virtual Machine:
  - Based on Ubuntu JeOS → Low footprint (380 Mbytes of disk)
  - Installation of GT 4.0.8 + dependencies (Java, make, gcc, etc.)
  - Results in a 1.1 Gbytes Virtual Machine Image (VMI)
- Pre-Contextualized VM based on GT4
  - Inoculation of contextualization data into the VM via OpenNebula (an ISO-based disk with data).
  - Contextualized at boot time in order to deploy the specific Grid Service + Replication Library.
  - Developed scripts to start contextualization right after booting the VM.

# APPLICATION OF CLOUD COMPUTING TO WSRF GRID SERVICE REPLICAS

## Cloud Computing support

- The Cloud supports the dynamic provision of new Grid service replicas in the case of failure.




1. Query the VA repository for a VM with GT4 installed.
2. Create a contextualization strategy.
3. Deployment of the VM via OpenNebula with the contextualization strategy.
4. The VM is contextualized to deploy the Grid service.
5. The new replica is integrated into the group of replicas.

# CASE STUDY: DESCRIPTION

Replication into Service-Oriented Metascheduling

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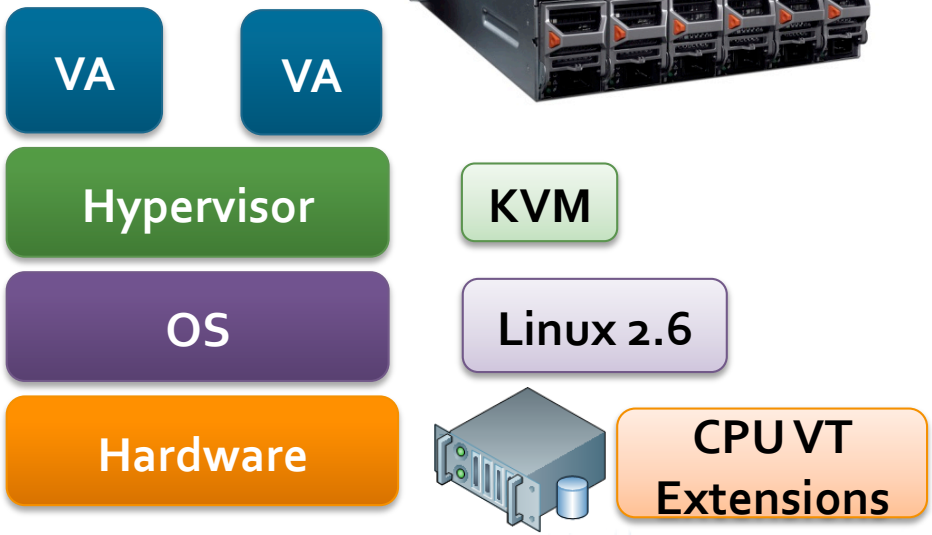
www.grycap.upv.es

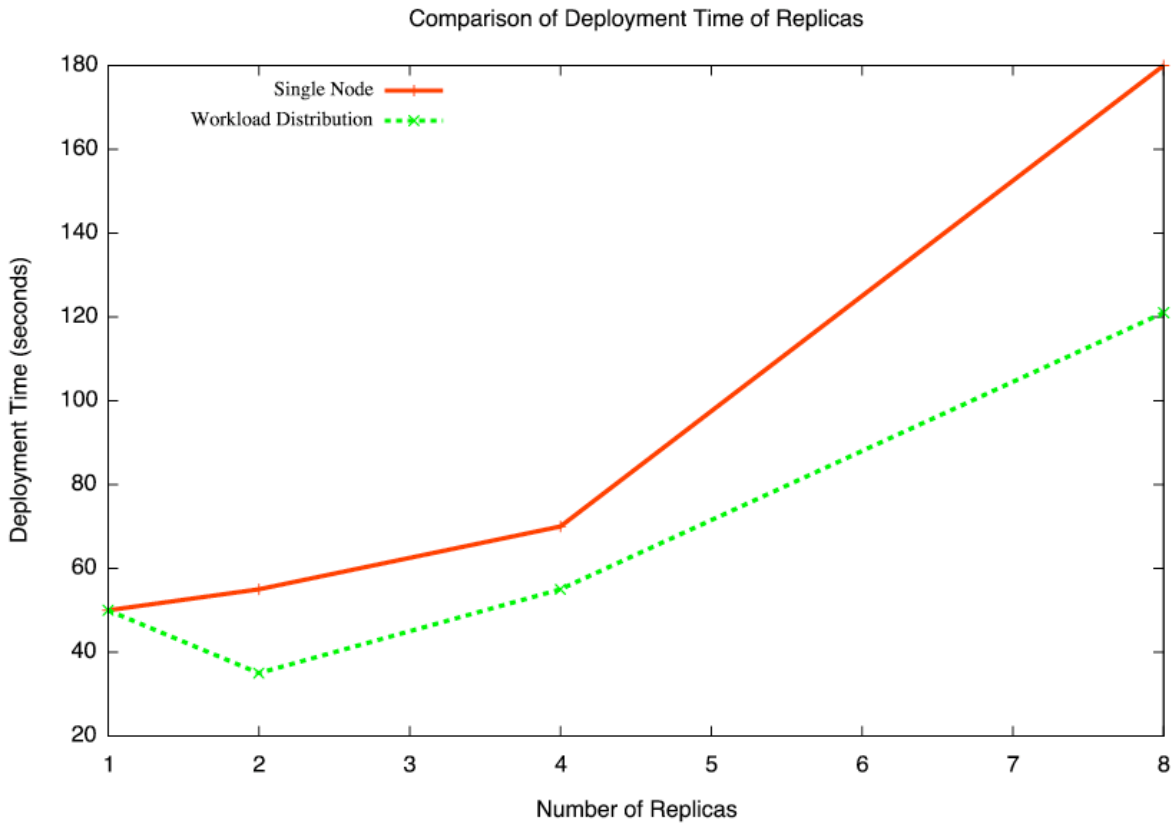
- Application to Service-Oriented Metascheduling
  - Replicated info: XML description of the task (state, jobId, etc.)
- Blade Servers for Virtualization
  - PROs
    - Reduced space
    - Reduced energy consumption
    - LEGO-style computing (pro?)
    - Monitoring and management
- Blade Infrastructure:
  - 1xDell PowerEdge M1000e
  - 4xDell PowerEdge M600,M610
    - 2 Intel Xeon QuadCore, 16 GB RAM
- Use of the KVM hypervisor.



# CASE STUDY: RESULTS

## Evaluate Deployment Time for New Replicas

- Deployment time: Since a request to the VMM is submitted until the VM is up and running.
  - 1 node vs 3 nodes of the Blade.




- The booting and contextualization phases are concurrent.
- Can pre-deploy VMI to internal node to avoid NFS copy delay.
- We are able to deploy 4 Grid service replicas in less than a minute.

# CONCLUSIONS

- The usage of a Cloud computing infrastructure allows the dynamic deployment of new Grid service replicas.
- The usage of contextualization software, combined with the capabilities of the VMM, eases the process of application deployment in the VM.
- Cataloging Virtual Machine Images leverage sharing and reusing.
- The Cloud infrastructure allows requesting and releasing computing resources as needed.

# FUTURE WORK

- Integration of a dynamic scaling module into the replication library.
  - Upper and lower boundaries to the number of replicas. Application-dependent information.
- Extension to other VMMs such as Eucalyptus and Globus Nimbus.
  - APIs to abstract the interaction with VMMs.
- Evolution to large scale Cloud infrastructures, such as Amazon EC2.