# Harnessing the Power of the Globus Toolkit

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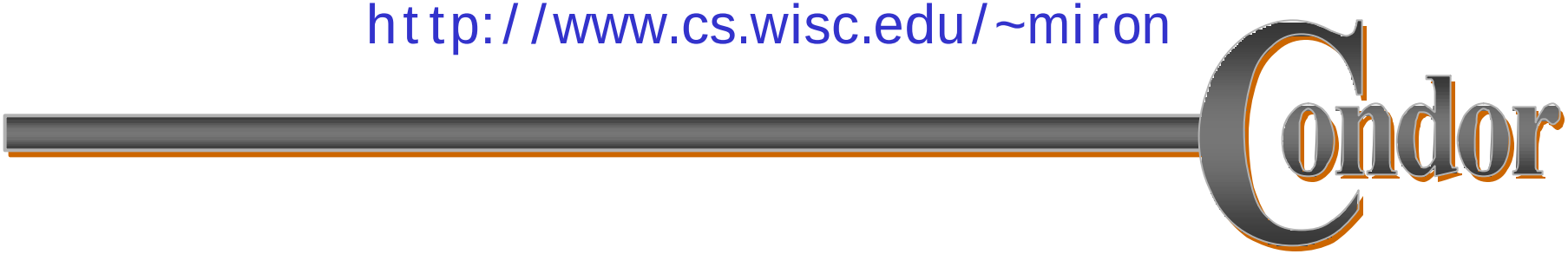

# Accomplishments
# Opportunities
# Challenges

# Grid of Technologies not just Resources


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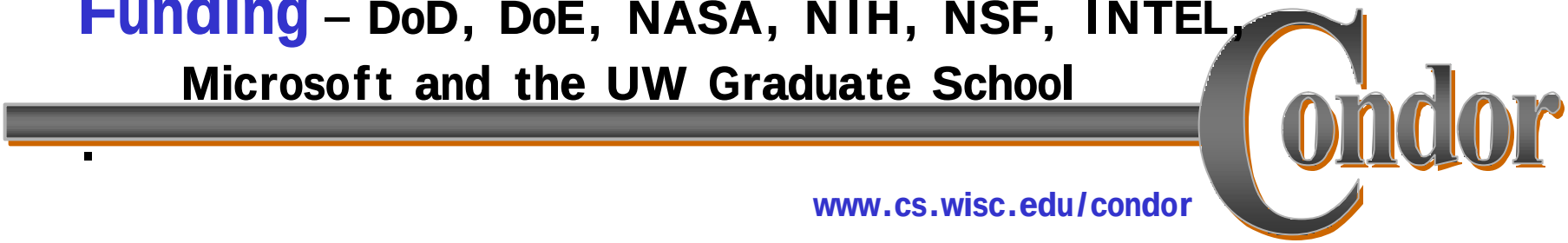
# Some background …

# The Condor Project (Established '85)

Distributed Computing research performed by a team of 30 faculty, full time staff and students who

- face software engineering challenges in a UNIX/Linux/NT environment,
- are involved in national and international collaborations,
- actively interact with users,
- maintain and support a distributed production environment,
- and educate and train students.

**Funding** – **DoD, DoE, NASA, NIH, NSF, INTEL, Microsoft and the UW Graduate School**



# Claims for "benefits" provided by Distributed Processing Systems

**P.H. Enslow, *"What is a Distributed Data Processing System?"* Computer, January 1978**

- High Availability and Reliability
- High System Performance
- Ease of Modular and Incremental Growth
- Automatic Load and Resource Sharing
- Good Response to Temporary Overloads
- Easy Expansion in Capacity and/or Function

**“ … Since the early days of mankind the primary motivation for the establishment of *communities* has been the idea that by being part of an organized group the capabilities of an individual are improved. The great progress in the area of inter-computer communication led to the development of means by which stand-alone processing sub-systems can be integrated into multi-computer ‘*communities*’. … “**

**Miron Livny, “ *Study of Load Balancing Algorithms for Decentralized Distributed Processing Systems*.”, Ph.D thesis, July 1983.**

# High Throughput Computing

For many experimental scientists, scientific progress and quality of research are strongly linked to computing throughput. In other words, they are less concerned about instantaneous computing power. Instead, what matters to them is the amount of computing they can harness over a month or a year --- they measure computing power in units of scenarios per day, wind patterns per week, instructions sets per month, or crystal configurations per year.

# High Throughput Computing is a 24-7-365 activity

**FLOPY** $^{1}$ *(60*60*24*7*52)*FLOPS*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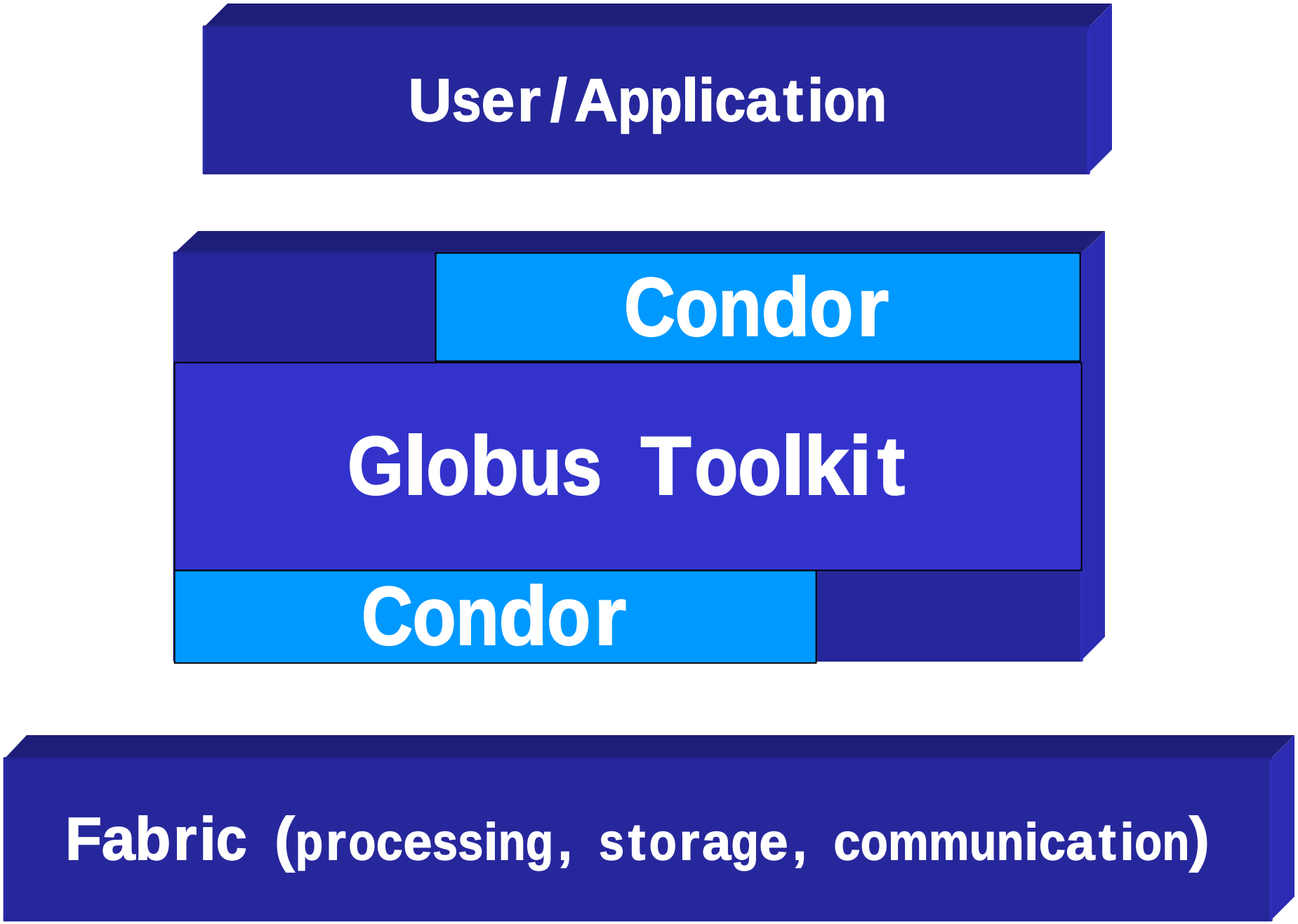
Bring Globus technology and services to end users as components of an end-to-end service.


User/Application
Condor
Globus Toolkit
Condor
Fabric (processing, storage, communication)

# Condor Layers

# Condor-G:
# Making the "Customer Agent" of Condor Globus aware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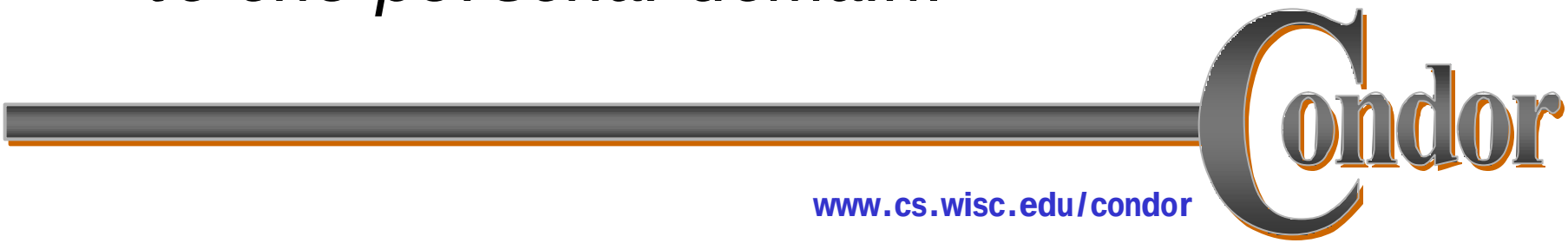
# Condor-G

Combine the inter-domain resource management protocols of the Globus Toolkit and the intra-domain resource management methods of Condor *to allow the user to harness large collections of resources across multiple domains as if they all belong to one personal domain*.



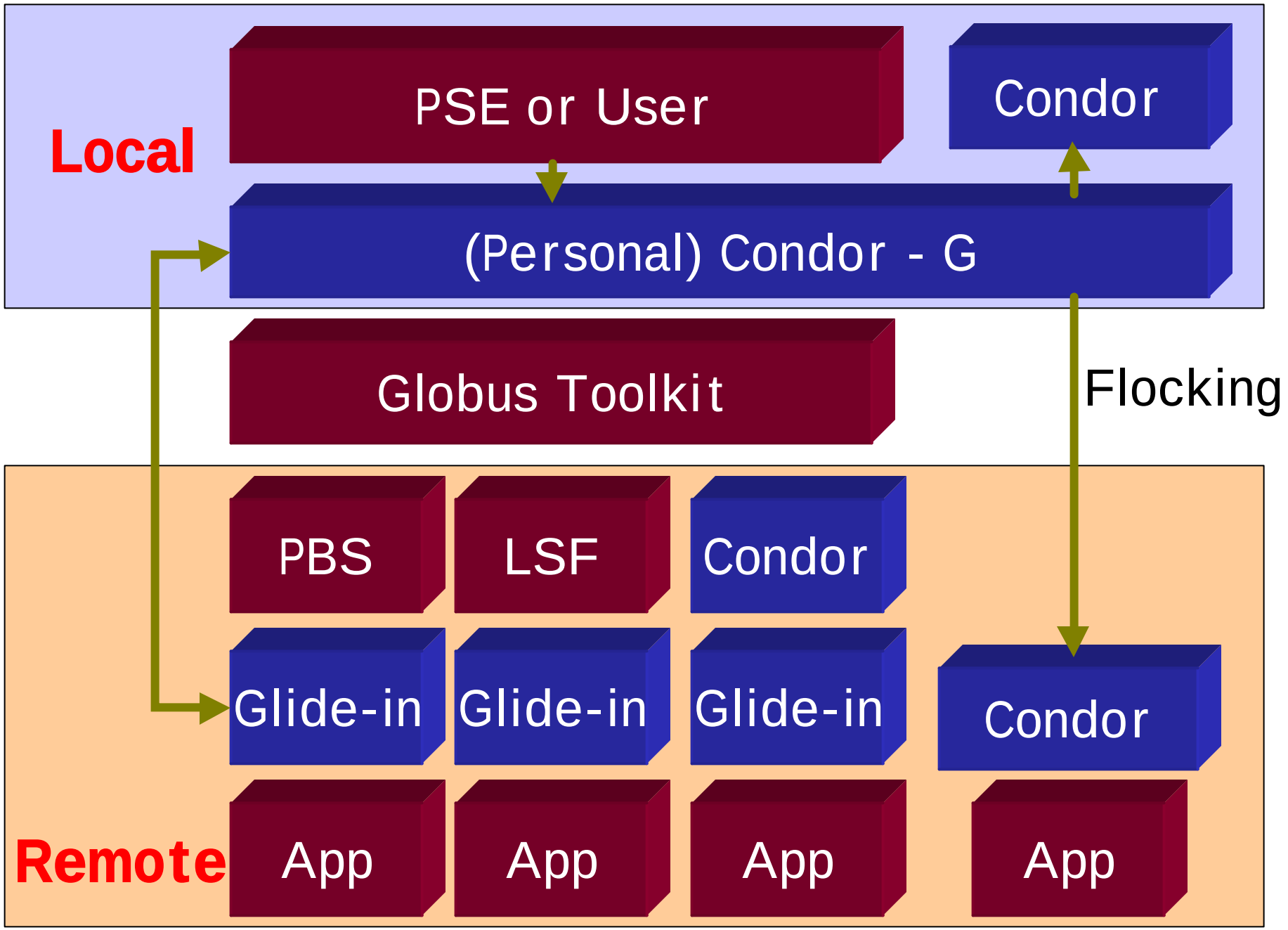
# Globus Toolkit Services

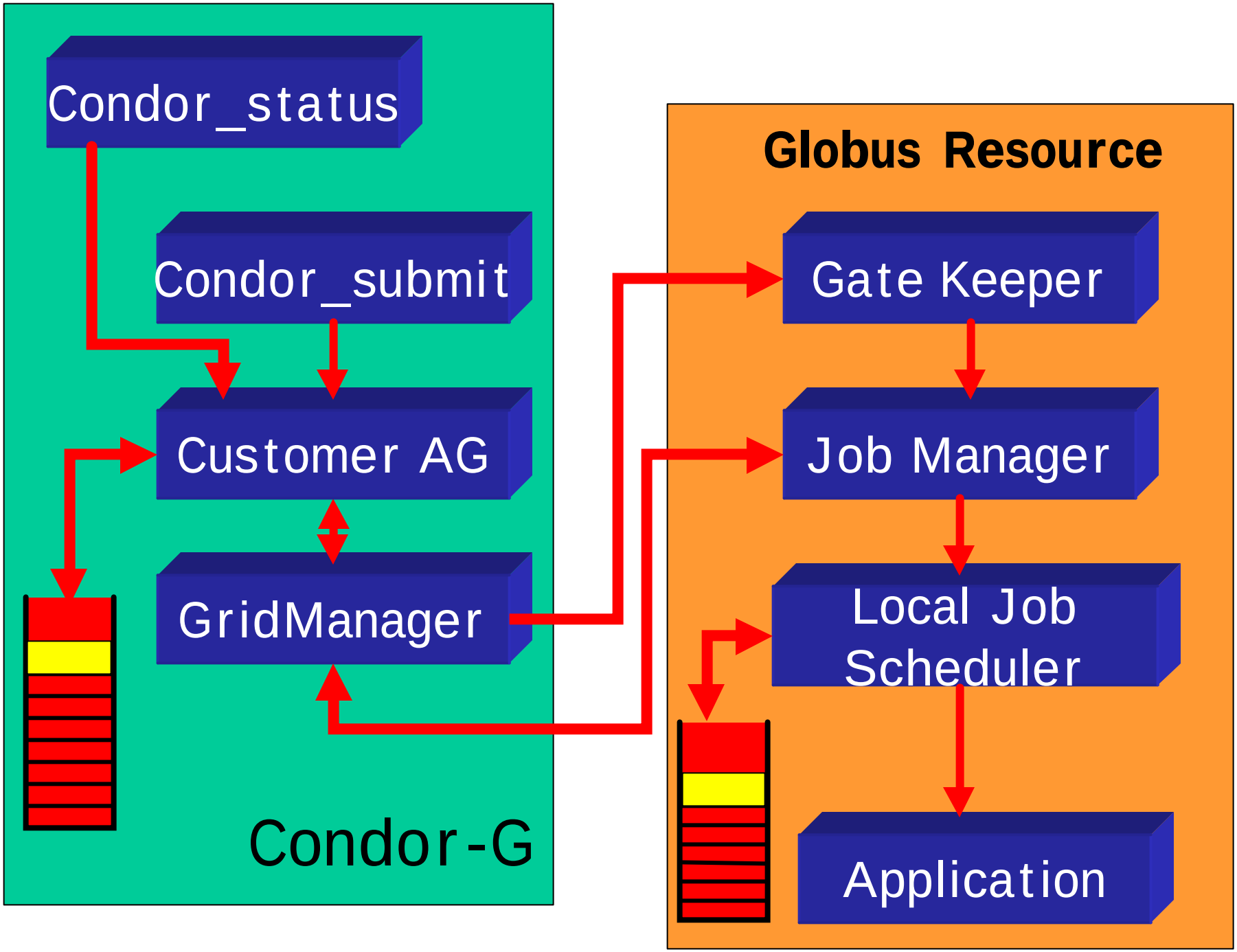
- GSI – Grid Security Infrastructure
- GRAM – Grid Resource Allocation and Management protocol
- GASS – Global Access to Secondary Storage

# Job Manager++ (GRAM 1.5)

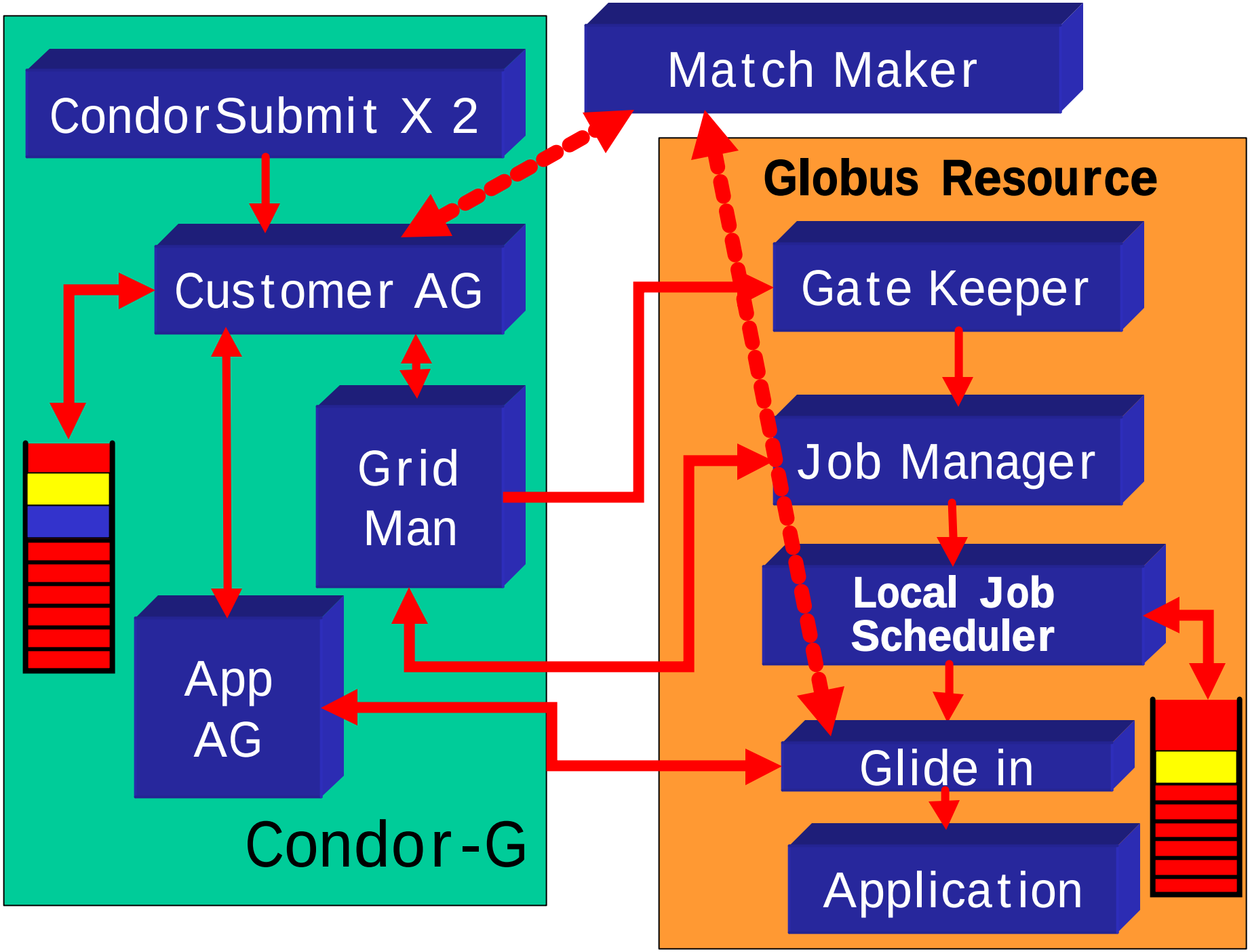
- Two-phase commit job submission protocol
- Attach to existing job
- Credential refresh (GRAM 1.6)

New version transferred to the Globus Team and is part of 2.0.


Local
PSE or User
Condor
(Personal) Condor - G
Globus Toolkit
Flocking
PBS
LSF
Condor
Glide-in
Glide-in
Glide-in
Condor
Remote
App
App
App
App


Condor_status
Condor_submit
Customer AG
GridManager
Condor-G
Globus Resource
Gate Keeper
Job Manager
Local Job Scheduler
Application

# Glide-in: Expending your Condor pool "on the fly" and executing your jobs on the remote resources in a "friendly" environment.

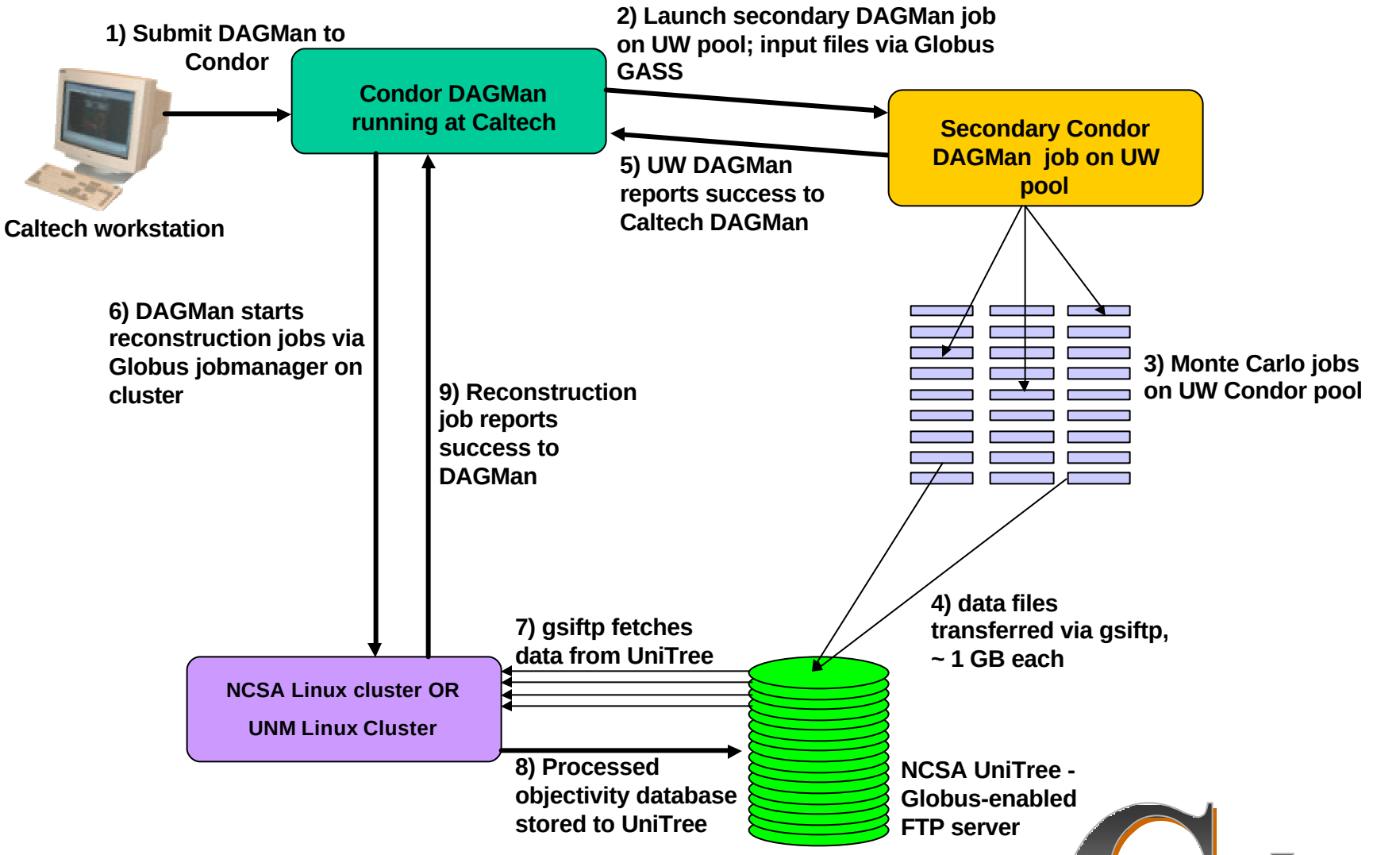

Match Maker
Condor Submit X 2
Customer AG
Grid Man
App AG
Condor-G
Globus Resource
Gate Keeper
Job Manager
Local Job Scheduler
Glide in
Application

# The CMS Production Story

## A collaboration* between:

- **Physicists & Computer Scientists**
  - **Vladimir Litvin (Caltech CMS)**
  - **Scott Koranda, Bruce Loftis, John Towns (NCSA)**
  - **Miron Livny, Peter Couvares, Todd Tannenbaum, Jamie Frey (UW-Madison Condor)**
- **Software**
  - **Condor, Globus, CMS**

* members of the GriPhyN project

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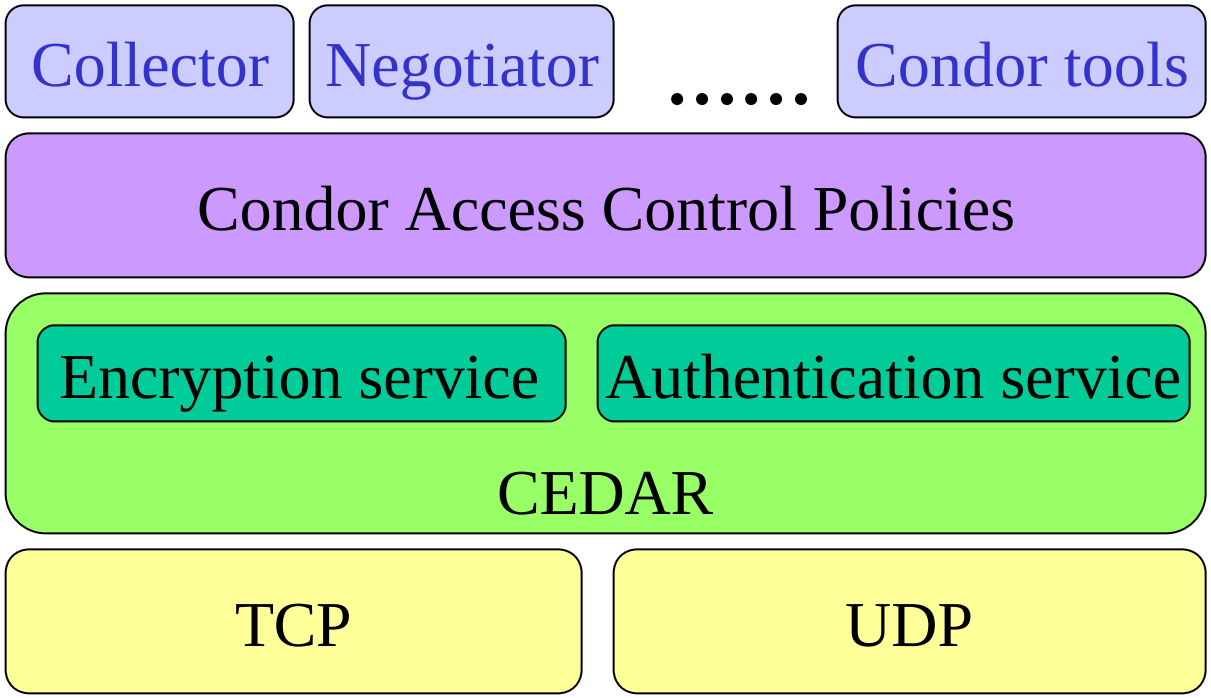
# X509 Authentication for all connections established by Condor

# Condor Security Infrastructure

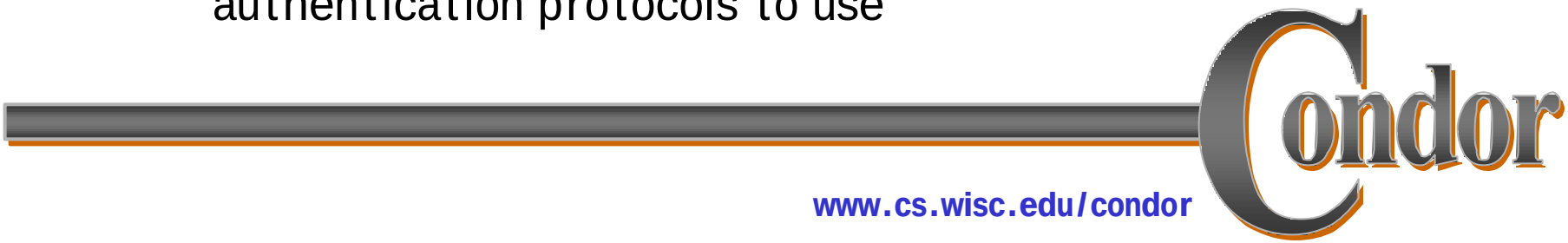
- Provide a flexible, powerful and maintainable security infrastructure
- Enable:
  - Authentication – identifying user, resources and software modules
  - Authorization – providing access control
  - Encryption – providing secure channel

# Condor Security Infrastructure

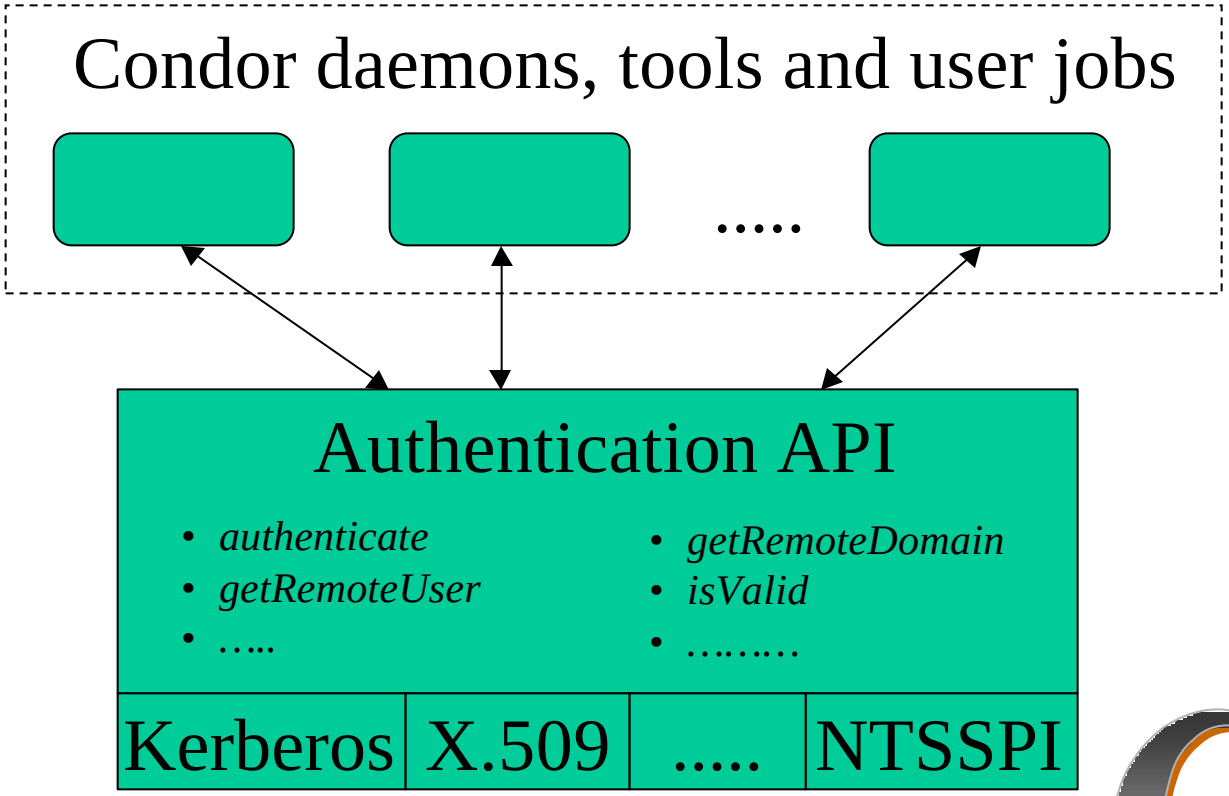


# Authentication in Condor

- Flexible
  - Condor's authentication infrastructure supports multiple authentication protocols
    - X.509, Kerberos, NTSSPI, etc.
- Simple and extensible
  - A common set of API to provide consistency and hide complexity of the protocols
- Negotiable
  - Handshake process allows two parties to negotiate the authentication protocols to use



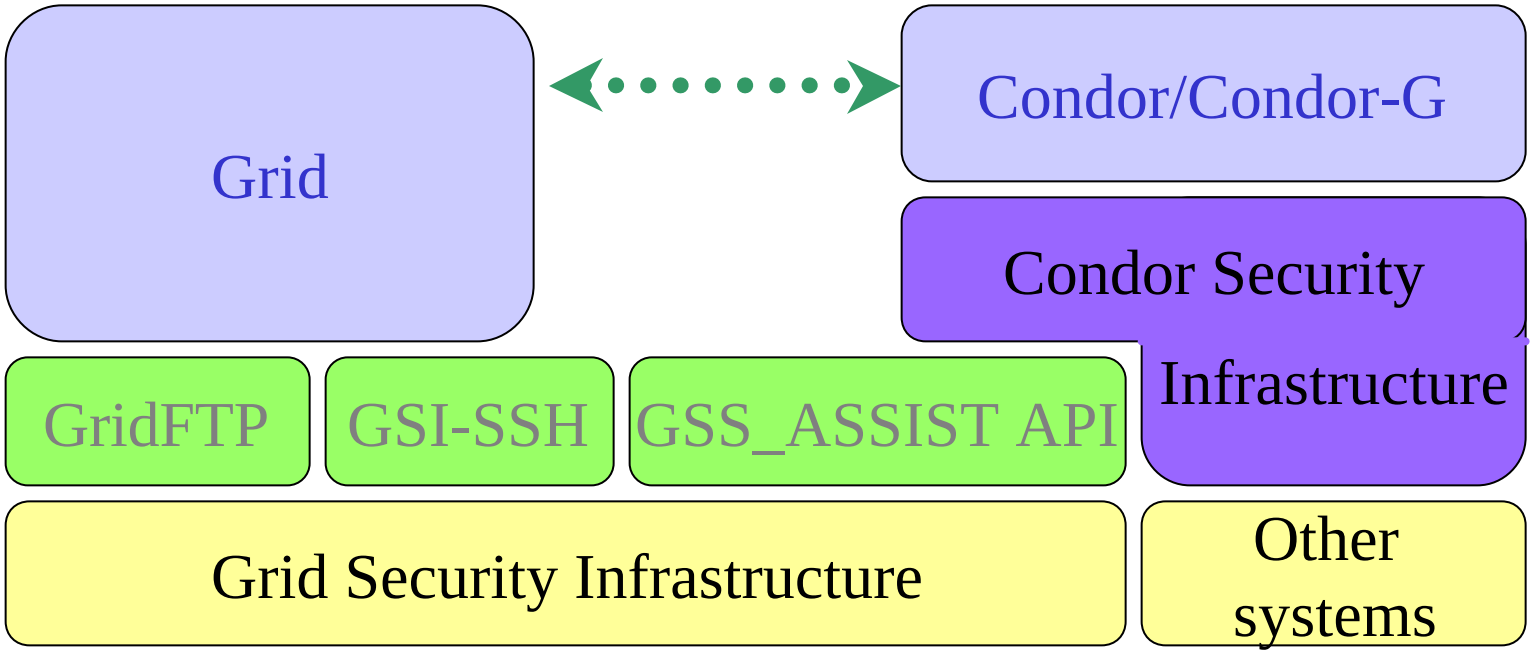
# Authentication API



# Credential Management

- Problems
  - Need to deal with credential expiration
    - Very important for unattended jobs
  - Need to manage all necessary credentials
  - Delegation – jobs move around
- Solutions?
  - Periodically check credential and automatically notify user when the credential is about to expire
  - Delegation support – only works with certain protocols such as X.509 and Kerberos

# The Big Picture

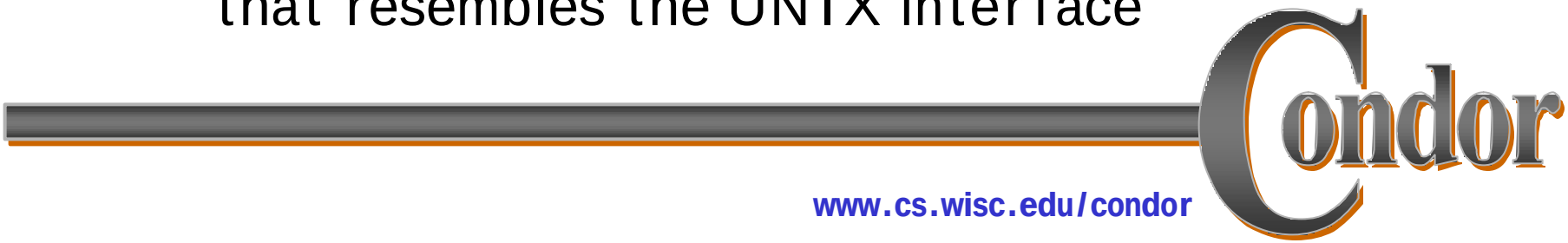


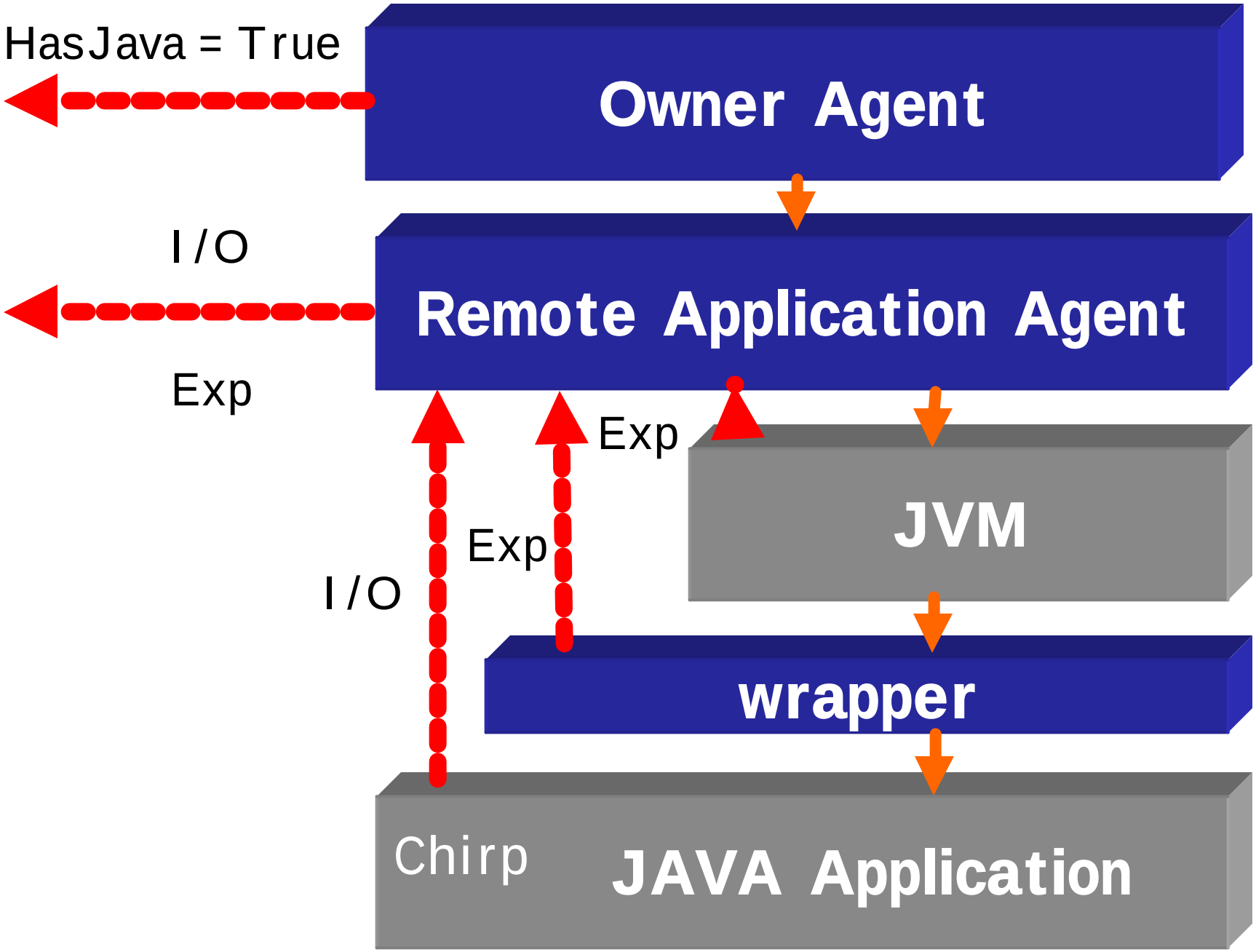
# An Example ...

# JAVA Universe

Make Condor "JAVA Aware"

- Route jobs to "JAVA capable" resources (HasJava = TRUE)
- Intercept, identify and communicate JVM errors and application exceptions back to submission point
- Support secure I/O to remote storage via a lightweight fine-grained I/O protocol (Chirp) that resembles the UNIX interface




HasJava = True
Owner Agent
I/O
Remote Application Agent
Exp
Exp
Exp
JVM
I/O
wrapper
Chirp
JAVA Application

# GridFTP – Interface to Remote I/O services and Storage Appliances

# GridFTP Libraries

- Used to implement server capabilities for NeST – a Grid enabled storage appliance - Provides space management and file transfer services.
- Re-implemented client services for Remote I/O support using ByPass technology and supporting Kangaroo distributed I/O services.

# NeST

Develop a portable self-contained storage “appliance”

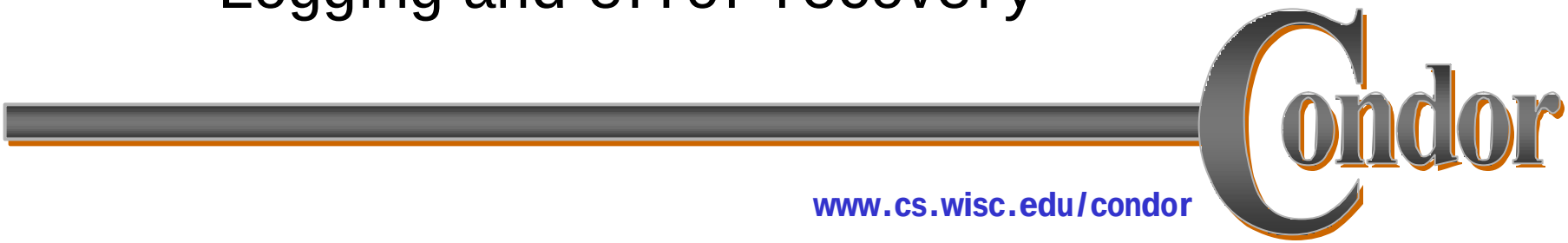
- Lot management
- User Management
- File Management
- File transfer support
- POSIX support

# The Data Management Challenge …

# Data Placement (DaP) Jobs

Define, manage and schedule DaPs like any other “CPU” job.

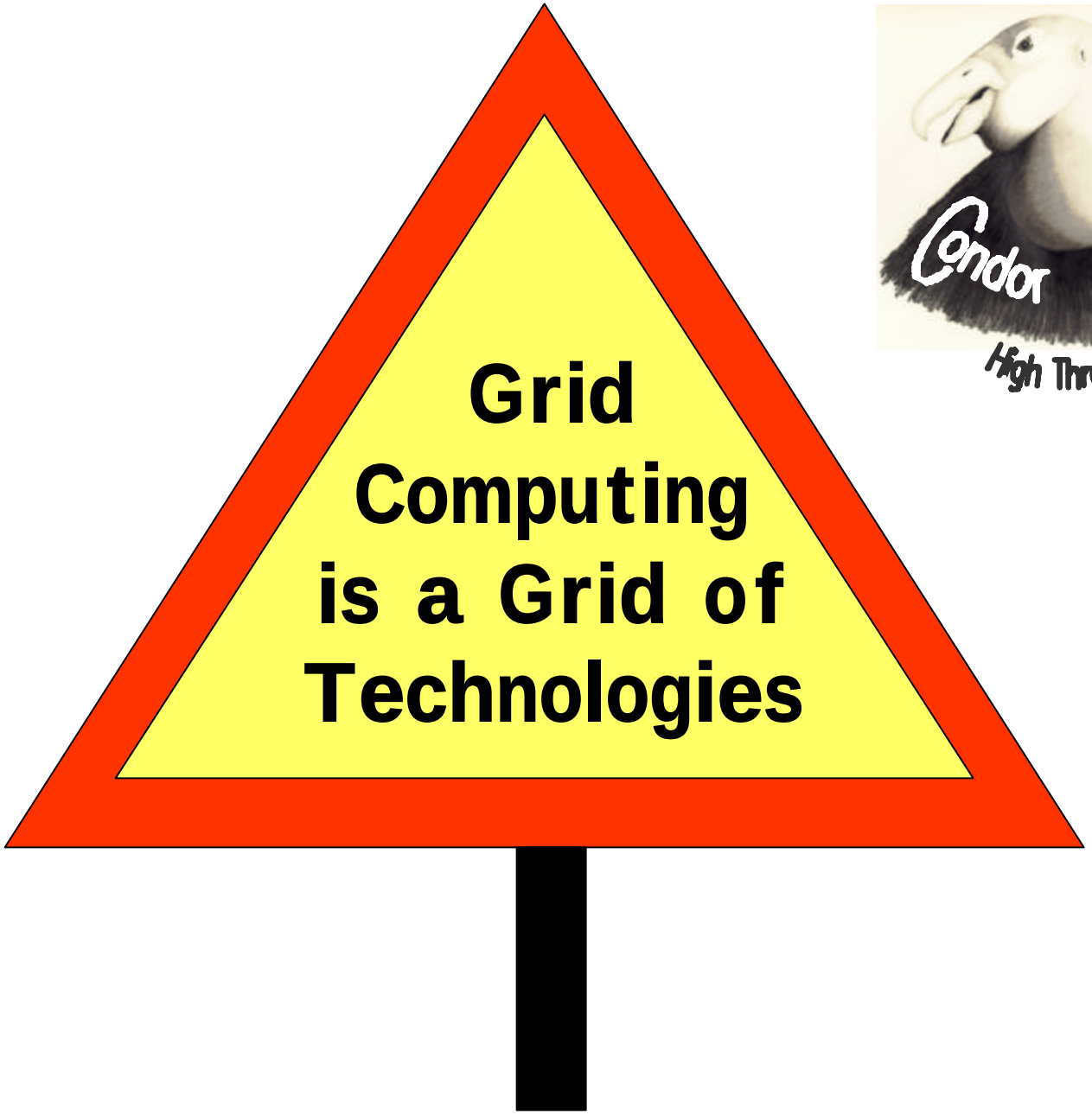
- Includes space/lot management
- Integrate with Kangaroo technology to support “lazy” operations
- Take advantage of “disk routers” to improve throughput of “bulk” data transfers
- Logging and error recovery



# Visit us at

# www.cs.wisc.edu/Condor

# and/or join us in Madison for the Paradyn/Condor meeting (March 4-6 2002)


Grid
Computing
is a Grid of
Technologies


Condor
High Throughput Computing