



Provisioning of Virtual Machines in Federated Clouds

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Problem

Using efficiently Cloud for HPC is complex, bad provisioning and task allocation can

- increase cost very fast;
- increase (local and global) makespan;

Problem

Current approaches focus only on selecting compute resource templates

- Application allocation on VMs (after provisioning) must be taken into account;
- Resources are heterogenous;
- Network latency, jitter and packet loss are high;
- Variability is high (interference, not the same underlying hardware, over-provisioning);
- Reliability must be taken into account e.g., Spot Instances;

Motivation

- Ease the usage of Cloud for Scientific Computing;
- Network latency and speed are the current weak points on Clouds for Scientific Computing;

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- BoT represents a large part of applications running on Cluster, Grid, Clouds;

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- BoT represents a large part of applications running on Cluster, Grid, Clouds;
- Many task allocation algorithms for BoT exists;

Goals

- Studying through simulation the different parameters of a BoT;
- Bag Of Tasks with real-world characteristics;
- Take into account the different methods that provide the same services e.g. EBS and S3;
- Being able to test by simulation the different algorithms and policies to provide high quality feedbacks to the user;

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- Being able to test by simulation the different algorithms and policies to provide high quality feedbacks to the user;
- Propose provisioning and allocation mechanisms to improve a set of requirements (cost, deadline, etc.);
- Simulator that reflects the real behavior of Clouds: network, storage, compute, virtualization overhead, interference, localisation, etc.;
- Extendable simulator to other type of workloads;

- 1 Bag Of Tasks
- 2 Simulation
- 3 Future Works: HPC, Workflow and Big Data

Bag Of Tasks Model

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 - Homogenous;
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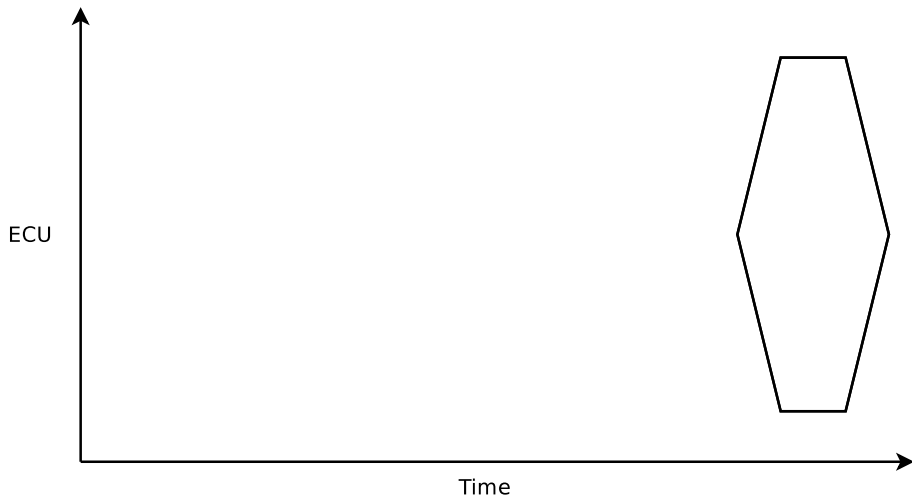
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 - At the beginning;
 - Poisson;
 - Dependency and think time;

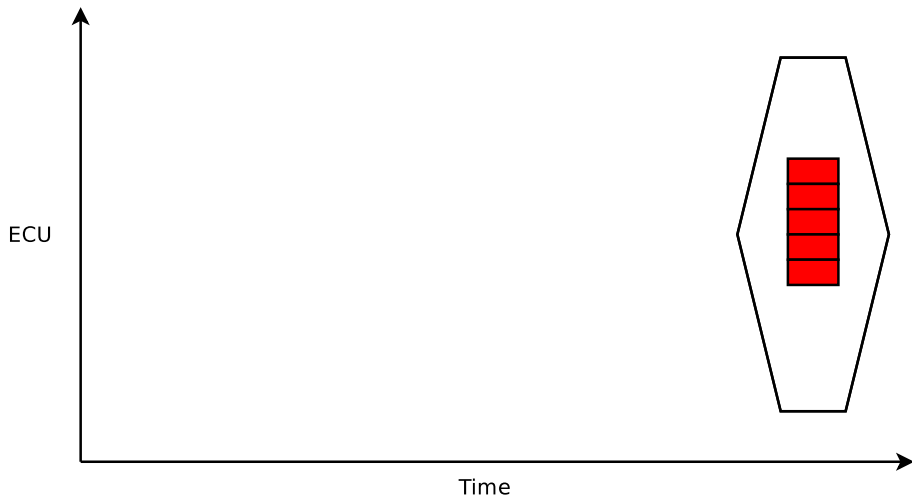
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- Different task arrival (impact on provisioning) models:
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 - Dependency and think time;
- Different objectives:
 - Cost;
 - Performance;
 - Deadline;
 - Etc.

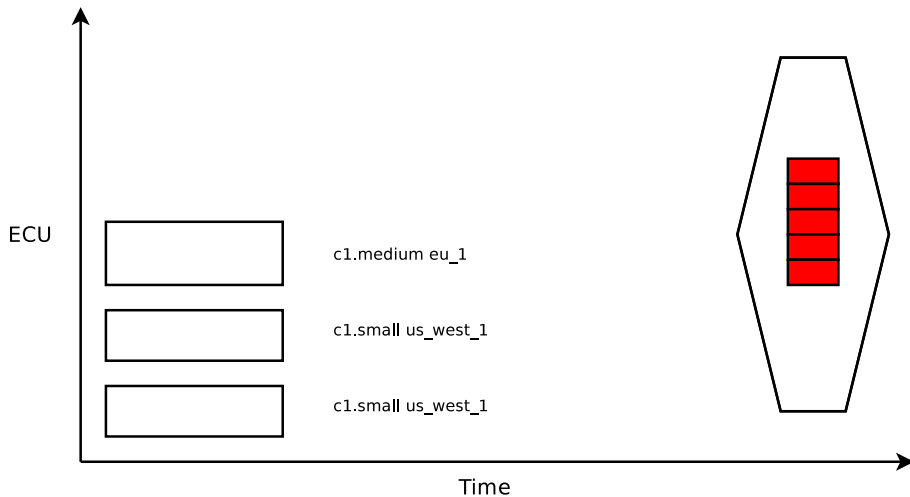
Bag of Tasks Example



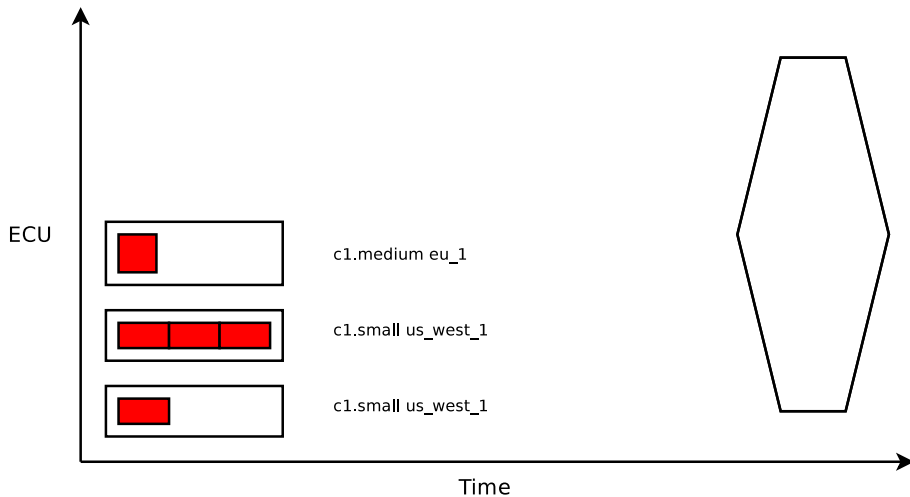
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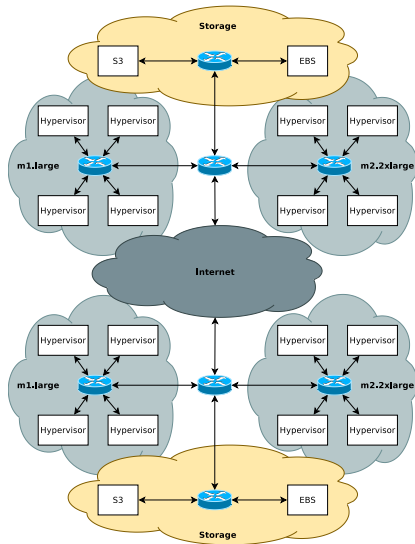
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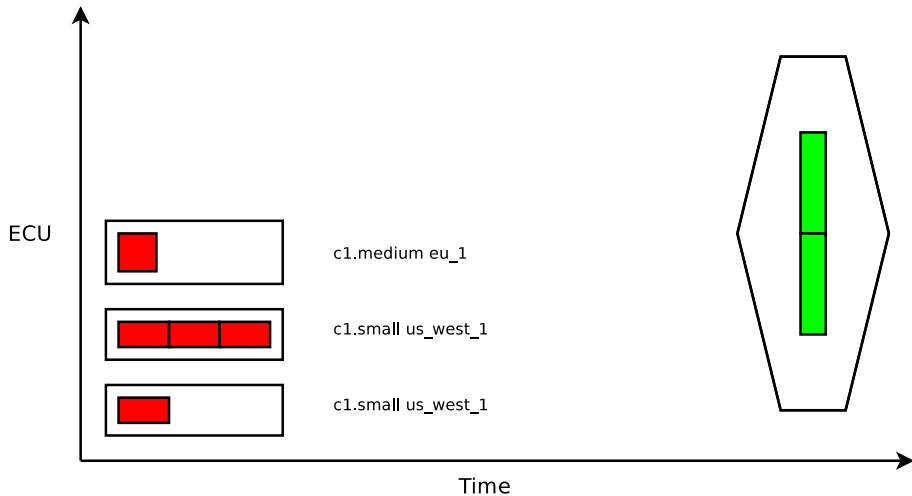
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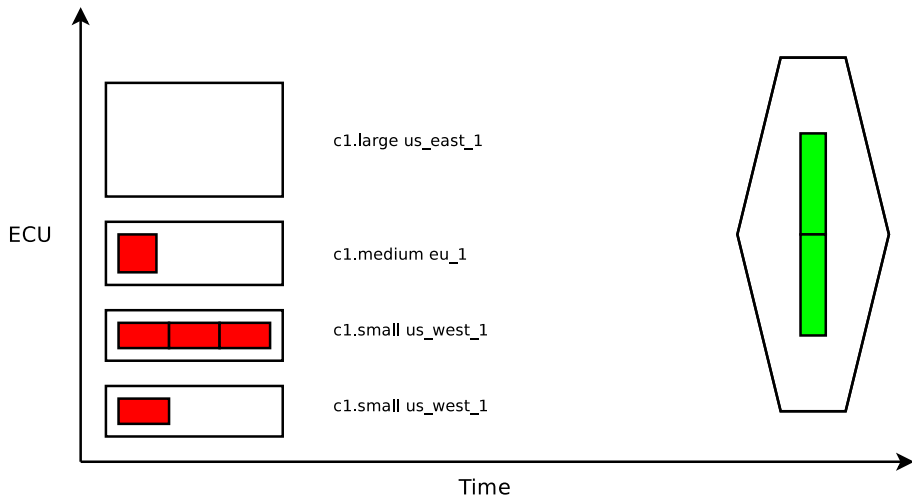
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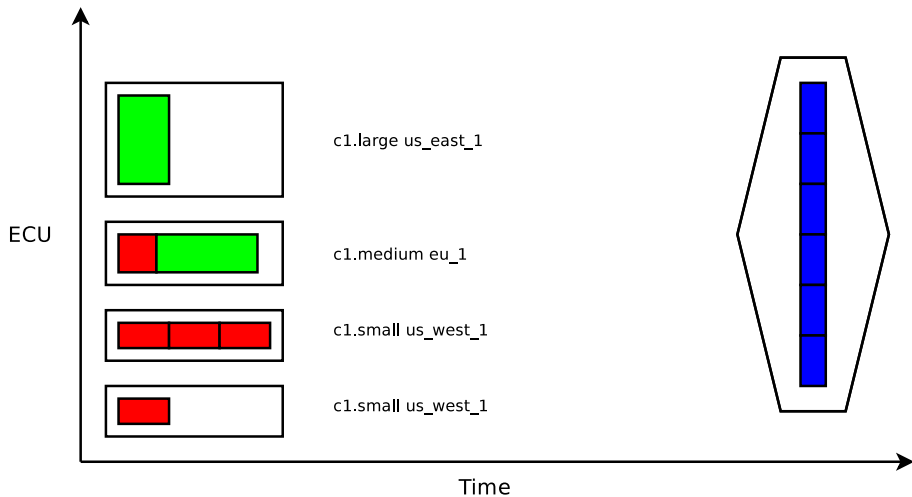
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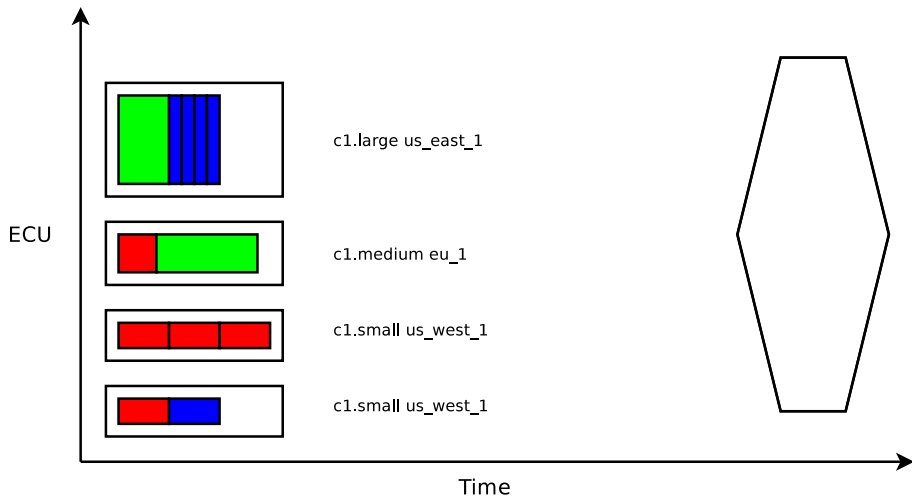
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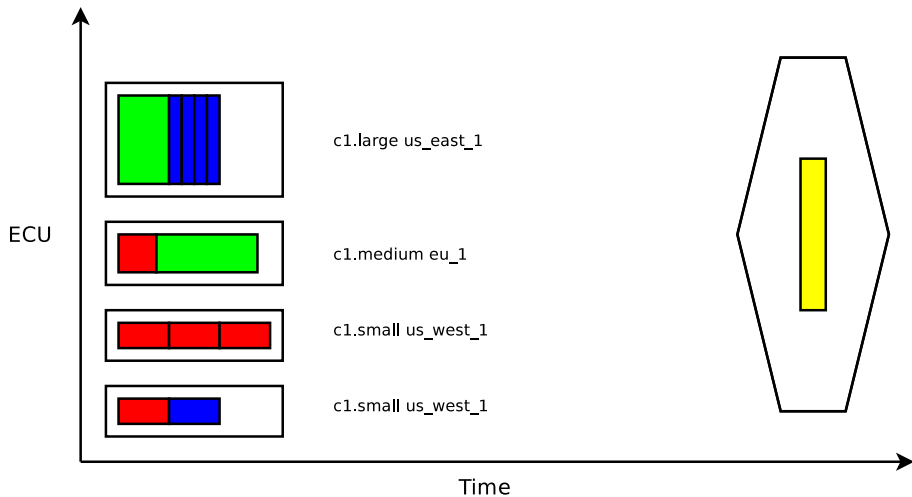
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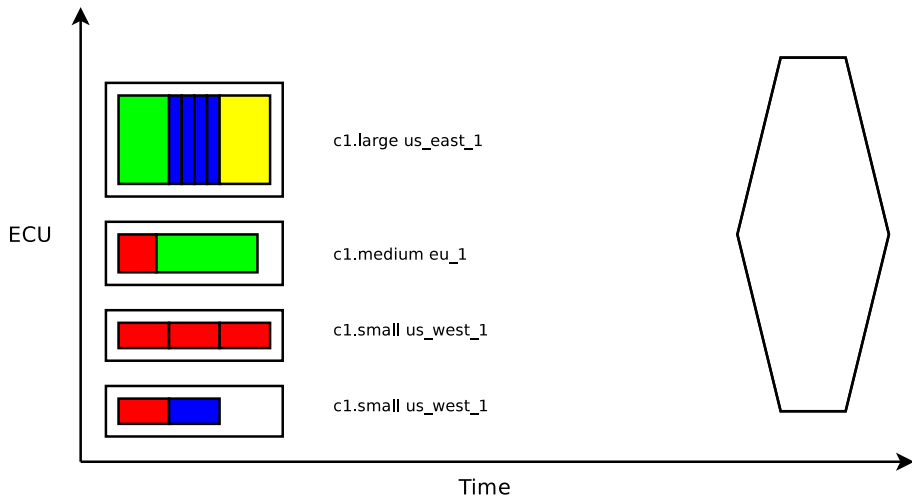
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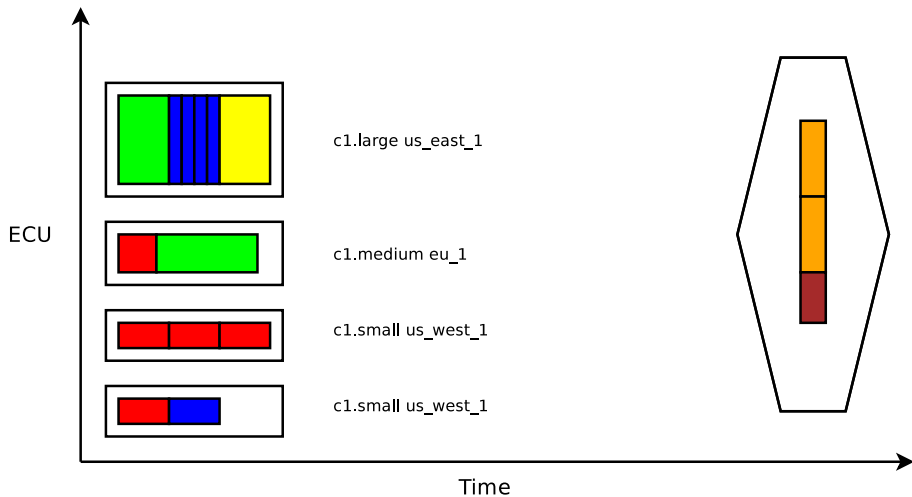
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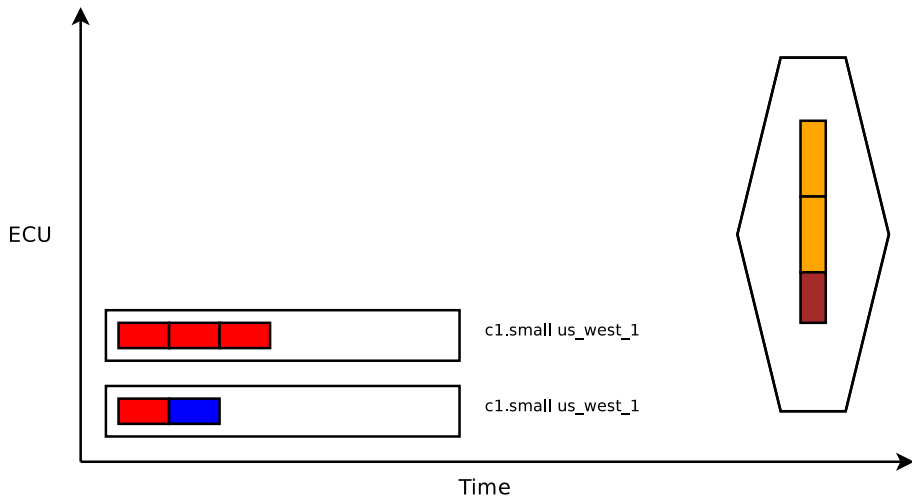
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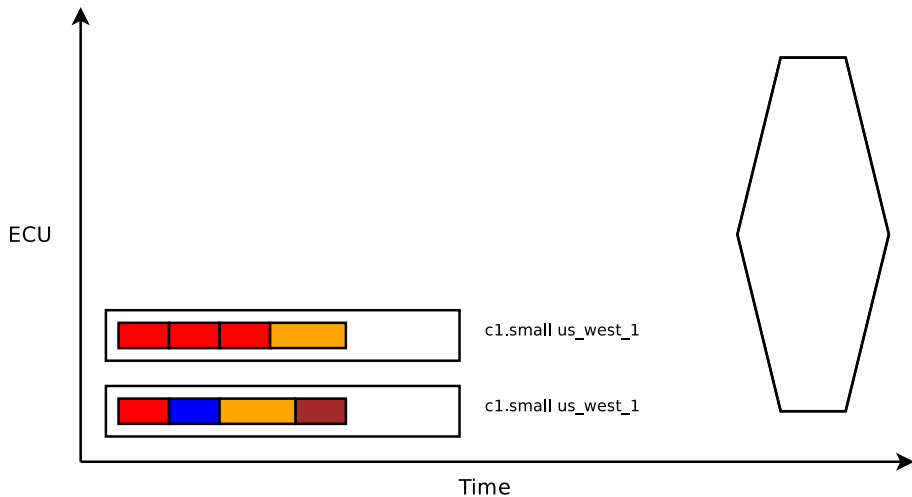
Bag of Tasks Example



Bag of Tasks Example



Bag of Tasks Example



Work in Progress

- Work in Progress;
- 7 Provisioning Algorithms;
- 18 Task Allocation Algorithms;
- Best combination of algorithms for each type of Bag Of Tasks;
- Storage policy impact;

- 1 Bag Of Tasks
- 2 Simulation
- 3 Future Works: HPC, Workflow and Big Data

SimGrid Cloud Broker

- A new SimGrid project: Started 1 year ago;
 - 12 years old; Open Source
 - Collaboration Loria / Inria Rhone-Alpes / CCIN2P3 / U. Hawaii
 - Allows studies of Grid, P2P, HPC, Volunteer Computing and others
 - Validated, Scalable, Usable; Modular; Portable
 - Grounded +100 papers; 100 members on simgrid-user@; Open Source

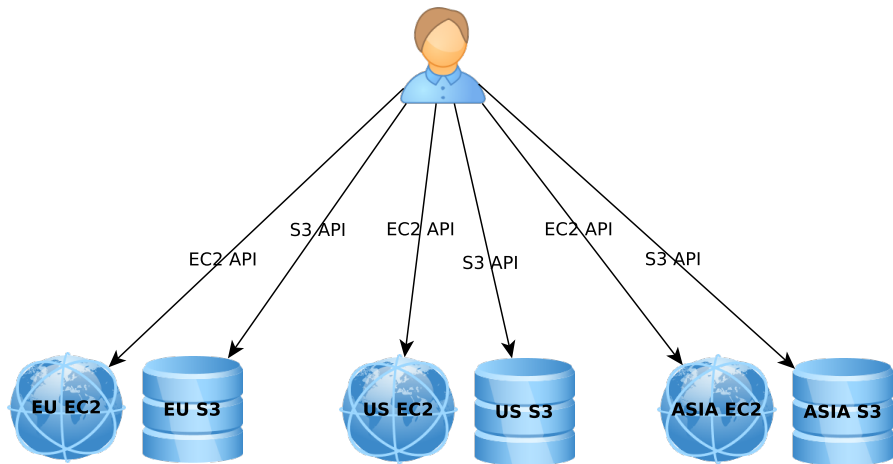
SimGrid Cloud Broker

- A new SimGrid project: Started 1 year ago;
- Not yet another Cloud simulator: Multi-clouds environment based EC2/S3 API;

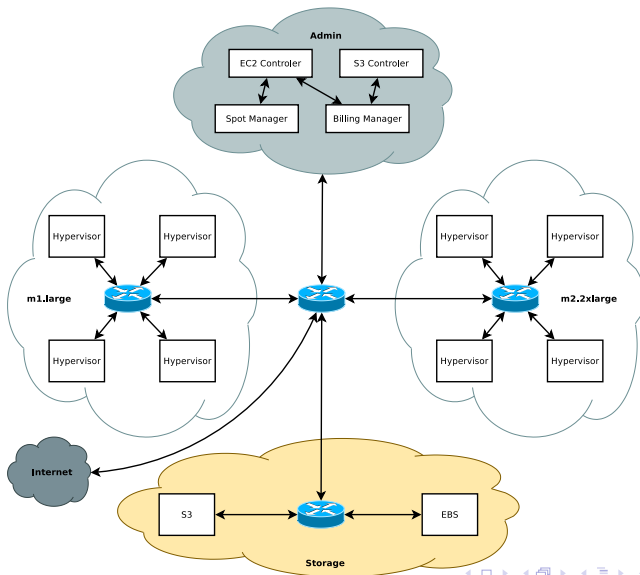
SimGrid Cloud Broker

- A new SimGrid project: Started 1 year ago;
- Work in progress but already features:
 - All AWS regions;
 - All instance types (resources and prices);
 - On-demand and spot instances;
 - S3 and EBS Storage;
 - Accounting of resources usage (Network, Compute, Storage);
 - Resources performance models based on information given by Amazon and extracted from scientific papers;
 - Spot Instances: 3 dynamic price policies (random, file, model);

SGCB: Client View



SGCB: Inside a Cloud



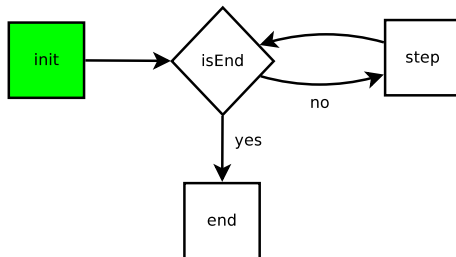
SGCB: Client View

- Purpose: Test an application and its provisioning mechanisms before deploying it;
- A SGCB user will just have to do call to S3 and EC2 API inside the simulator;
- Using SimGrid processes and tasks, he can also simulate his applications;
- A set of examples exists to demonstrate the different use cases;
- A complete SimGrid trace is available to enable post execution analysis: bill, network usage, etc.;

SGCB: Application Scenario (1)

- Application Scenario is a way in SGCB to ease the simulation of an application;
- The life cycle in Clouds is composed of 3 basic steps:
 - **init** Provisioning of the VM and start the application;
 - **step** Adapts the number and type of VMs to the current load (while not *isEnd*);
 - **end** Stop the application and release the resources;
- **isEnd** function checks if the application is over;

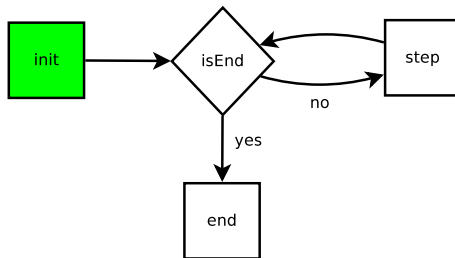
SGCB: Application Scenario (Example)



init

- 1 Select the best template and region where to start the master;

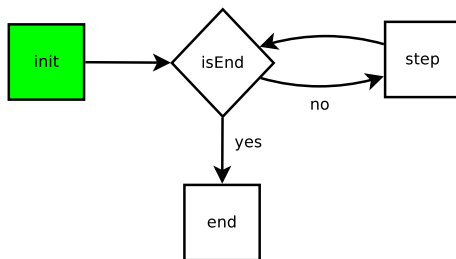
SGCB: Application Scenario (Example)



init

- ① Select the best template and region where to start the master;
 - ① Upload to S3 the VM image of the master VM;
 - ② Register the uploaded image as an S3-backed AMI;
 - ③ Run one instance of template in the selected region;
 - ④ When the VM is started (describeInstances), start the master application;

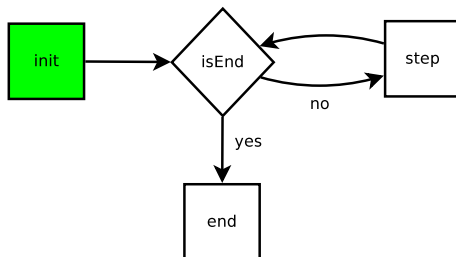
SGCB: Application Scenario (Example)



init

- 1 Select the best template and region where to start the master;
- 2 Do the same for the Slaves;

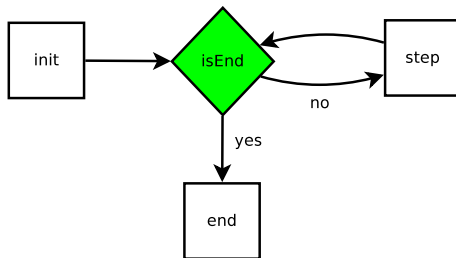
SGCB: Application Scenario (Example)



init

- 1 Select the best template and region where to start the master;
- 2 Do the same for the Slaves;
- 3 Send 10 Computing Tasks out of N to the master;

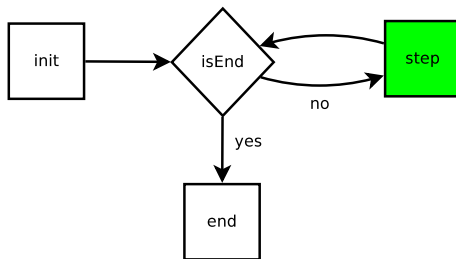
SGCB: Application Scenario (Example)



isEnd

- 1 Check if all N Computing Tasks have been sent;
- 2 Check if all results of the computing tasks have been fetched;

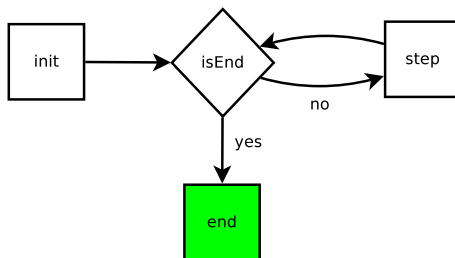
SGCB: Application Scenario (Example)



step

- 1 Send 10 more Computing Tasks to the master;
- 2 Fetch the results of already computed tasks;

SGCB: Application Scenario (Example)



end

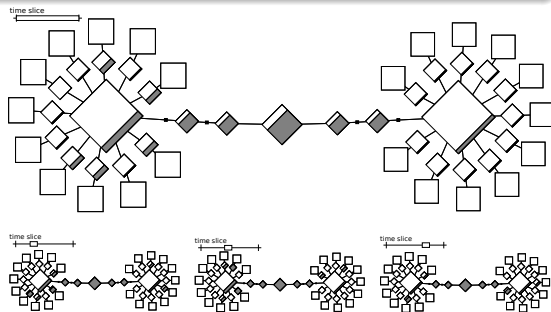
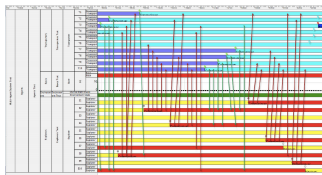
- 1 Stop the master and slaves;
- 2 Release the VM;
- 3 Remove the VM Image;

SGCB: Application Scenario (Example)

Post-processing

Analyze the trace:

- Pajé
- Viva
- R



- 1 Bag Of Tasks
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Bag Of Tasks on Federated Clouds

- Analyze the trace generated by the simulator;
- Propose new provisioning and task allocation algorithms;
- Work on storage policy;
- See the impact of amount of input and output data on the bill;
- Take into account new users' requirements e.g. storage location;
- Work on real-world traces to simulate the Bag of Tasks;

SimGrid Cloud Broker

- Improve performance models (network, storage, etc.);
- Verify the SGCB results with real-world execution;
- Add basic multi-core simulation;
- Available on demand (soon on github);

Potential Collaboration: HPC on Clouds

Tightly coupled applications are the weakness of Clouds:

- Work on VM scheduling algorithms to improve their performances;
- Work on VM scheduling algorithms to reduce noise due to neighbors;
- Co-scheduling with Network as a Service to improve network for HPC;
- Co-scheduling with Storage as a Service to improve network for HPC;
- How to bill the new resources related to HPC;

Potential Collaboration: Scientific Workflow on Clouds

- Extend current Cloud Middleware to support scientific workflow;
- Propose a Broker for Cloud Middleware;
- Work on VM scheduling algorithms for cloud workflow inside a cloud;
- Work on provisioning mechanisms for cloud workflow in a federated cloud;

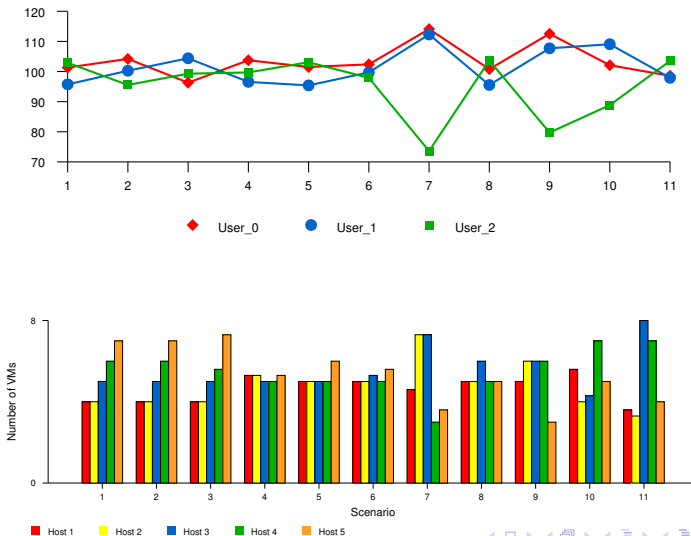
Potential Collaboration: Cloud Security

- European Project Celtic+ Seed4C;
- Create a highly secured Cloud;
- Leader of the demonstrator;
- Work on the HPC and Big Data use cases;
- Security on HPC, Big Data and Clouds: smart provisioning, self-configuration of security devices, access and information flow controls;

Potential Collaboration: Big Data on Clouds

- Work on VM provisioning algorithms to improve MapReduce performance in federated cloud;
- Work on VM placement algorithms to improve MapReduce performance inside a cloud;
- Efficiently used storage service to provide Big Data services in cloud;

Potential Collaboration: Big Data on Clouds



Potential Collaboration: Big Data on Clouds

	User 0		User 1		User 2	
	Isolation	# of VMs	Isolation	# of VMs	Isolation	# of VMs
1	1	21	1	21	1	21
2	1	14	1	14	2	7
3	2	7	2	7	2	7
4	1	21	1	21	1	21
5	1	14	1	14	2	7
6	2	7	2	7	2	7
7	1	14	1	14	3	7
8	2 with user 1 3 with user 2	7	2	7	2 with user 1 3 with user 0	7
9	1	14	1	14	3	7
10	2	7	2	7	3	7
11	3	7	3	7	3	7