Energy-efficient User-oriented Cloud Elasticity for Data-driven Applications

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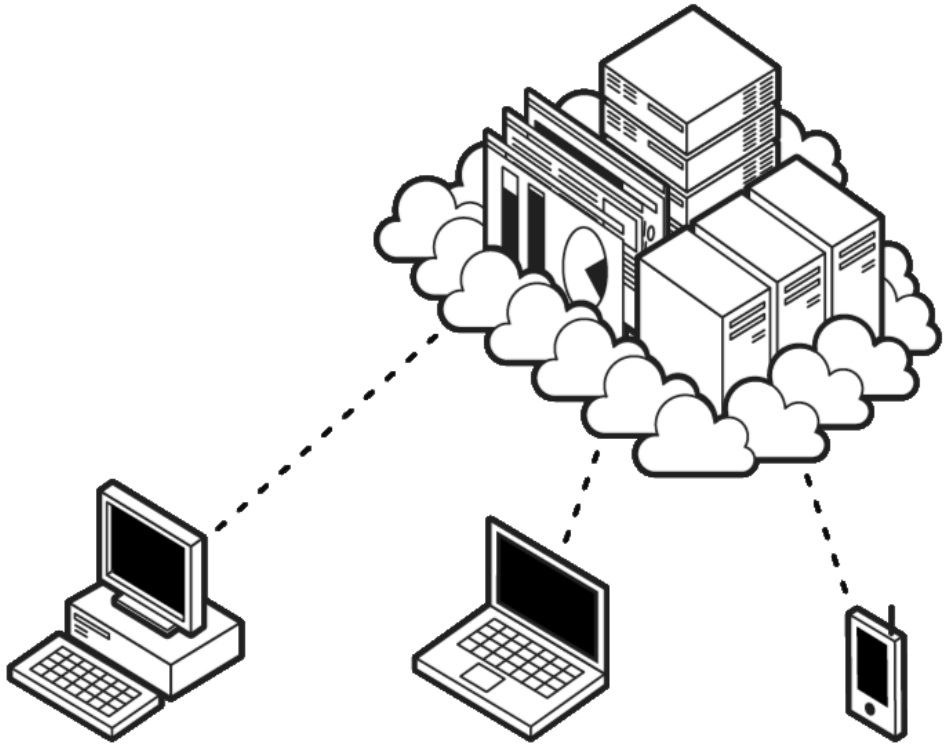
Summary

Summary – Context and Motivations

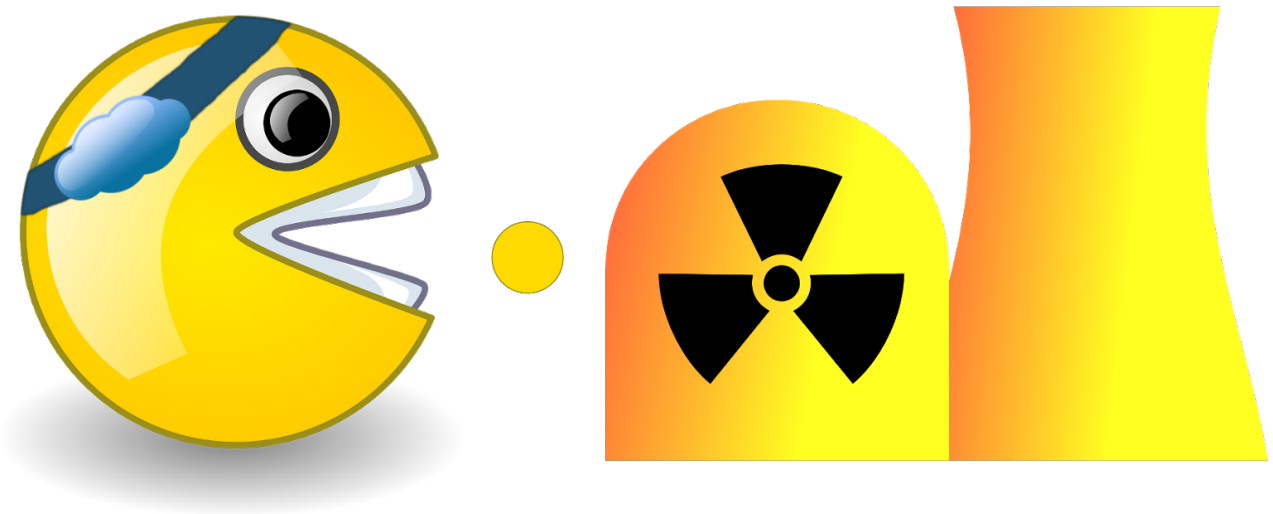
Cloud Computing



- Infrastructure-as-a-Service
- CPU, RAM and disk resources
- Computer resources packed into Virtual Machines

The Cloud consumes an enormous amount of Energy

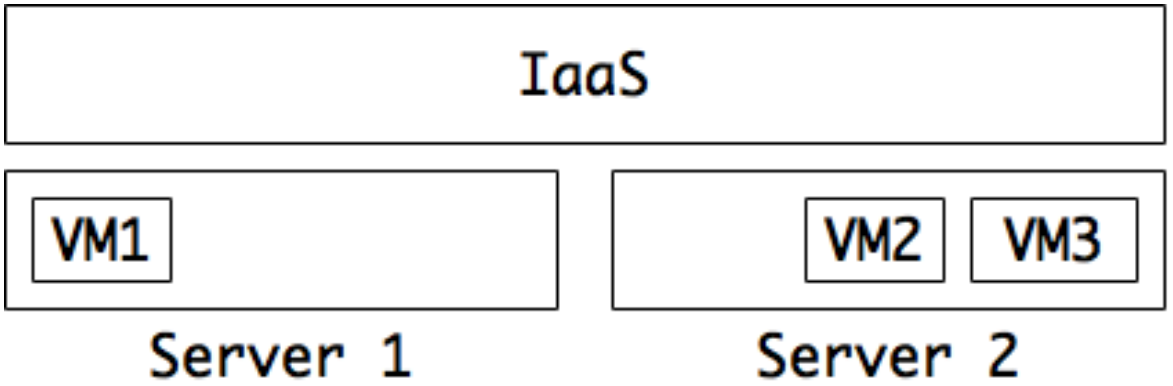
- The Cloud consumes around 2% of the worldwide total energy
- Quadruple by 2020 if the demand continues to go on



Existing Solutions use Consolidation

Turning off as many hosts as possible

- Consolidation



Limitations:

- Do not take the user into consideration
- Complex to configure

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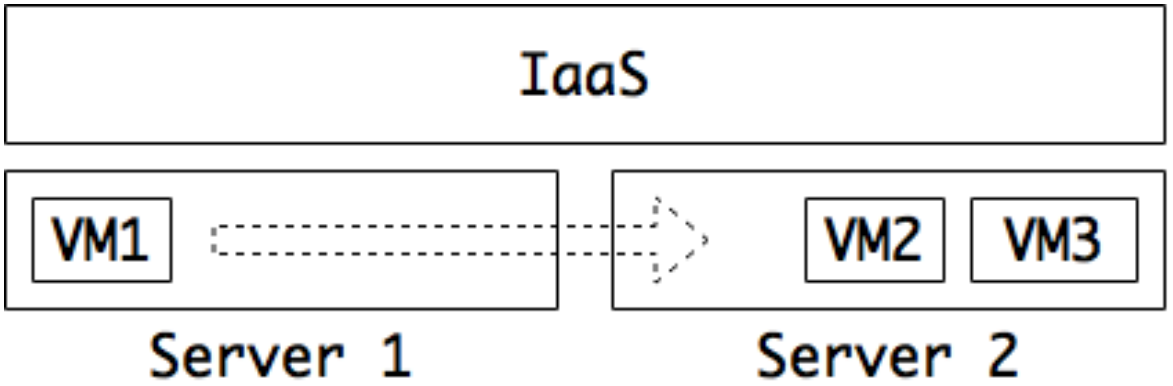

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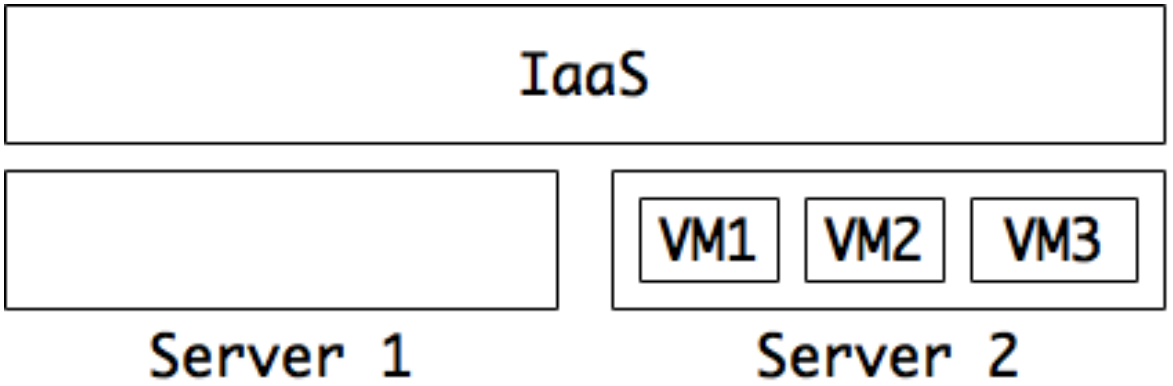

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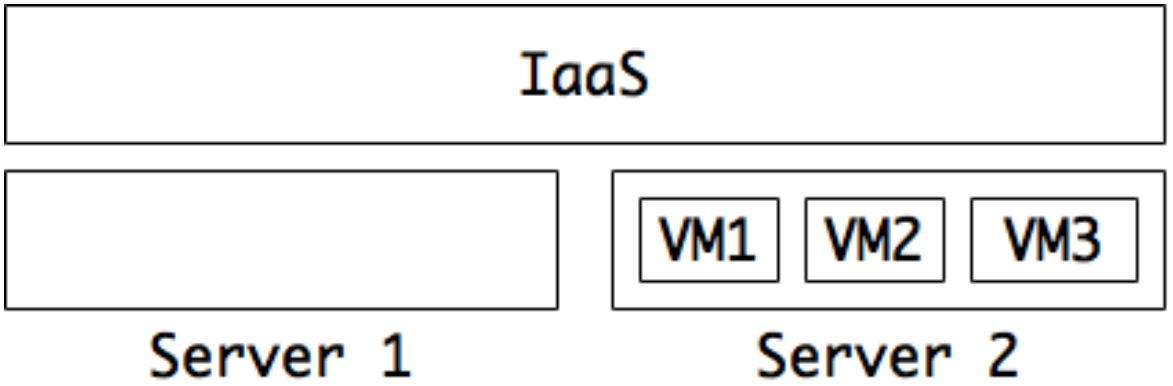

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Our Objective

To reduce the electrical consumption of the Cloud
by including the user in the optimization system

Summary – Our Contributions

Contributions

1. Easy-to-use interface to involve the user
2. Algo to select VM size depending on chosen execution mode
3. Algo for the VMs placement on the servers
4. Prototype for the evaluation of the benefits of our approach

Our Research Contribution

Give the user an easy-to-use parameter

- Choice between *energy efficiency* and *performance*
- Less performance → fewer resources → better consolidation

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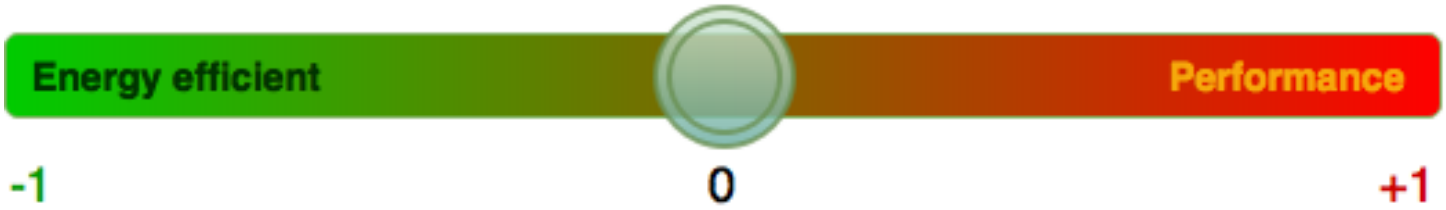
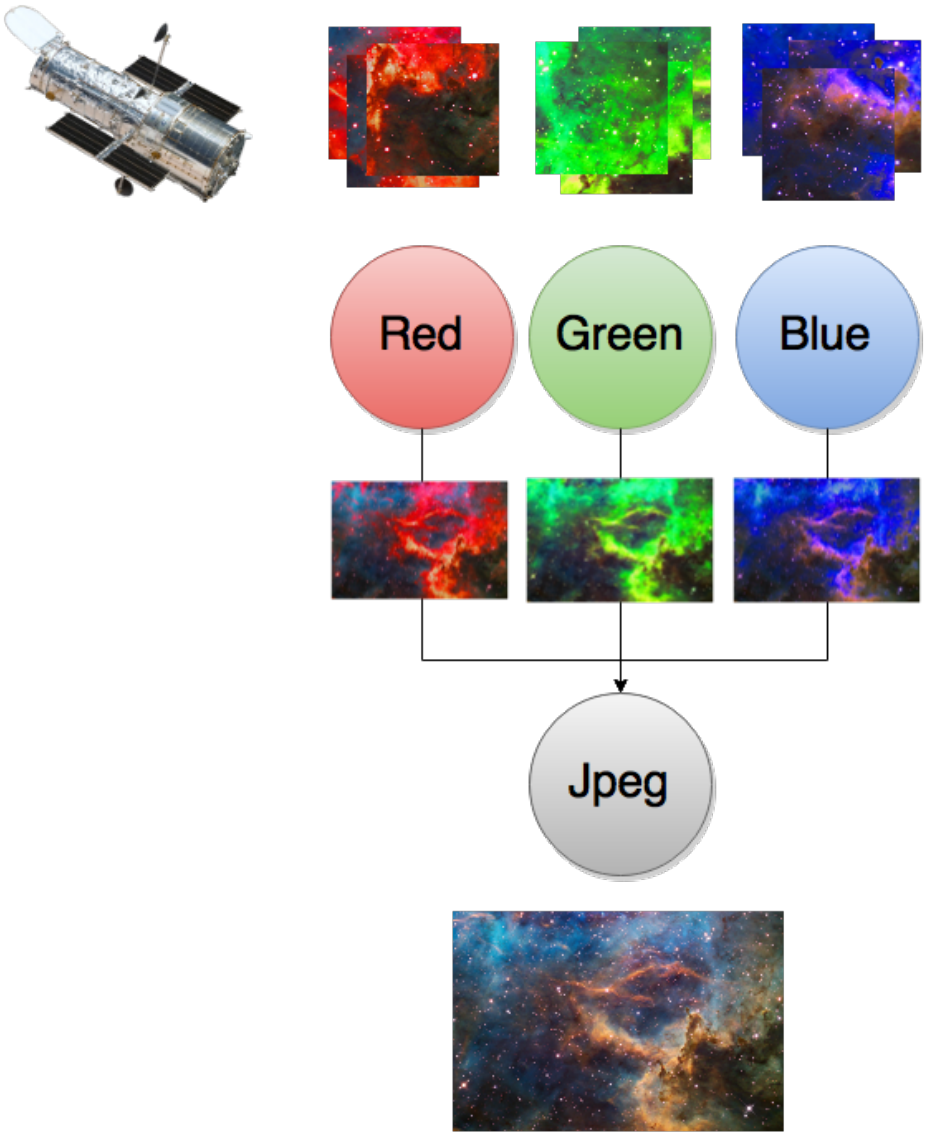


User's Application

Data-intensive scientific workflow



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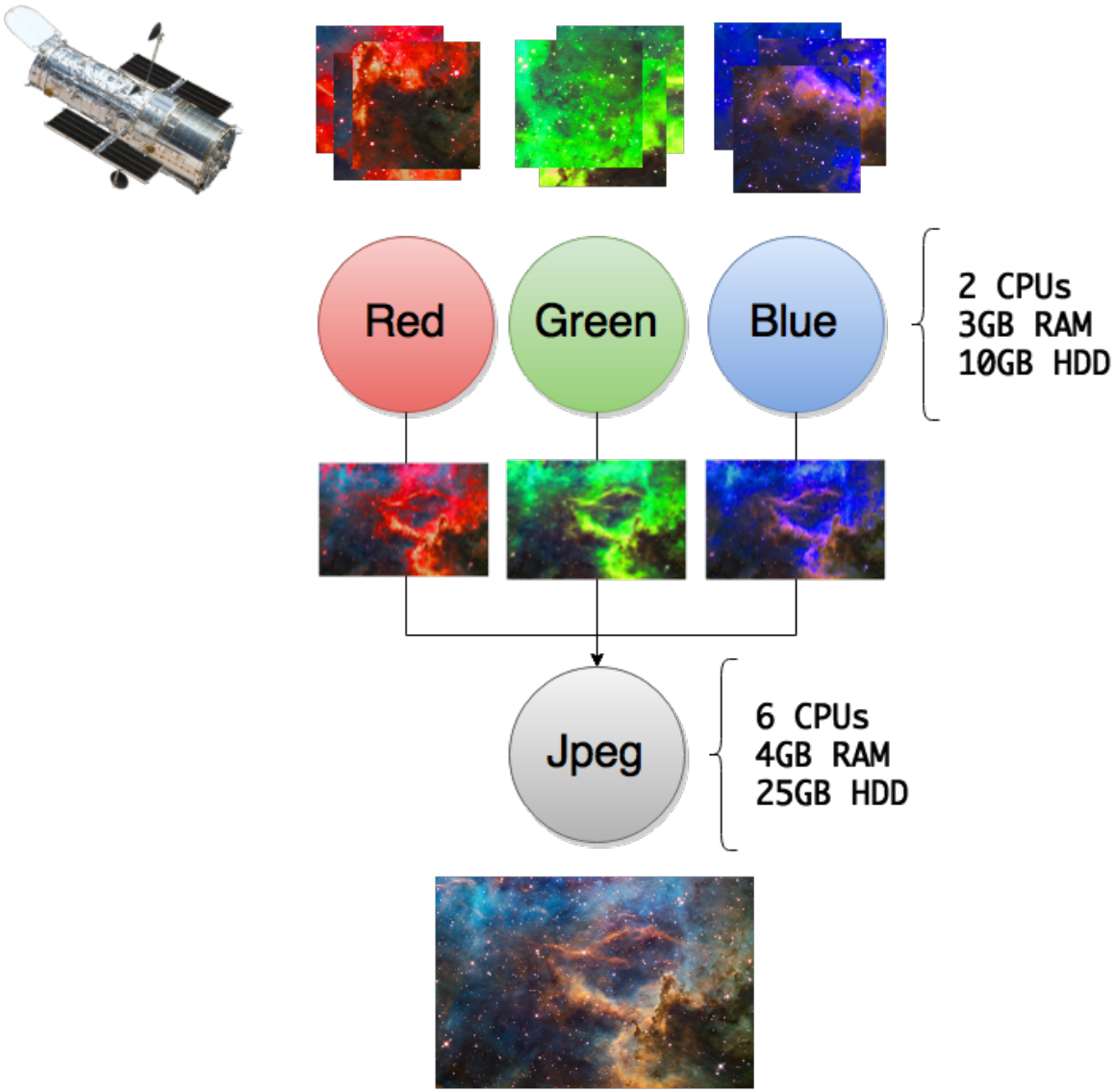
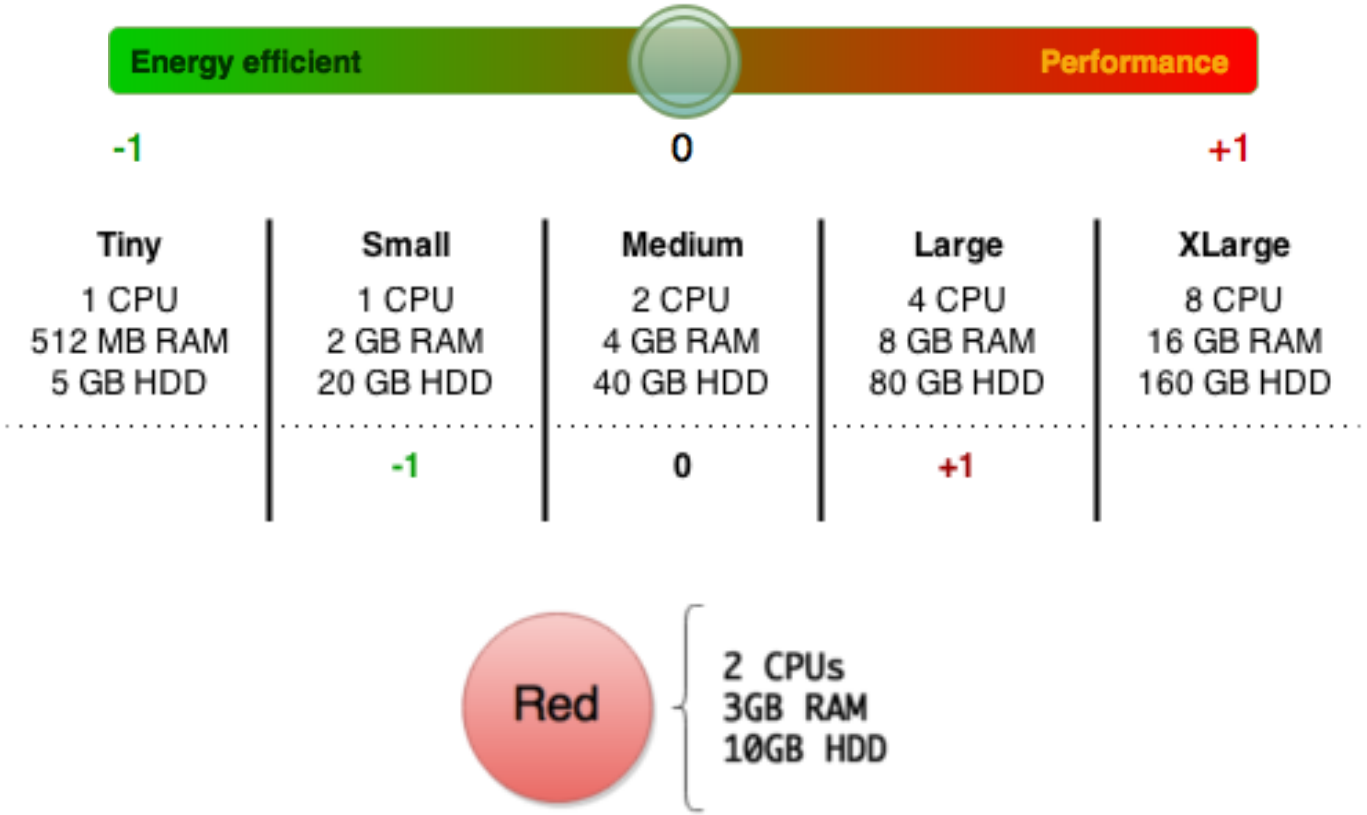


Virtual Machine Selection depending on the trade-off

Each VM has a *flavor* type

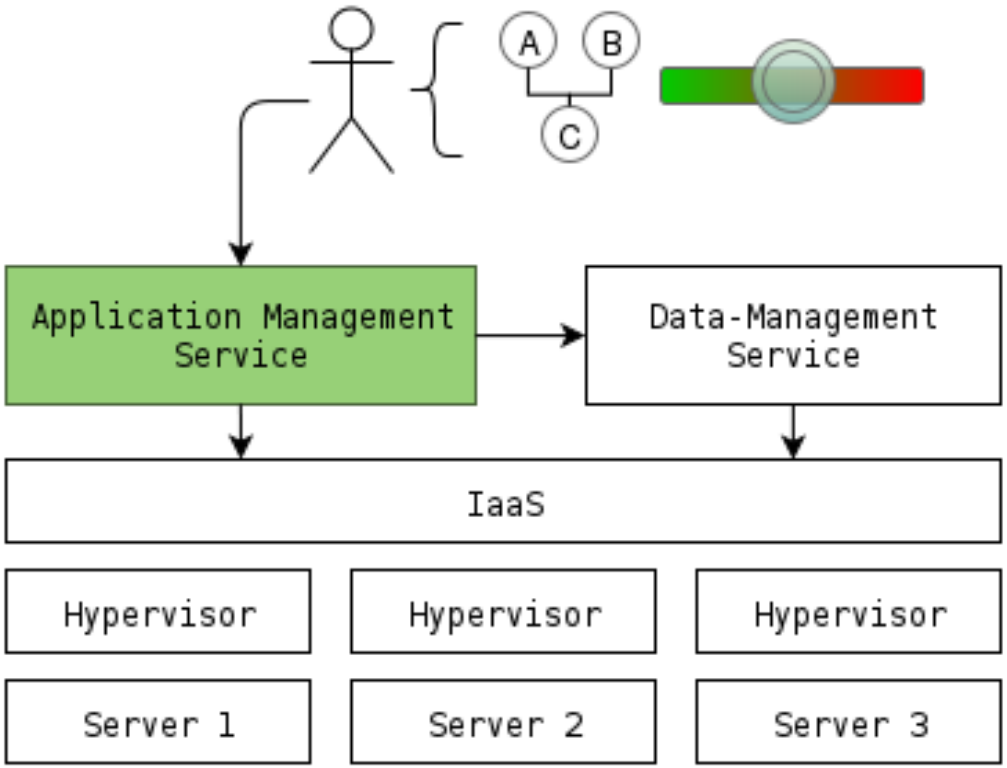


Virtual Machine Selection depending on the trade-off

Each VM has a *flavor* type

Tiny	Small	Medium	Large	XLarge
1 CPU 512 MB RAM 5 GB HDD	1 CPU 2 GB RAM 20 GB HDD	2 CPU 4 GB RAM 40 GB HDD	4 CPU 8 GB RAM 80 GB HDD	8 CPU 16 GB RAM 160 GB HDD
	-1	0	+1	
-1	0	+1		
		-1	0	+1
-1 0	+1			
			-1	0 +1

System Architecture



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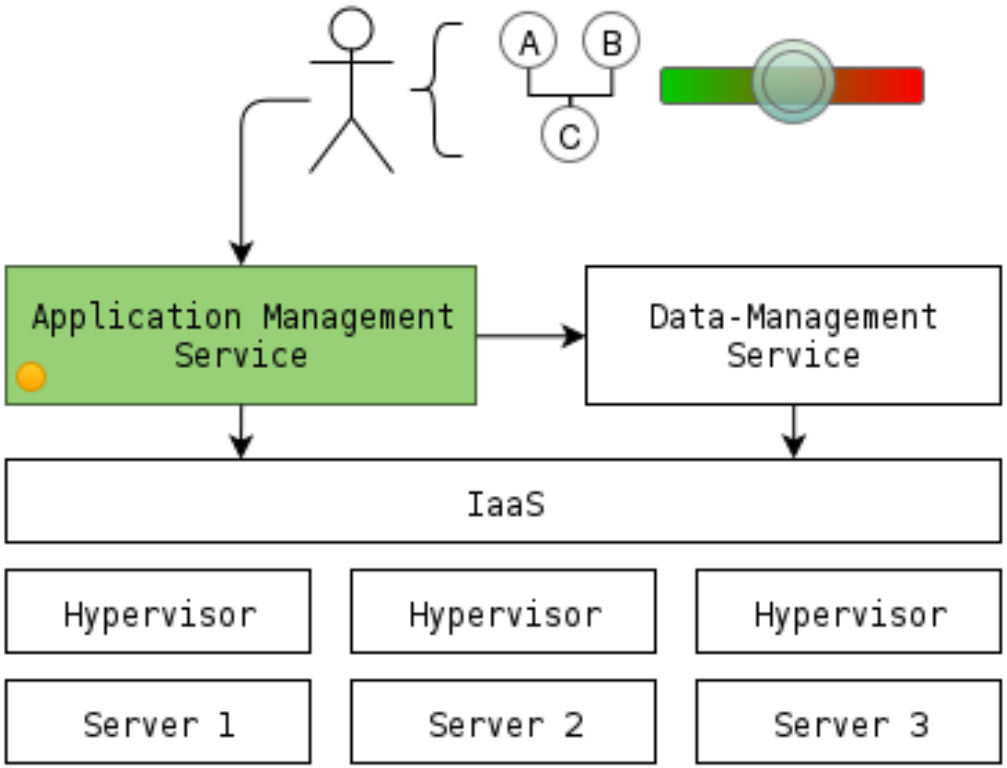

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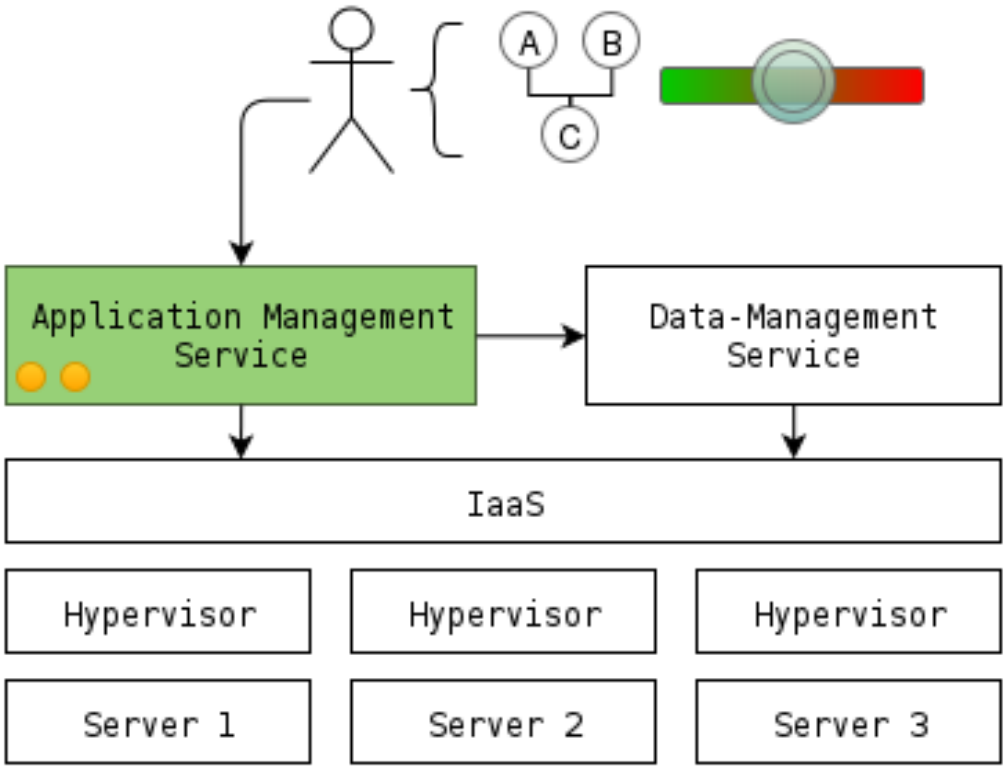
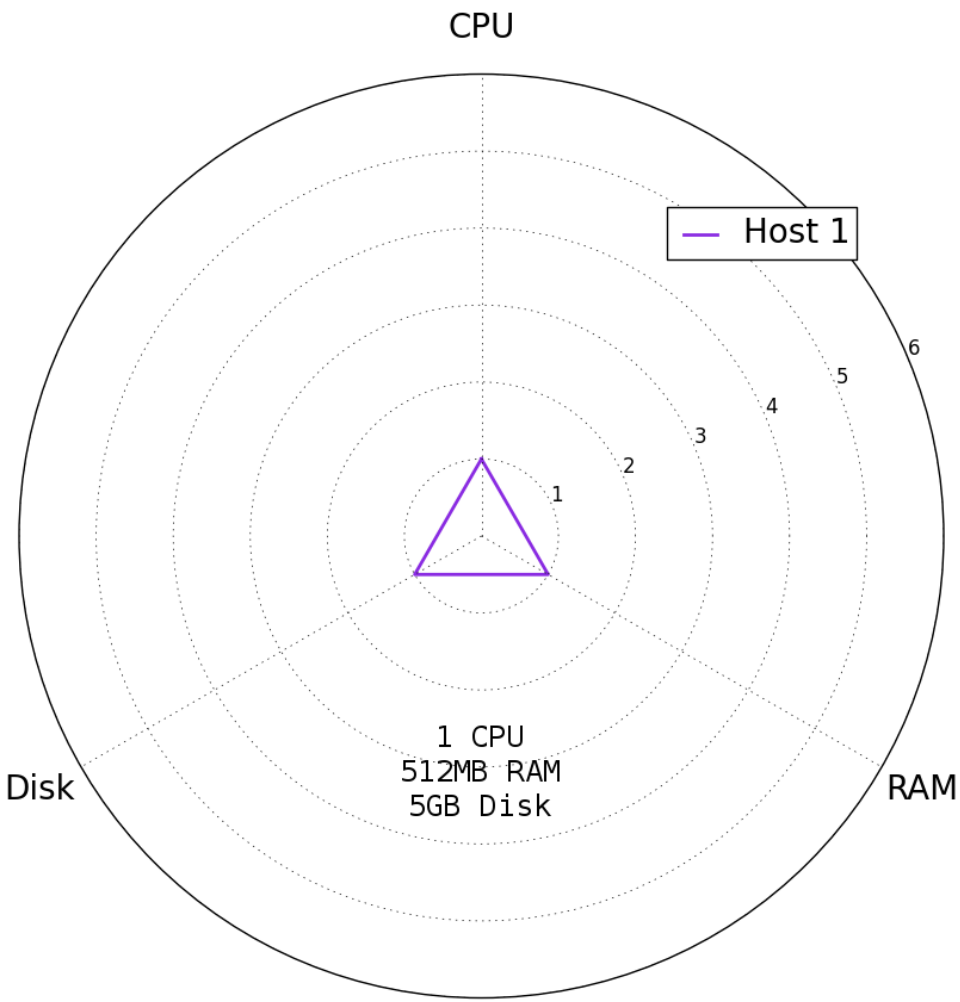


Selection of the Best Suitable Host for a VM



1 unit = tiny flavor

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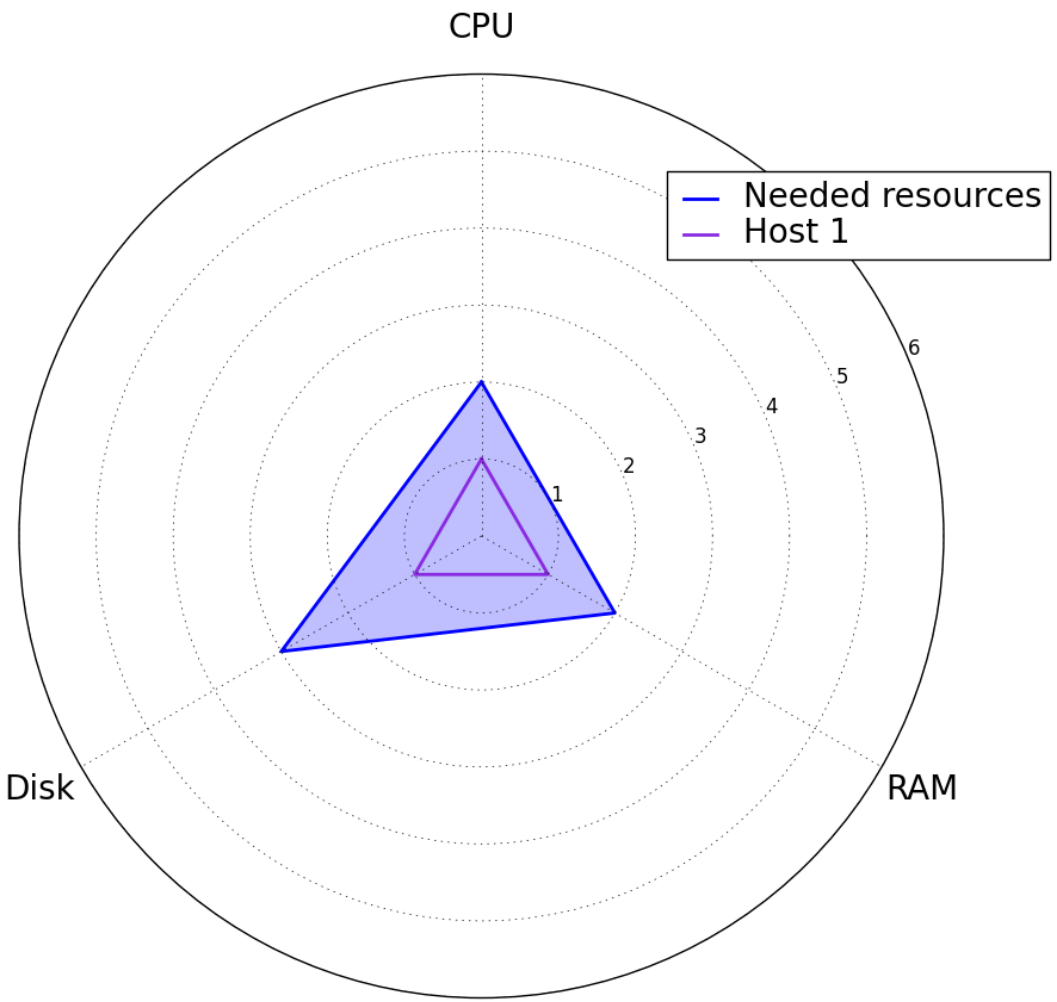

blue triangle = Virtual Machine to create

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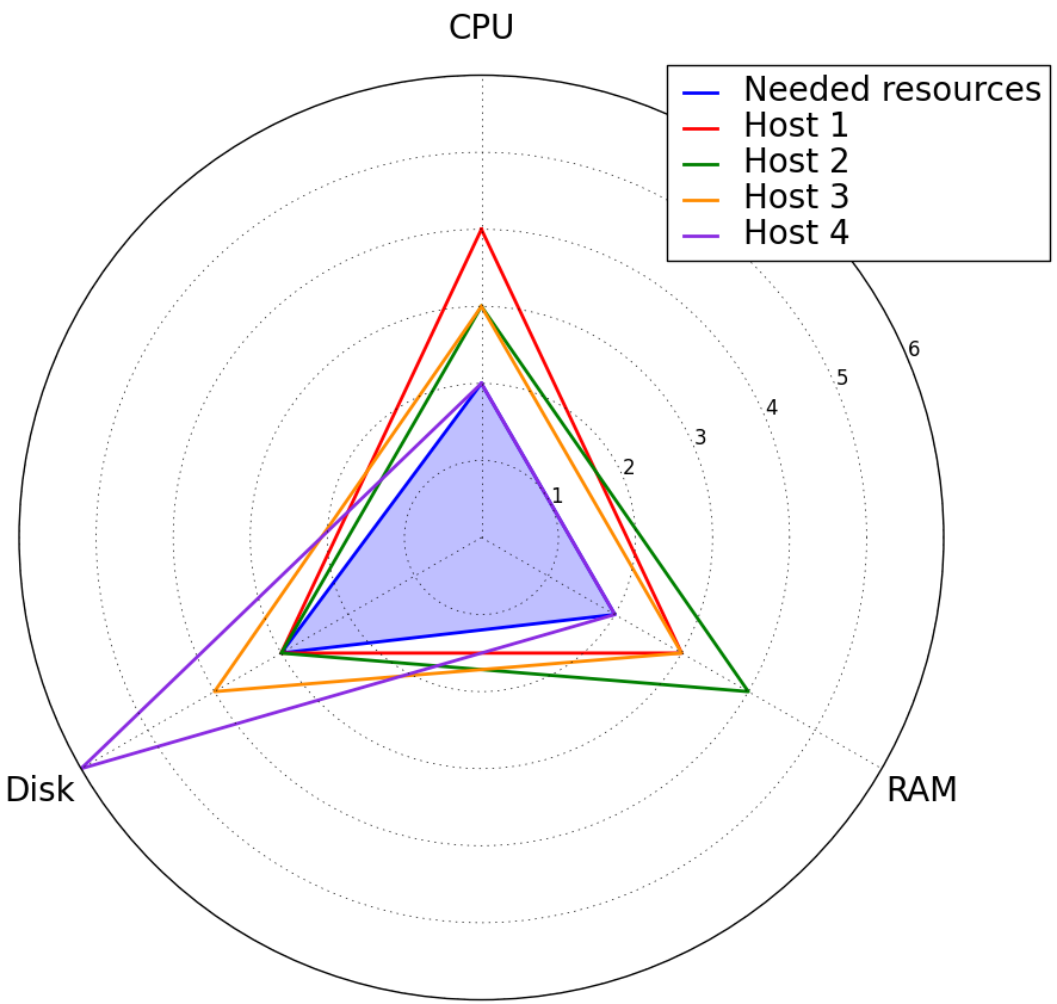

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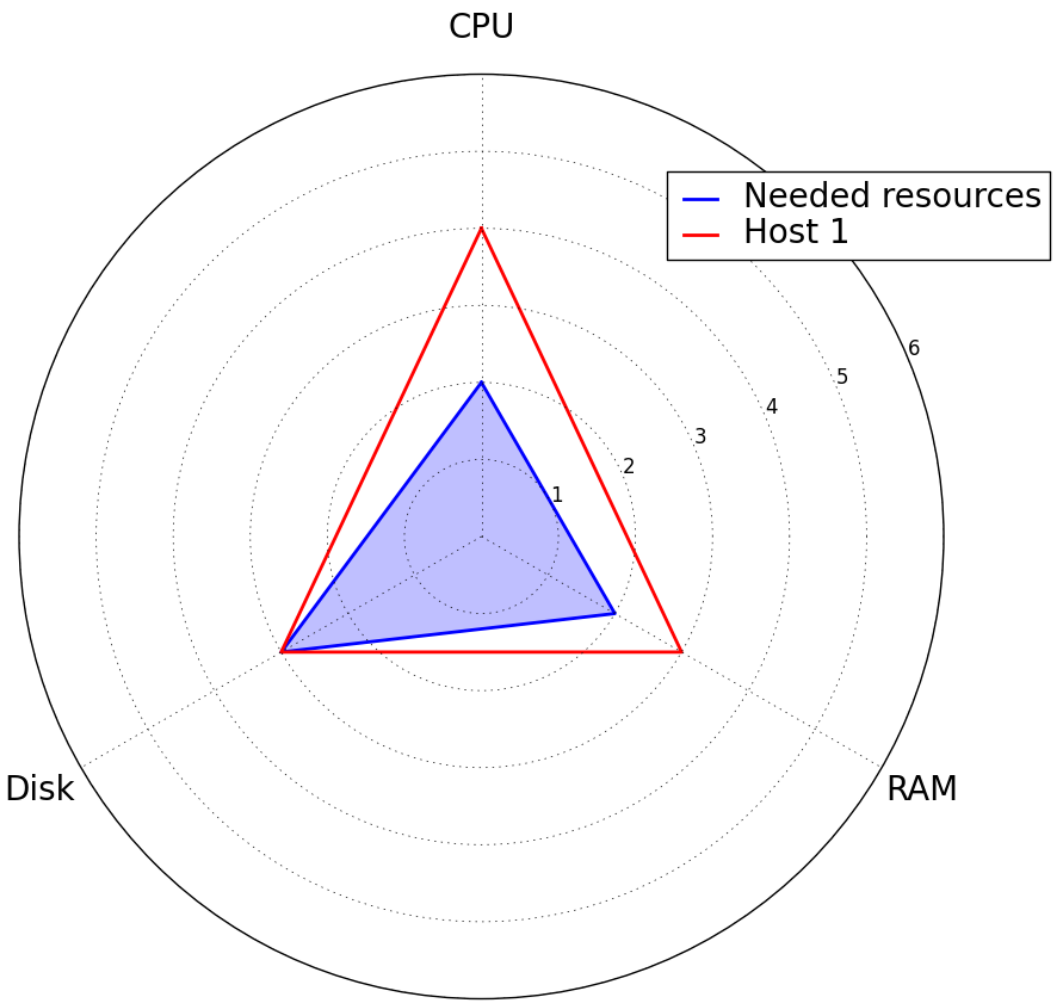

Δ calculation

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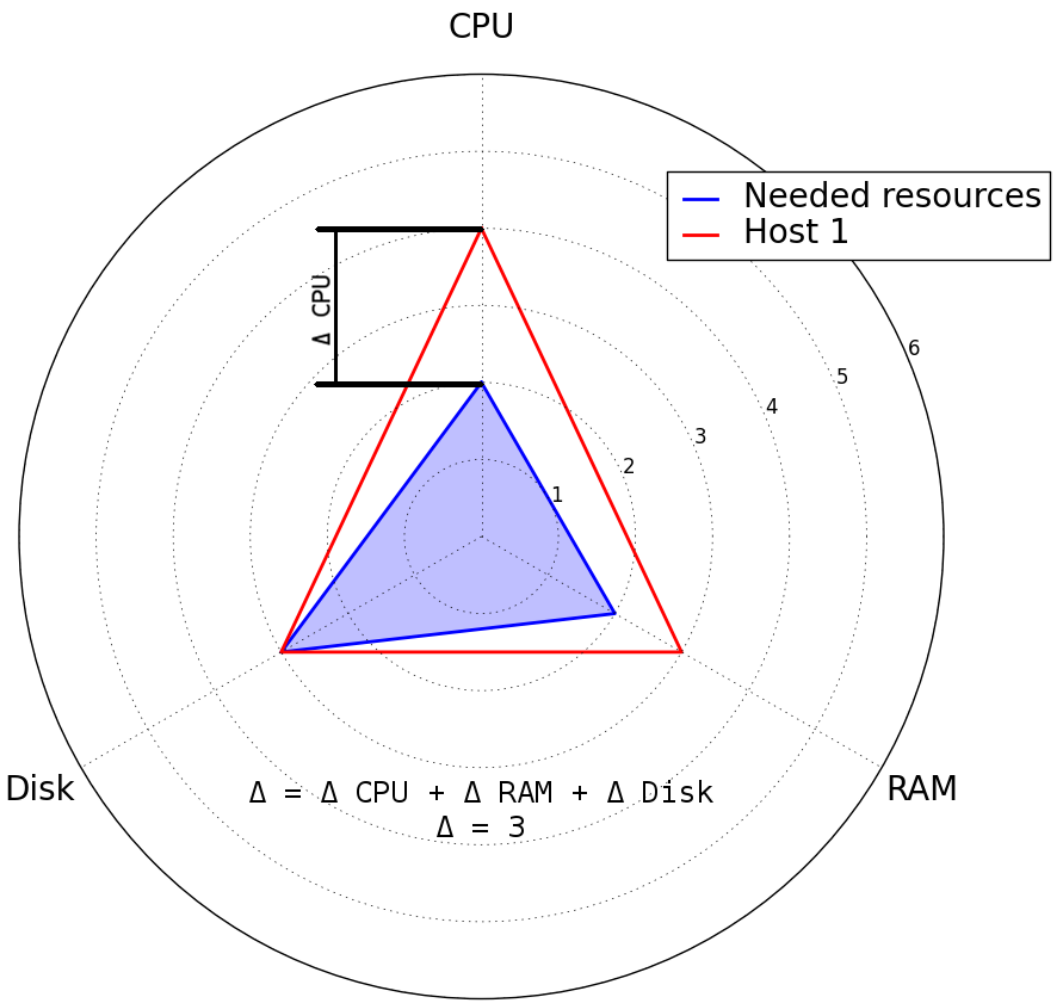

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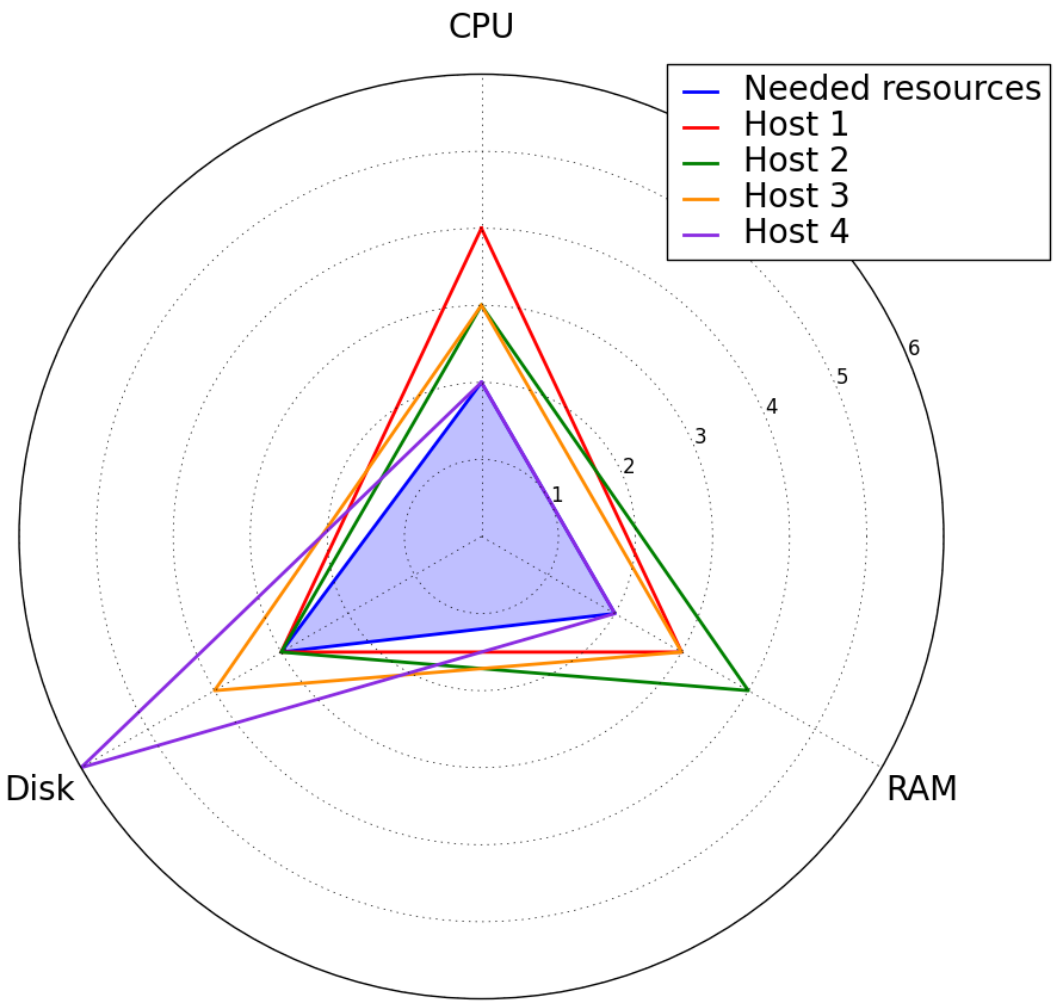

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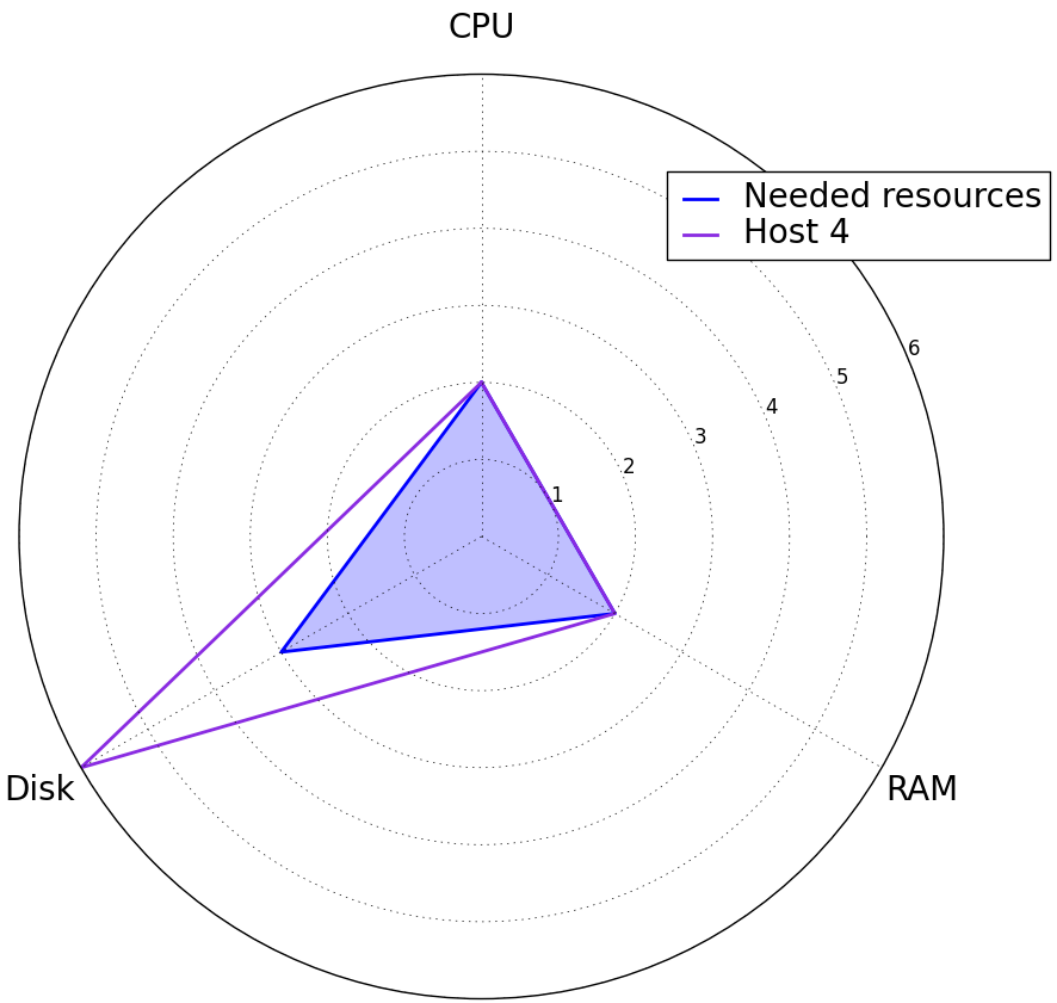

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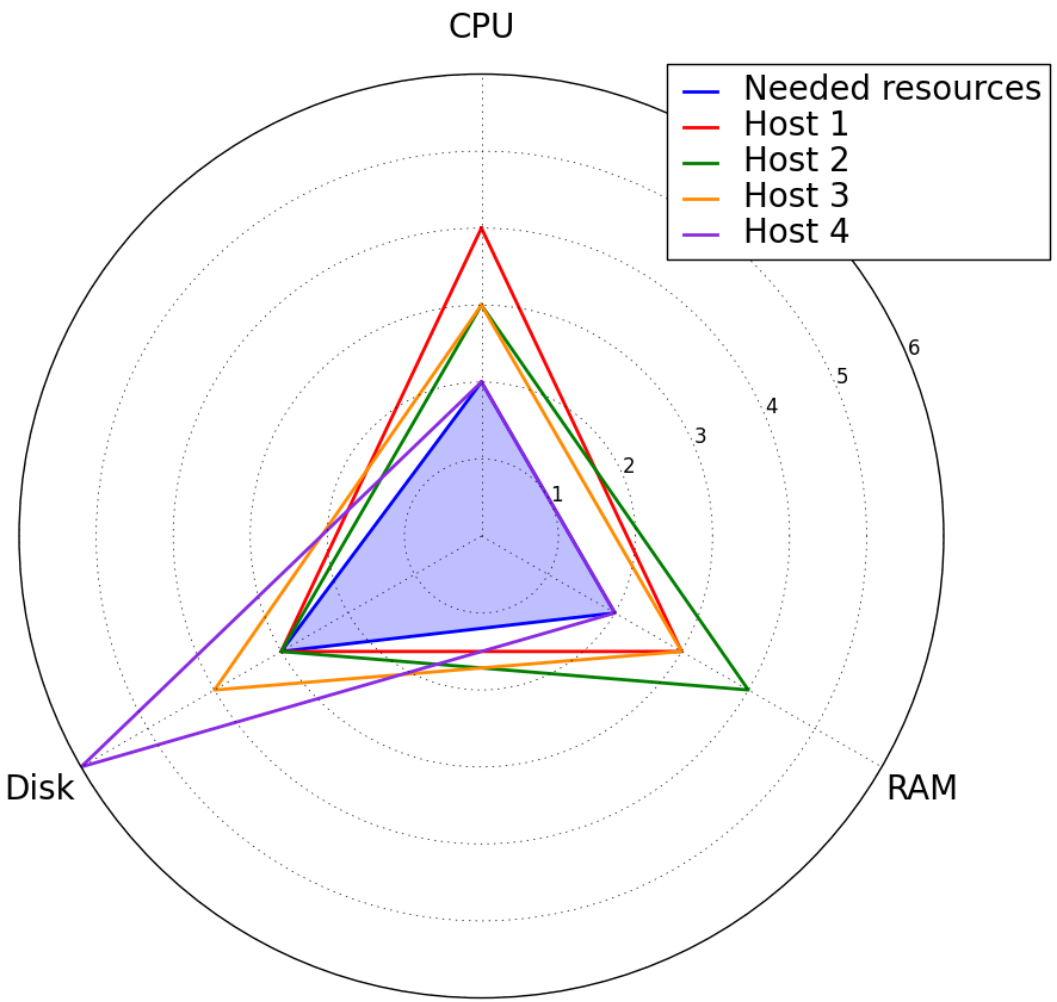

all Δ are equal to 3

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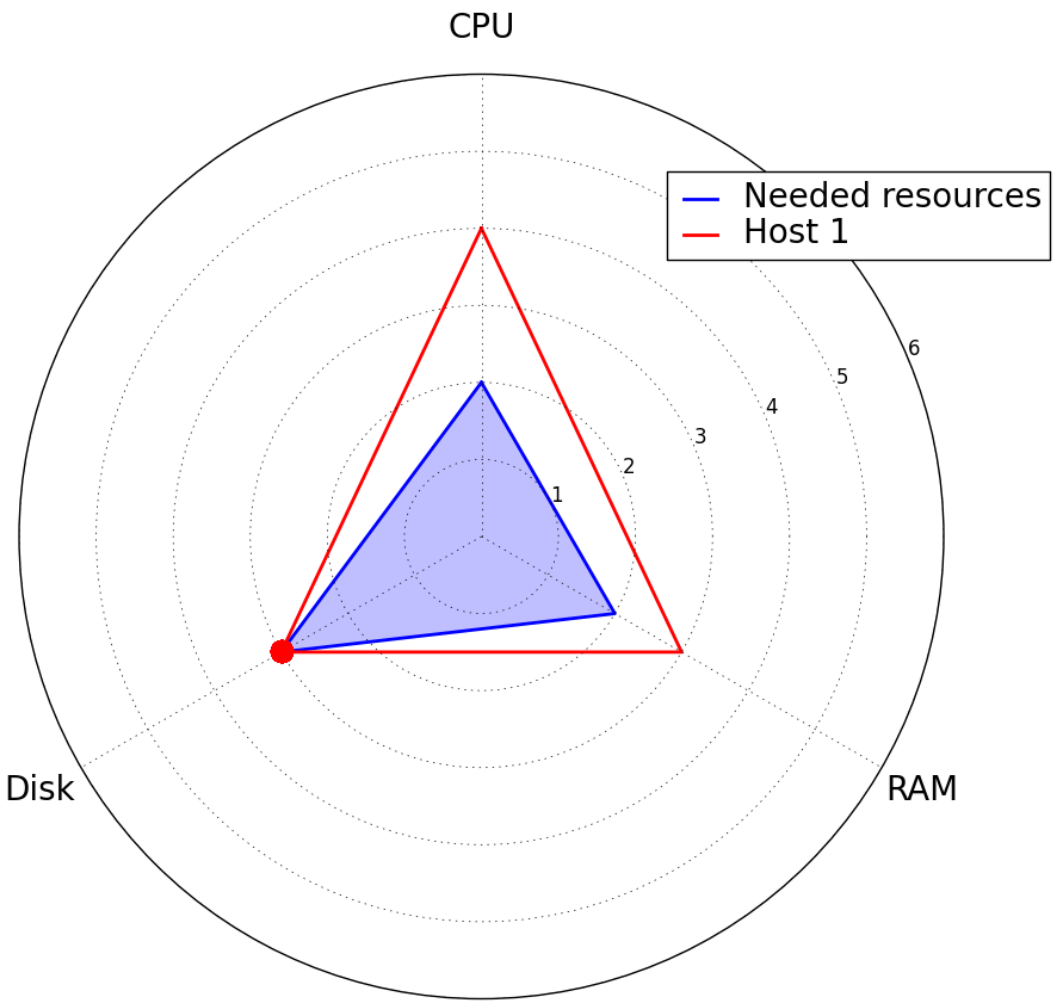

"number of Δ to 0" calculation

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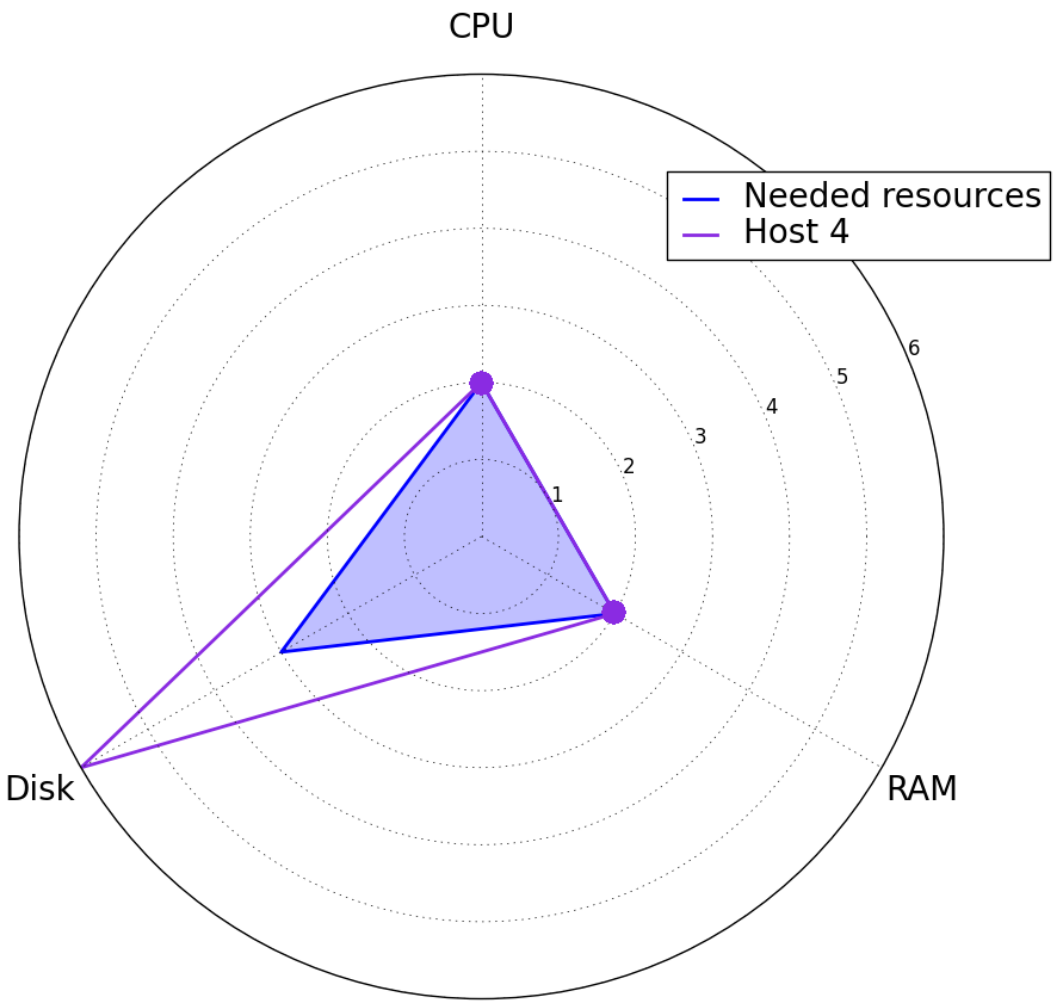

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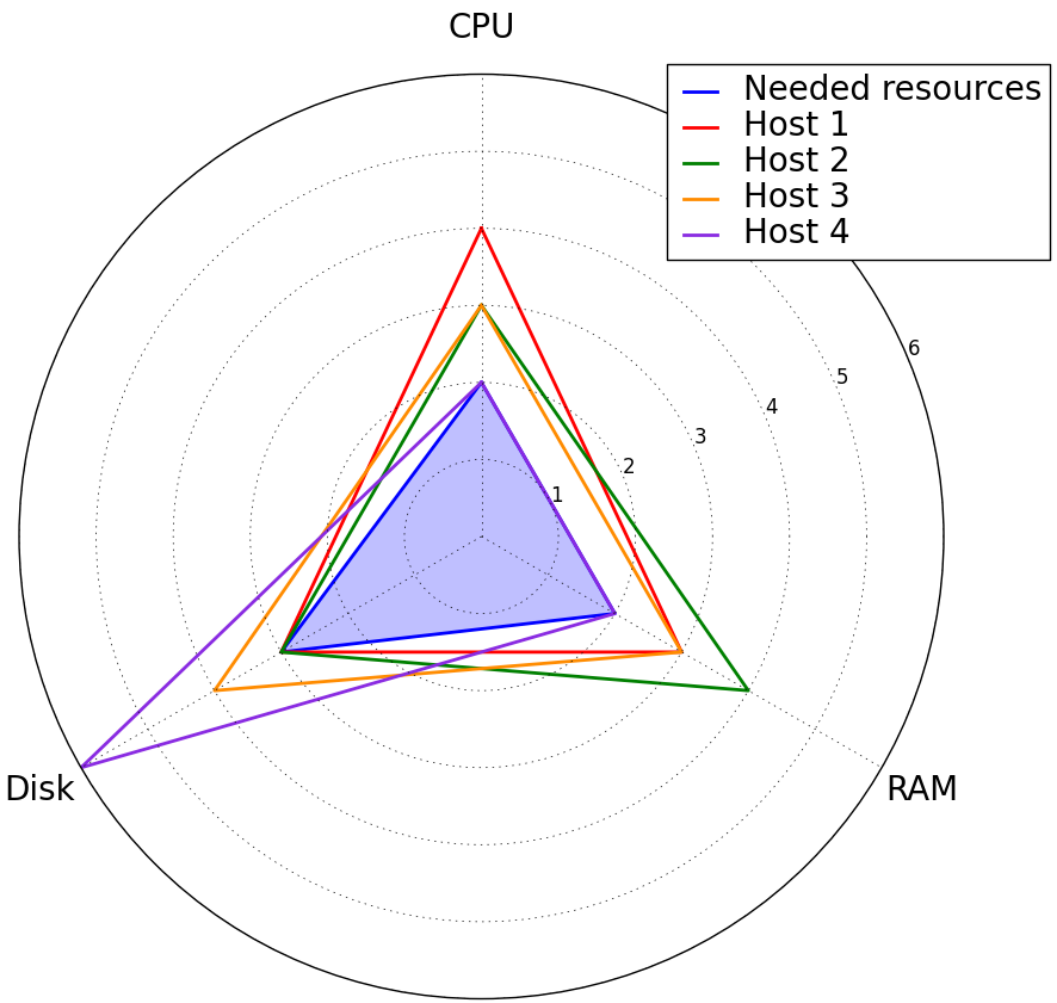
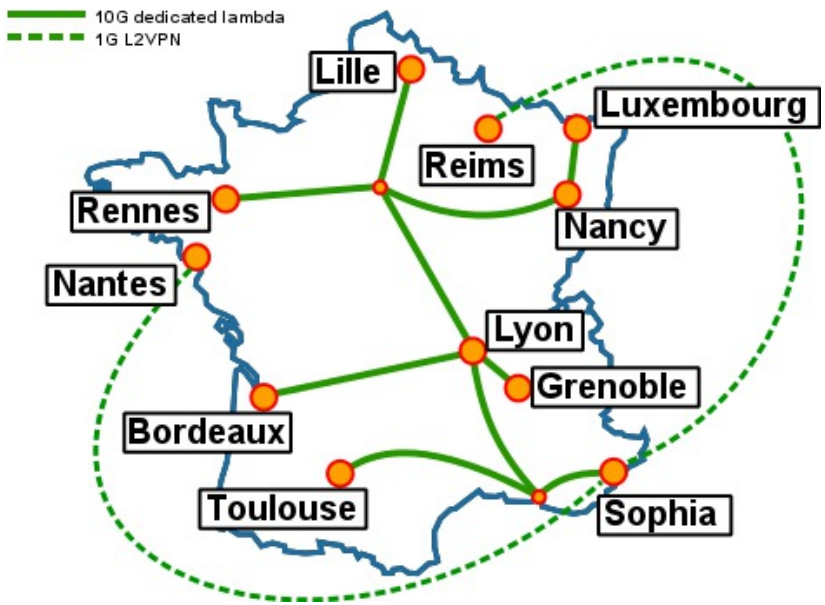


host 4 is the best suitable host

Summary – Experimentation and Results

Experimentation

- Prototype with OpenStack and FRIEDA[1]
- Grid'5000: *Taurus* cluster in Lyon, France
- Montage workflow



[1] developed at Lawrence Berkeley National Laboratory

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- Prototype with OpenStack and FRIEDA[1]
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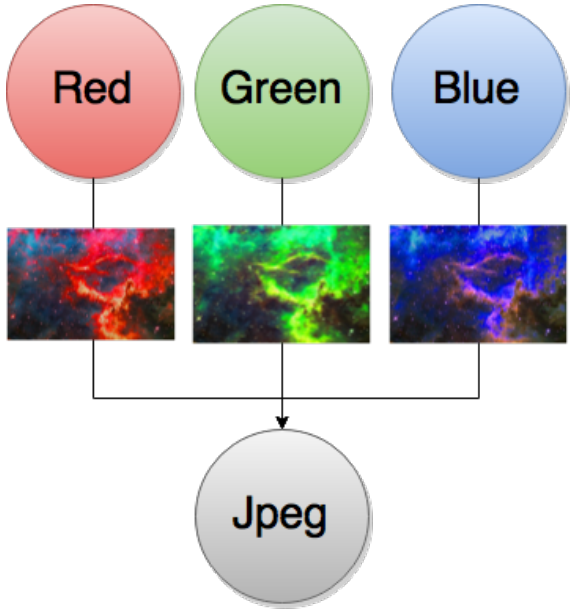
  - 2 workflows executing in parallel
  - 2 different execution conditions
  - different amount of data
  - different execution times



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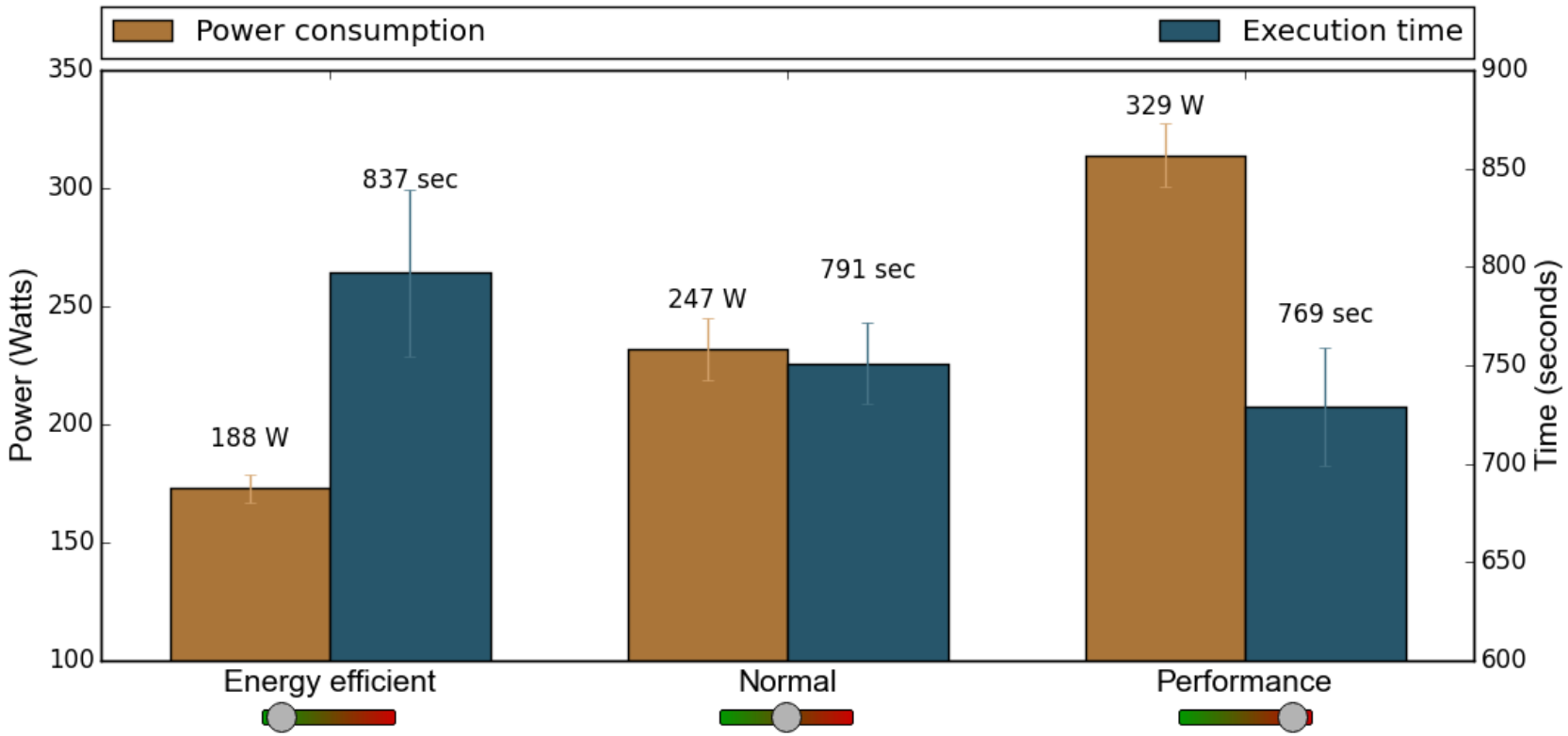
Results

Average values after 5 experiments on each execution mode



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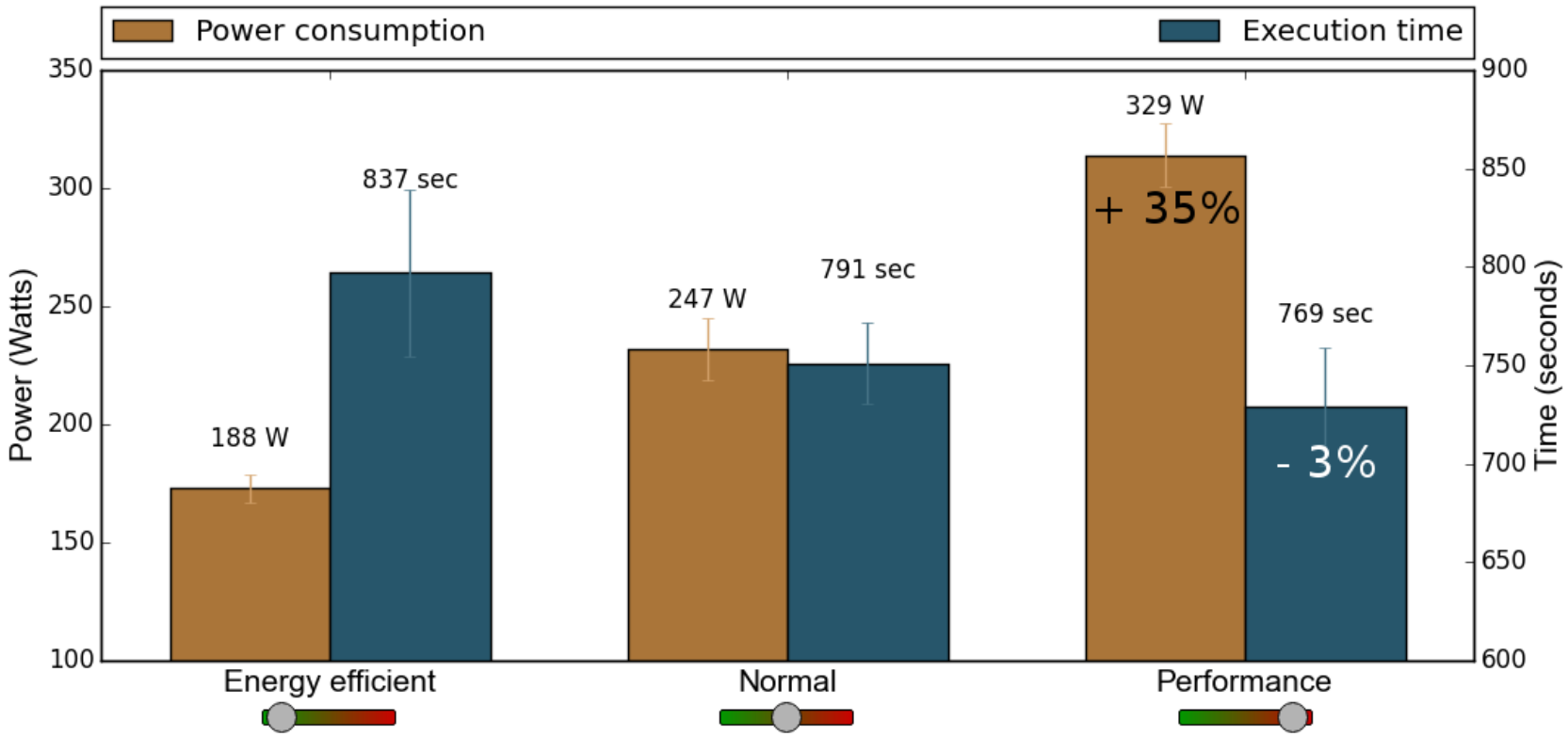

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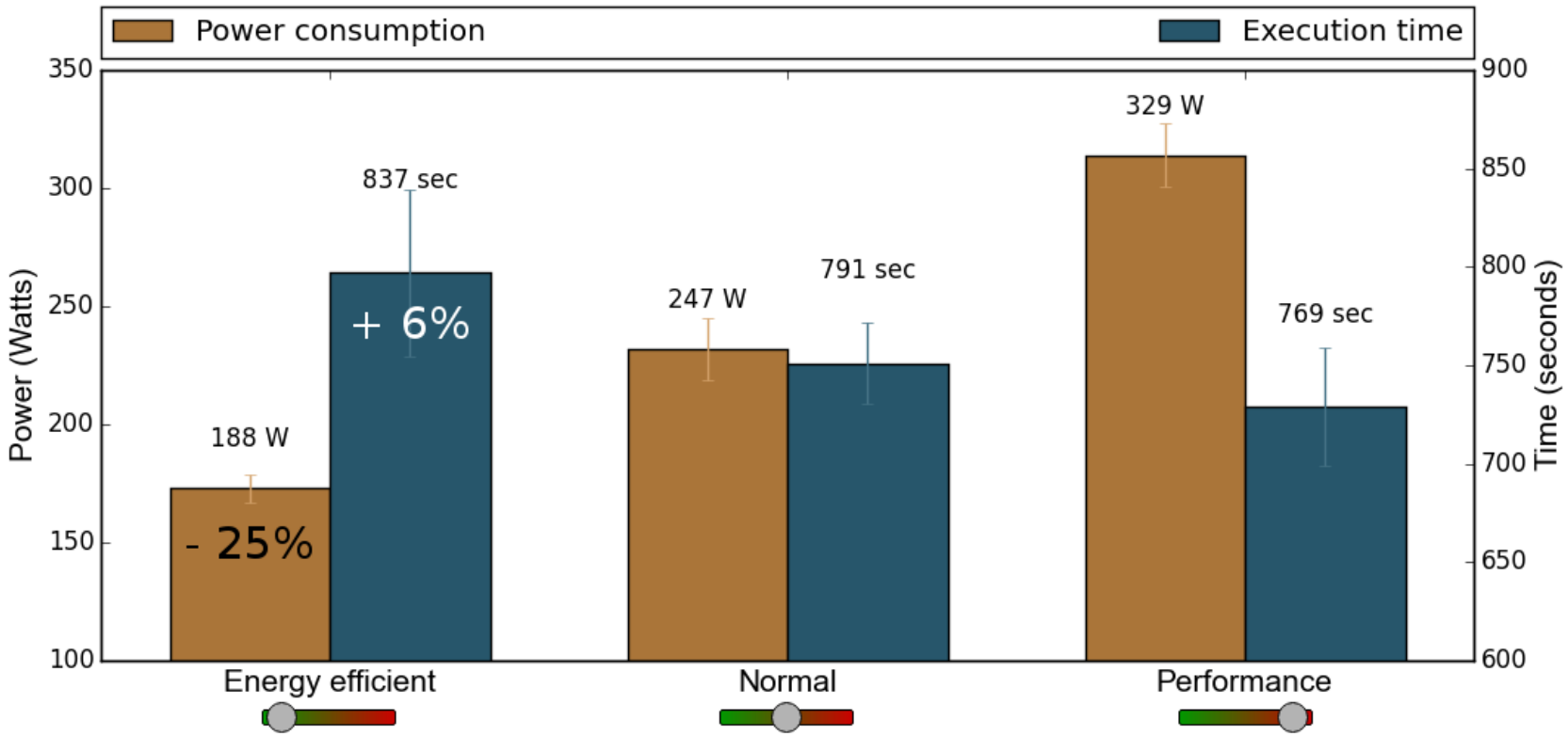

Summary – Conclusion

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- A system that takes the user into consideration to save energy
- Promising preliminary results
- 25% less in energy consumption for 6% more in execution time

Future works:

- Experiments with many users with different profiles
- Design incentive model
  - carbon tax when using *performance* mode
  - green points when using *energy-efficient* mode

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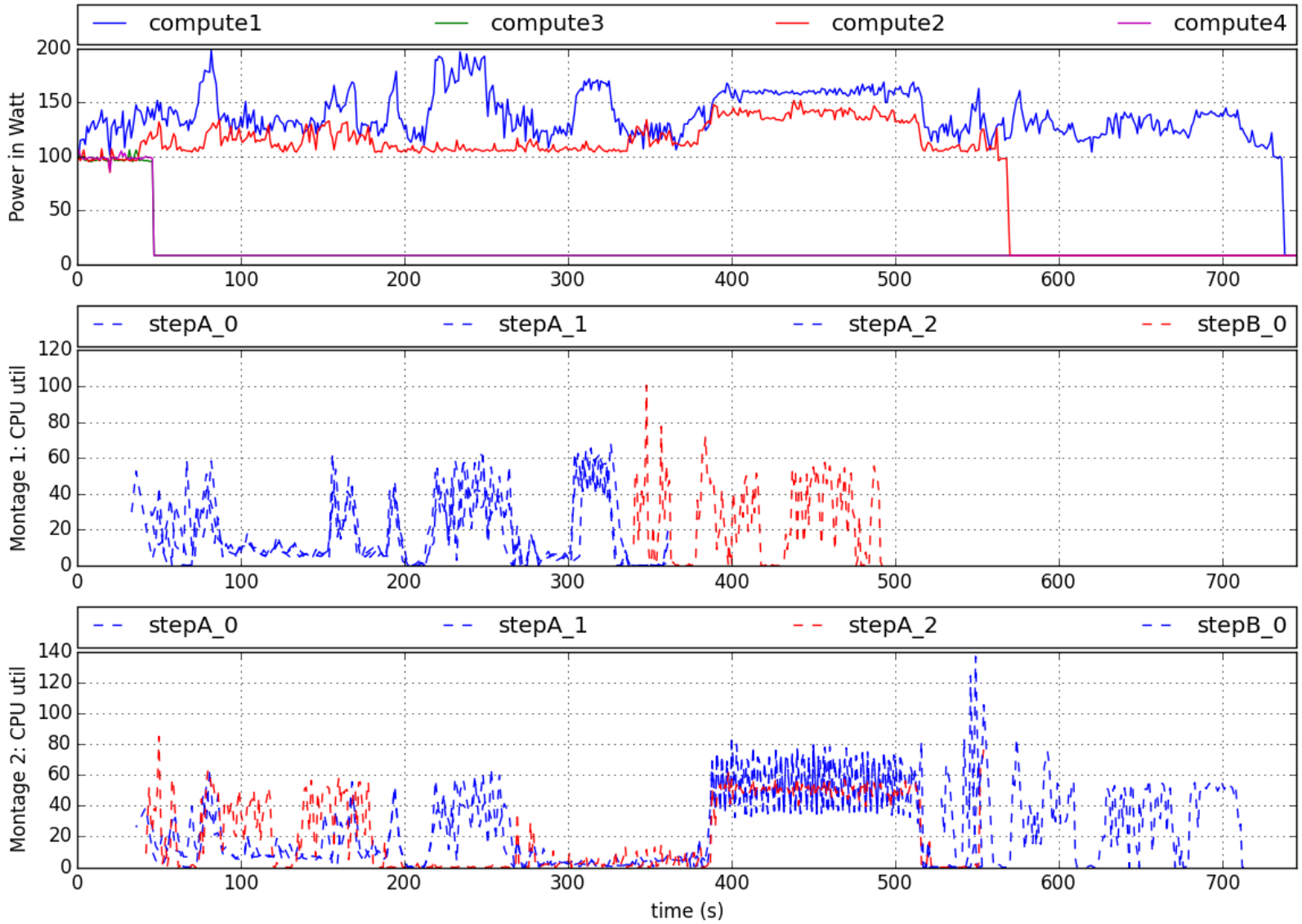
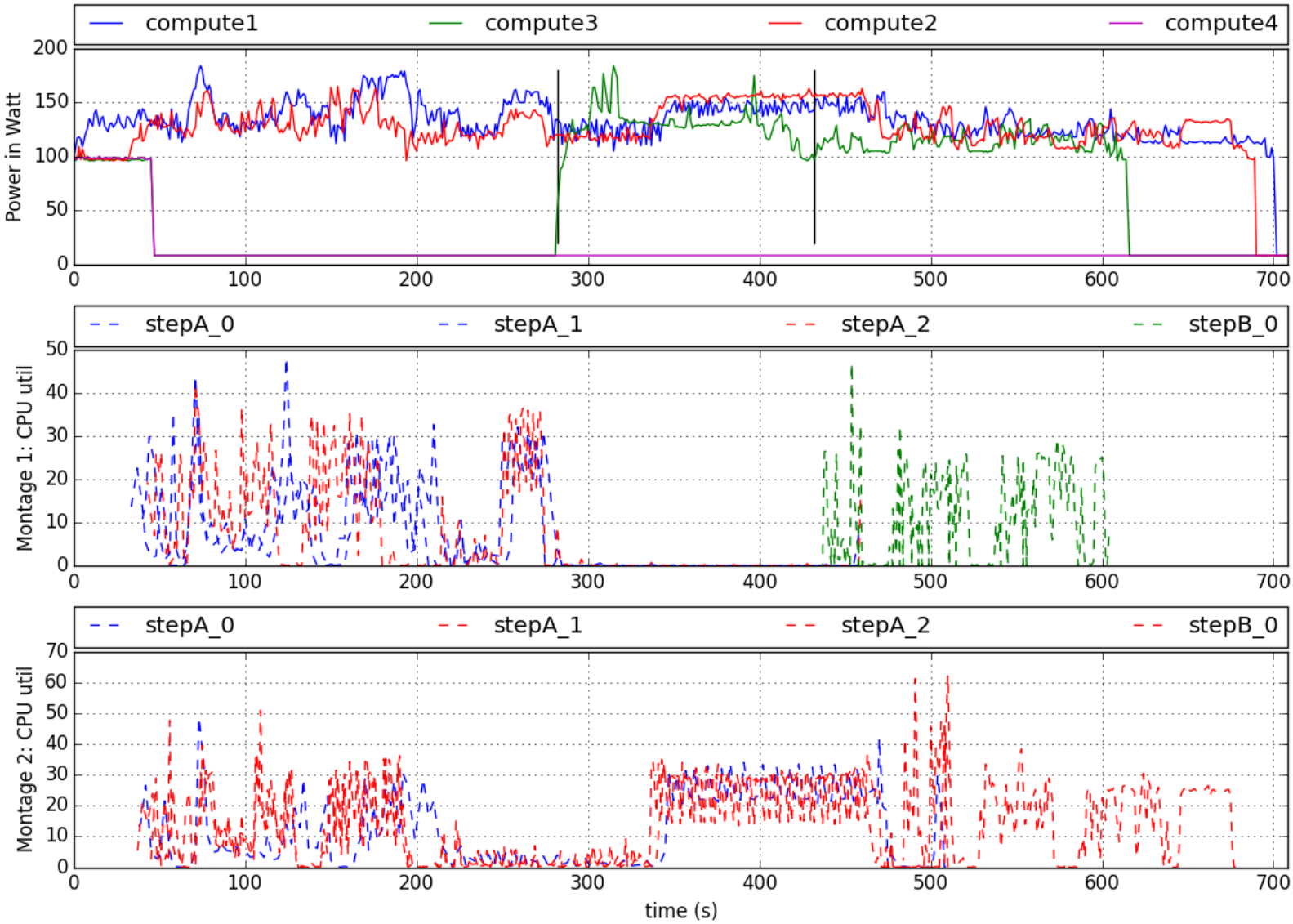
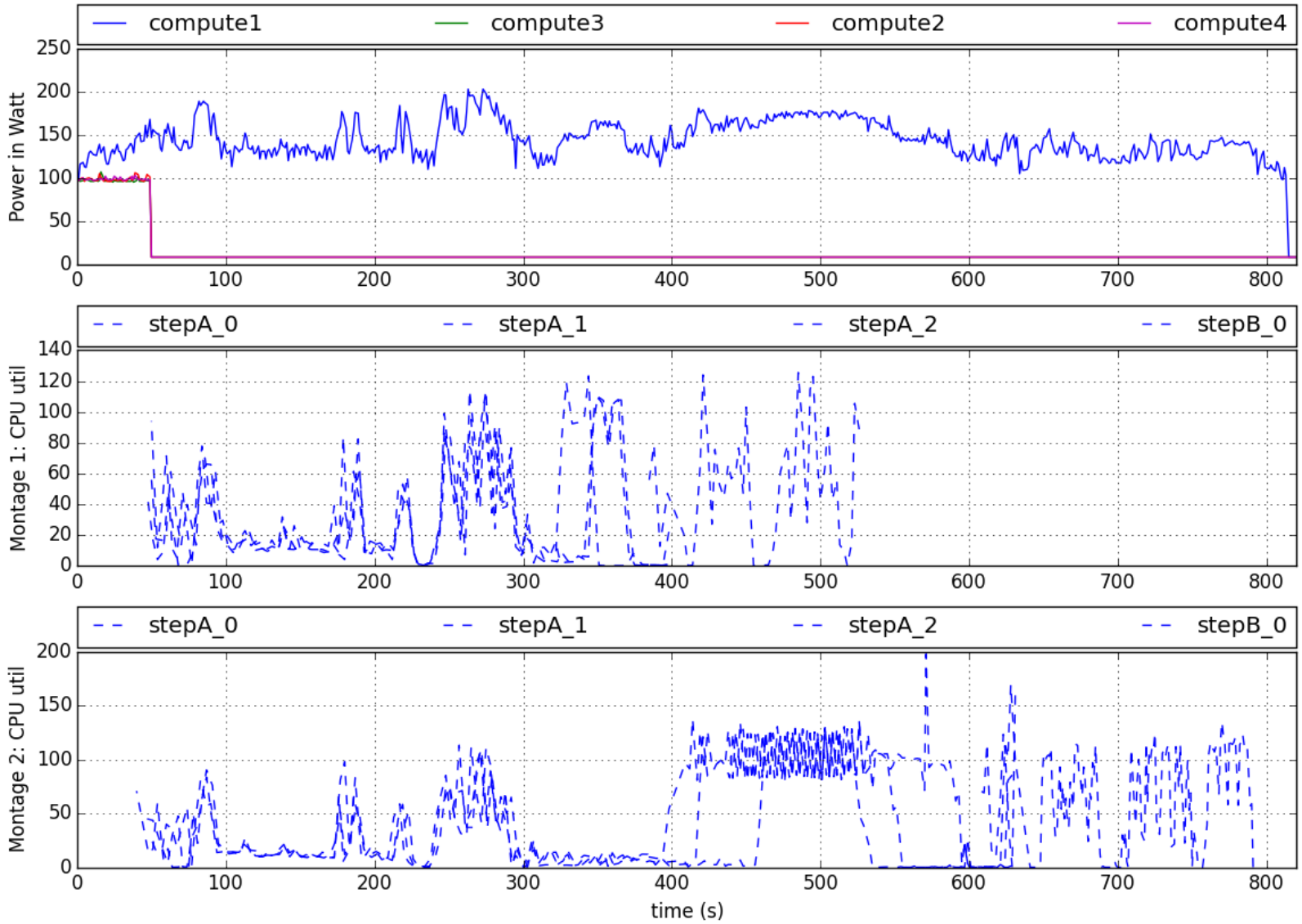
Experiment Graph in *Normal* mode



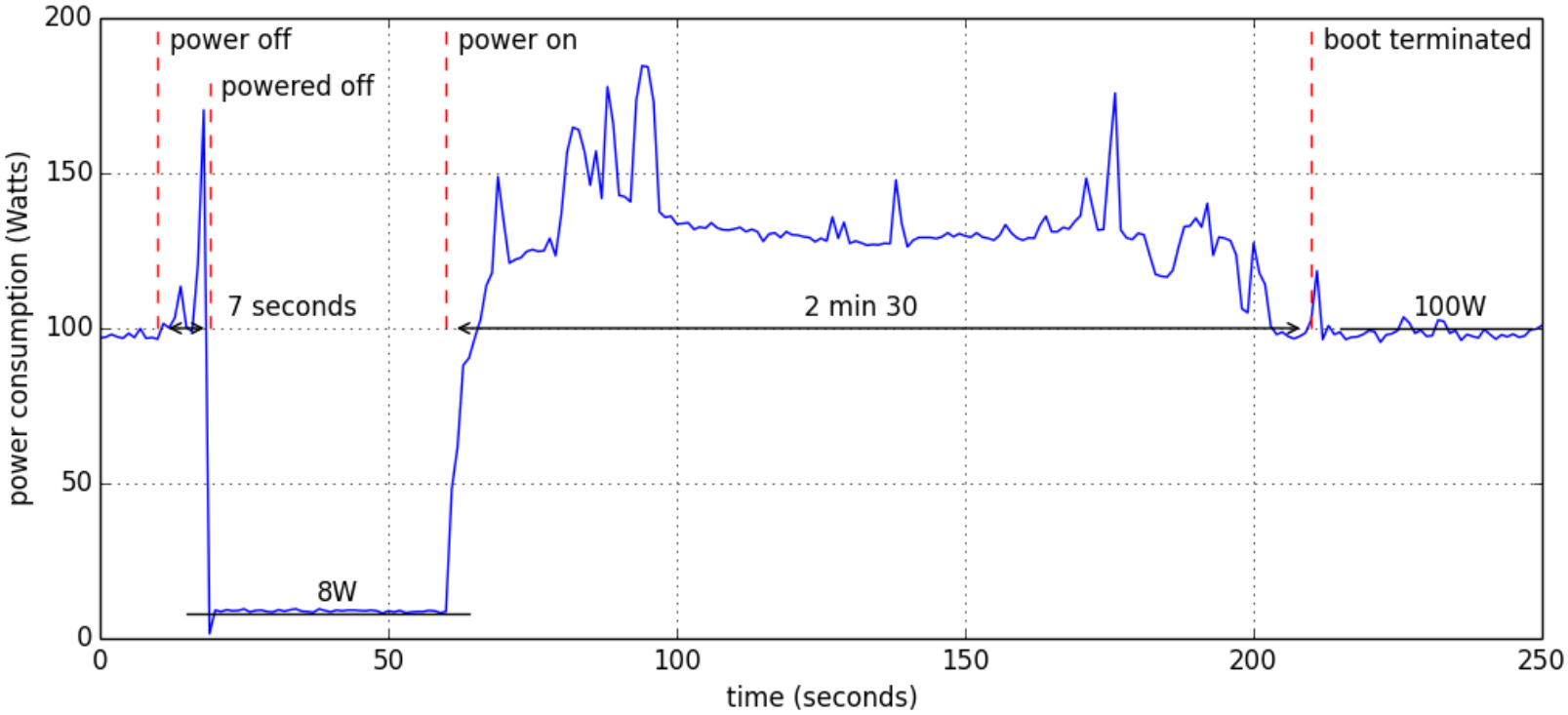
Experiment Graph in *Performance* mode



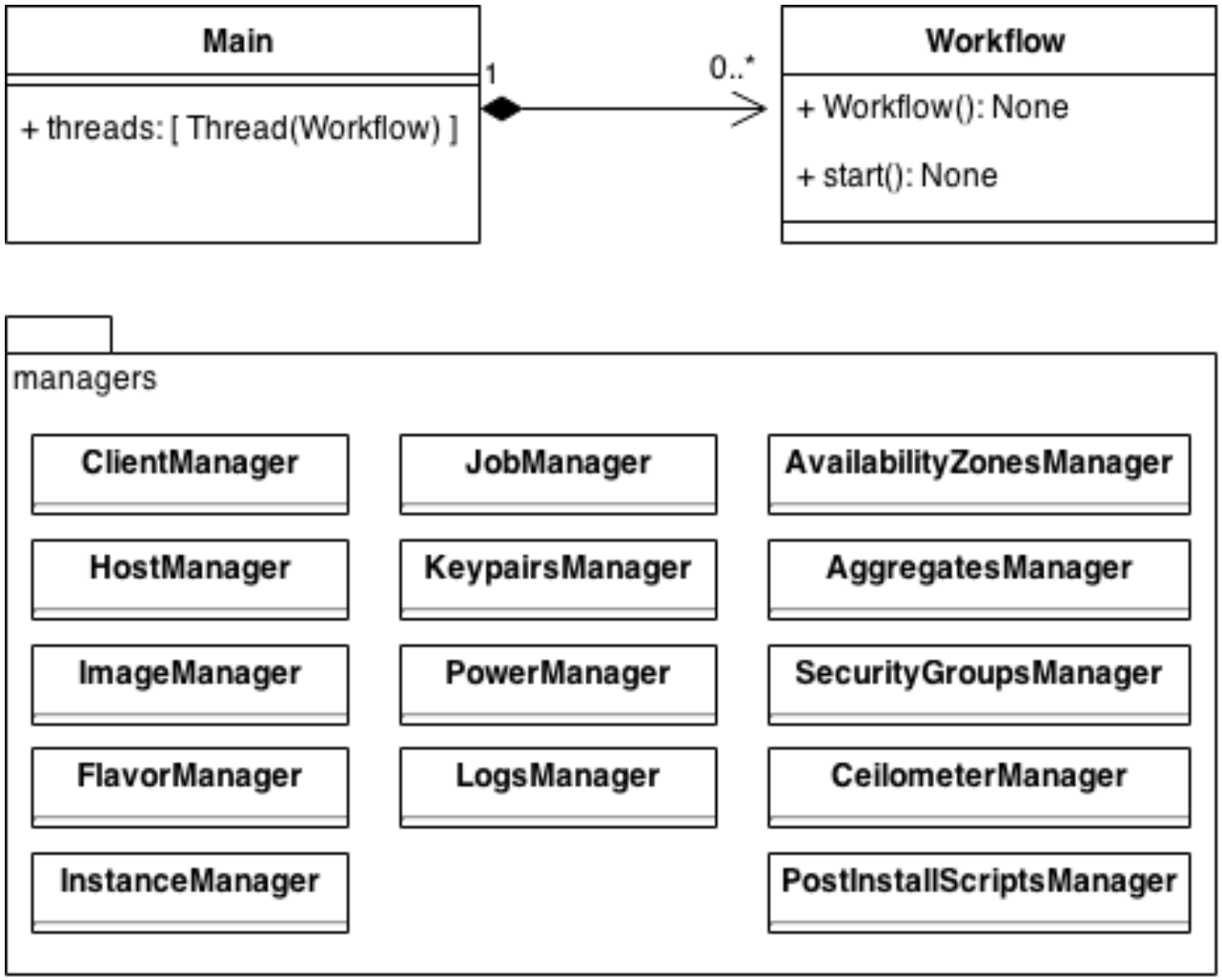
Experiment Graph in *Energy Efficient* mode



Power Simulation on the *Taurus* nodes



UML Diagram


Main
+ threads: [Thread(Workflow)]
1
0..*
Workflow
+ Workflow(): None
+ start(): None
managers
ClientManager
JobManager
AvailabilityZonesManager
HostManager
KeypairsManager
AggregatesManager
ImageManager
PowerManager
SecurityGroupsManager
FlavorManager
LogsManager
CeilometerManager
InstanceManager
PostInstallScriptsManager

Execution Diagram