Grid Technology Overview

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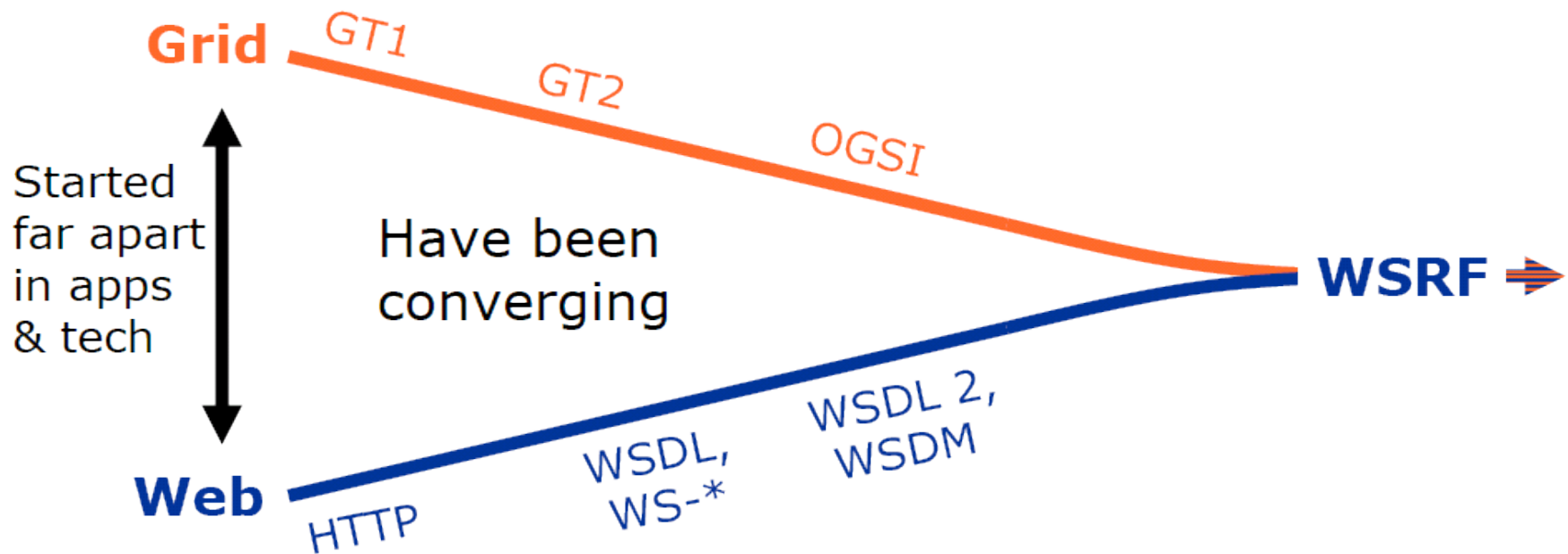
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Grid Computing is …

- "**Coordinated resource sharing** and **problem solving** in **dynamic** multi-institutional **virtual organization**." [*Foster, Kesselman, Tuecke*]

  - **Coordinated resource sharing** - multiple resources working in concert (e.g., compute cycles, databases, files, application services, instruments)
  - **Problem solving** - focus on solving scientific problems
  - **Dynamic** - environments that are changing in unpredictable ways
  - **Virtual Organization** - resources spanning multiple organizations and administrative domains, security domains, and technical domains

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Outline

- **Web Services & the Grid**
- **Grid Architecture Components**
  - Computation
  - Data access, transfer, management
  - Security
  - Information Services
- **Application Tools**
- **User Interfaces**
- **Grid Administration**

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Web Services & the Grid

Grid — GT1, GT2, OGSI → **WSRF**

Web — HTTP, WSDL, WS-*, WSDL 2, WSDM → **WSRF**

Started far apart in apps & tech

Have been converging

The definition of WSRF means that the Grid and Web services communities can move forward on a common base.

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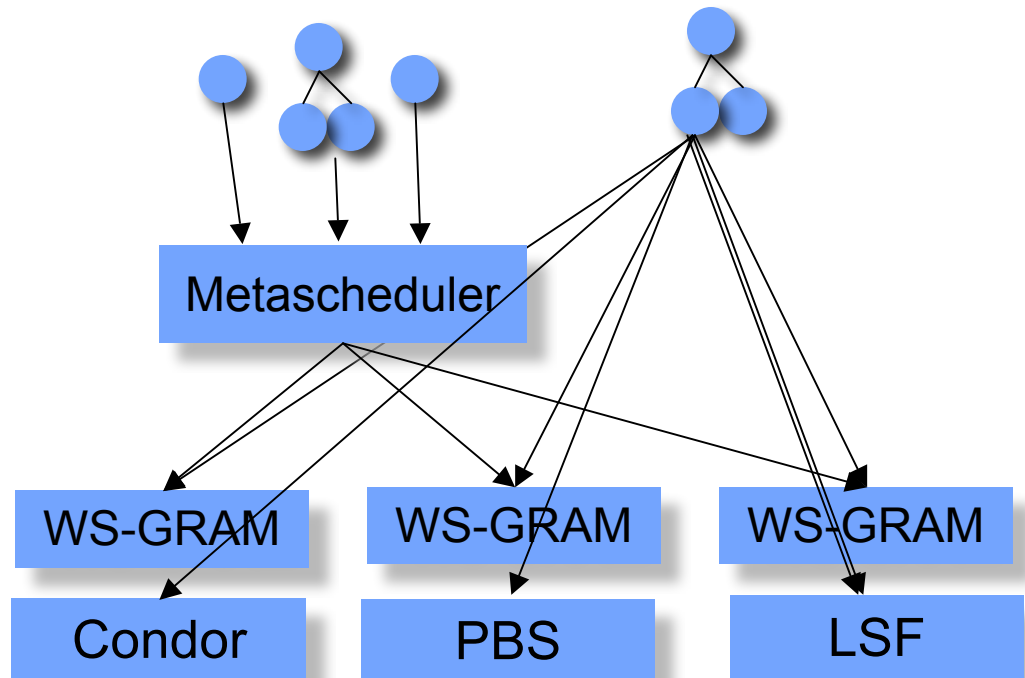- **User Interfaces**
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Computation

Applications (jobs)

Brokering

Metascheduler
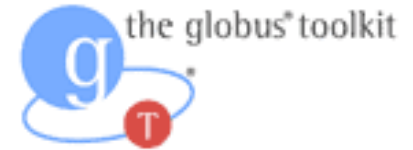
Standardized job submission
and control interface

Different batch
schedulers

Distributed, heterogenous
resources

WS-GRAM   WS-GRAM   WS-GRAM

Condor   PBS   LSF

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WS-GRAM

- **Component of the Globus Toolkit 4**
- **Uniform interface to remote job submission and control**
- **Supports fork and batch schedulers (e.g., loadleveler, lsf, pbs, condor)**
- **Features**
  - Flexible job request language
  - File staging
  - Remote I/O redirection
  - Job status monitoring
  - Job signaling (stop, restart, kill, etc.)

- **WS-Agreement**

Metascheduler

- **intermediary between user and resources by providing single point of submission for tasks (aka community scheduler, resource broker)**
- **Some products:**
  - Condor-G
    - Extension of Condor
    - Interfaces to Grid resources via Globus
    - Use condor commands to manage your personal pool of resources (Grid)
    - DAGMan - submit workflows
    - GridShell provides a shell interface to Condor-G
  - CSF (Community Scheduler Framework)
    - Distributed in Platform's Globus Toolkit product
    - Round-robin and job throttling scheduling
    - Supports reservations
  - GridWay Metascheduler
    - User-level checkpointing support
    - Job migration for adaptive applications
    - Support workflows

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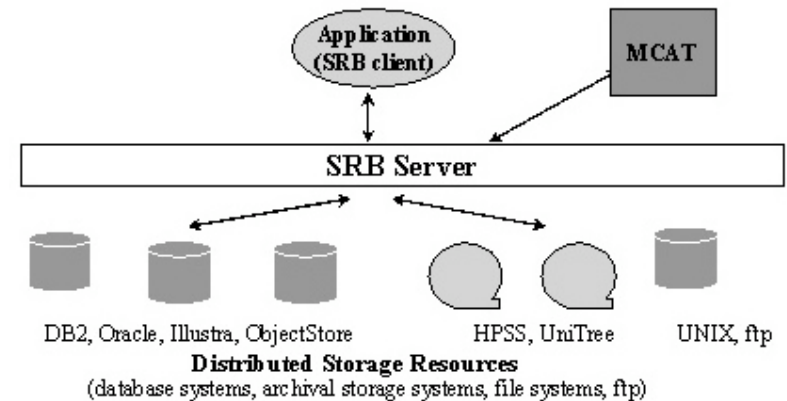- **User Interfaces**
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Data

- **Uniform access to data**

- **Reliable, efficient data transfer**

- **Management**

  Data covered further this afternoon in Reagan Moore's talk

Data Tools

- **SRB (Storage Resource Broker)**
    - Uniform access to data
    - Bulk data operations
    - Supports metadata
    - Data Replication
    - … more this afternoon


- **OGSA-DAI (Data Access and Integration)**
    - Access to files and relational and XML databases via web services interface
    - Supports queries, updates, transforms
   - Supports metadata

Data Tools (cont.)

- **GridFTP** the globus® toolkit

  - "secure, robust, fast, efficient, standards based, widely accepted data transfer protocol"

  - Extends FTP

  - Supports 3rd party transfers

  - Supports striping for large data transfers

  - TGCP - automatically configures gridftp transfers across TeraGrid resources

  - Supports SRB
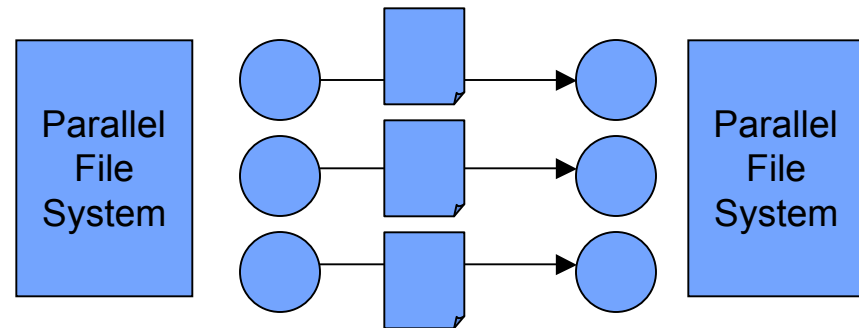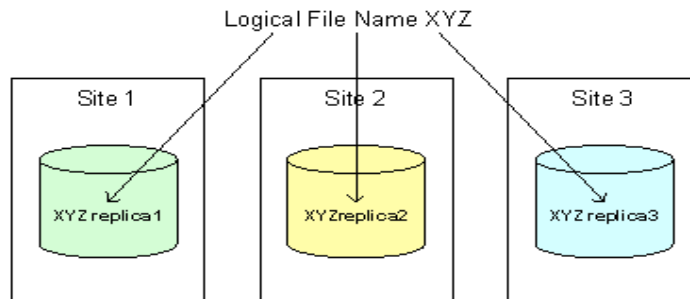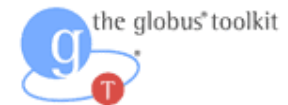
Data Tools (cont.)

- **RFT (Reliable File Transfer)**
  - Provides WSRF interface to GridFTP
  - Submit request (like a job) and query status
  - Utilizes 3rd party transfers
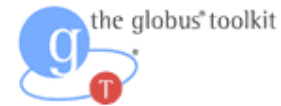
- **RLS (Replica Location Service)**
  - Directory - maps logical filenames to physical filenames

Logical File Name XYZ

Site 1	Site 2	Site 3
XYZ replica1	XYZreplica2	XYZ replica3

- **DRS (Data Replication Service)**
  - Combines RFT and RLS

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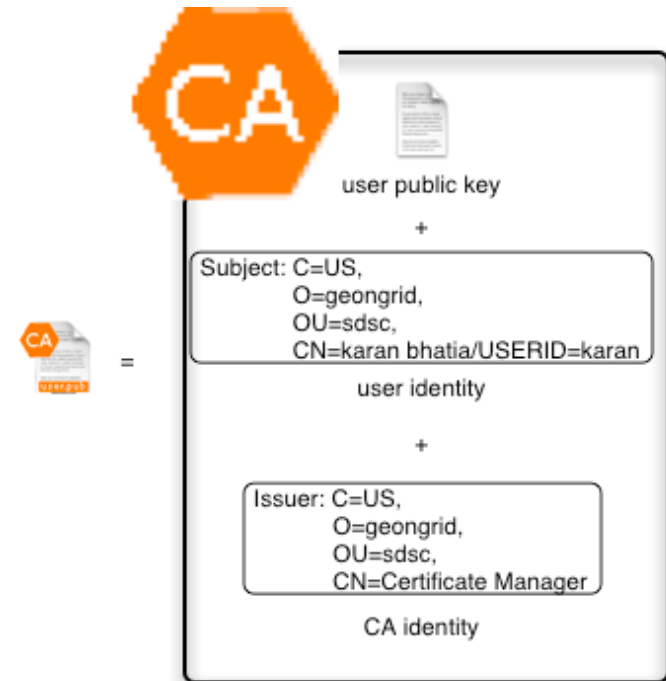
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Grid Security Infrastructure (GSI)

- **Secure communication between Grid components**

- **Support security across organizational boundaries (not centralized)**

- **Support "single sign-on"**

Credential

- **GSI utilizes public key cryptography**
- **Every user and service on the Grid is identified via a certificate, a text file containing the following information:**
  - Subject name and public key identifying the person or object that the certificate represents
  - Identity and signature of a Certificate Authority (CA)
  - Mutual authentication
- **Grid-mapfile maps user subject names to local user account**

- **CACL**
  - OpenSSL-based CA
  - Simplify the issuance and use of certificates

user public key

+

Subject: C=US,
O=geongrid,
OU=sdsc,
CN=karan bhatia/USERID=karan

user identity

+

Issuer: C=US,
O=geongrid,
OU=sdsc,
CN=Certificate Manager

CA identity

SDSC

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Proxy Certificate

- Provides single sign-on
- Self-signed certificate (rather than a CA)
- Contains new certificate with a new public and unecrypted private key.
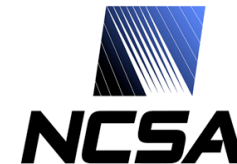- Limited lifetime in order to minimize the security vulnerability (default 12 hours)

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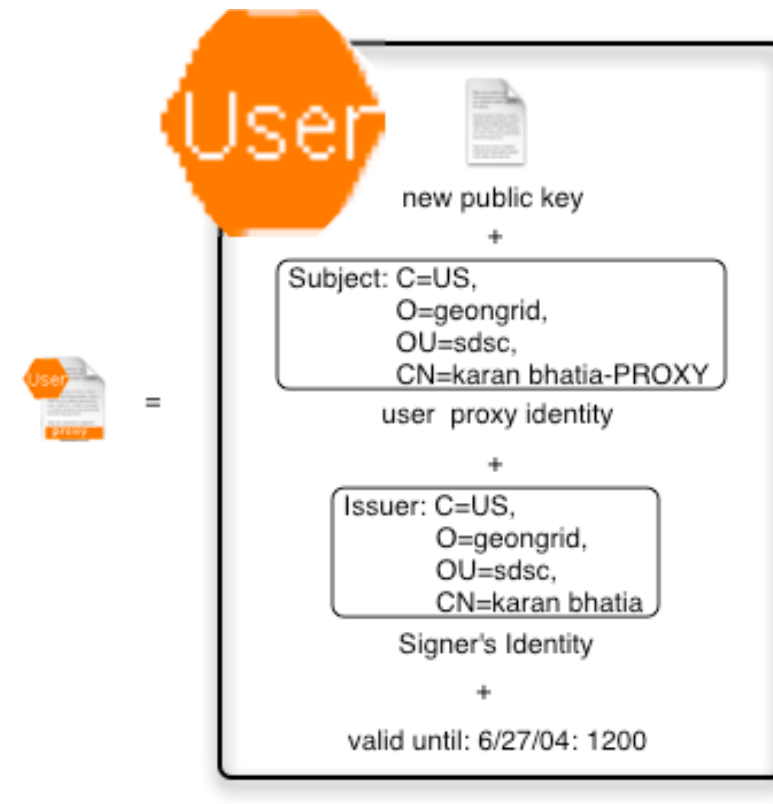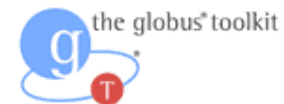
Grid Security Tools

- **MyProxy**
  - Securely stores user credentials
  - User can retrieve credentials via a password
  - Useful for portals
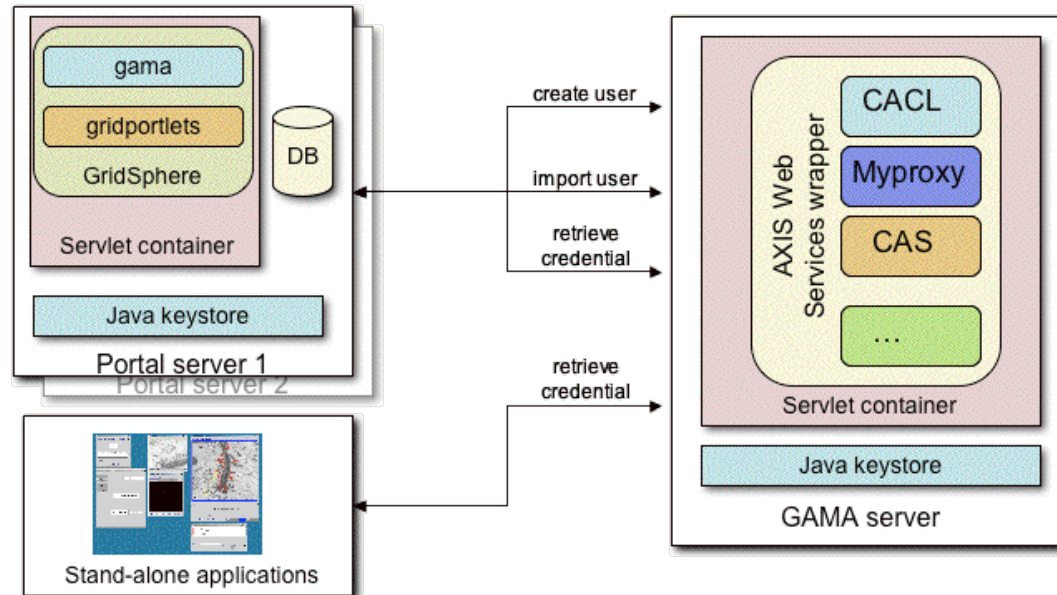
- **CAS (Community Authorization Service)**
  - Community shares single GSI credential
  - Resource providers grant privileges to community (e.g., user account)
  - Community defines fine-grained access control to users - issues proxy credentials

Grid Security Tools (cont.)

- **GAMA (Grid Account Management Architecture)**
  - Provides complete GSI credential management
  - Hide complexities from users
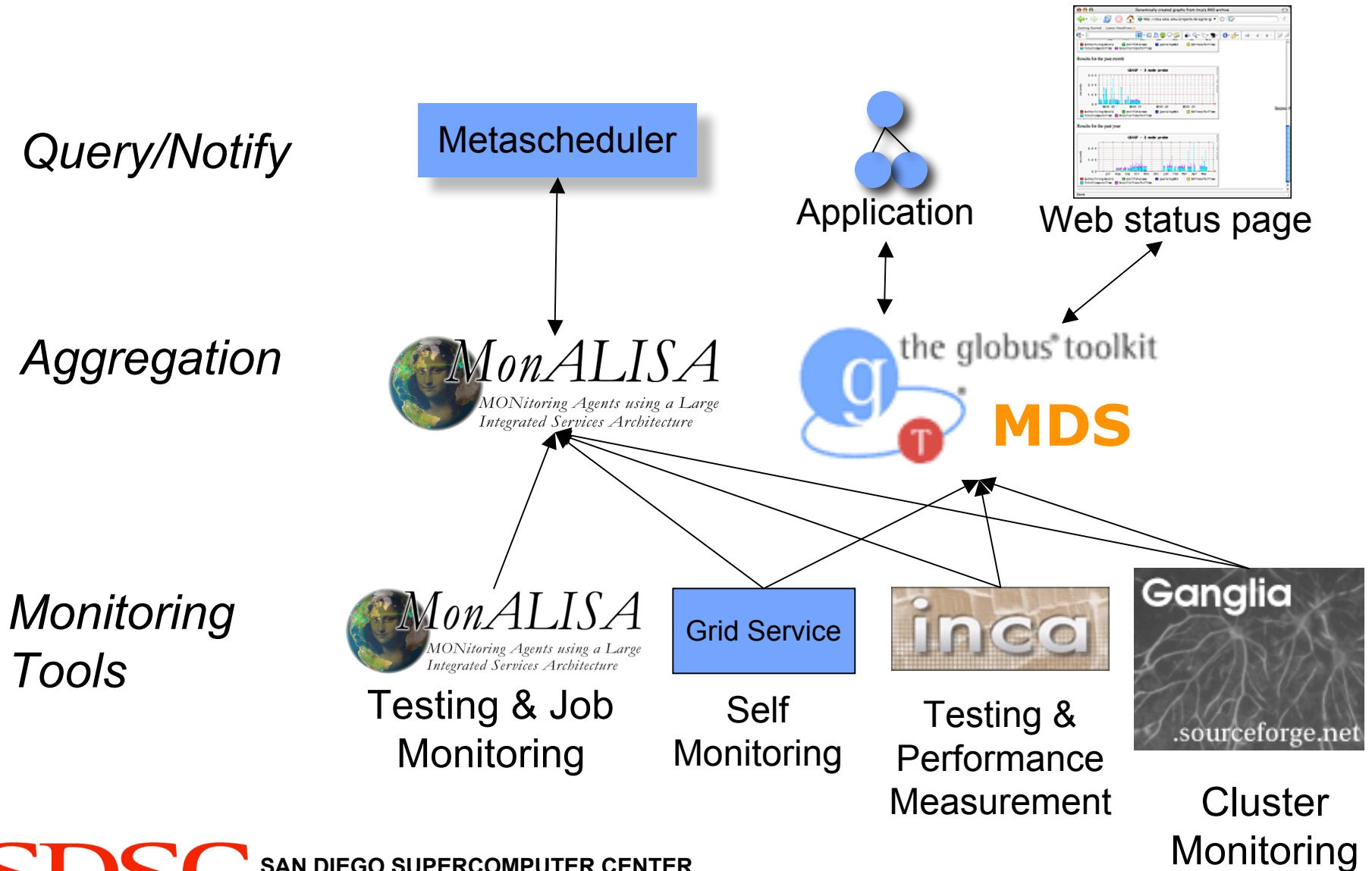 - Leverages existing technologies

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Information Services

Query/Notify

Aggregation

Monitoring Tools

Metascheduler

Application

Web status page

MonALISA
MONitoring Agents using a Large
Integrated Services Architecture

the globus® toolkit
MDS

MonALISA
MONitoring Agents using a Large
Integrated Services Architecture

Testing & Job Monitoring

Grid Service

Self Monitoring

inca

Testing & Performance Measurement

Ganglia
.sourceforge.net

Cluster Monitoring

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Application Tools

- **Opal**
  - Enables rapid deployment of scientific applications as Web services
  - Execution scheduling using Globus and Condor/SGE
  - Job and data management
  - Stores service state in a PostgreSQL database
  - Steps
    - Application writers create configuration file(s) for a scientific application
    - Deploy the application as a Web service using Opal's simple deployment mechanism (via Apache Ant)
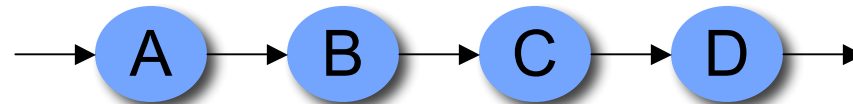   - Users can now access this application as a Web service via a unique URL

Application Tools (cont.)

- **Workflow Tools**
 - Compose applications from multiple distributed components

  - Specify data dependencies and input parameters
  - E.g., processing a raw image from an electron microscope
  - Kepler
    - A framework for design, execution and deployment of scientific workflows
    - Caters specifically to the domain scientist
  - DAGMan
    - Part of Condor

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Application Tools (cont.)

- ## Netlogger
  - Set of tools for troubleshooting and analyzing a distributed application
  - Instrument code
  - Data collected at central location and can be visualized
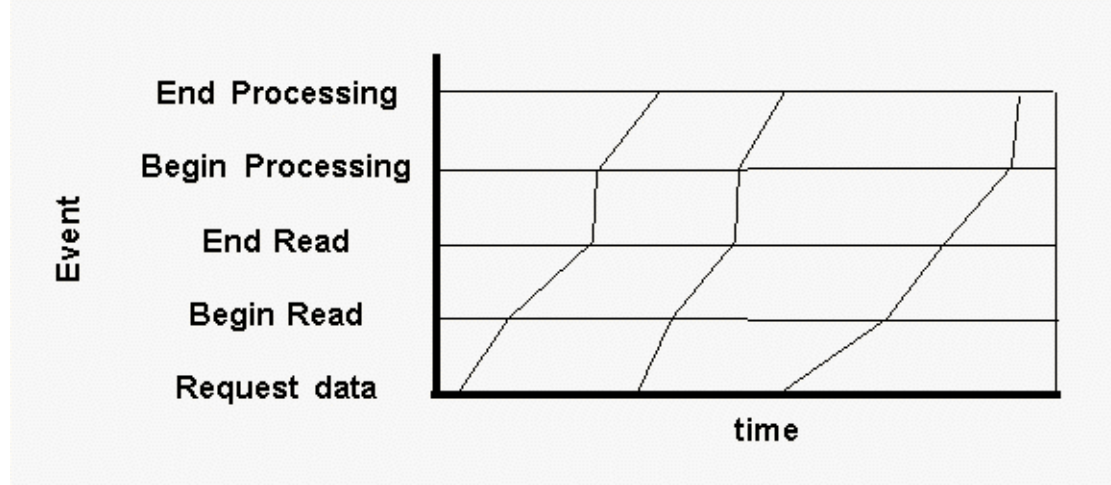
  - Incorporates system monitoring (e.g., ganglia)

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User Interfaces

- **Portals**
  - Single access point to Grid services and resources
  - Hide complexities of running on the Grid
  - General or application-specific
  - Portal framework
    - Plug-in functionality via portlets - JSR 168 standard
    - GridSphere
      – Support for GAMA
      – Job submission, file transfer, etc. portlets
    - OGCE Portlets
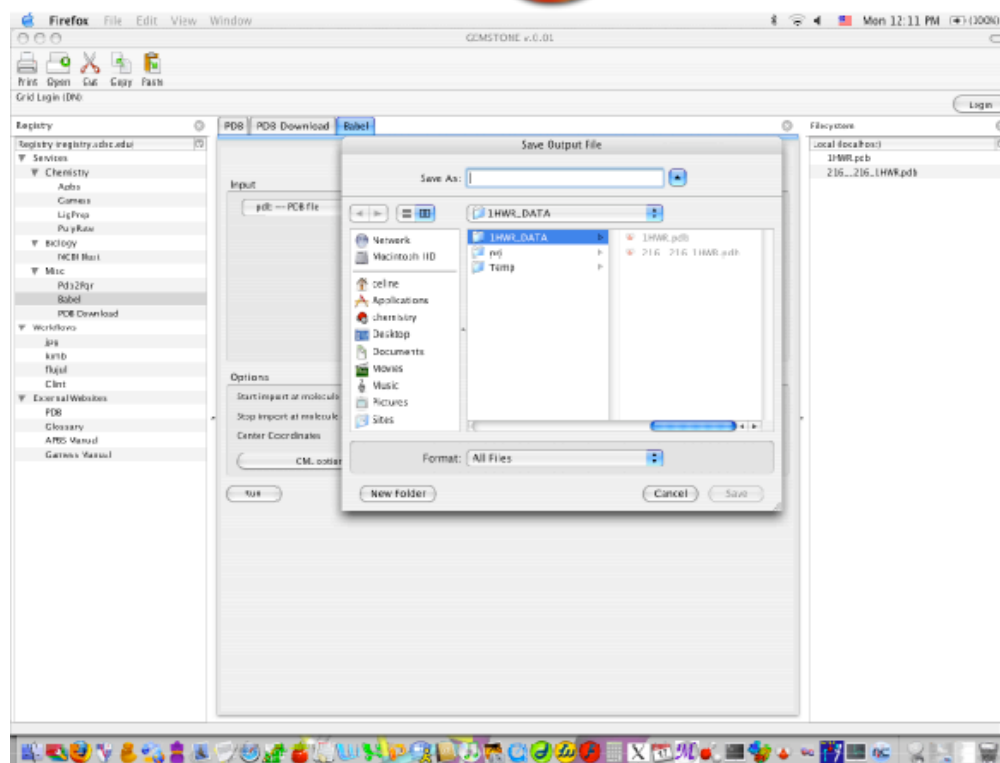   – Job submission (GRAM, Condor), SRB, file transfer

User Interfaces

- **GEMSTONE**
  - Grid-Enabled Molecular Science through Online Networked Environments
  - Desktop application that provides a "dynamic" user interface that updates automatically as additional services and/or applications are added
  - Built on top of Mozilla engine
  - Plugs into Mozilla Firefox

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Installing Grid Software

- **Rocks**
  - Goal: *make clusters easy*
  - Built on top of RedHat Linux releases
  - Installing Grid roll will install Globus
  - … more information in Rocks talk on Wed
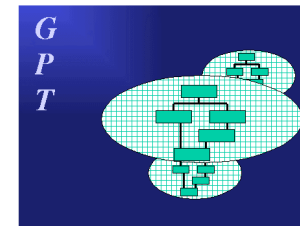
- **Grid software bundles:** VDT Virtual Data Toolkit NMI

- **Packaging Technologies: Pacman**

  Grid Packaging Toolkit

Summary

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Typical Grid Application

- **Implementations are provided by a mix of**
  - Application-specific code
  - "Off the shelf" tools and services
  - Tools and services from the Globus Toolkit
  - Tools and services from the Grid community (compatible with GT)
- **Glued together by…**
  - Application development
  - System integration

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More Information

- **http://www.ggf.org**

- **http://www.globus.org**

- **http://www-128.ibm.com/developerworks/grid**

- **http://www.sdsc.edu**

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