Integration of SimGrid in the Datazero project: challenges and solutions

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September 12-13 2018, Troyes

Outline

- Presentation of the Datazero project
- Presentation of SimGrid
- Goals
- Challenges
- Proposed solution
- Demo
- Conclusion

The Datazero project (ANR 2015-2019)

❑ Observation

- ✓ Exponential growth of datacenter usage
- ✓ Electricity still often obtained from fossil sources (coal)

❑ Context

- ✓ DataCenter with several renewable energy sources (wind, solar, fuel cell, battery…)
- ✓ Energy production constraints
  - ➢ Intermittence
  - ➢ Storage
- ✓ IT constraints
  - ➢ Ensure a quality of service negotiated with the users

The Datazero project (ANR 2015-2019)

❑ Goals

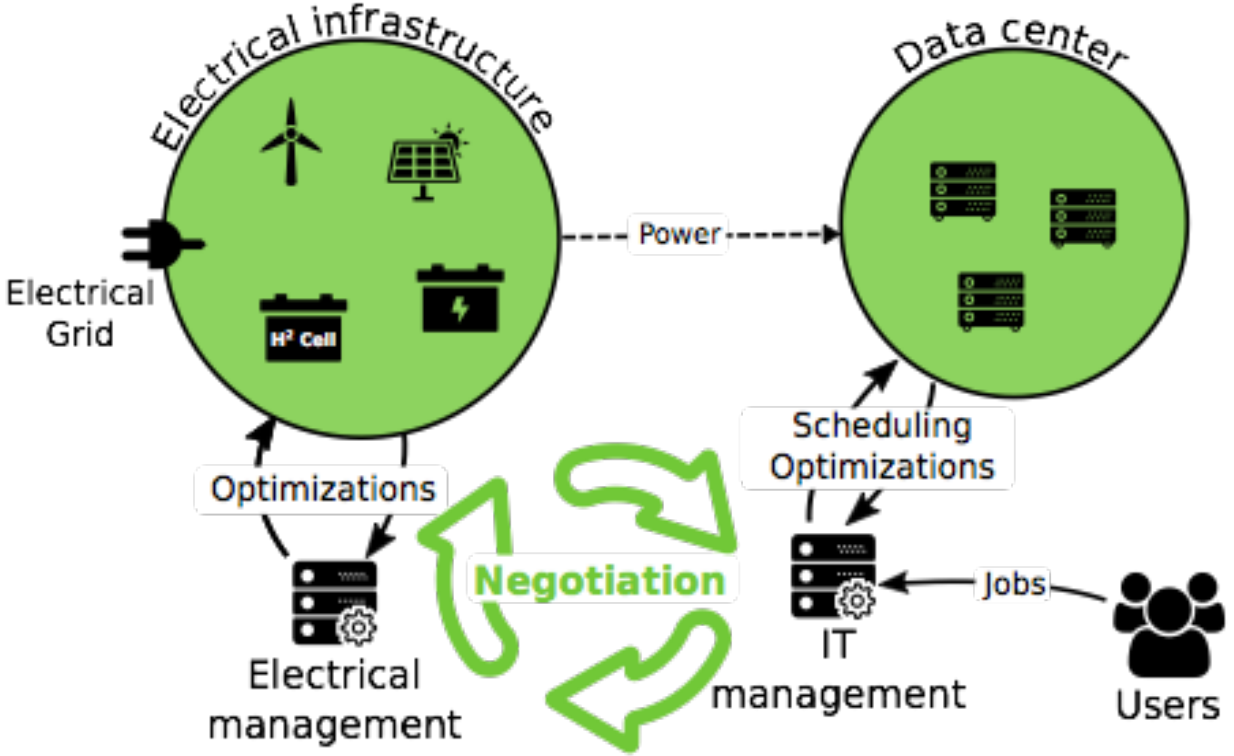
- ✓ Ensure, in a robust and efficient manner, the best possible quality of service for the users

and

- ✓ Aim towards running solely on renewable power

❑ Idea

- ✓ Implement a negotiation to consider both IT and power constraints

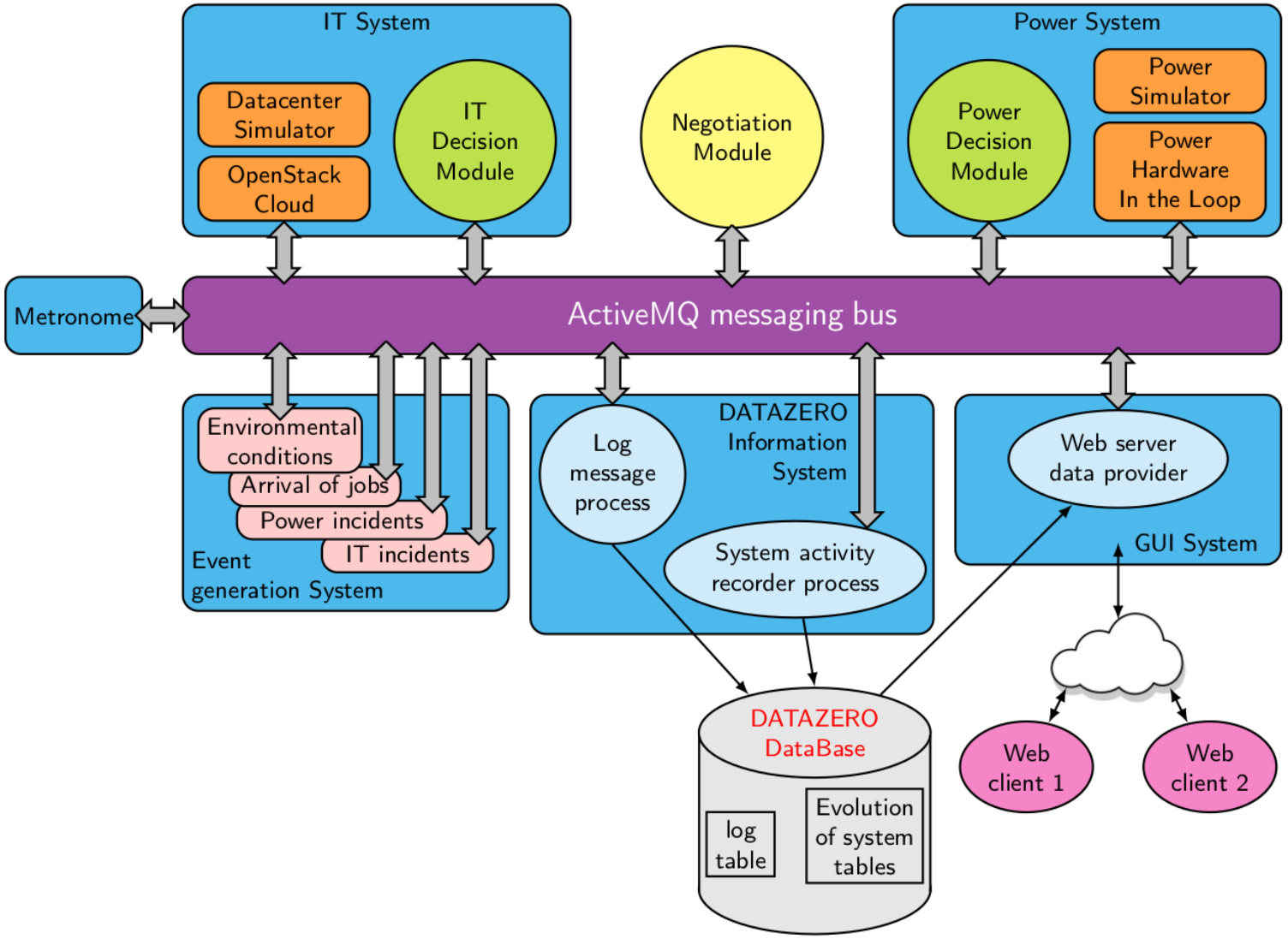


The Datazero project (ANR 2015-2019)

- **Several cooperating components/processes**
- **Communication through an ActiveMQ message bus**
- **Two implementation scenarios for a component**
  - **Simulated version, without material constraints, to:**
    - Validate the proposed concepts
    - Allow easier observation of the system behavior on time scales which would be unpractical (month, year...)
  - **Real implementation:**
    - Validate concept feasibility
    - Confront theoretical results to actual observations
    - Using an Openstack architecture
- **Possible mix of the 2 scenarios in a single experiment**

The Datazero project

Middleware and Datazero components

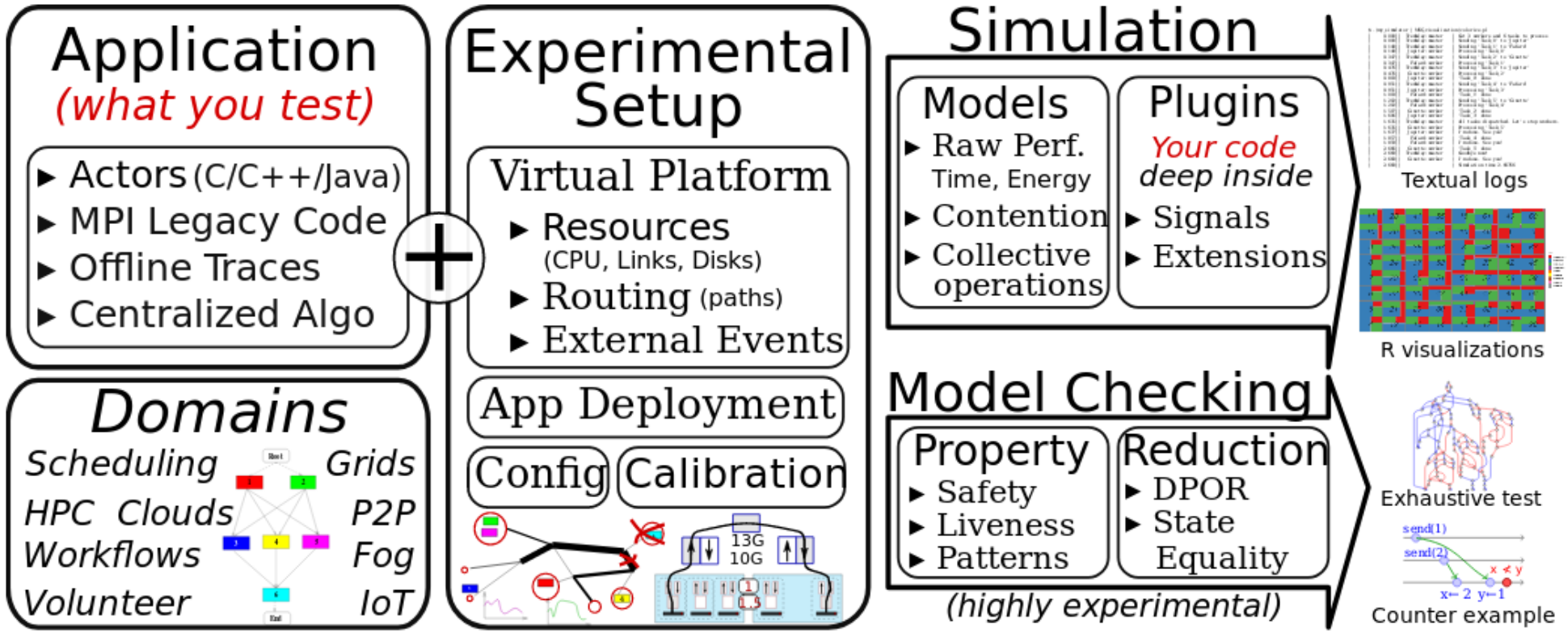


Implementation

❑ SimGrid

✓ Open source software supported by INRIA

« SimGrid is a scientific instrument to study the behavior of large-scale distributed systems such as Grids, Clouds, HPC or P2P systems. It can be used to evaluate heuristics, prototype applications or even assess legacy MPI applications. All this as a free software. »



Implementation

- **SimGrid**
  - ✓ Simulation library
  - ✓ Infrastructure under study: uses XML file as input
  - ✓ Deployment of the application being tested: code or XML
- **Reasons for this choice**
  - ✓ Validated, active project
  - ✓ Open source
  - ✓ User community
  - ✓ Simulation of electrical consumption

Implementation

❑ SimGrid

✓ Usage of SimGrid Java API

- Main MSG simulation Functions
- Process Management Functions
- Host Management Functions
- Task Management Functions
- Mailbox Management Functions
- File Management Functions
- Task Actions
- VMs

✓ More → simgrid.gforge.inria.fr

Goals

✓ Model Datazero concepts

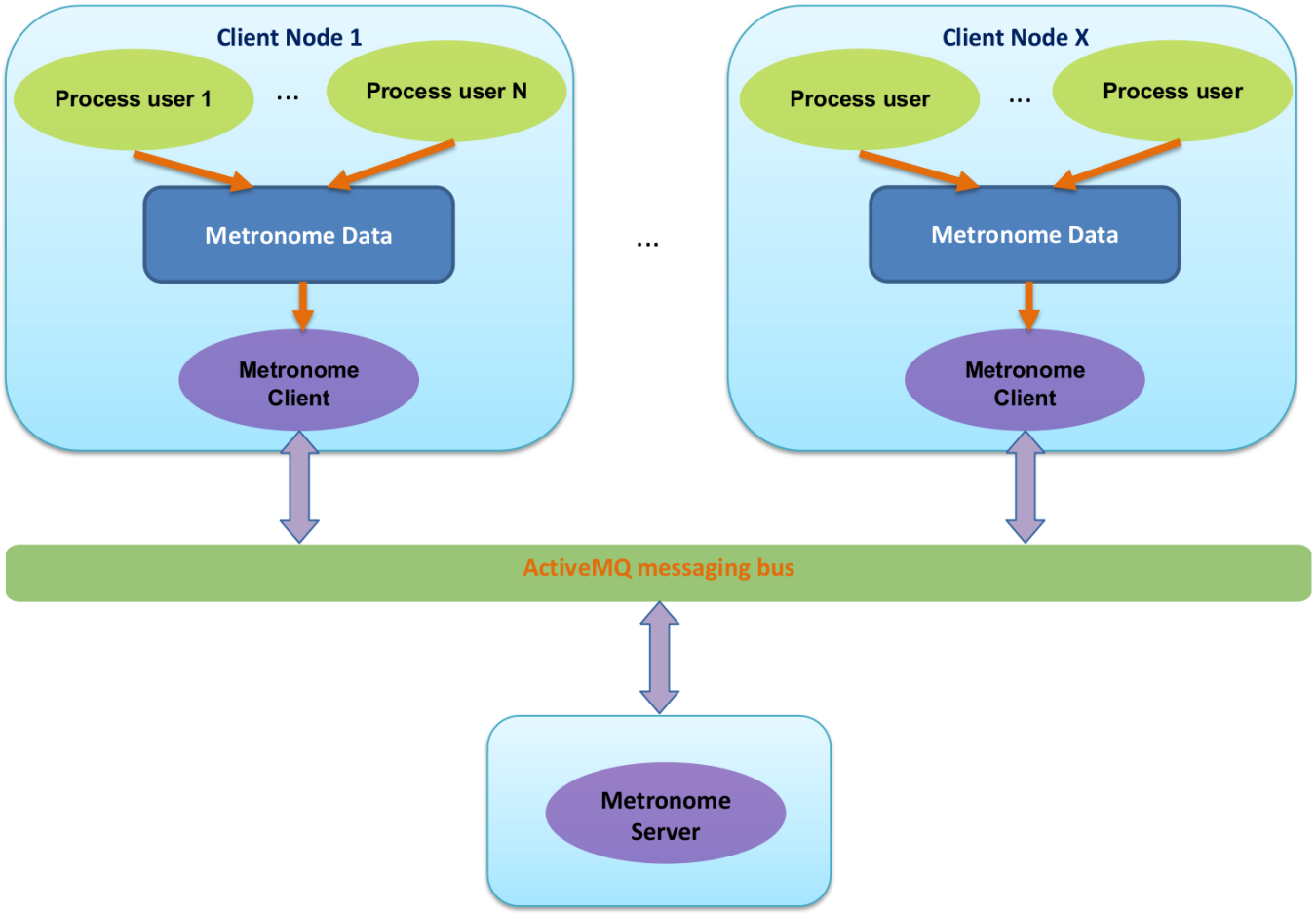
- Infrastructure
  - Machine
  - Rack
  - DataCenter
- Activity
  - Job: task to run on servers, either batch or service
  - Phase: part of a Job with fixed resource consumption
  - Flavor: VM characteristics (CPU, RAM…) to run a Job

✓ Interface with the other parts of the middleware

- Exchange messages through the ActiveMQ bus
  - Receive orders (job arrivals, machine startup...)
  - Send statuses (number of jobs, consumption)

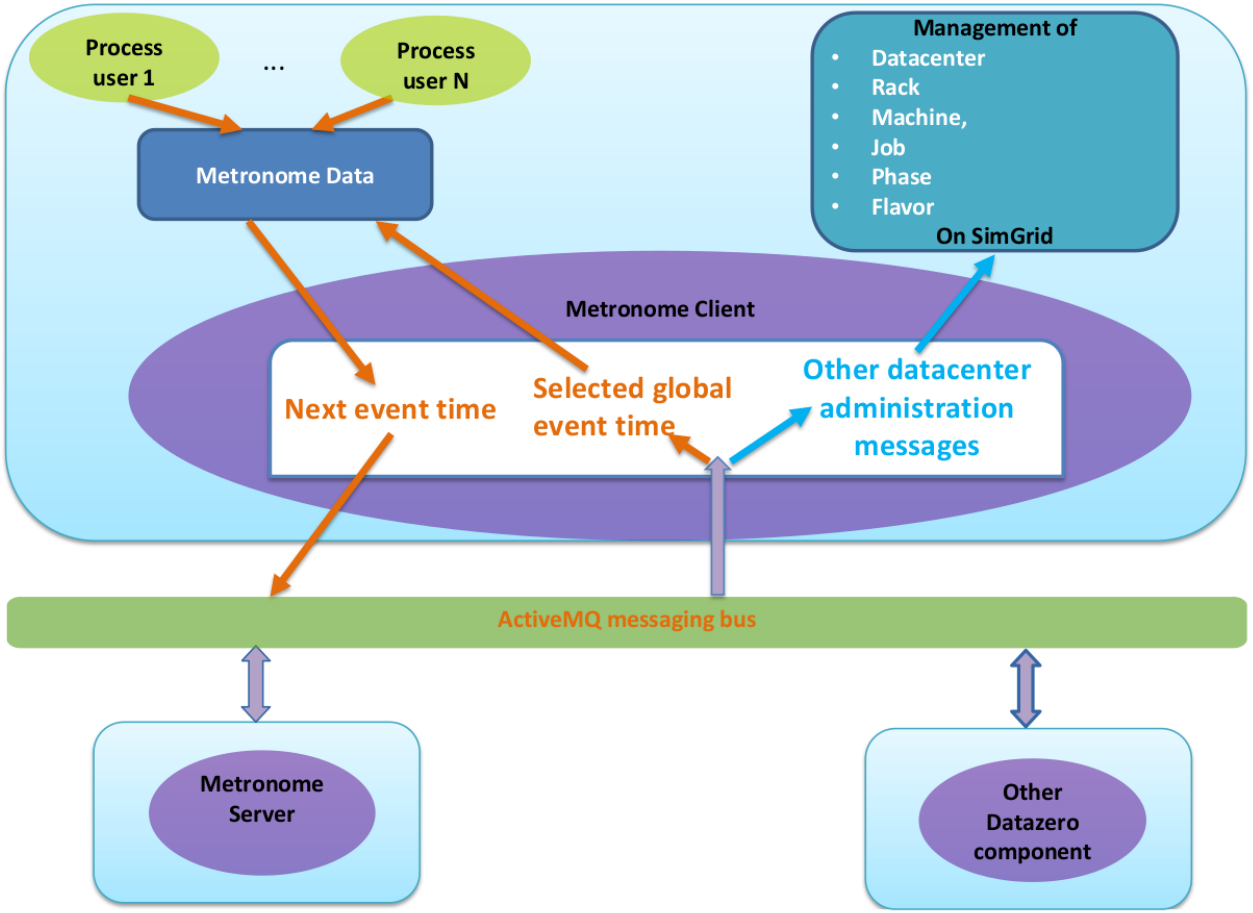
Goals

- ✓ **Synchronize SimGrid datacenter events with the other DZ components**
  - On each Datazero site, activities produce events which need to be globally ordered
    - → Local scheduling through the internal clock of the underlying system (tasks of a Java VM, processes of a SimGrid simulation...)
    - → Global scheduling between all Datazero sites, through a client/server application called the Metronome



Challenges

✓ SimGrid constraints: ActiveMQ messages



- A synchronous method call blocks the simulation
- Impossible to take into account external events (like message arrivals on the ActiveMQ bus) on an asynchronous fashion

Proposed solution

✓ **Projection of the DataZero concepts**

DataZero	SimGrid	Class
Job	Process	DZSimGridProcess
Phase	Task	DZTask
Machine	Host	Machine
DataCenter	main	DataCenter
Rack	As (zone)	Rack
Flavor	VM	VmDataZero

Proposed solution

✓ Implementation without modifying the SimGrid kernel

- Development of a software overlay to intercept SimGrid "system calls" which have an impact on time

SimGrid	Datazero SimGrid	Overload
Process	DZSimGridProcess	Constructor waitFor main exit
Task	DZTask	execute

Proposed solution

✓ Datacenter in SimGrid

- Reception of messages to act on the simulation
  - Job arrivals, hardware state change
- Sending of messages on datacenter evolution
  - Job termination, number of jobs in progress
  - Needed, for example for the GUI
  - Periodic sending of observations
- Metronome integration
  - Time advances in simgrid according to messages received from the metronome
  - Send the time corresponding to the next events
  - Using the metronome client and the overloads of Task and Process

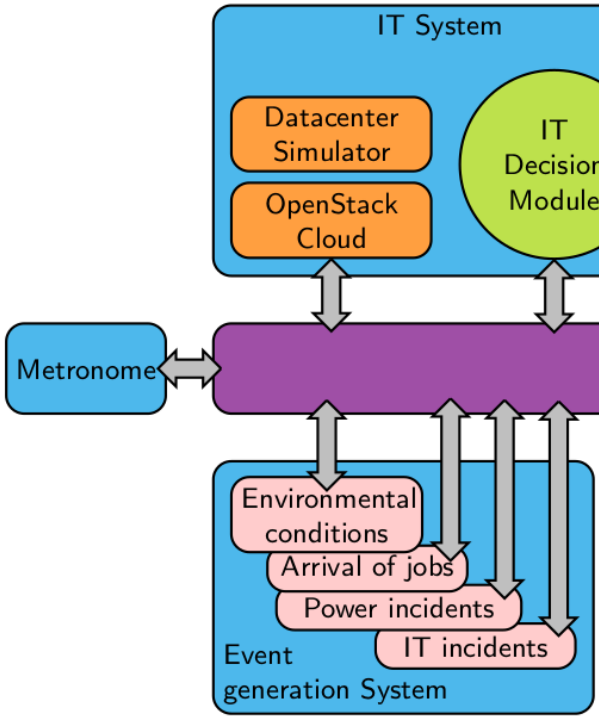
Proposed solution

✓ Datacenter in SimGrid (2)

- Addition of a supervision machine to the datacenter
  - Processes received messages
  - Controls the other machines
- New parameters in the XML infrastructure description file
  - Rack consumption
  - Startup/shutdown time of machines with the corresponding consumption
- Application deployment: according to the received messages for job arrivals

Demo: using the metronome

- SimGrid + overload
- Event generator: machine startup, job arrivals
- Java metronome user (non SimGrid)
- ActiveMQ bus
- Metronome
  - The « plain » Java user slows down the simulation



Conclusion

- Need for a datacenter simulator for the Datazero
- Choice: SimGrid
- Issues
  - Management of external events
  - Synchronization with the global time
- Solution
  - Addition of a Java overload to SimGrid to integrate it to the middleware
  - Metronome application to manage the global time
  - No modification of SimGrid C++ kernel

Questions

www.datazero.org