Condor: High-throughput Computing From Clusters to Grid Computing

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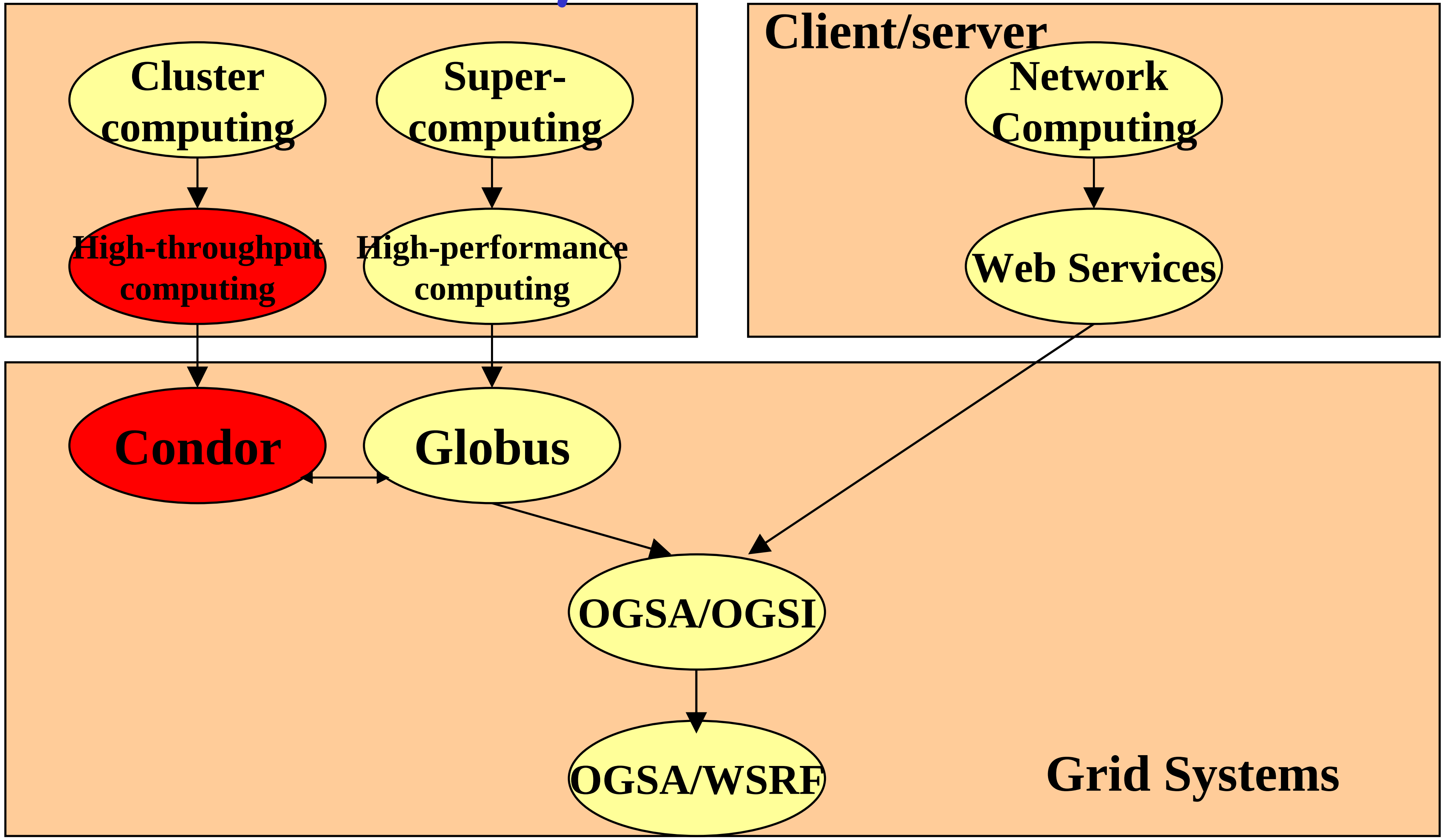
Progress in Grid Systems



Goals of Condor

Goal:
Grid technology should turn every "ordinary" user into a "supercomputing" user.

Computational Grids should give us access to resources ***anywhere****.*

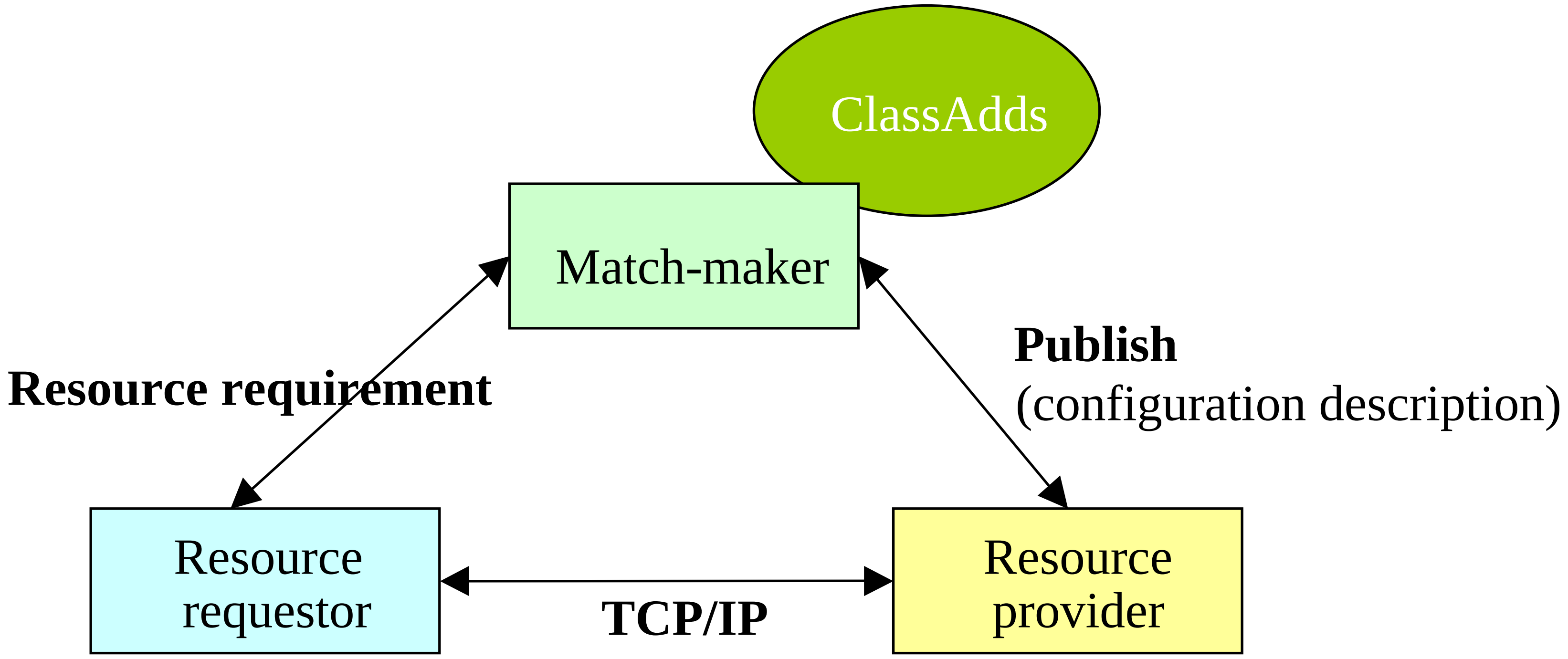
Question:
How can we make them usable by ***anyone****?*

Main features of Condor

Special resource management (batch) system

- Distributed, heterogeneous system.
- Goal: exploitation of spare computing cycles.
- It can migrate sequential jobs from one machine to another.
- The ClassAds mechanism is used to match resource requirements and resources

The Condor model



Client program moves to resource(s)

Security is a serious problem!

ClassAds

- Resources of the Grid have different properties (architecture, OS, performance, etc.) and these are described as advertisements (ClassAds)
- Creating a job, we can describe our requirements (and preferencies) for these properties.
- Condor tries to match the requirements and the ClassAds to provide the most optimal resources for our jobs.

Requirements and Ranks

```
      Requirements = Arch=="SUN4u"
                   && OpSys == "SOLARIS251"
```

Exact matching is needed..

```
      Rank = Memory + Mips
```

If there is a choice, Condor will choose the resource with bigger memory. If all the memories are the same, it will choose the faster machine.

The two sides to match (1)

User side: submit command file

```
Requirements = Arch == "INTEL"
    && OpSys == "LINUX"
Rank = Memory + Disk + Mips
```

The two sides to match (2)

Resource side: configuration file (owners of resources may place constrains and preferences on their machines)

```
Friend  = Owner == "haver"
Trusted = Owner != "judas"
Mygroup = Owner == "zoli" || Owner == "jani"
Requirements  = Trusted && (Mygroup ||
        LoadAvg < 0.5 && KeyboardIdle > 10*60)
Rank = Friend + MyGroup
```

Condor Universes

- Standard
- Vanilla
- PVM
- MPI
- Globus

Standard universe

- checkpointing, automatical migration for sequential jobs
- Existing program should be re-linked with the Condor instrumentation library
- The application cannot use some system calls (fork, socket, alarm, mmap)
- Grabs file operations and passes back to the shadow process

Vanilla universe

- No checkpointing, no migration
- The existing executable can be used without re-compiling or re-linking
- There is no restriction for system calls
- NFS, or AFS is needed.

PVM universe

- To run MW (Master/Worker) PVM programs
- PVM 3.4.2 + extensions for task management
- Dinamic Virtual Machine creation.
- Support for heterogeneous environment
- User can define check-points in the master process
- Worker processes are net check-pointed

MPI universe

- MPICH usage without any necessary changes
- Dinamic changes are not supported
- No check-pointing
- The application cannot be suspended
- NFS or AFS is needed.

A simple job description

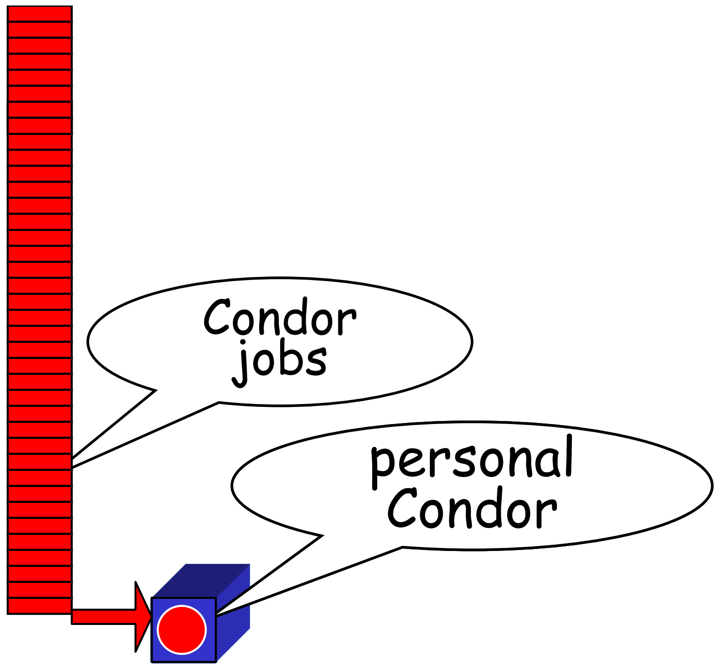
```
universe = vanilla
executable = mathematica
input = in$(Process).dat
output = out$(Process).dat
queue 5
```

Turn your workstation into a Personal Condor

- Install the Condor software on your workstation:
  - submit
  - execute
  - scheduling services.
- Submit your application to your Condor system, for example, as a "Standard" universe job

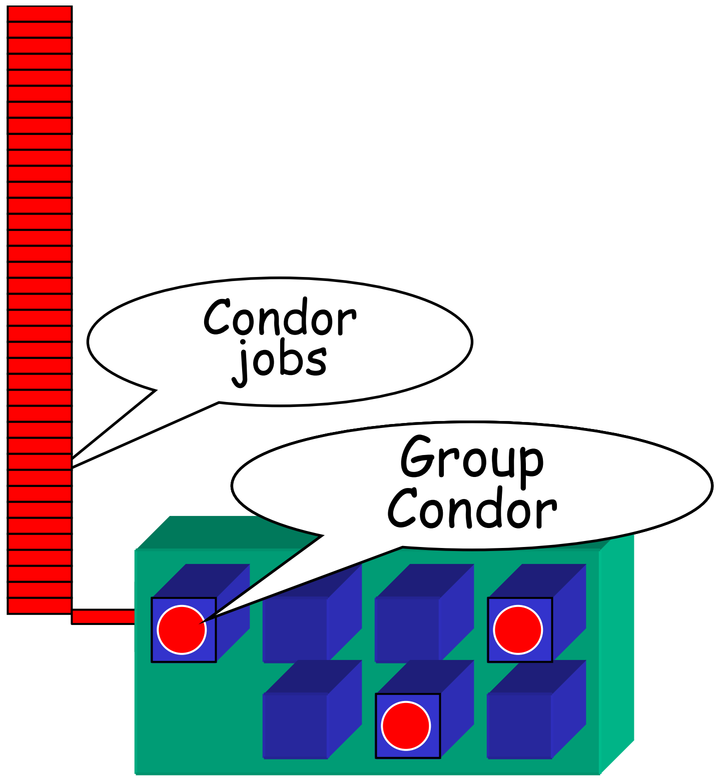
Your Personal Condor ...

- ... provides reliable and recoverable job and resource management services
- ... keeps an eye on your jobs and keeps you posted on their progress
- ... implements your policy on
  - when the jobs can run on your workstation
  - the execution order of the jobs
- .. adds fault tolerance to your jobs
- … keeps a log of your job activities

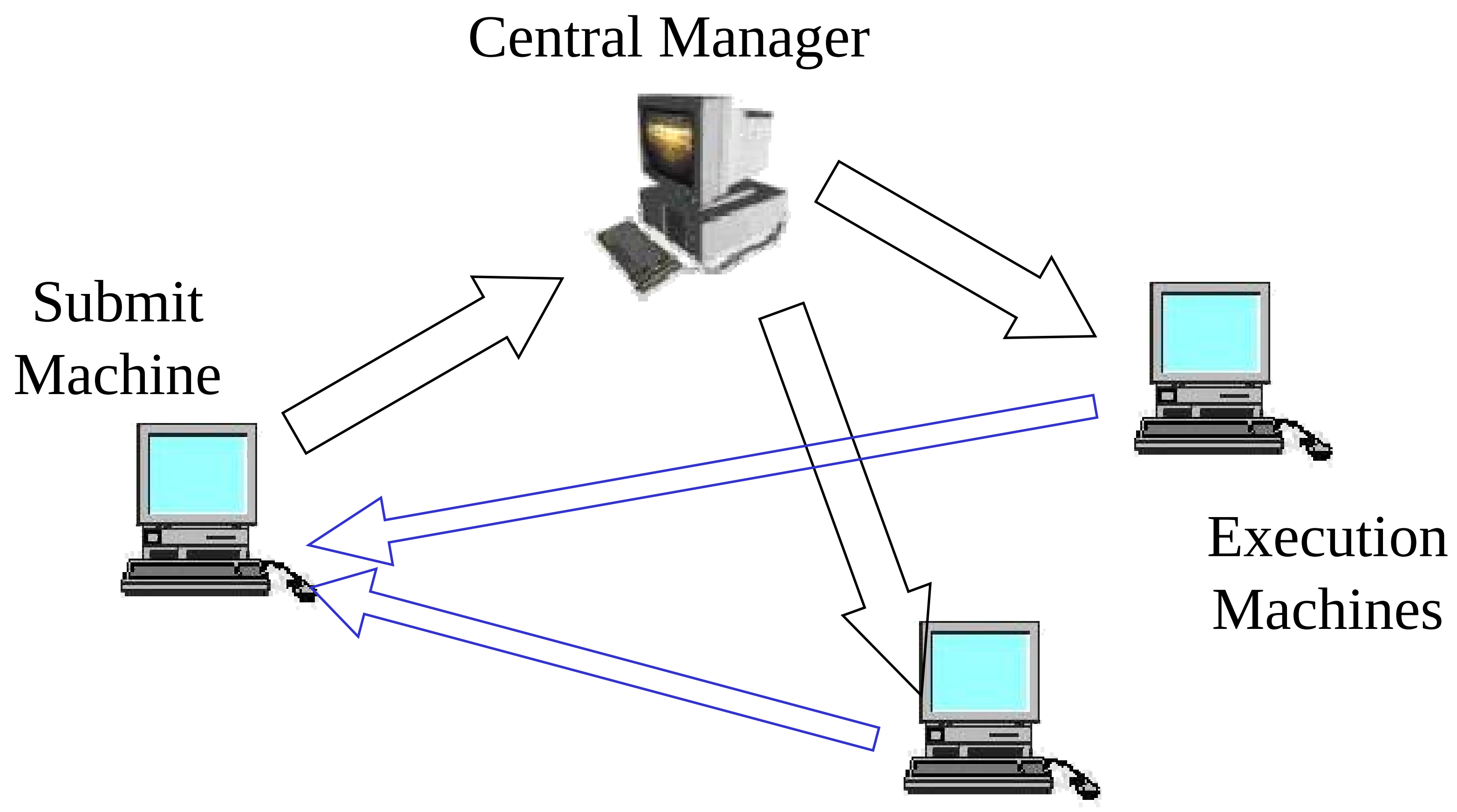

Condor jobs
personal Condor

Build a personal Condor Pool

- Install Condor on the desk-top machine next door
- Install Condor on the machines in the class room
- Configure these machines to be part of your Condor pool


Condor jobs
Group Condor

Architecture of a Condor pool



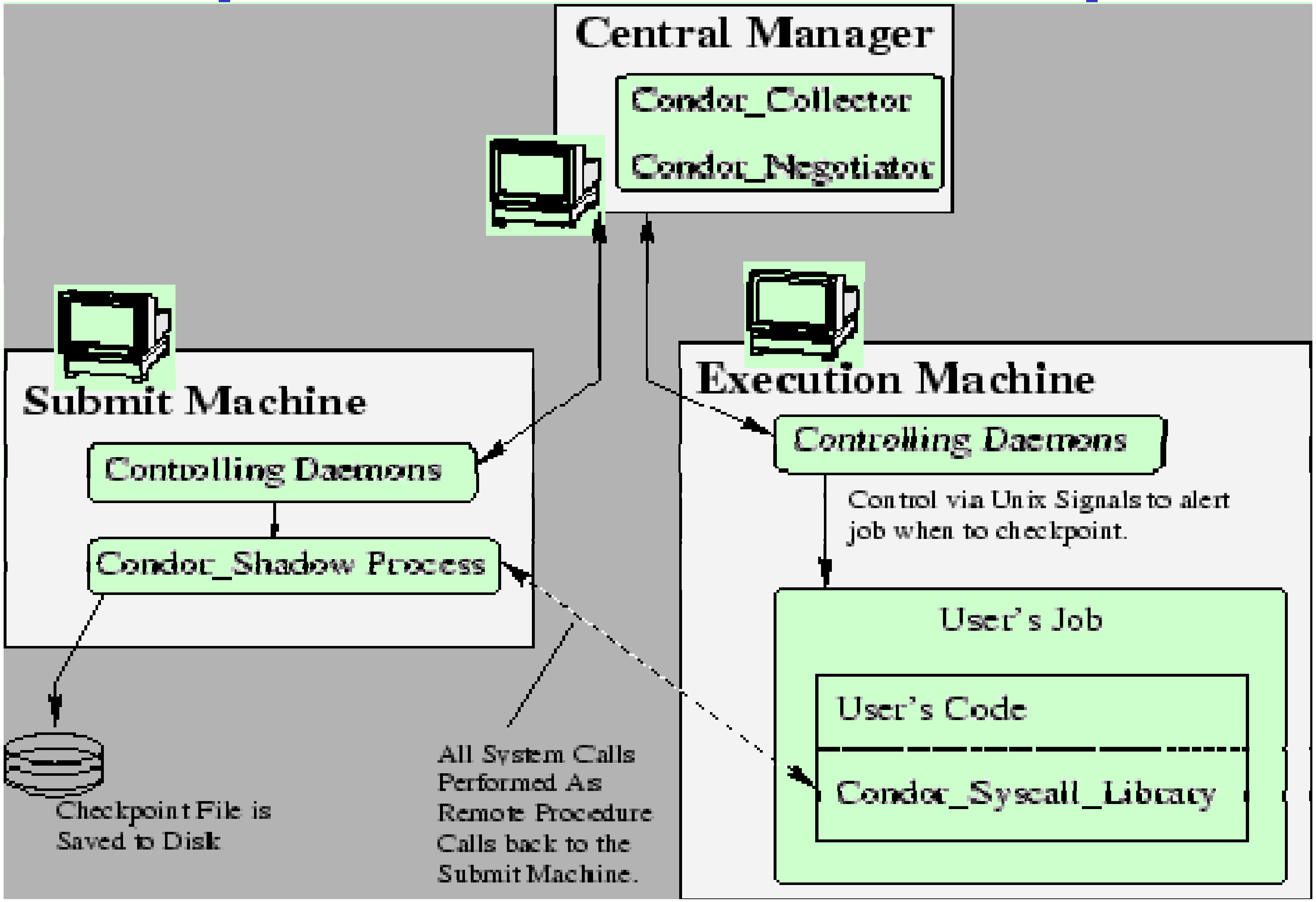
Components of Your Condor Pool

- A particular host of the pool:
  - Central manager
    - Collector (scheduler)
    - Negotiator (matchmaker)
- On each host of the pool:
  - Controlling daemons
    - Submit machine: Submit daemon
    - Execution machine: Startd daemon
  - Checkpoint server (on Submit machine)

How does Your Condor Pool work?

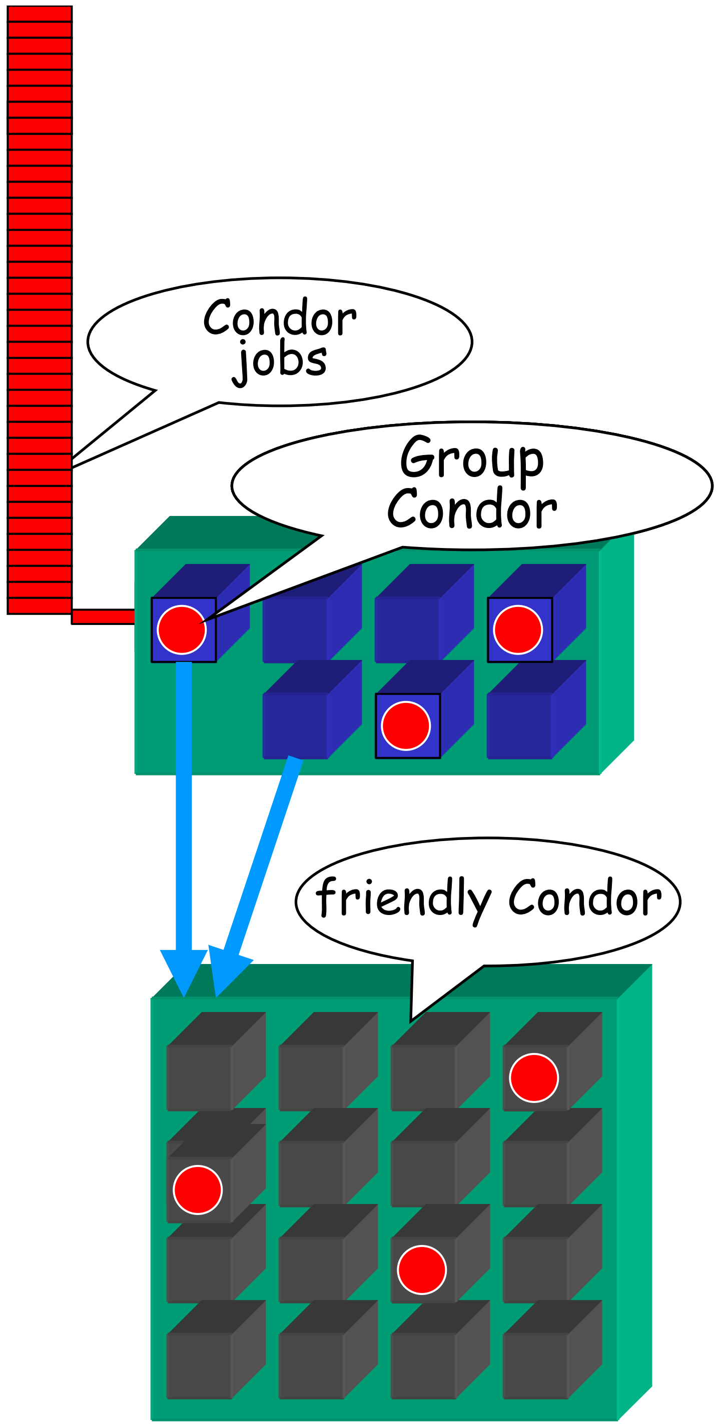
- You can submit a Condor job on any host of your pool (submit machine)
- The submitted job registers at the central manager with its classads (requirements)
- The CM performs matchmaking and selects an execution host
- The matchmaker notifies the two hosts of their compatibility with respect to the particular job
- The job is transferred to the execution host
- A shadow process is created at the submit machine

Components of a Condor pool



Take advantage of your friends

- Get permission from "friendly" Condor pools to access their resources
- Configure your personal Condor to "flock" to these pools:
  - additional central managers of remote Condor pools can be specified as configuration parameter of schedd.
  - When the local pool doesn't satisfy all its job requests, the schedd will try these remote pools in turn



Your schedd daemons see the CM of the other pool as if it was part of your pool

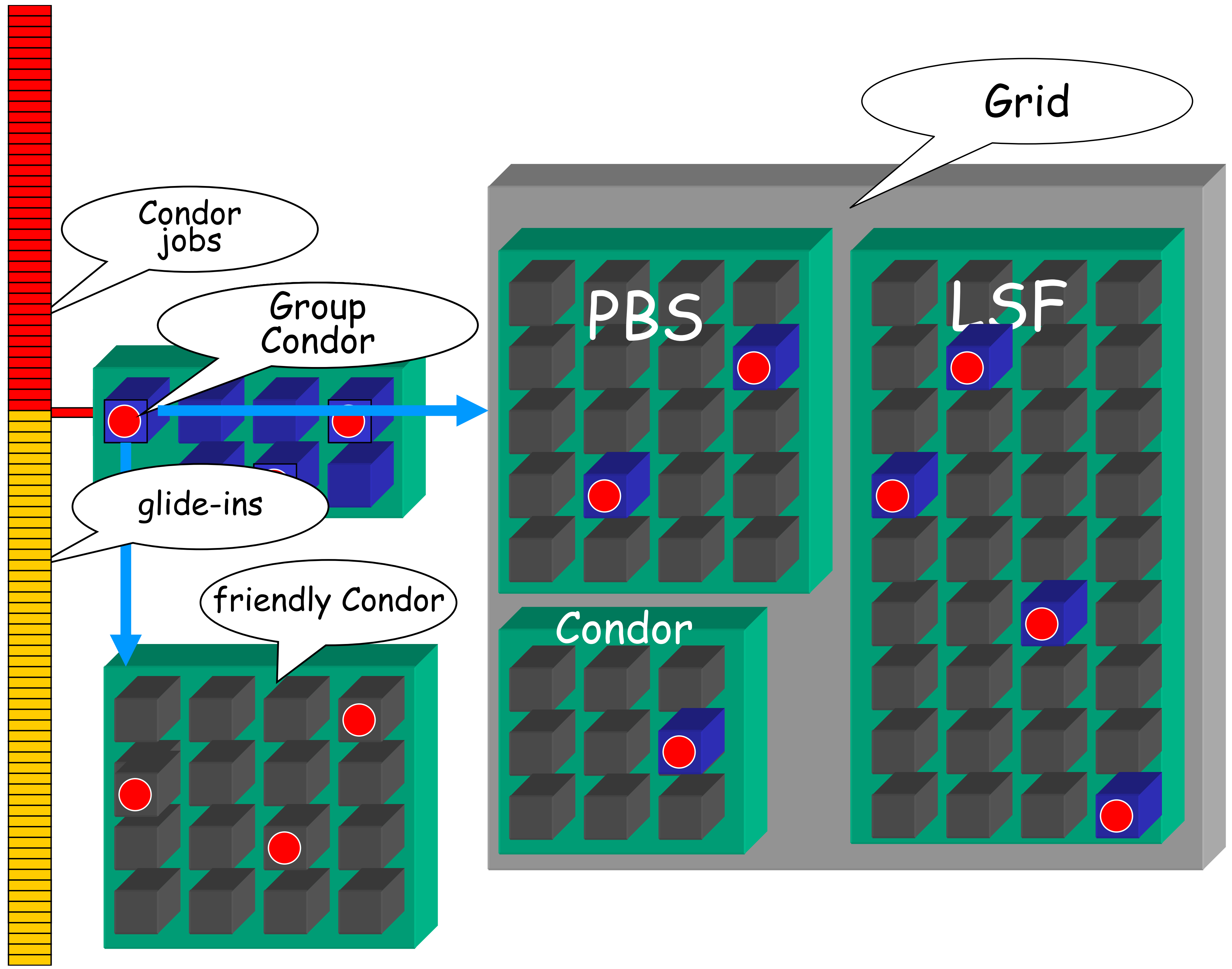
Condor-glide-in

Enable an application to dynamically turn allocated Grid resources into members of your Condor pool even if there is no Condor system on those resources.

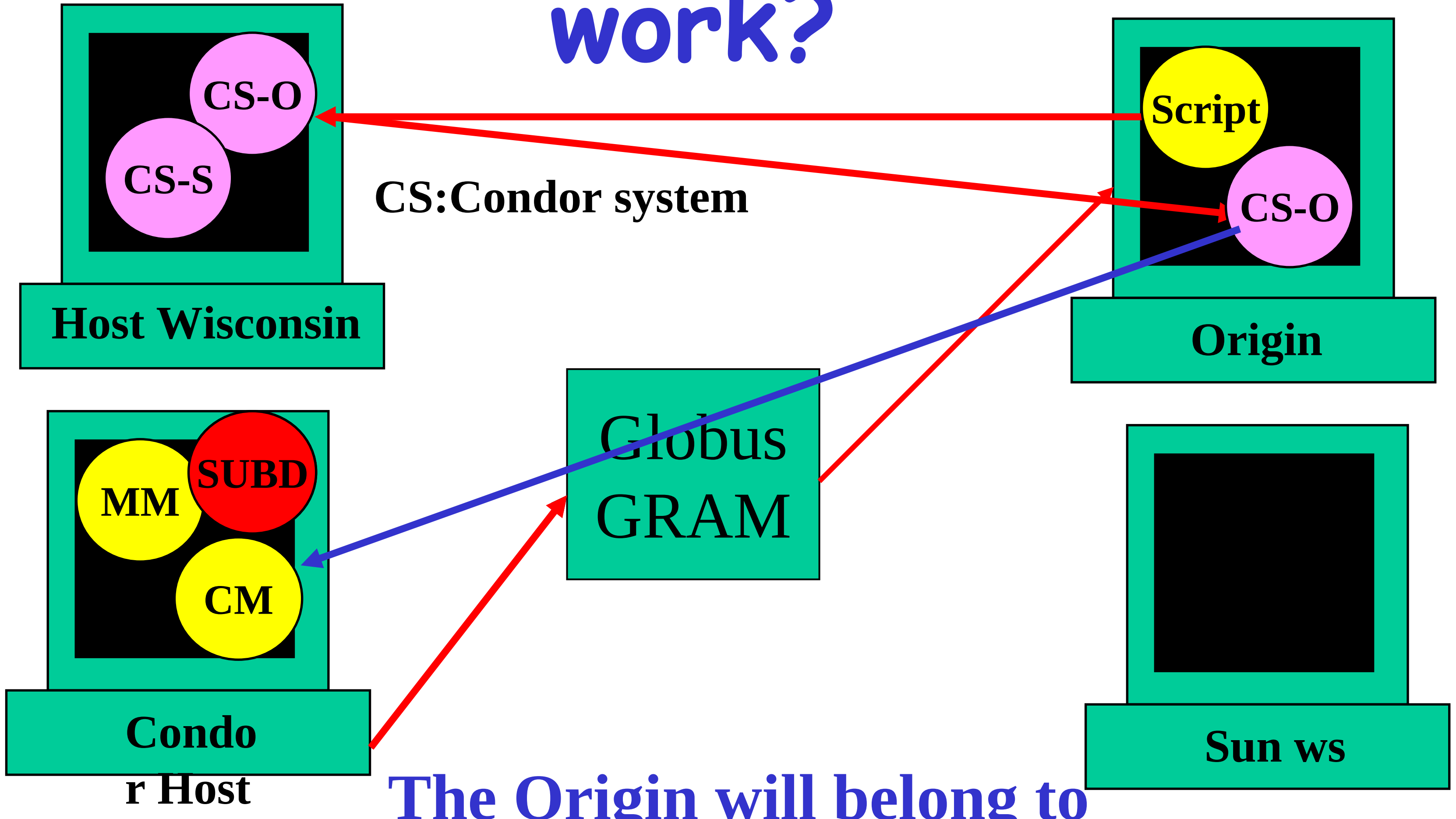
- Easy to use on different platforms
- Robust
- Supports SMPs
- Provides uniformity

Exploit Grid resources

- Get access (account(s) + certificate(s)) to a "Computational" Grid
- Submit "Grid Universe" Condor-glide-in jobs to your personal Condor
- Manage your glide-ins


Grid
Condor jobs
Group Condor
glide-ins
friendly Condor
PBS
LSF
Condor

How does Condor glide-in work?

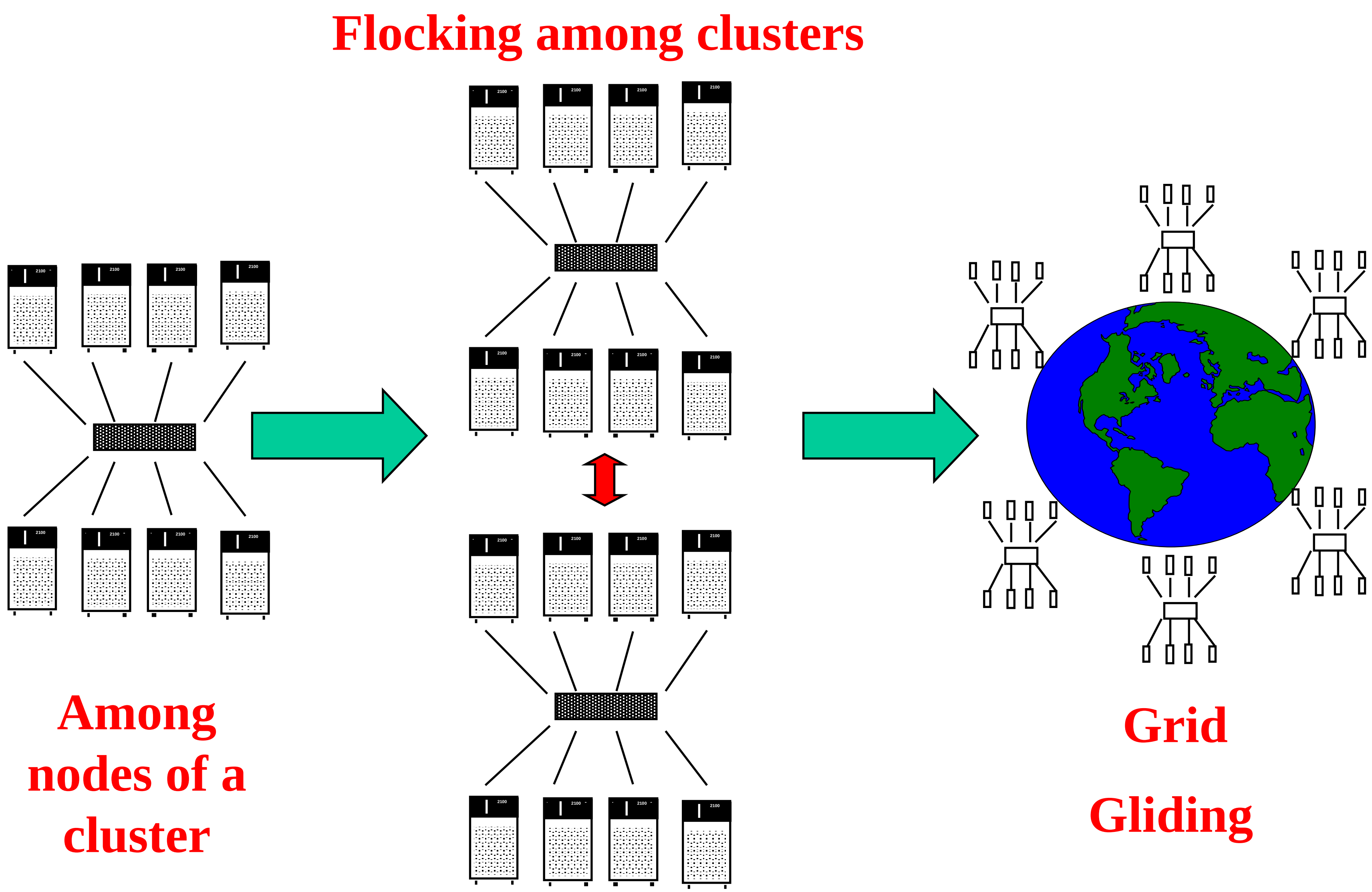


The Origin will belong to your Condor pool

General rule for Condor pools

- A Condor pool has a Central Manager
- If you are flocking the Central Manager of the friendly pool becomes visible to your pool and hence hosts in the other pool can be reached
- If you are gliding all the new Condor resources will directly connect to your CM

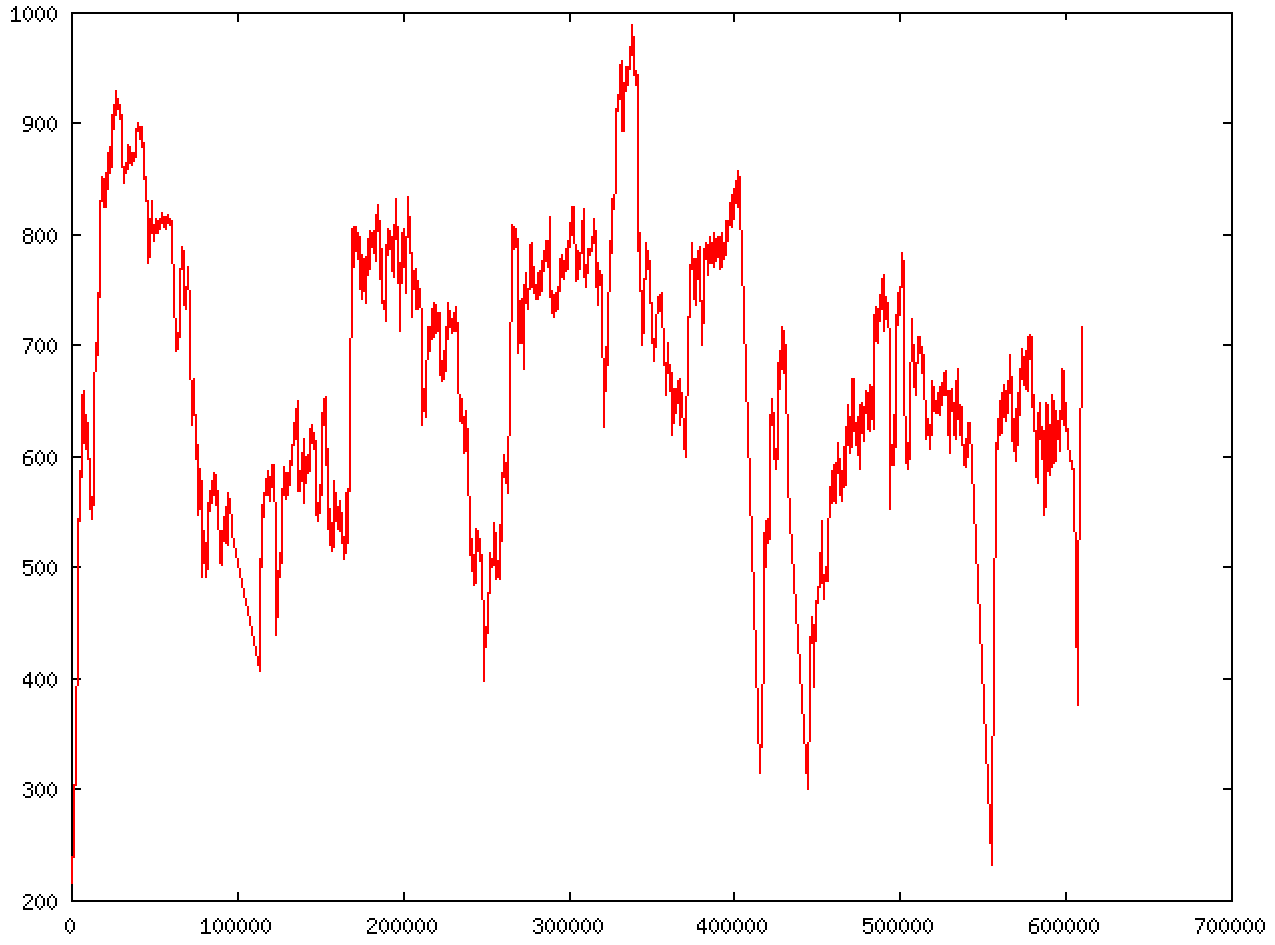
Three levels of scalability in Condor



NUG30 - Solved!!!

- Solved in 7 days instead of 10.9 years
- The first 600K seconds …

Number of workers



Problems with Condor flocking "grids"

- Friendly relationships are defined **statically**.
- **Firewalls are not allowed** between friendly pools.
- Client can not choose resources (pools) directly.
- Non-standard "**Condor protocols**" are used to connect friendly pools together.
- The **client needs an account** to be able to submit a job and get the results back.
- **Not service-oriented**

Thank you