Orchestration of Applications on Multiple Clouds with COMPSs

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CLOUD COMPUTING 2013 - Valencia, May 28 2013
Outline

- Overview of COMPSs/ServiceSs
- Overview of interoperability approaches with COMPSs/ServiceSs
- Interoperability to cloud middleware through connectors
- Use cases & projects
The StarSs programming model

StarSs

- Sequential C/Fortran/Java + annotations
- Task based
- Simple linear address space
- Support for SMP, GPUs, Cluster, Grids and Clouds

Programmability/Portability
- “Same” source code runs on “any” machine
- Incremental parallelization/restructure
- Focus in the problem, not in the hardware

Performance
- Intelligent Runtime
  - Automatically extracts and exploits parallelism
  - Locality awareness
  - Matches computations to specific resources on each type of target platform

Open Source
http://compss.sourceforge.net

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initialize(f1);
for (int i = 0; i < 2; i++) {
genRandom(f2);
    add(f1, f2);
}
print(f2);

User code

Annotated interface

Custom Loader

Javassist

Clusters

Clouds

Files

COMPSs Runtime

Task Processor

TA

DIP

Task Dispatcher

RM

TS

SO

JM

FTM

COMPSs Infrastructure
Overview of interoperability approaches with COMPSs/ServiceSs

- Interoperability through web services: ServiceSs
  - “Tasks” in ServiceSs can be WS
  - Whole applications can be exposed as WS

- Interoperability through high-level standards
  - Venus C execution platform implements OGSA-BE standard
  - Enables transparent execution of applications

- Interoperability to cloud middleware through connectors
Introduction to COMPSs

COMPSs'Run+me'

Cloud'
- Azure'
- OCCI'
- EC2'

Job'
- GAT'
- GRAM'
- gLite'

Storage'
- CDMI'
- S3'
- FTP'
- gridFTP'

Accounting'

Usage'Records'

Cloud Computing Interface

Open Source Cloud Computing

Open Nebula

Amazon Web Services

Windows Azure

GAT

gLite

Open Science Grid

EGI

IBERGRID

BSC

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Interoperability to cloud middleware through connectors

- The runtime communicates with the Cloud by means of Cloud connectors.
- The connectors implement the interaction of the runtime with a given Cloud provider.
- Connectors abstract the runtime from the particular API of each provider.
- This design facilitates the addition of new connectors for other providers.
Middleware interoperability in COMPSs

- **Task Scheduler**
  - Assigns tasks to VMs or physical resources
  - Each VM or resource has its own task queue

- **Scheduling Optimizer**
  - Checks status of workers
  - Can decide
    - To perform load balancing
    - Create/destroy new VMs

- **Resource Manager**
  - Manages all cloud middleware related features
  - Holds information about all workers and about cloud providers
  - Scheduler Optimizer sends to the RM requirements about new VM characteristics
    - i.e., VM that can run 3 tasks of type T1 and 2 tasks of type T2
  - Resource Manager, evaluates the cloud providers and chooses the best option
    - More economic
    - The decision can be to open a new private or public VM
  - For each Cloud provider, a data structure stores the different available instances (with its features) and the connector that should be used
Cloud Connector

- Interface that enables
  - Create VM
  - Destroy VM
  - Cost?
  - Time to create?

- When we want to add a new Cloud Provider, we just need to implement this interface
  - A special case is an implementation that supports the OCCI standard

- Two type of threads in the Connector
  - Creation thread
    - To create and contextualize a VM
  - Deletion thread
    - To destroy a machine
    - Before destroying the VM, TS waits until all tasks assigned finish and FTM moves remaining files to the master
OPTIMIS
The cloud's silver lining

Facilitating Cloud Deployment
OPTIMIS Programming Model and IDE allow developers to focus on business logic not worrying on implementation Cloud issues. OPTIMIS takes care of creating a Service Manifest and all images required for deployment.

Multi-Cloud Broker
OPTIMIS Cloud Broker includes capabilities that enable multi-cloud deployment supported with enhanced security provisioning including VPN Overlay Intelligent Protection System and Secure Storage for each of the services deployed through the Cloud Broker.

Optimizing the full Cloud Lifecycle
OPTIMIS ToolKit optimizes full service lifecycle from development, deployment and operation taking trust, risk, eco-efficiency, cost and legal issues into account.

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OPTIMIS deployment

Federated clouds

Service Provider

Internal infrastructure

Infrastructure Provider

Bursted internal clouds

Service Provider

Infrastructure Provider

Infrastructure Provider

Multi-clouds

Service Provider

Infrastructure Provider

Infrastructure Provider

broker

Infrastructure Provider

Infrastructure Provider
The VENUS-C Platform

Goal: “Create a sustainable infrastructure that enables user applications to leverage cloud computing principles”

Funded by European Commission as FP7 Research Infrastructures Projects

Interactive web and training channel: http://www.venus-c.eu/

e-Science as a Service
  – 7 Scenarios
  – 15 Open-Call Pilots
  – 5 Open-Call Experiments

June ‘10 - May ‘12
(support until May ‘13)

Free of charge access to Azure

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Combining *Biodiversity Science* and the *Open Access Movement* to deploy a joint European and Brazilian e-Infrastructure of open access resources supporting the needs of the biodiversity scientific community.

Who will benefit from EUBrazilOpenBio?

- EU & Brazilian biodiversity scientific communities
- Data and resource managers & Open Access community
- European & Brazilian policy and funding bodies

Two biodiversity use cases

- Computing resources & SW platforms
- Further EU-Brazil collaboration in support of the biodiversity area & infrastructures
Interoperable execution of workflows in EGI Cloud

- **EGI Federated Cloud**: interoperable integration of virtualised resources from different resource providers to provide an integrated federated virtualised resources infrastructure for exploitation by EGI’s user community.
- **Interoperability based on standards**
- **Different communities same architecture.**
- **COMPSs** enables the execution of Taverna workflows thanks to interoperability features
Evaluation: Elasticity and Bursting
Evaluation: Performance and Scalability
Hybrid configuration: workload unbalance. When the number of resources allows a good load balancing, the speedup curve recovers (see 32+12)

The speedup keeps a quasi-linear gain.

- Execution time (a) and speedup (b) values depending on the number of processors
Conclusions

- COMPSs/ServiceSs abstract application developers from the underlying infrastructure
- Provides a PaaS interoperable with different Cloud providers
- ServiceSs applications can be offered as SaaS
- Interoperability offered at different levels
Thanks for your attention

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