# Future of Ibis

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# Short Recap...

- JavaGAT can be used as a master key to access various resources.
- IPL+SmartSockets can be used as glue to combine resources into a single pool and run coupled codes.
- IbisDeploy can be used for easy deployment of such applications.

# What is Missing ?

- Support for heterogeneity between resources:
  - Available cores, memory, storage, GPUs, etc.
  - Installed application, libraries, etc.
  - Data locality
- Support for equi-kernels:
  - Multiple functionally equivalent implementations of some algorithm with different resource requirements
  - Example: AMUSE

# Next steps...

- Currently, we either assume all resources to be equal, or we assume the user/application knows which resource can run which code.
  - “Run code X on resource Y because it has a GPU”
- Can we come up with an simple and flexible way to express both heterogeneity (in all its forms) and equi-kernels ?

# Constellation

- New system on the Ibis stack (research!)
  - Similar to the Pilot Job framework we saw earlier
  - ... but much more advanced!
- Offers task scheduling with application specific match-making
  - Ensures that each job is send to a resource that can actually execute it.

# Constellation Model

- Application: set of activities (= Jobs)
  - Loosly coupled (communicate using events)
  - Size and complexity may vary
    - Sub-second sequential jobs to large parallel simulations that take hours
- Resources: set of executors (= Pilot Jobs)
  - Capable of running activities
  - May represent anything from a single core to entire cluster, a GPU, etc.

# Constellation Model

## Differences with pilot job model

- Individual executors may only be able to process a subset of the activities (heterogeneity)
- Executors may offer equivalent functionality but differ in implementation (equi-kernels)
- Running activities may submit other activities (any resource is source of work)

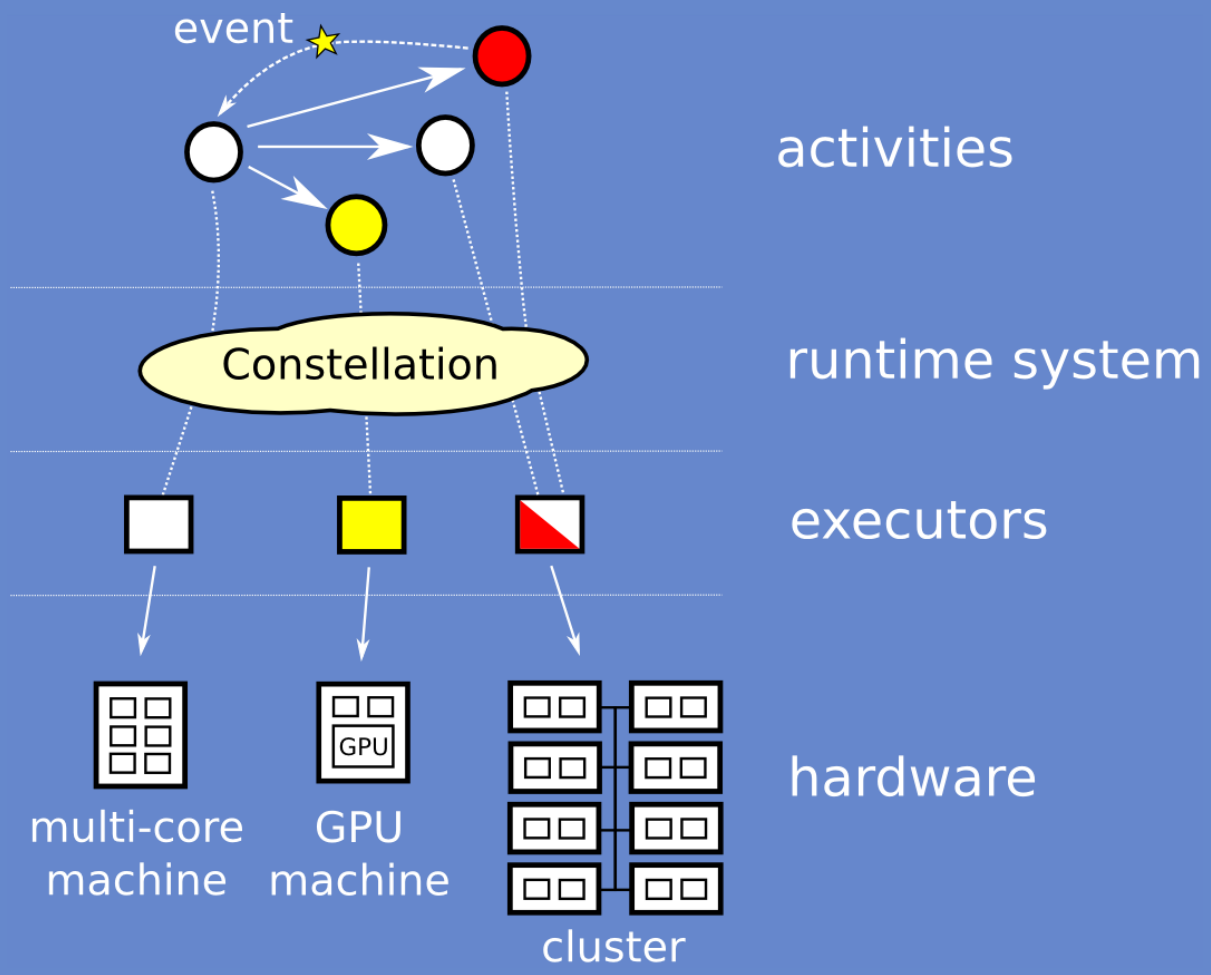
# Constellation Model

- Each application consists of
  - A collection of many distinct, yet somehow related activities – a (possibly dynamic) DAGs of tasks.
  - A (possibly heterogeneous) set of executors, which together are capable of executing these tasks.
- It is now up to Constellation to ensure the correct mapping between activities and executors....

# Constellation Model

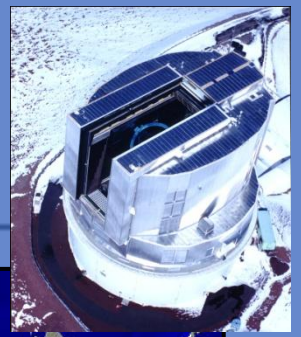
- Both activities and executors can be tagged using a context:
  - Simple application defined label (= a string)
  - Defines which activites and executors are “a match”
  - Application defined = extremly flexible
- Constellation RTS performs
  - match-making (using these contexts)
  - load-balancing (using workstealing)

# Constellation Example

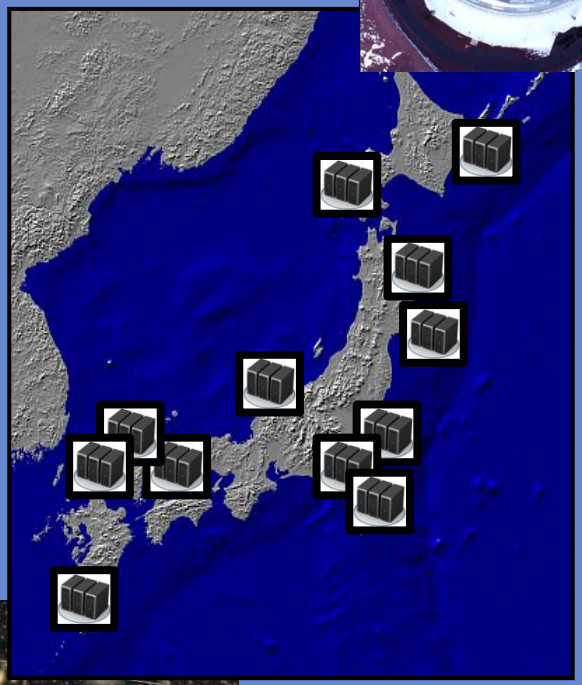


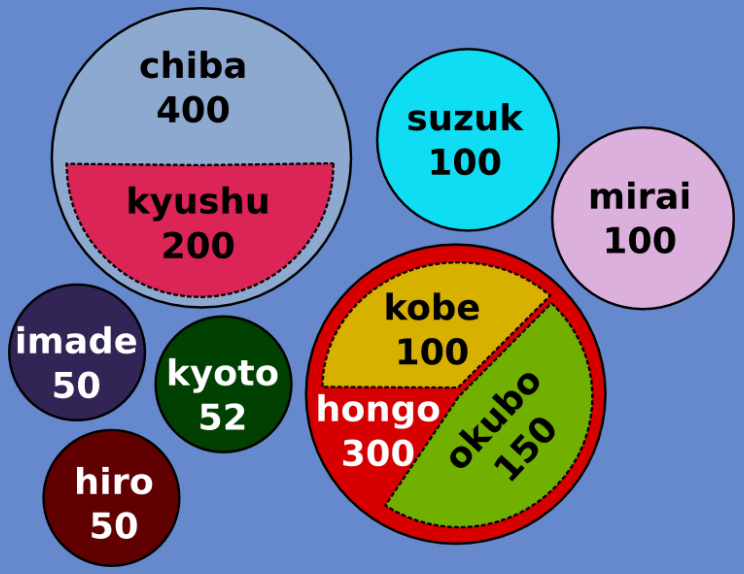
# Supernova Detection

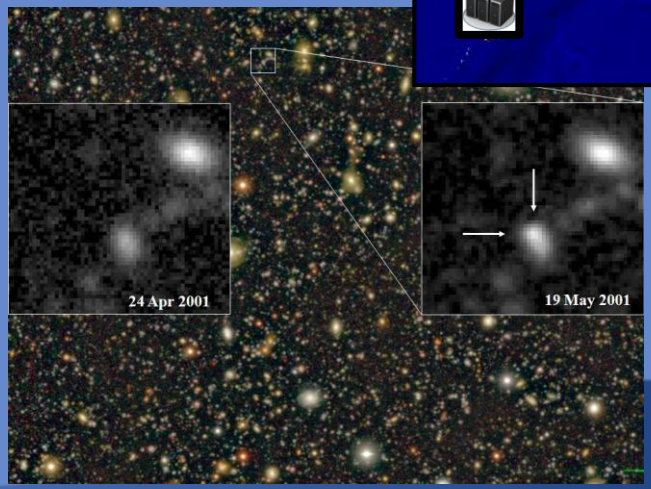
## 2008 Data Challenge Winner



- Analyse 1052 image pairs
  - 10~12 clusters (1162 cores max)
  - Partitioned / replicated data
  - Varying resolution

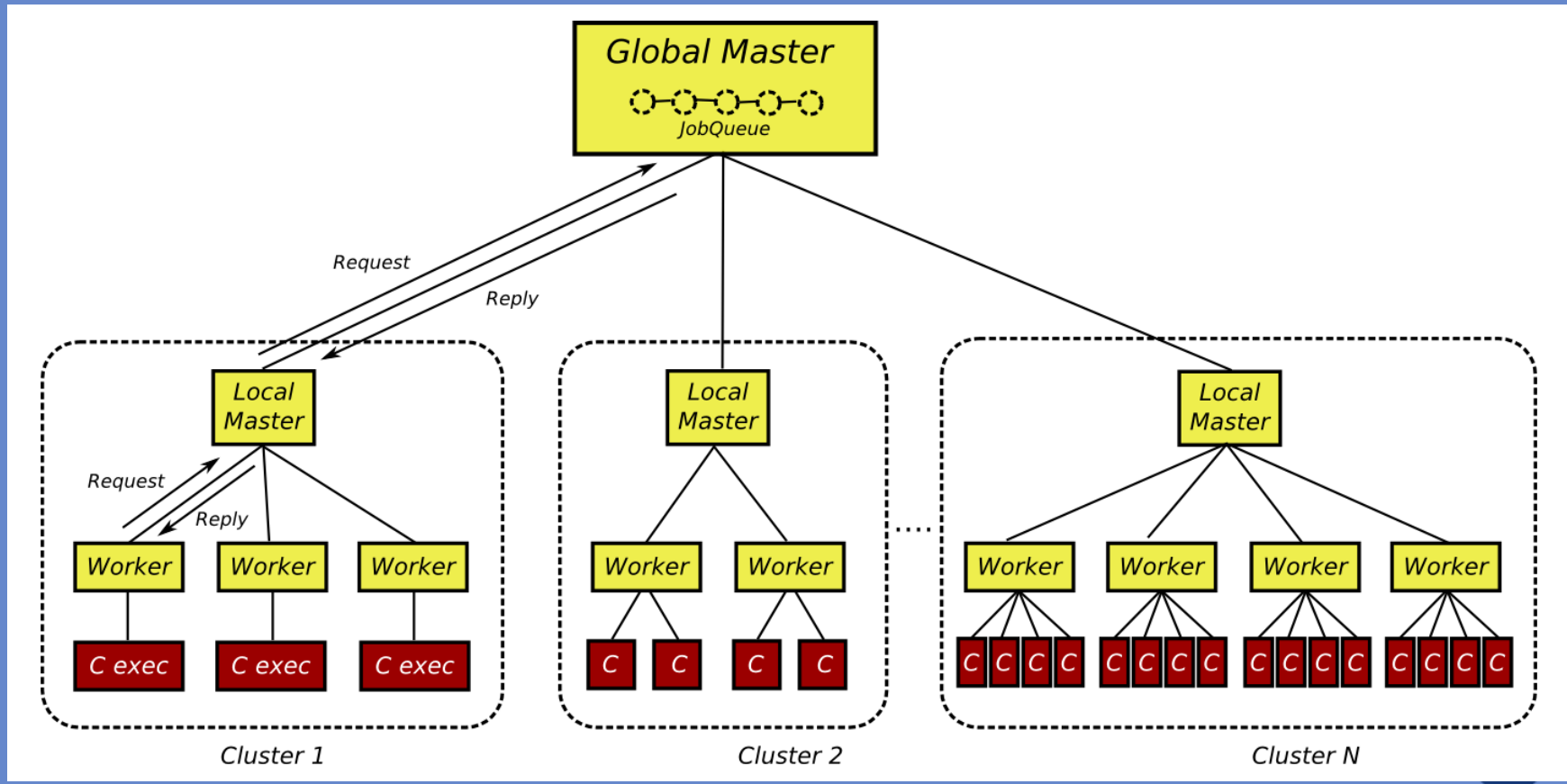




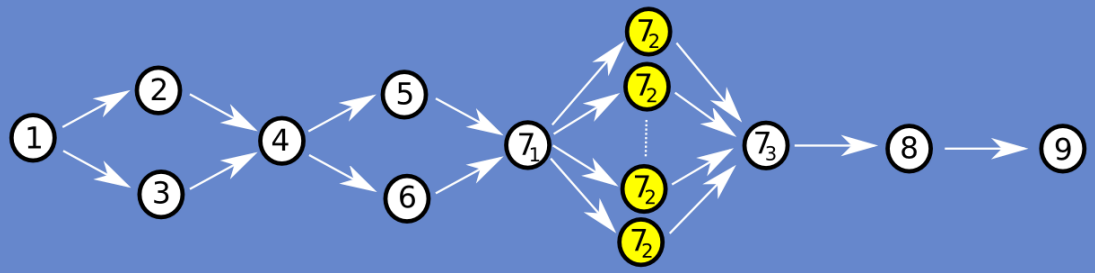
# 2008 Solution

## Hierachical Pilot Job Framework



# Early Experiments

- Application is a DAG / Workflow

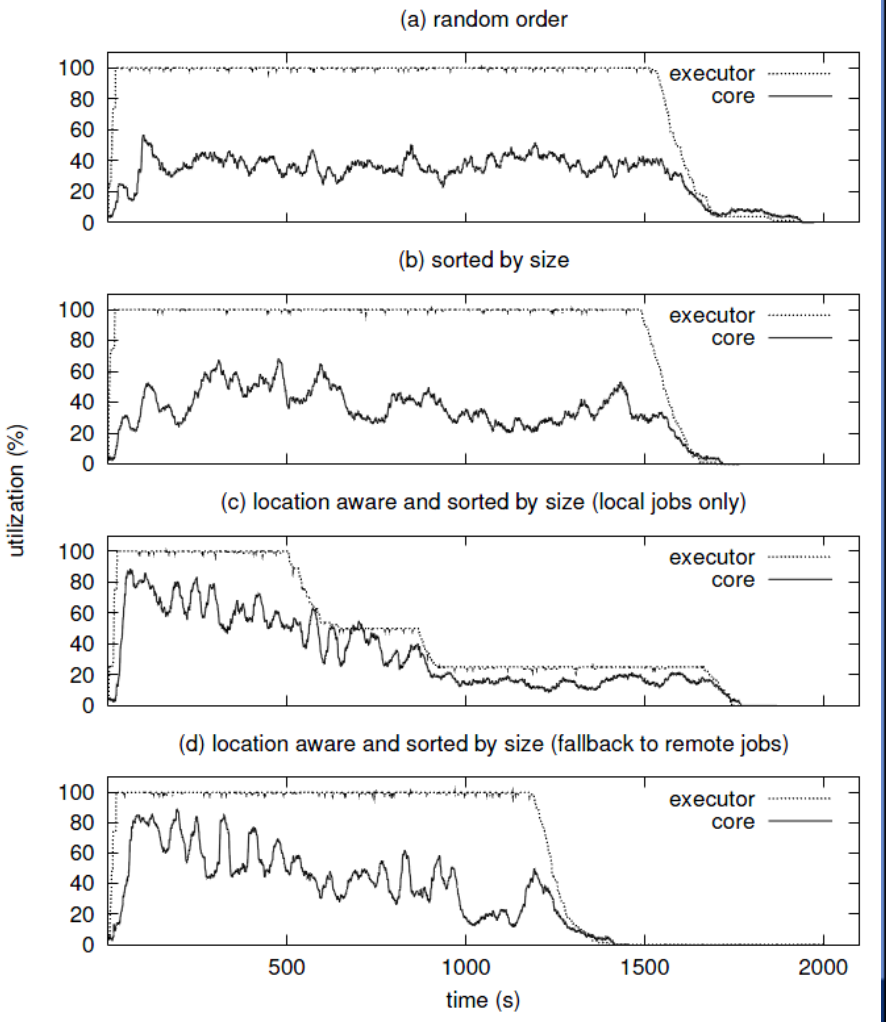



x 1052!

- Test Constellation in 3 different scenarios:
  - Data locality
  - Executor granularity
  - Heterogeneity

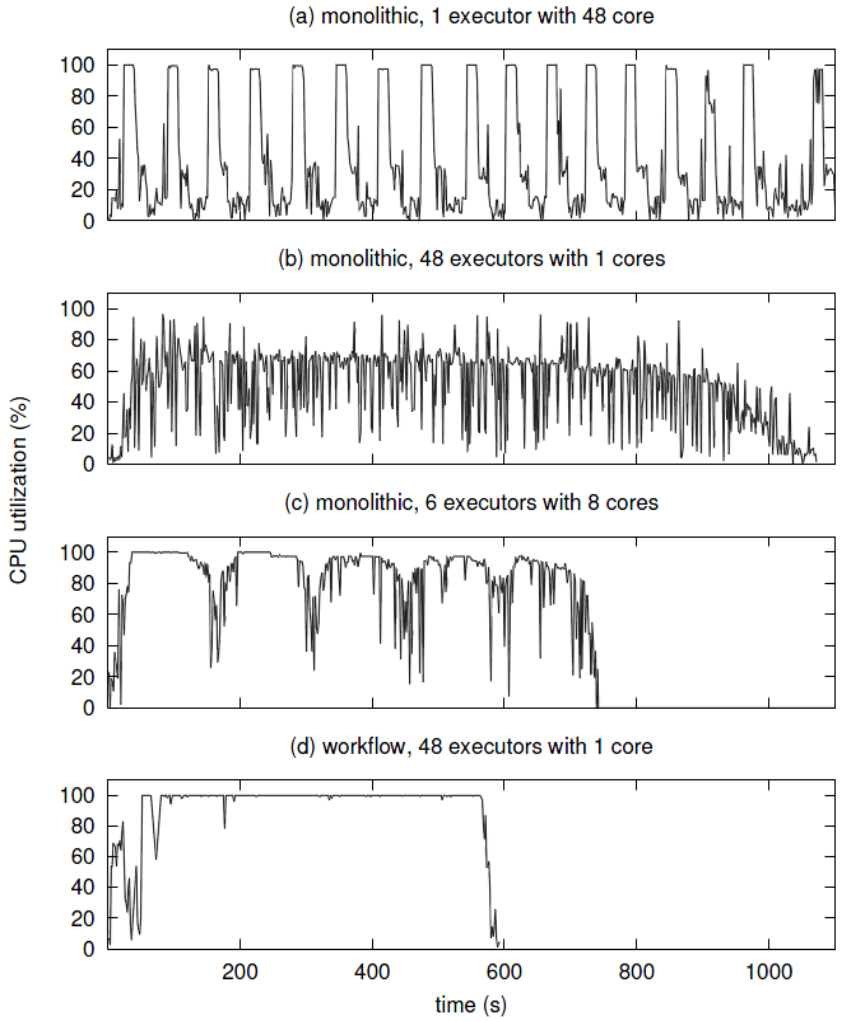
# Scenario 1
## Data Locality

- Data distributed over 4 clusters (DAS3/4)
  - Activity: entire application
  - Executor: complete node
- Use context to express data locality
  - Locality aware task farming
- No change in application
  - Use constellation wrapper
  - Adapt context to tune application



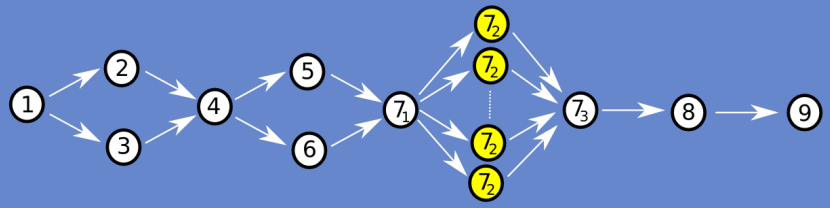
# Scenario 2
## Executor Granularity

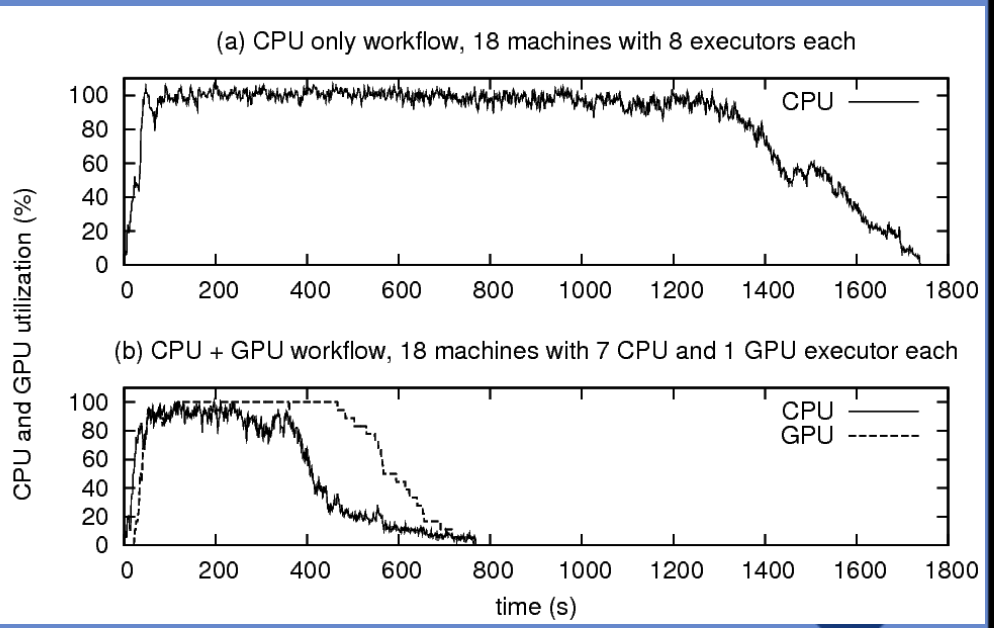
- Single 48 core machine
  - Activity: entire application (a-c) single task (d)
  - Executor: [n]-cores
- No change in application for experiment (a-c)
  - Only change executor config.
- Completely ported application in (d)
  - Significant performance gain!



# Scenario 3:
## Heterogeneous System

- 18 node GPU cluster
  - 8 cores + 1 GPU per node
  - Activity: single task
  - Executor: 1 core (top)
    1 core or 1 GPU (bot.)
- Replaced activity 7.2 with GPU version.
  - Label activities and executors accordingly
  - Constellation takes care of rest!
  - Significant performance gain.



# Conclusions

- Initial experiments show that Constellation works well for a wide range of hardware configurations
- Constellation offers a highly configurable model
  - Easy to extend and reconfigure applications
  - Allows integration of specialized accellerator codes
- Suitable basis for a Jungle Computing model ?

# Future Work

## Easy ones

- More applications on wider range of hardware
- Implement on top of Constellation:
  - Domain specific languages
    - Phyxis-DT (successor of Joris)
  - User-friendly workflow models
  - Existing programming models (Satin)
  - Applications (SAT)

# Future Work

## Interresting ones!

- Integration of executor deployment into model
  - Currently it is up to de user to deploy the right type and right amount of executors
- Can we automate this ?
  - User has to provide the correct executors and a set of available resources
  - Constellation then dynamically selects the right resources and the right number of resources and performs the deployment

# Zorilla 2.0

## Wild ideas...

- Merge the existing P2P middleware with the SmartSockets overlay and the resource selection mechanism needed by Constellation ?

- A single solution for many open questions ?