



Enabling Grids for E-scienceE

# Middleware Concepts and Services in Campus, National and International Grids

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[www.eu-egee.org](http://www.eu-egee.org)



Information Society

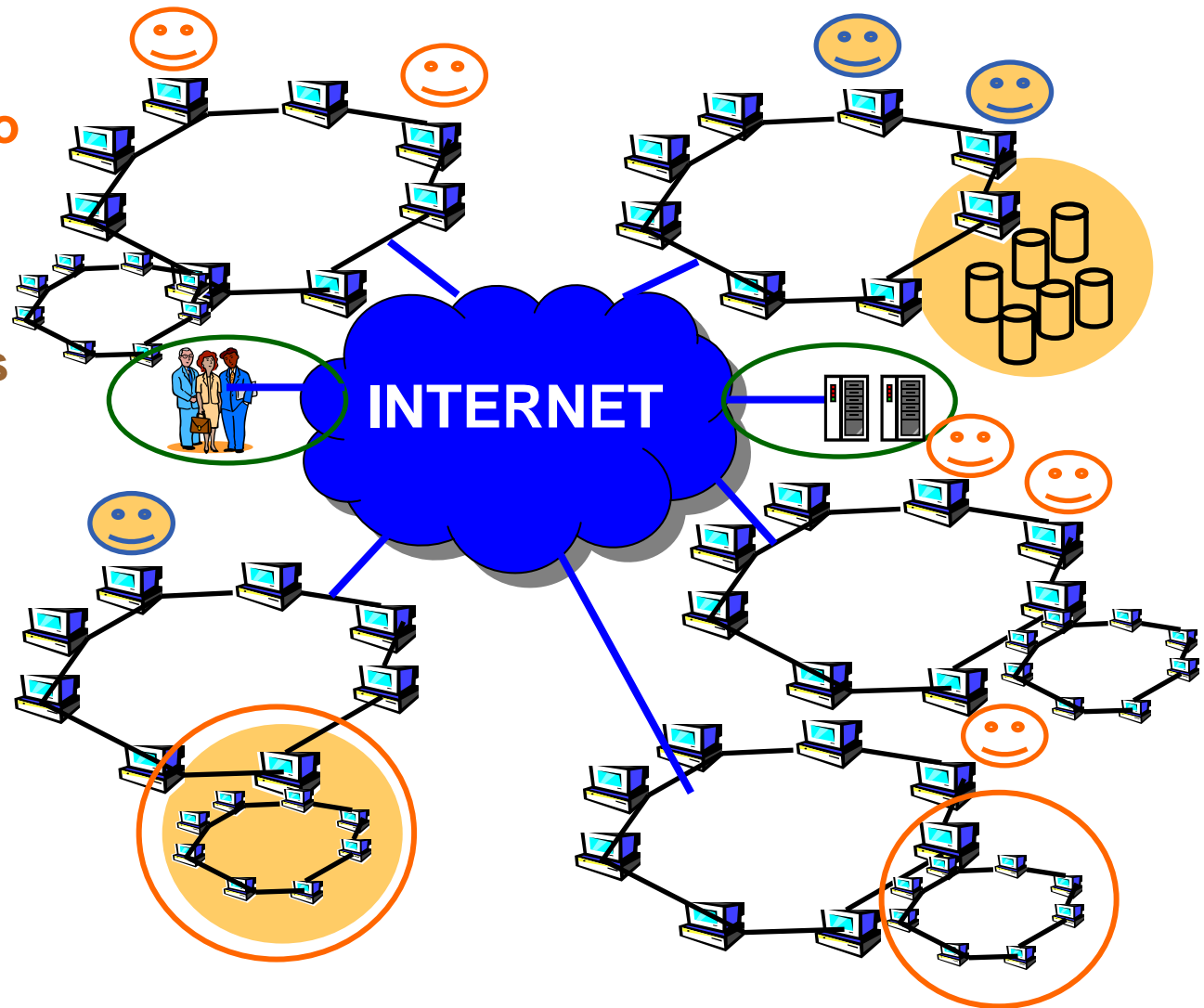


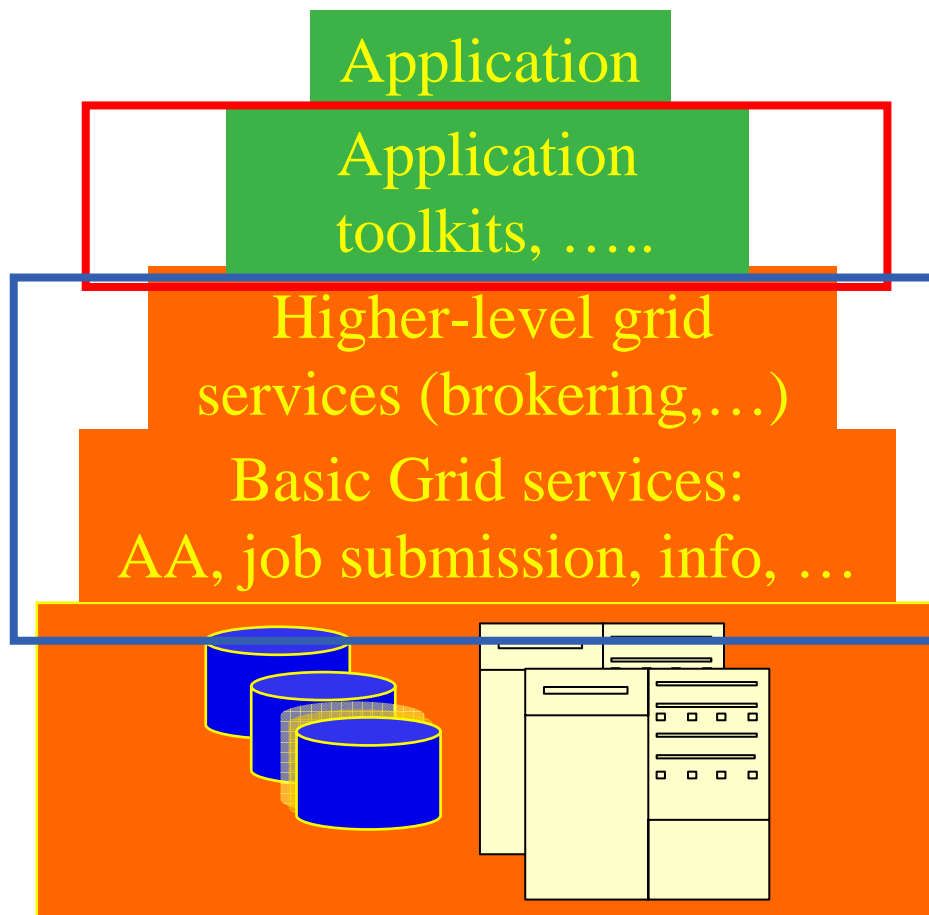
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- **Concepts: Grids enable “Virtual computing across administrative domains”**
- **Current middleware in**
  - International - EGEE grid
  - National Grid Service
  - Campus Grids
- **Service orientation**
  - Web services and Grids: “Open Grid Services Architecture”

- **When using a PC or workstation you**
  - Login with a username and password (“Authentication”)
  - Use rights given to you (“Authorisation”)
  - Run jobs
  - Manage files: create them, read/write, list directories
- **Components are linked by a bus**
- **Operating system**
- **One admin domain**
- **When using a Grid you**
  - Login with digital credentials – single sign-on (“Authentication”)
  - Use rights given you (“Authorisation”)
  - Run jobs
  - Manage files: create them, read/write, list directories
- **Services are linked by the Internet**
- **Middleware**
- **Many admin domains**

- **Virtual organisations (collaborations) negotiate with sites to agree access to resources**
- **Grid middleware runs on each shared resource to provide**
  - Data services
  - Computation services
  - Single sign-on
- **Distributed services (both people and middleware) enable the grid**





**Where computer science meets the application communities!**

**Developments built on higher-level tools and core services**

**Makes Grid services useable by non-specialists**

**Grids provide the compute and data storage resources**

**Production grids provide these core services.**

International instruments,..

National datacentres,  
HPC, instruments

Institutes' data;  
Condor pools

Wider collaboration  
greater resources



International grid (EGEE)

National grids  
(National Grid Service)

Regional grids (e.g.  
White Rose Grid)

Campus grids: PlymGrid

Desktop

**EGEE: “Enabling Grids for  
e-Science”**

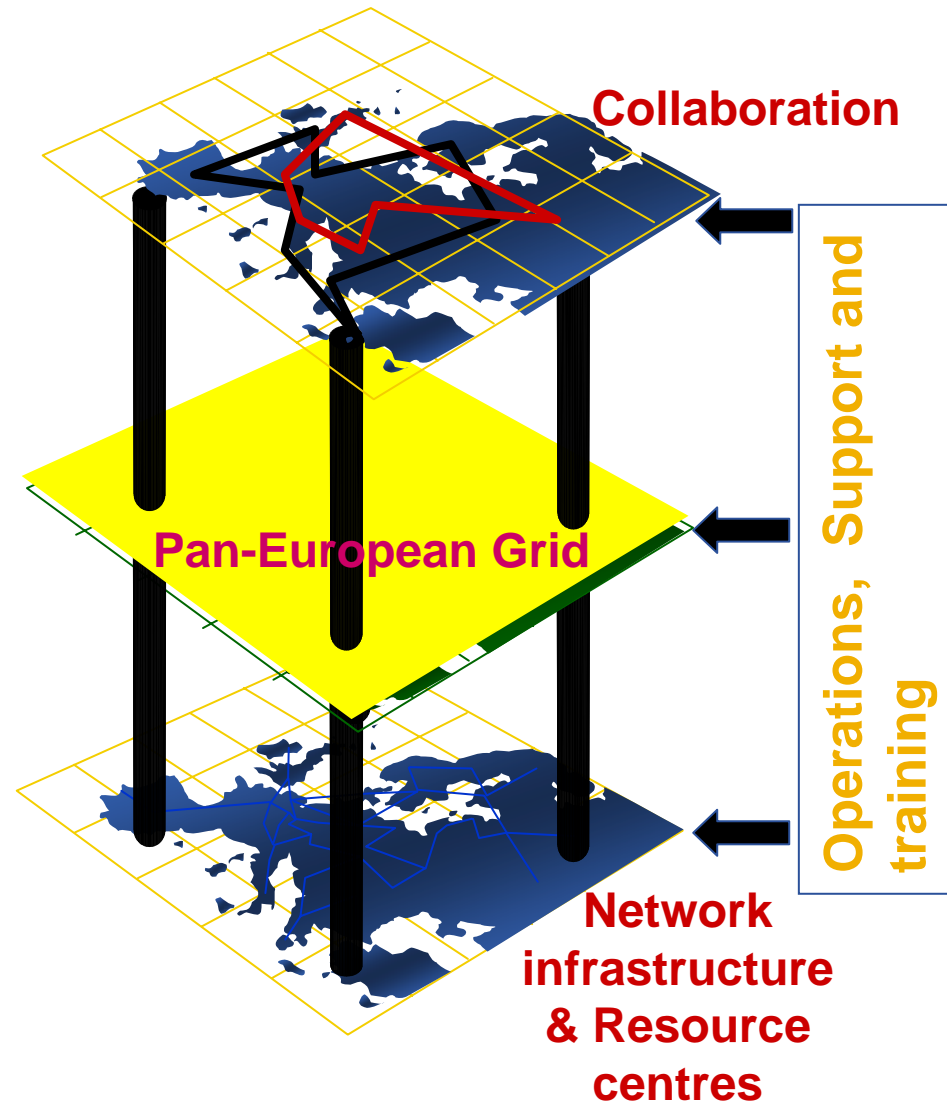
**and the**

**gLite middleware**



## A four year programme:

- **Build, deploy and operate a consistent, robust a large scale production grid service that**
  - Links with and build on national, regional and international initiatives
- **Improve and maintain the middleware in order to deliver a reliable service to users**
- **Attract new users from research and industry and ensure training and support for them**





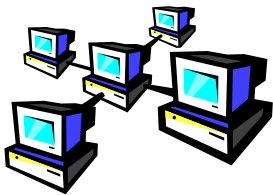
**Access service** How users logon to a Grid



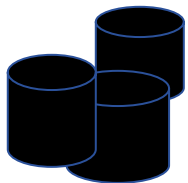
**Resource Broker (RB)**: Service that matches the user's requirements with the available resources on a Grid



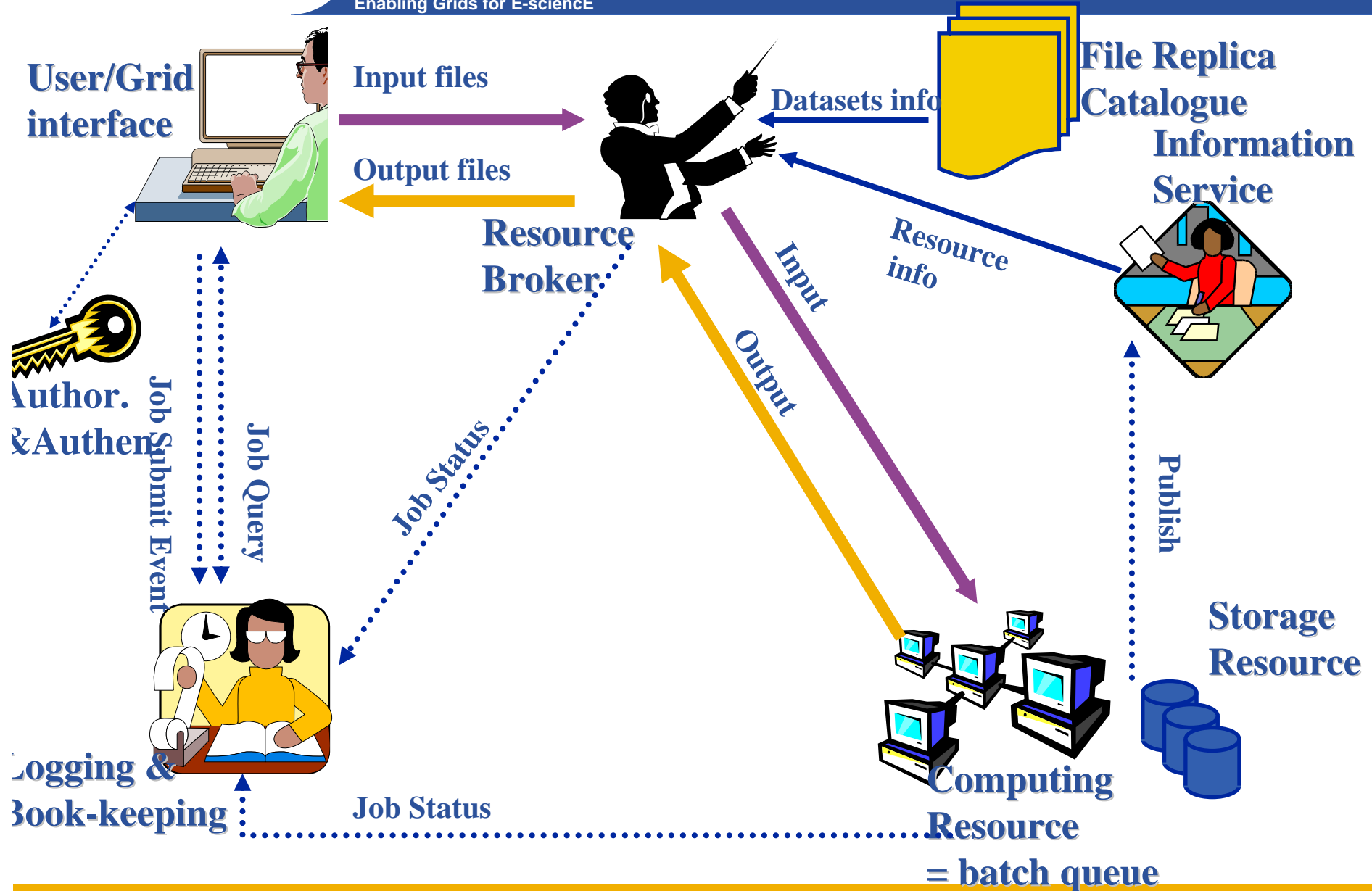
**Information System**: Characteristics and status of resources



**Computing Element (CE)**: A batch queue on a site's computers where the user's job is executed



**Storage Element (SE)**: provides (large-scale) storage for files



- Submit job to grid via the “resource broker (RB)”,
- `glite_job_submit my.jdl`  
Returns a “job-id” used to monitor job, retrieve output

## Example JDL file

```
Executable = "gridTest";
StdError = "stderr.log";
StdOutput = "stdout.log";
InputSandbox = {"/home/joda/test/gridTest"};
OutputSandbox = {"stderr.log", "stdout.log"};
InputData = "lfn:/grid/gilda/training/testbed0-00019";
DataAccessProtocol = "gridftp";
Requirements = other.Architecture=="INTEL" && \
               other.OpSys=="LINUX";
Rank = "other.GlueHostBenchmarkSF00";
```

# Who provides the resources?!

| <u>Service</u>                | <u>Provider</u>                           | <u>Note</u>   |
|-------------------------------|---|---|
| <u>Access service</u>         | User / institute/ VO / grid operations    | Computer with client software   |
| <u>Resource Broker (RB)</u>   | VO / grid operations                      | (No NGS-wide RB)  |
| <u>Information System:</u>    | ditto                                     |   |
| <u>Computing Element (CE)</u> | VO / sometimes centralised provision also | Scalability requires that VOs provide resources to match average need |
| <u>Storage Element (SE)</u>   | ditto                                     | ditto   |

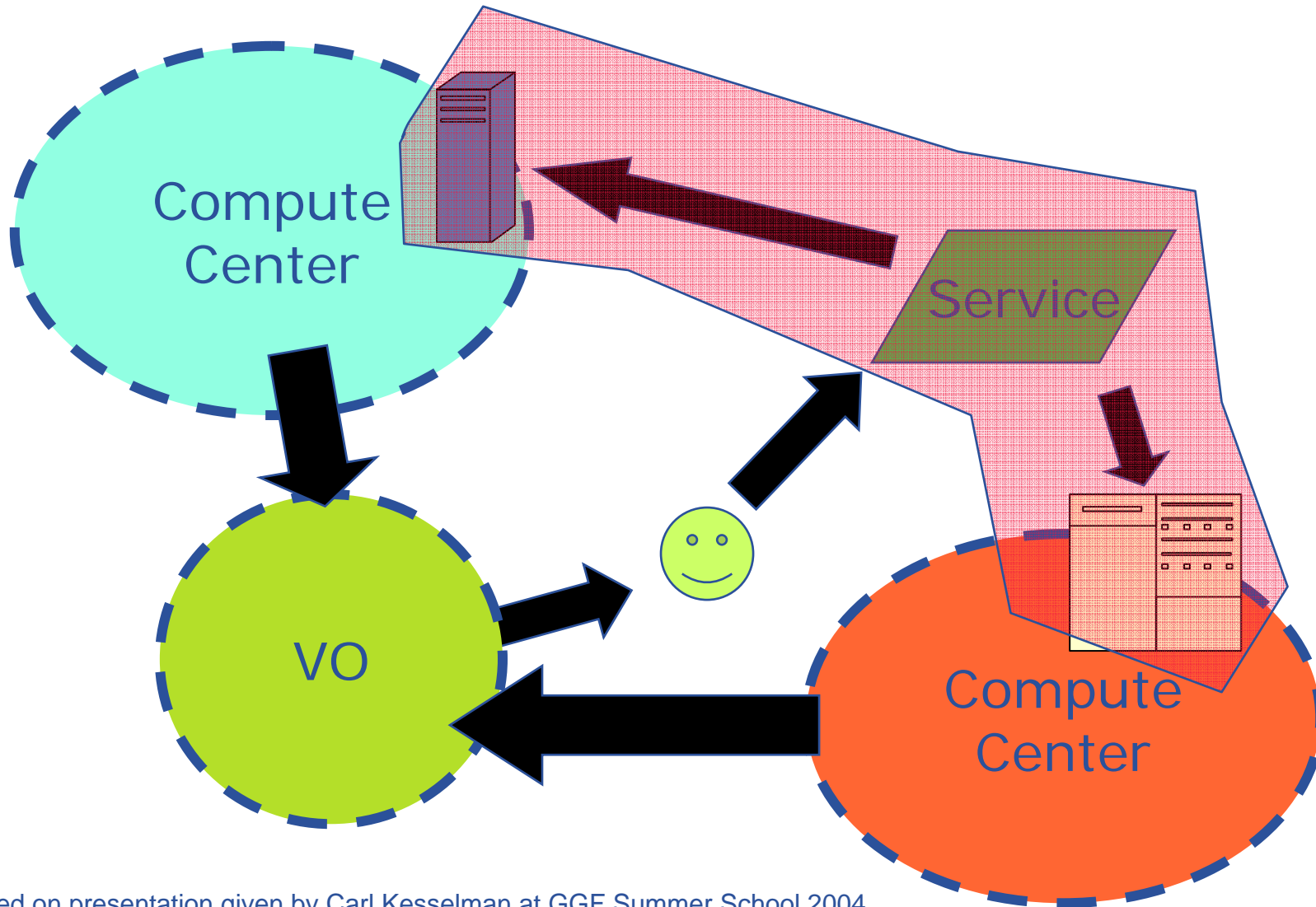
“VO”: virtual organisation

“Grid operations”: funded effort

- **VDT: Virtual Data Toolkit**
  - ensemble of grid middleware that can be easily installed and configured
  - Includes Globus Toolkit, Condor, MyProxy,...
  - Been used by EGEE

<http://vdt.cs.wisc.edu/>

- **Providers of resources (computers, databases,...) need risks to be controlled: they are asked to trust users they do not know**
- **User's need**
  - single sign-on: to be able to logon to a machine that can pass the user's identity to other resources
  - To trust owners of the resources they are using
- **Build middleware on layer providing:**
  - *Authentication*: know who wants to use resource
  - *Authorisation*: know what the user is allowed to do
  - *Security*: reduce vulnerability, e.g. from outside the firewall
  - *Non-repudiation*: knowing who did what
- **The “Grid Security Infrastructure” middleware is the basis of (most) production grids**



slide based on presentation given by Carl Kesselman at GGF Summer School 2004





# The National Grid Service

- The core UK grid, resulting from the UK's e-Science programme.
- Production use of computational and data grid resources.
- Supported by JISC

# NGS Facilities

- **Leeds and Oxford (core compute nodes)**
  - 64 dual CPU intel 3.06GHz (1MB cache). Each node: 2GB memory, 2x120GB disk, Redhat ES3.0. Gigabit Myrinet connection. 2TB data server.
- **Manchester and Rutherford Appleton Laboratory (core data nodes)**
  - 20 dual CPU (as above). 18TB SAN.
- **Bristol**
  - initially 20 2.3GHz Athlon processors in 10 dual CPU nodes.
- **Cardiff**
  - 1000 hrs/week on a SGI Origin system comprising 4 dual CPU Origin 300 servers with a Myrinet™ interconnect.
- **Lancaster**
  - 8 Sun Blade 1000 execution nodes, each with dual UltraSPARC IIIc processors connected via a Dell 1750 head node.
- **Westminster**
  - 32 Sun V60 compute nodes
- **HPCx**
  - ...

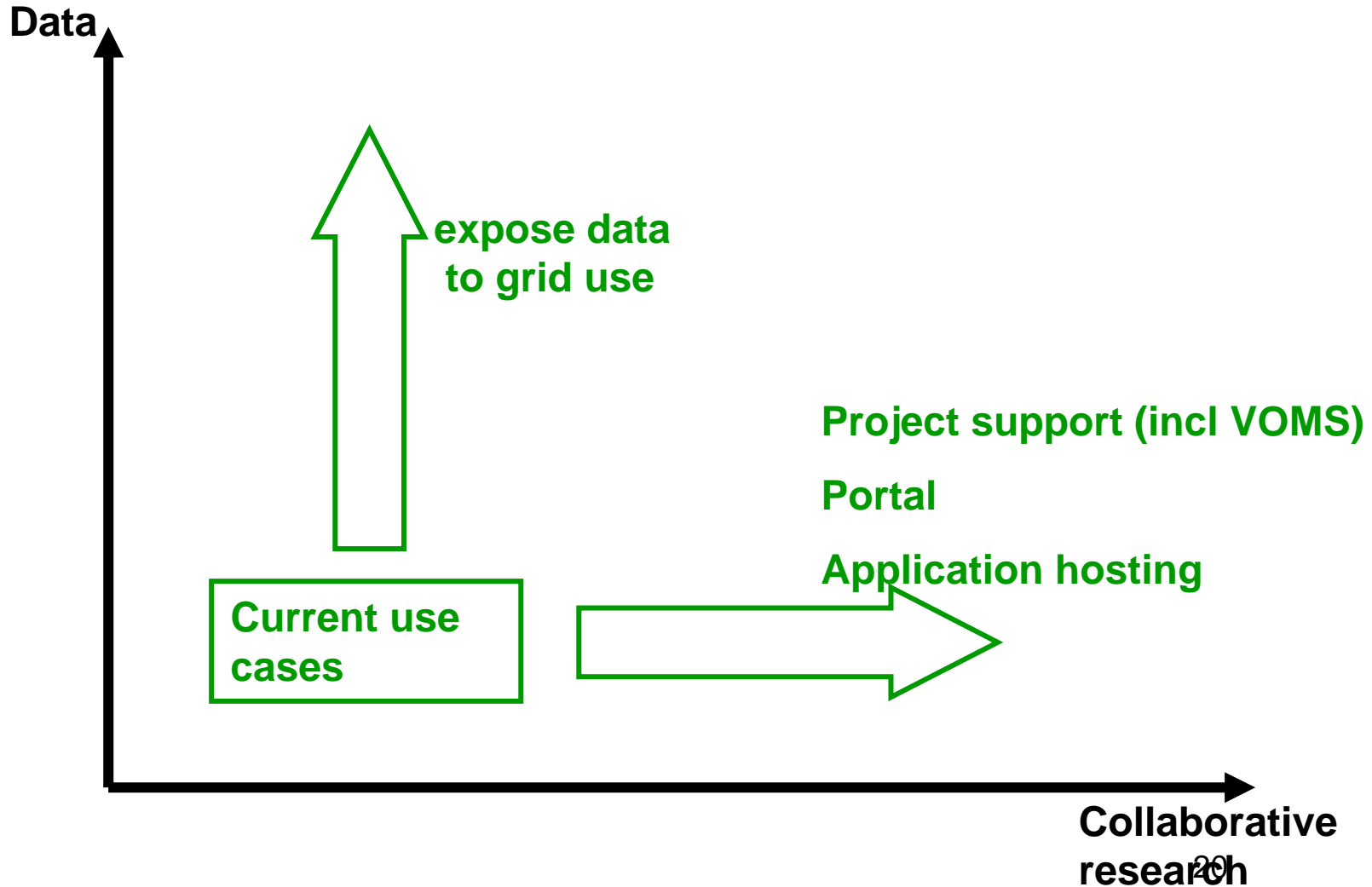
For more details: <http://www.ngs.ac.uk/resources.html>

# NGS software

- **Computation services** based on **Globus Toolkit**
  - Use compute nodes for sequential or parallel jobs, primarily from batch queues
  - Can run multiple jobs concurrently (be reasonable!)
- **Data services:**
  - **Later talk**



# UK National Grid Service





# NGS – The Future

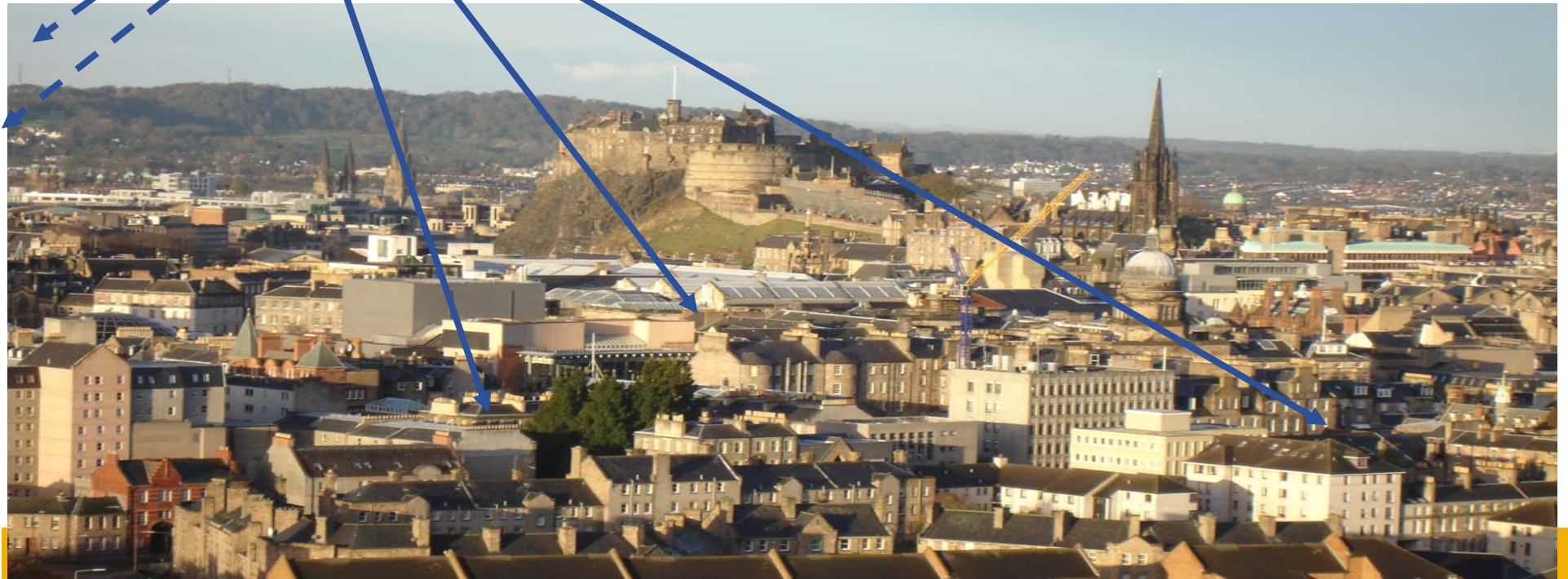
- Middleware recently deployed
  - Portal v2
  - GridSAM – alternative job submission and monitoring
- Being deployed
  - VOMS
- Under development
  - Shibboleth integration

# Campus “grids”

**Often-idle processors!!**

**Analyses constrained by CPU time!**

**Teaching labs. +  
Researchers**



- Teaching lab machines lie idle for most of the time
- Harvest spare compute cycles to create a low-cost “high throughput computing” (HTC) platform
  - Goal: run many tasks in a week, month, ...
  - Typically: many similar tasks invoked from workflow or a script
    - Monte-Carlo
    - Simulation – parameter sweeps
- Pool of processors are a **batch processing resource**
- Condor most common approach
  - <http://www.cs.wisc.edu/condor/>
- Job is described in a text file
- “Match-maker” selects appropriate resource

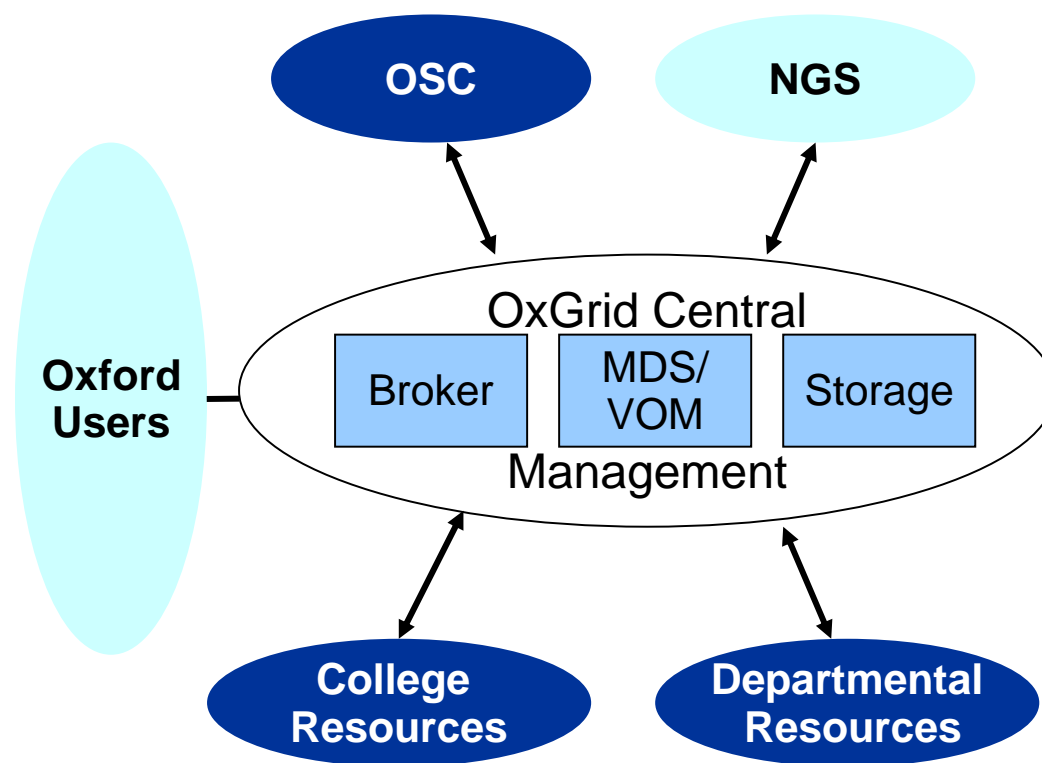


- Resources in many administrative domains
- Need basic services that provide:
  - **Authentication, Authorisation** mechanisms
    - Based on certificates
    - Single sign-on to access many resources
    - Control of who can do what
  - **Job submission** services
    - Submit jobs to batch queues on clusters or Condor pools
  - **Information systems**
    - So you know what can be used
  - **Ability to share data**

- **Condor** <http://www.cs.wisc.edu/condor/>
  - Harvest compute cycles
- **Globus toolkit** <http://www.globus.org/>
  - Tools built on Grid Security Infrastructure and include:
    - **Job submission**: run a job on a remote computer
    - **Information services**: So I know which computer to use
    - ...
- **Storage Resource Broker** <http://www.sdsc.edu/srb/>
  - **Sharing of files** held in SRB vaults in multiple locations
- **SRB and Globus Toolkit are part of the National Grid Service stack**

# Example: OxGrid, a University Campus Grid

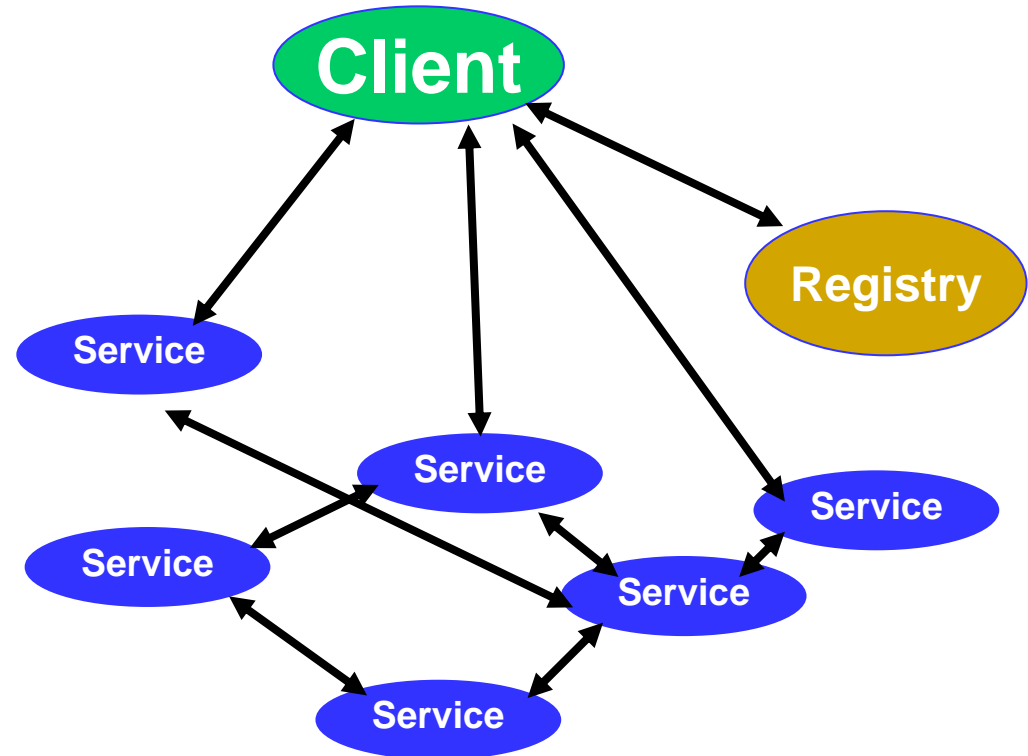
- Single entry point for Oxford users to shared and dedicated resources
- Seamless access to National Grid Service and Oxford Supercomputing Centre for registered users
- Single sign-on using PKI technology integrated with current methods



David Wallom

# Service oriented middleware

- Accessible across a network
- Loosely coupled, defined by the messages they receive / send
- Interoperable: each service has a description that is accessible and can be used to create software to invoke that service
- Based on standards (for which tools do / could exist)
- Developed in anticipation of new uses



## Web Services

## Grid Technology

- Commerce
- Standards
- Tools

## Grid Services

- Research driven
  - Data-intensive
  - Compute intensive
  - Collaboration – sharing of resources
- Trust:  
opening resources

infrastructure for the information society

## Web Services

- Short-lived Interactions
- Call-return interaction

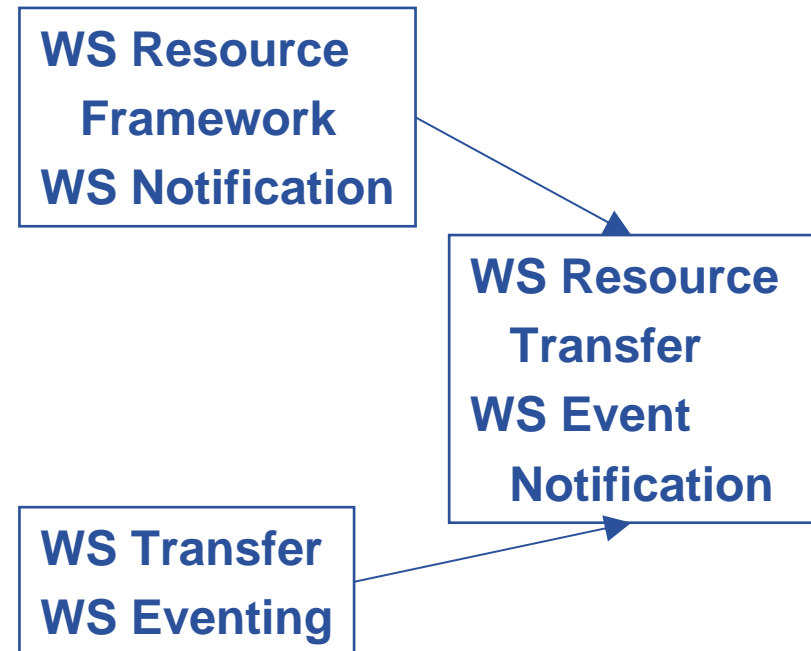
## Grids

- Persistence –
  - Infrastructure
  - Computation
  - Data
  - People
- also, Event-driven interactions

Need to add to basic web services the notion of persistency

**STATEFUL SERVICES**

- **Resource**
  - Existence
    - creation
    - identifier
    - deletion
    - lifetime
  - Resource Properties – state elements
    - XML representation
    - get
    - put
    - partial get
    - partial put
- **Event Driven**
  - Subscribe to a topic
    - itself a resource
  - Notify a topic-relevant event





- **Widely used middleware:**
  - Grid Security Infrastructure:
    - Authorisation and authentication underpins it all
  - Compute services
    - Condor – cycle harvesting from pools of processors
    - Globus – job submission across administrative domains
  - Data services
    - Growth area !!
  - “Higher level services” built on these
    - Portals,...
- **Service orientation**
  - Basis of emerging standards built on web services

- **Open Grid Forum** <http://www.gridforum.org/>
- **Globus Alliance** <http://www.globus.org/>
- **VDT** <http://www.cs.wisc.edu/vdt/>
- **Grid Today** <http://www.gridtoday.com/>
- **The Grid Cafe** [www.gridcafe.org](http://www.gridcafe.org)

- **EGEE Conference: 25-29 September 2006**  
<http://www.eu-egee.org/news/registration-open-for-egee201906-conference-September-2006-geneva/>
- **EGEE digital library:** <http://egee.lib.ed.ac.uk/>
- **EGEE** [www.eu-egee.org](http://www.eu-egee.org)
- **EGEE: 1<sup>st</sup> user Forum**  
<http://egee-intranet.web.cern.ch/egee-intranet/User-Forum>
- **gLite** <http://www.glite.org/>



# NGS Web Sites

- NGS
  - <http://www.ngs.ac.uk>
  - To see what's happening: <http://ganglia.ngs.rl.ac.uk/>
  - New wiki service: <http://wiki.ngs.ac.uk>
  - Training events: <http://www.nesc.ac.uk/training>
  
- HPCx
  - <http://www.hpcx.ac.uk>