Simple Locality-Aware Co-Allocation in Peer-to-Peer Supercomputing

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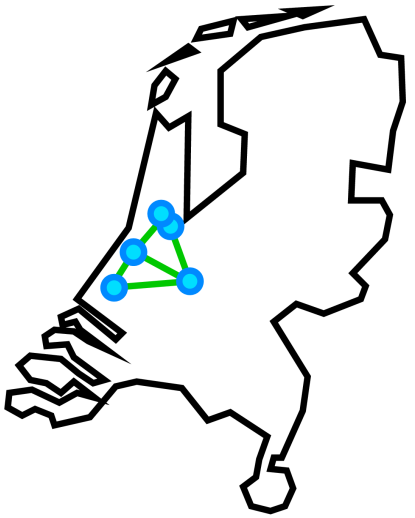
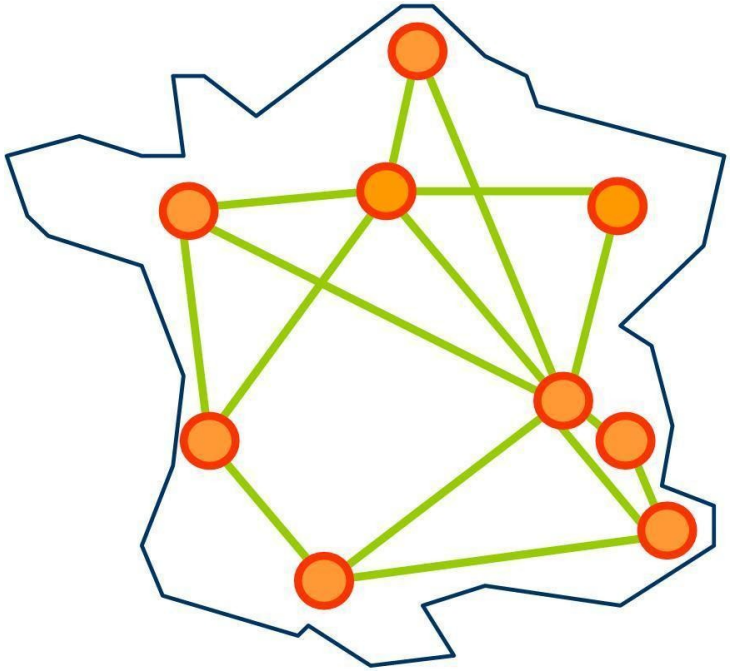
Goal of Research

Create a middleware system capable of running distributed supercomputing applications.





Current Solutions

- Difficult to setup and maintain
  (Globus)
- Centralized components
  (Koala, Xtremweb)
- Co-allocation usually not available
  (Boinc)

P2P Solution

- Advantages
  - Little or no maintenance
  - Fault-tolerant
  - Scalable
- Disadvantages
  - Co-ordination
  - Security and Trust

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Outline

- ✔ Introduction
- ➔ Zorilla
- Flood Scheduling
- Implementation
- Experiments (on > 800 Grid5000 cpus)
- Conclusions, Future work

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Zorilla

- Prototype Java Peer-to-Peer supercomputing middleware system
- Fully Distributed
- P2P network: Bamboo
  - Structured overlay
    (Pastry like)
  - Locality aware

ibis
efficient Java-based grid computing

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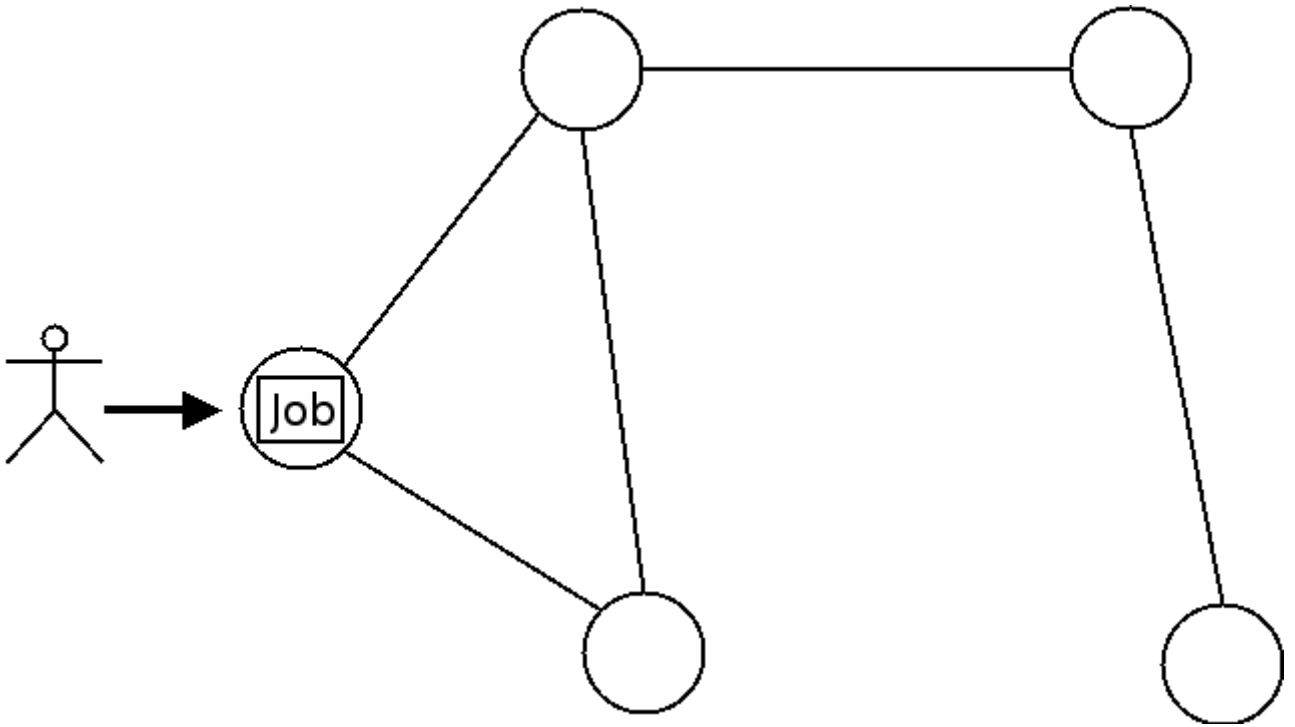
Running an Application (Current)

- Deployment
  - Copy program and input files to all sites
  - Determine local job scheduling mechanism
  - Write job submission scripts
  - Determine network setup of all clusters
- Running
  - Determine site and node availability
  - Submit application to the scheduler on each site
  - Monitor progress of application
- Clean up
  - Gather output and log files
  - Cancel remaining reservations
  - Remove program, input, output and log files from sites

Running an Application (Zorilla)

```
$ zubmit -i nqueens.jar -#w 676 NQueens 1 22 5
```

Life of a job in Zorilla (1/4)



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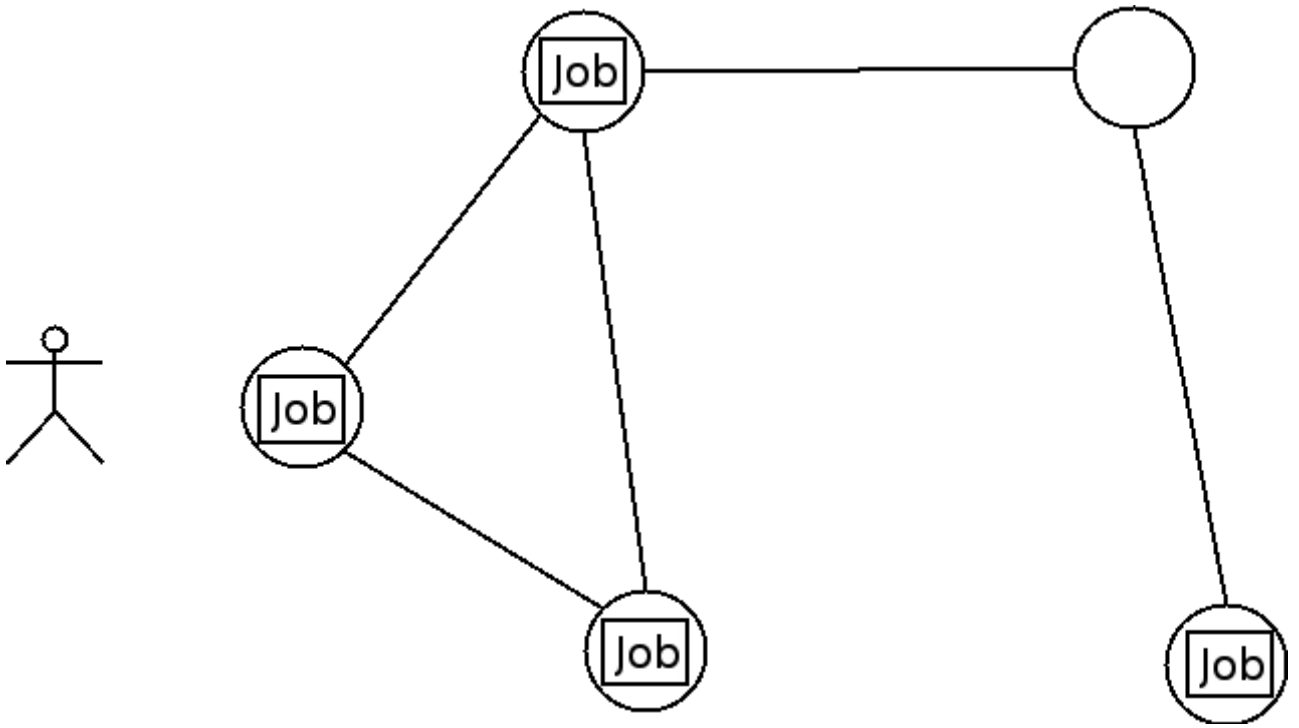
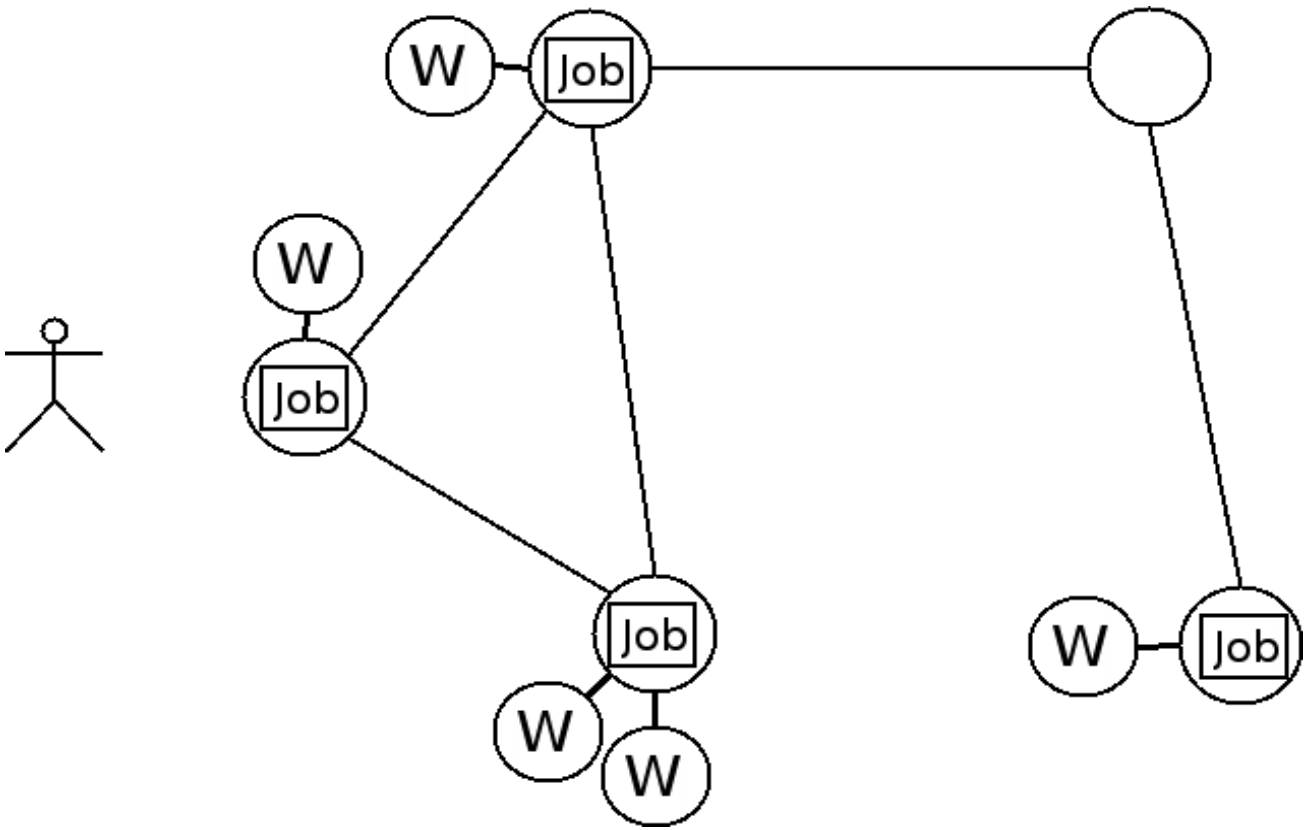
Life of a job in Zorilla (1/4)

Life of a job in Zorilla (2/4)

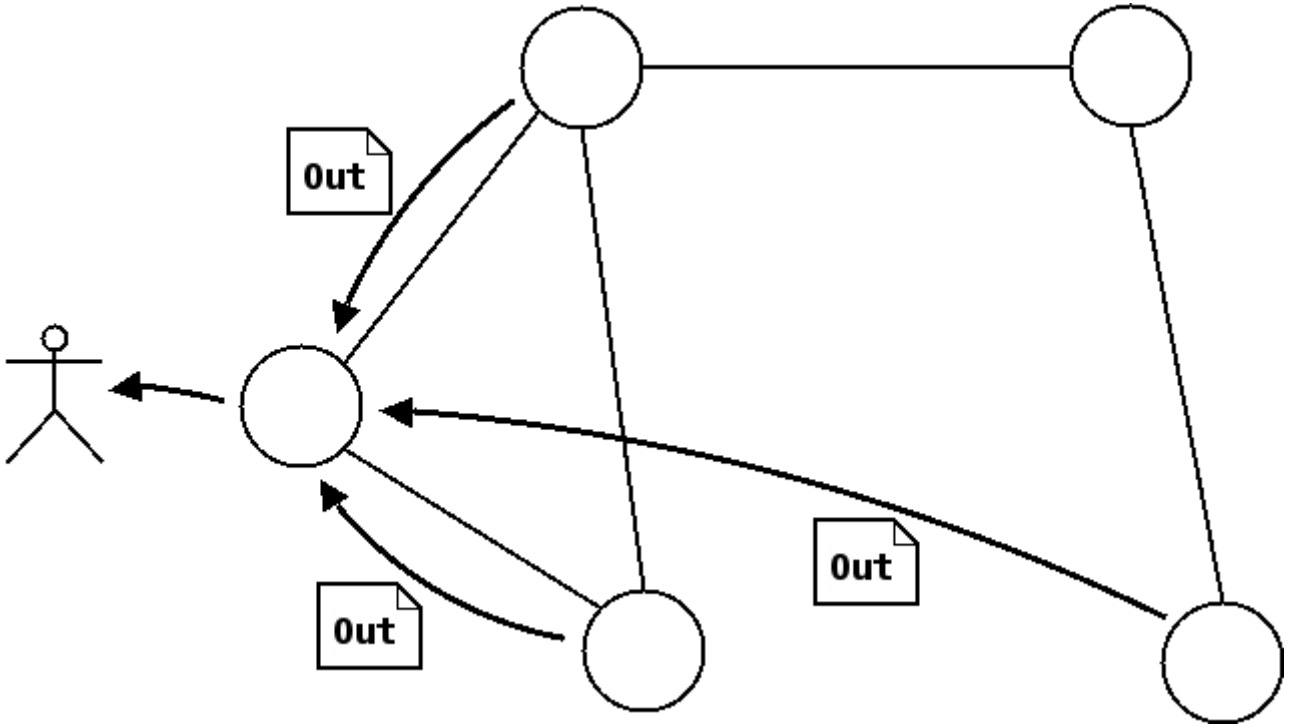


Life of a job in Zorilla (3/4)



W = worker running application

Life of a job in Zorilla (4/4)



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- ✔ Zorilla
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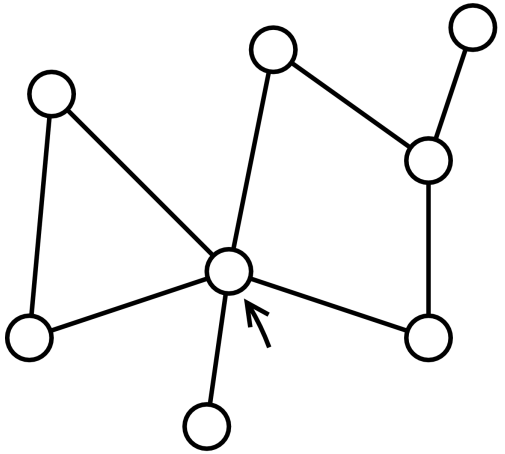
Scheduler Requirements

- Co-allocation
- Locality Aware
- Fault-tolerant
- Flexible

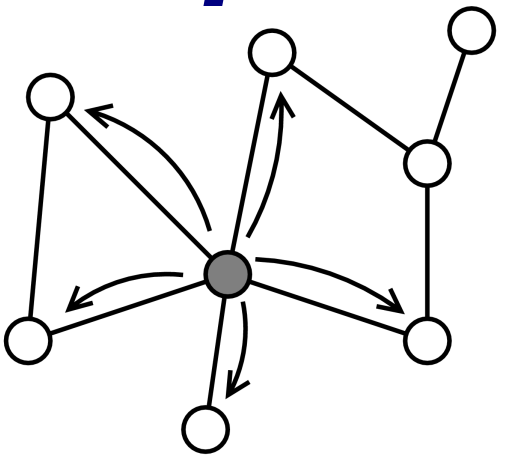
Flood Scheduling

- Nodes flood advertisements for jobs
- Radius (TTL) limits diameter of flood
- Nodes decide locally if they join computation

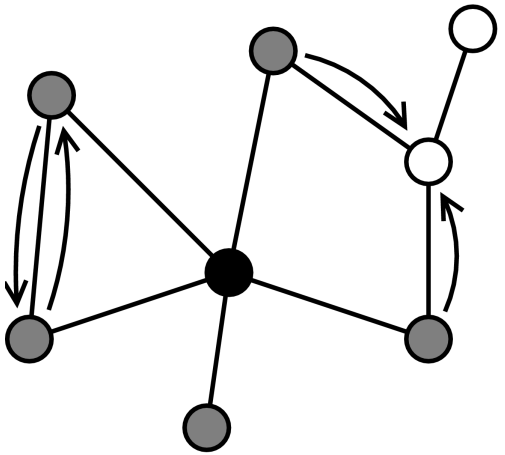
Flood Example



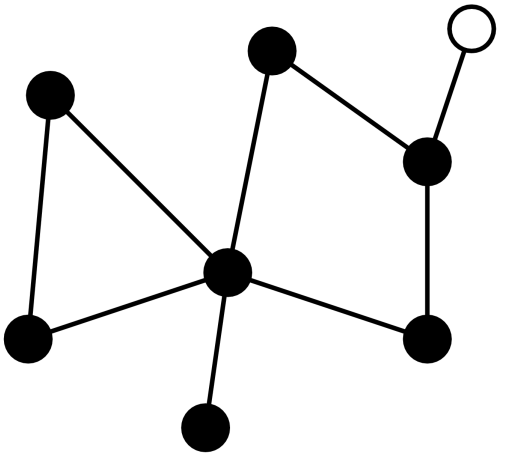
(a)



(b)



(c)



(d)

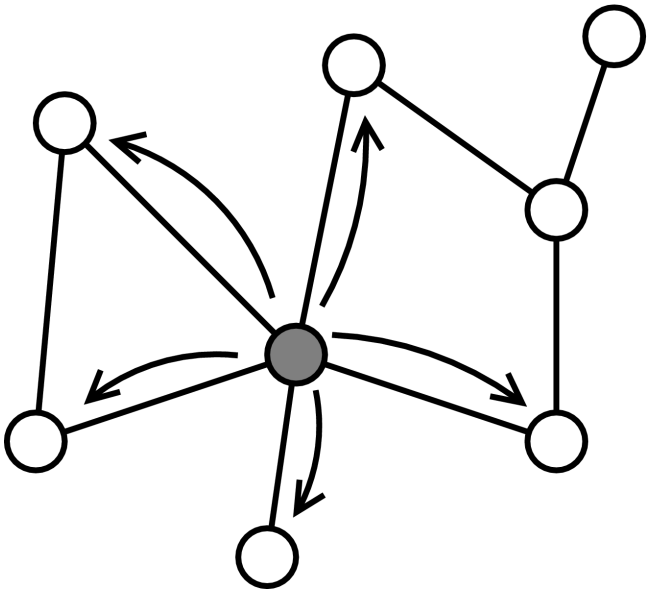
Radius = 2

Scheduling algorithm

```
int radius = 1;
int time = 1; //seconds
while (!enough_workers()) {
   flood_job_advertisement(radius);
   add_new_workers_to_computation();
   wait(time);
   radius++;
   time = time * 2;
}
```

Scheduler Requirements (Revisited)

- Co-allocation
- Locality Aware
- Fault-tolerant
- Flexible



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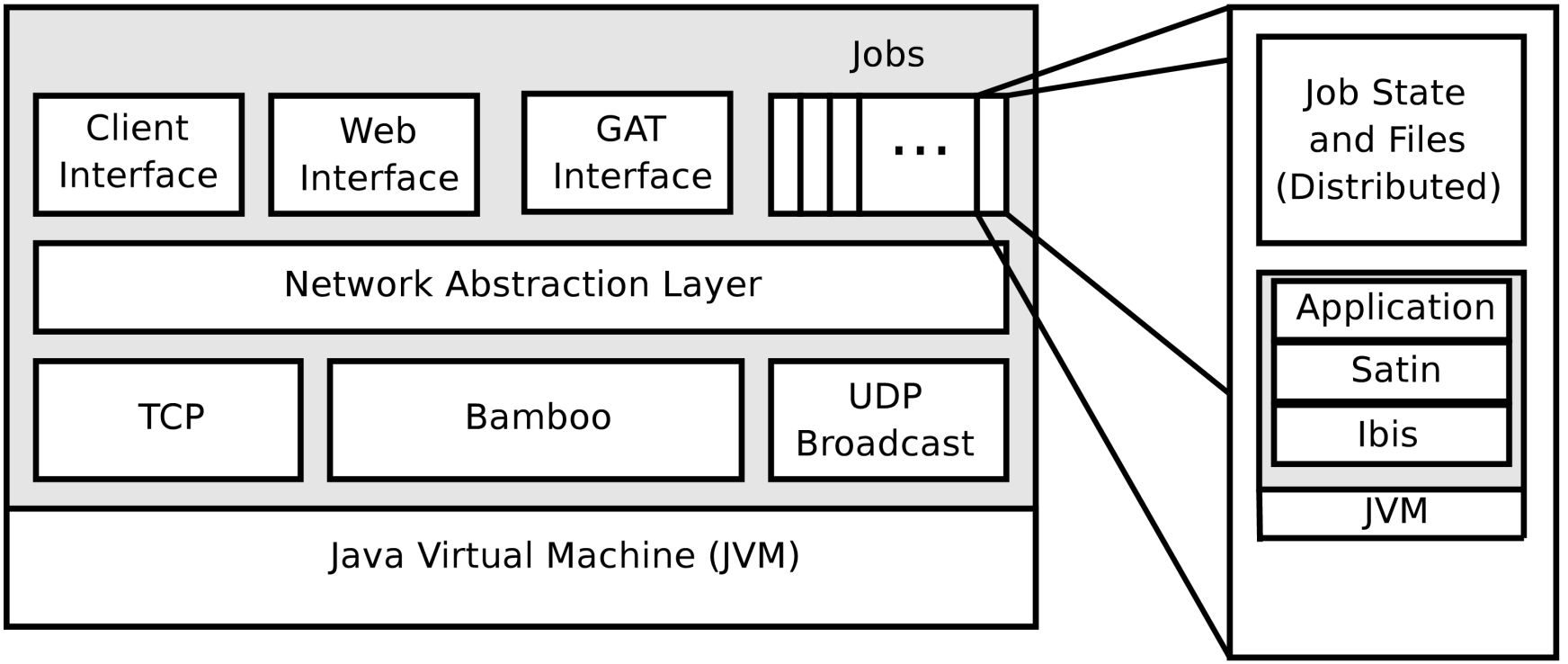
Implementation



Experiment

- Grid5000, Six clusters, 430 nodes, 860 processors
- Submit jobs from single node (at Sophia)

```
while(more_nodes_available) {
   submit_new_job();
}
```

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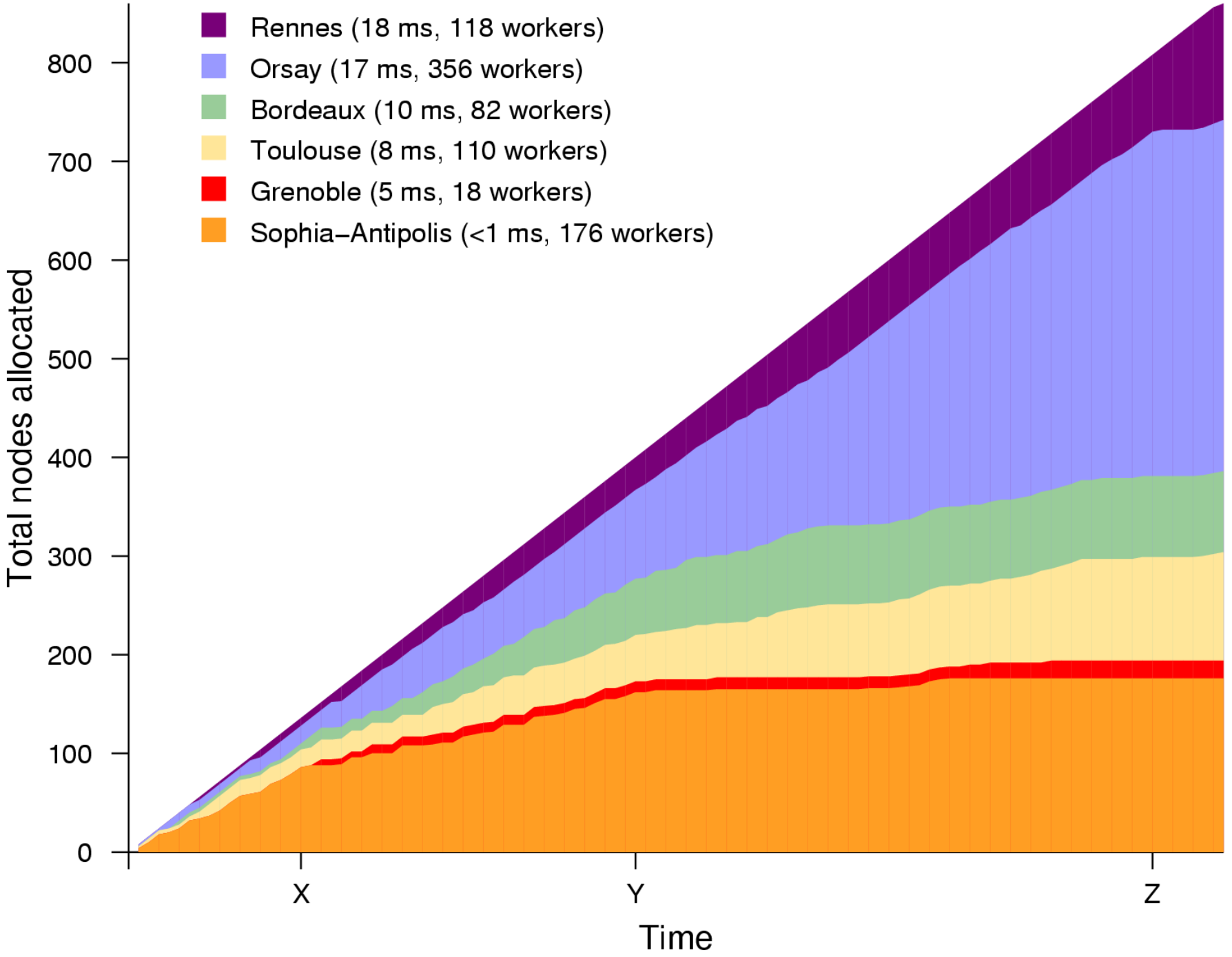
Rennes (18 ms, 118 workers)
Orsay (17 ms, 356 workers)
Bordeaux (10 ms, 82 workers)
Toulouse (8 ms, 110 workers)
Grenoble (5 ms, 18 workers)
Sophia−Antipolis (<1 ms, 176 workers)
Total nodes allocated
0
100
200
300
400
500
600
700
800
X
Y
Z
Time

Conclusions

- Flood scheduling is able to efficiently schedule resources to jobs in a grid environment.
- A better P2P network is needed to further optimize scheduling.
- P2P middleware is a promising alternative to current grid systems.

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Current/Future Work

- Redesign of P2P Network
  - Better locality awareness
  - Support of more metrics (bandwidth, trust, reliability, etc)
- Authentication, Authorization, (Accounting) , based on PGP
- Fair scheduling
- Explicit support for workflow and data-intensive applications

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?

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What about starvation?

- Jobs “split” resources
  - Applications started when a single resource is available, expand when more found
  - Only works with malleable applications
  - Example: Satin applications
- Single job wins, other jobs fail
  - Needs scheduling support

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Scheduling algorithm (Thread 1)

```
int radius = 1;
int time = 1; //seconds
while (!started) {
   flood_job_advertisement(radius);
   radius++;
   time = time * 2;
   wait(time);
}
```

Scheduling algorithm (Thread 2)

```
while(!started) {
   update_available_workers_list();
   if(enough_workers_available()) {
      try {
         claim_available_nodes();
         start_workers();
         started = true;
      }
   }
   wait(A_WHILE);
}
```