gLite
Application Developers Course

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Information Society

Application development for the EGEE grid

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Definition

What is a grid application?

Software that interacts with grid services to achieve requirements that are specific to a particular VO or user.

Goals of this session

- This talk maps the landscape – a high-level view of application development in Grids
- Practicals will explore specific features in that landscape

Contents

- What are grids for??
- Types of Grid applications
- Challenges to researchers who write applications
- More about gLite Services
- Overview of the rest of the afternoon

What are grids for?

Collaborative
"virtual computing"

Sharing data, computers, software
Enabled by Grids:
National, regional,
International: EGEE grid

Improvised cooperation

Email
File exchange
ssh access to run programs
Enabled by networks:
national, regional and
International: GEANT

People with shared goals

Grids: a foundation for e-Research

- Enabling a whole-system approach
- A challenge to the imagination
- Effect > Σparts

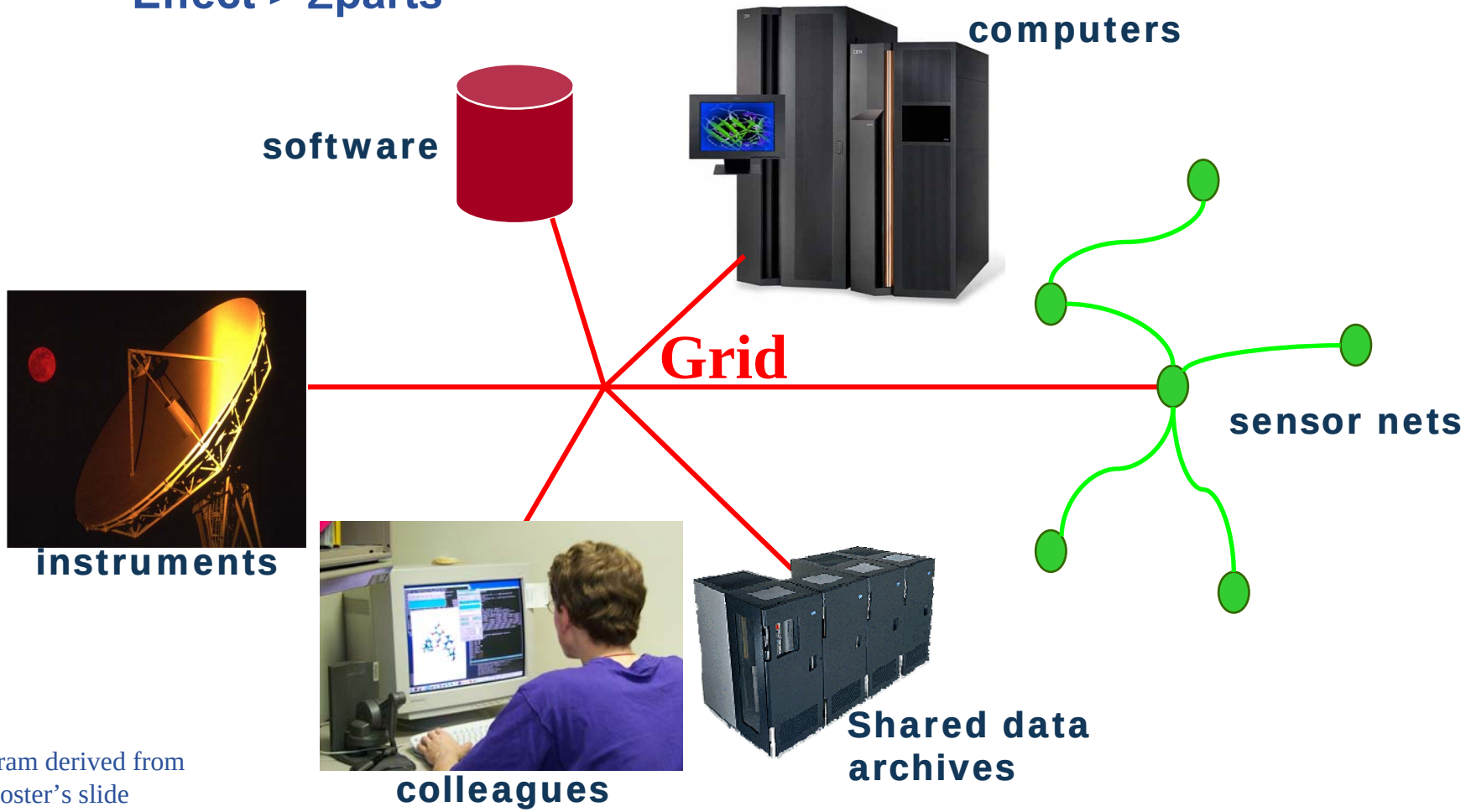
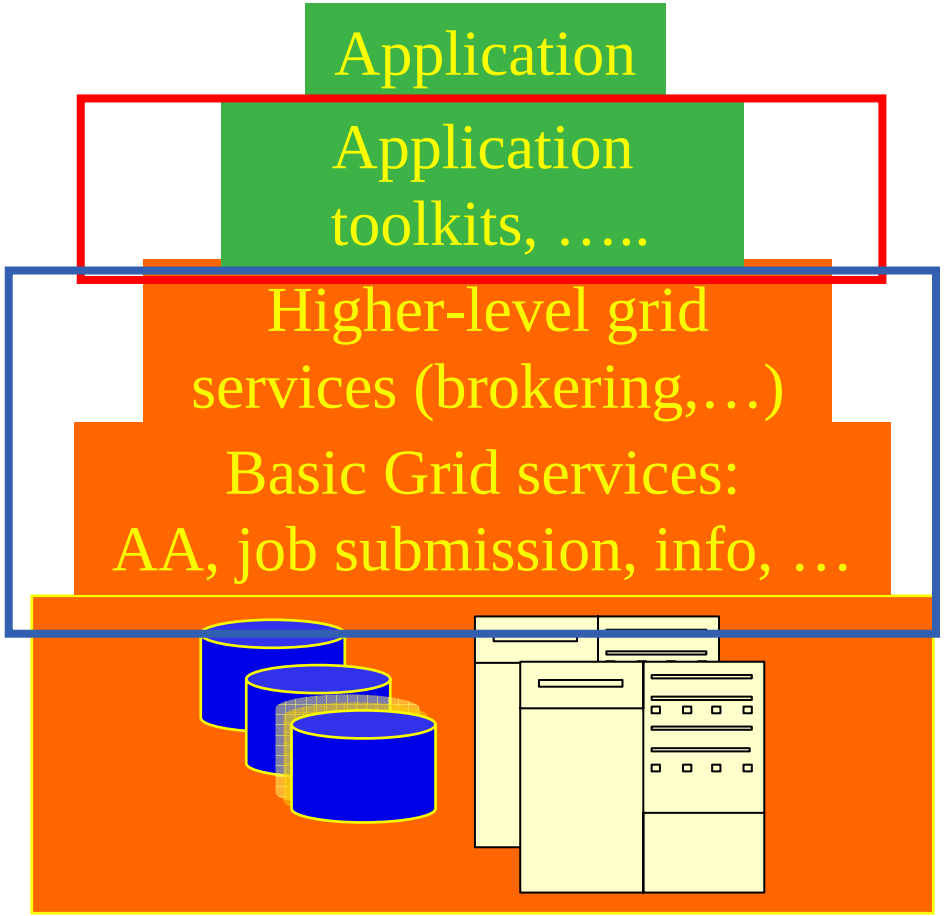


Diagram derived from Ian Foster's slide

"Effect > Σparts"

- **Flexible orchestration of resources available to a Virtual Organisation (VO)**
  - Across administrative domains
  - Abstractions hide detail of individual resources
    - Conform to Grid's procedures to gain benefit
  - Decoupled provision of resources and their use
  - Additional benefits from
    - Operations services (people and software)
    - Engagement in diverse e-research communities
- **Increased utilisation of resources**
  - Within a VO
  - Between VOs – EGEE, …
    - Each VO can benefit from
      - *Heterogeneity*
      - *Scale*

The vital layer



Where computer science meets the application communities!

VO-specific 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.

Types of grid applications

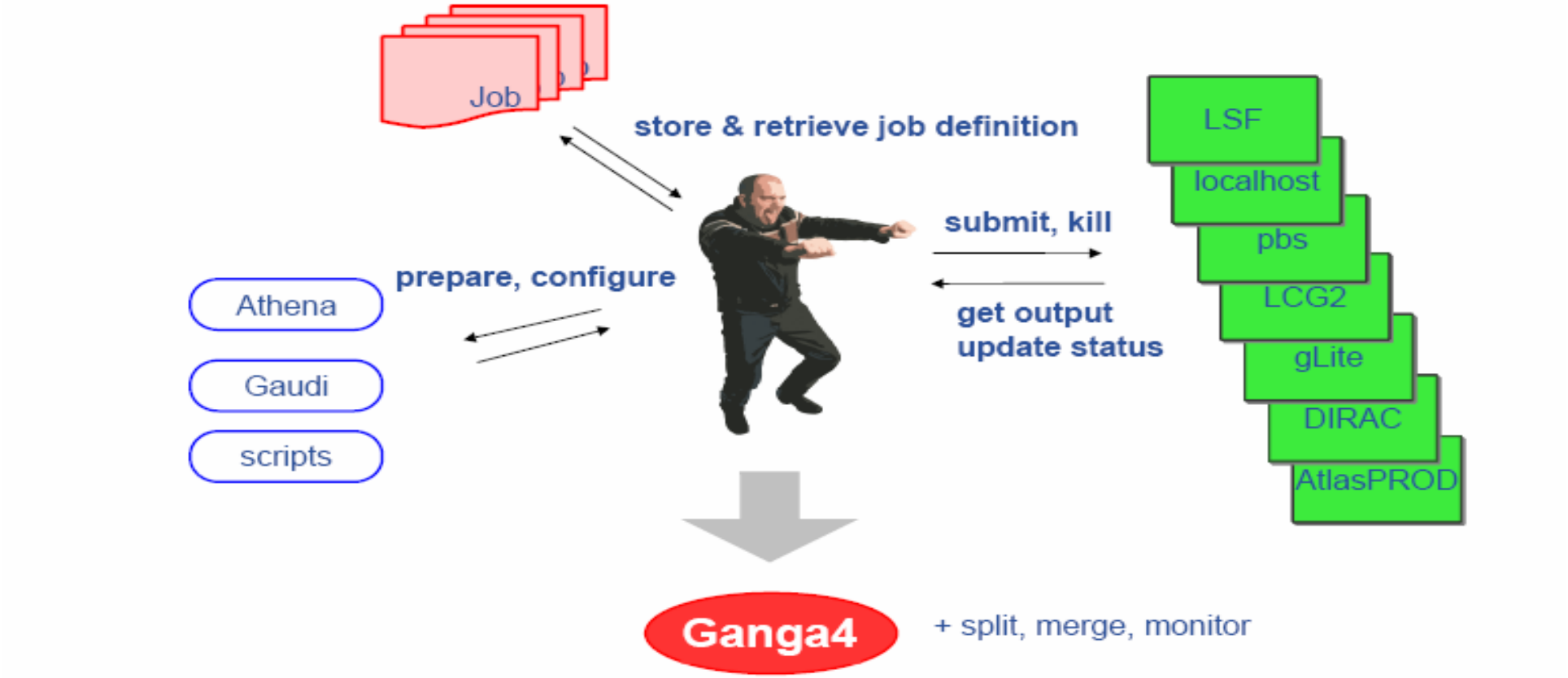
Types of grid applications

1. **Simple jobs – submitted to WMS to run in batch mode**
2. **Job invokes grid services**
   - To read & write files on SE
   - Monitoring
   - For outbound connectivity (interactive jobs)
   - To manage metadata
   - …
3. **Complex jobs**
   - An environment controls multiple jobs on users' behalf
     - High-level services
     - Portals with workflow – e.g. P-GRADE
     - Software written for the VO (or by the user)
     - …

Invocation of applications

- **From the UI**
  - Command Line Interfaces / Scripts
  - APIs
  - Higher level tools
- **From desktop Windows applications**
  - Use Grids without awareness of them!
  - But gLite not (yet) supporting Windows
- **From portals**
  - For recurring tasks: “core grid services” as well as application layer
  - Accessible from any browser
  - Tailored to applications
  - In EGEE: P-GRADE and GENIUS

Example of higher-level tools -1: GANGA

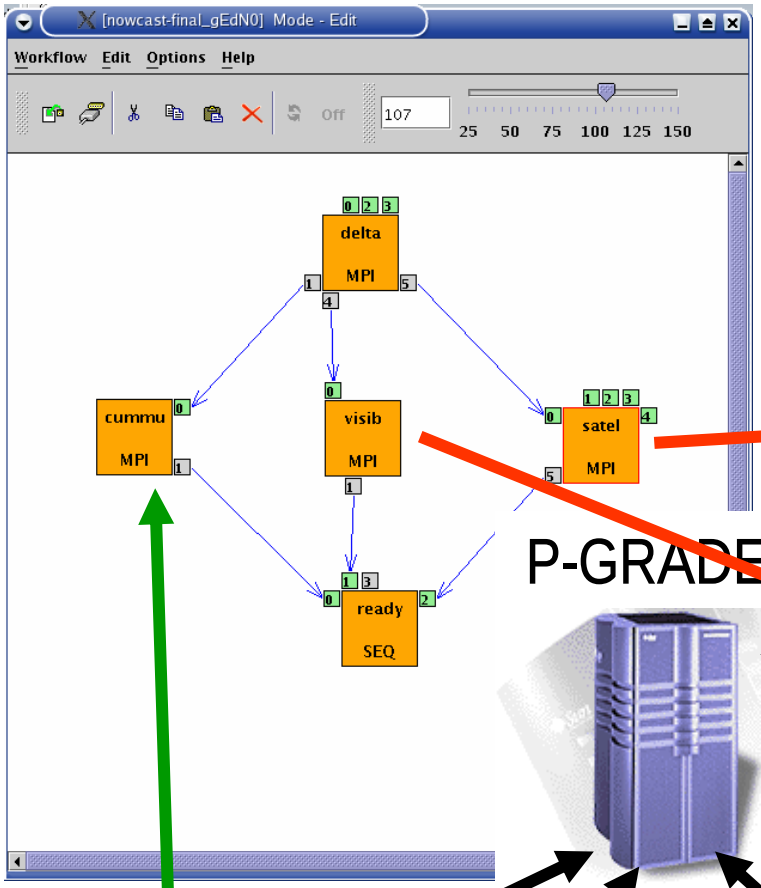


- **Ganga is a lightweight user tool**
  ganga.web.cern.ch/
- **But also: Ganga is a developer framework**

GENIUS

- **For many application communities**
  - Interface can be tailored for specific requirements
- **For demonstration purposes**
  - https://glite-demo.ct.infn.it/
    - Available for anyone to use
  - https://glite-tutor.ct.infn.it/
    - Fuller functionality for users who have stored long-lived proxy in MyProxy server

Multi-Grid P-GRADE Portal



Different jobs of a workflow can be executed in different grids

EGEE Grid
e.g. VOCE

P-GRADE-Portal

The portal can be connected to multiple grids

UK NGS

London

Rome

Athens

Characteristics of VOs

- **What is being shared?**
  - resources of storage and/or compute cycles
  - software and/or data

- **Developers and users**
  - Some VOs have distinct groups of developers and users…
    - Biomedical applications used by clinicians,….
  - …. Some don't
    - Physics application developers who share data but write own analyses
  - Effect: need to
    - hide complexity from the 1st type of VOs…. E.g. AA
    - expose functionality to 2nd type of VOs

Different Goals for App. Development

- **I need resources for my research**
  - I need richer functionality
    - MPI, parametric sweeps,…
    - Data and compute services together…
- **I provide an application for (y)our research**
  - How!?
    - Pre-install executables ?
    - Hosting environment?
    - Share data
    - Use it via portal?
- ***We* provide applications for (y)our research**
  - Also need:
    - Coordination of development
    - Standards
    - …

Engineering challenges increasing

Challenges to researchers who write grid applications

Challenges

- **Research software is often**
  - Created for one user : the developer
  - Familiarity makes it useable
  - Short-term goals: Used until papers are written and then discarded
- **Grid applications are often used**
  - by a VO
  - Without support from developer
  - In new contexts and workflows
- **Grid application developers are**
  - In a research environment
  - Yet their s/w must have:
    - Stability
    - Documentation
    - Useability
    - Extendability
  - i.e. Production quality

Need expertise in:

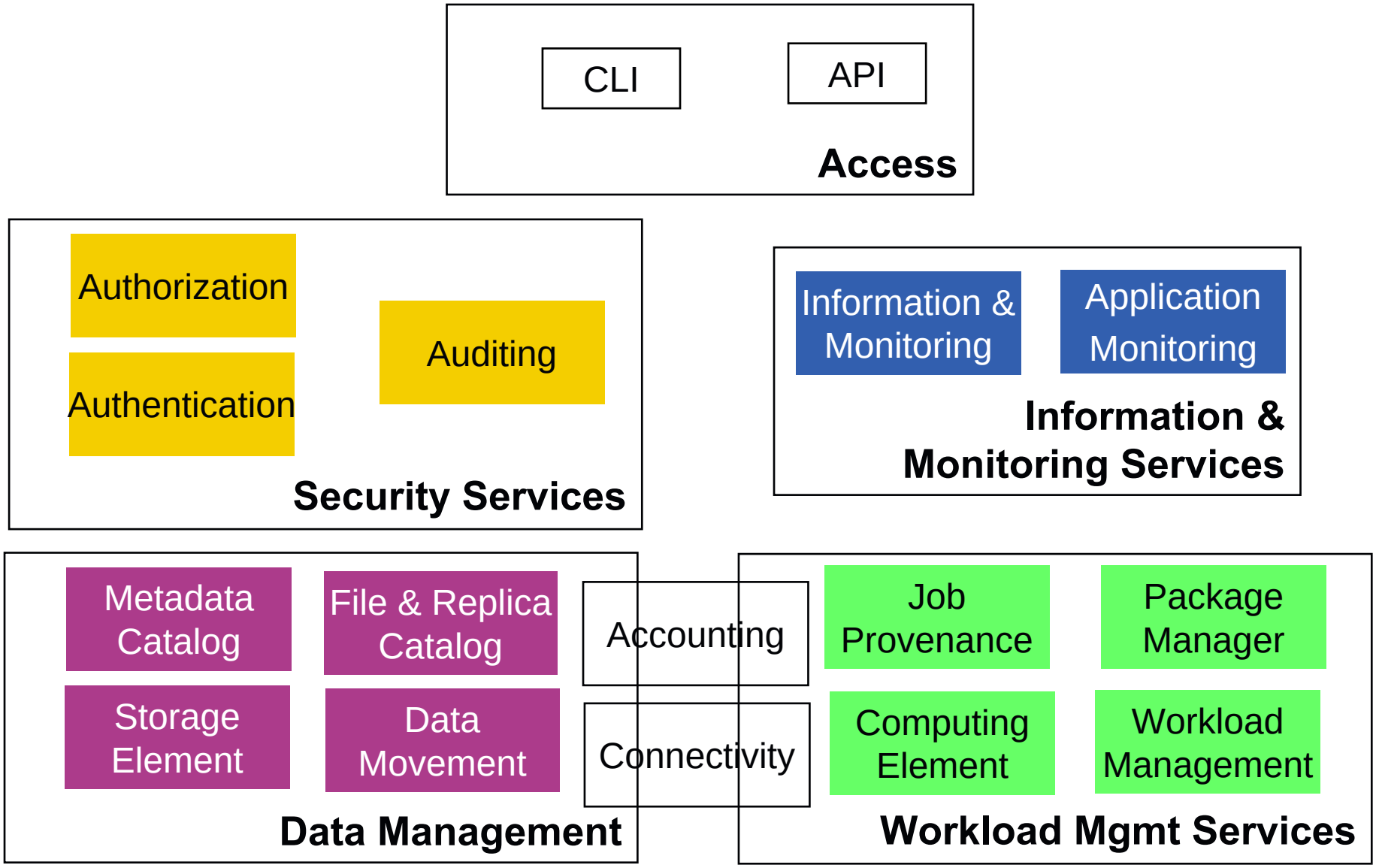
- **software engineering**
- **application domain**
- **grid computing**

Consequences

- **Team work!**
- **Engaged in world-wide initiatives – reuse don't make your own! Cross disciplines for solutions.**
- **From research to production software: ~5 times the effort.**
  - "80% of the time for last 10% of the functionality & reliability"
- **Standardisation is key**
  - For re-use, for dynamic configuration of services,..
  - Both for middleware and domain specific (e.g. GEON)
- **Need development process discipline!!**
  - Discipline = formal, staged, deliberate process
    - Waterfall? Rapid prototyping?
  - Need a deliberate approach: requirements engineering, design, implementation, validation, deployment
  - Need formalising, need deliberation because aiming for
    - Production quality, through teamwork, with distinct user community

More about gLite services

gLite Grid Middleware Services



More about gLite services

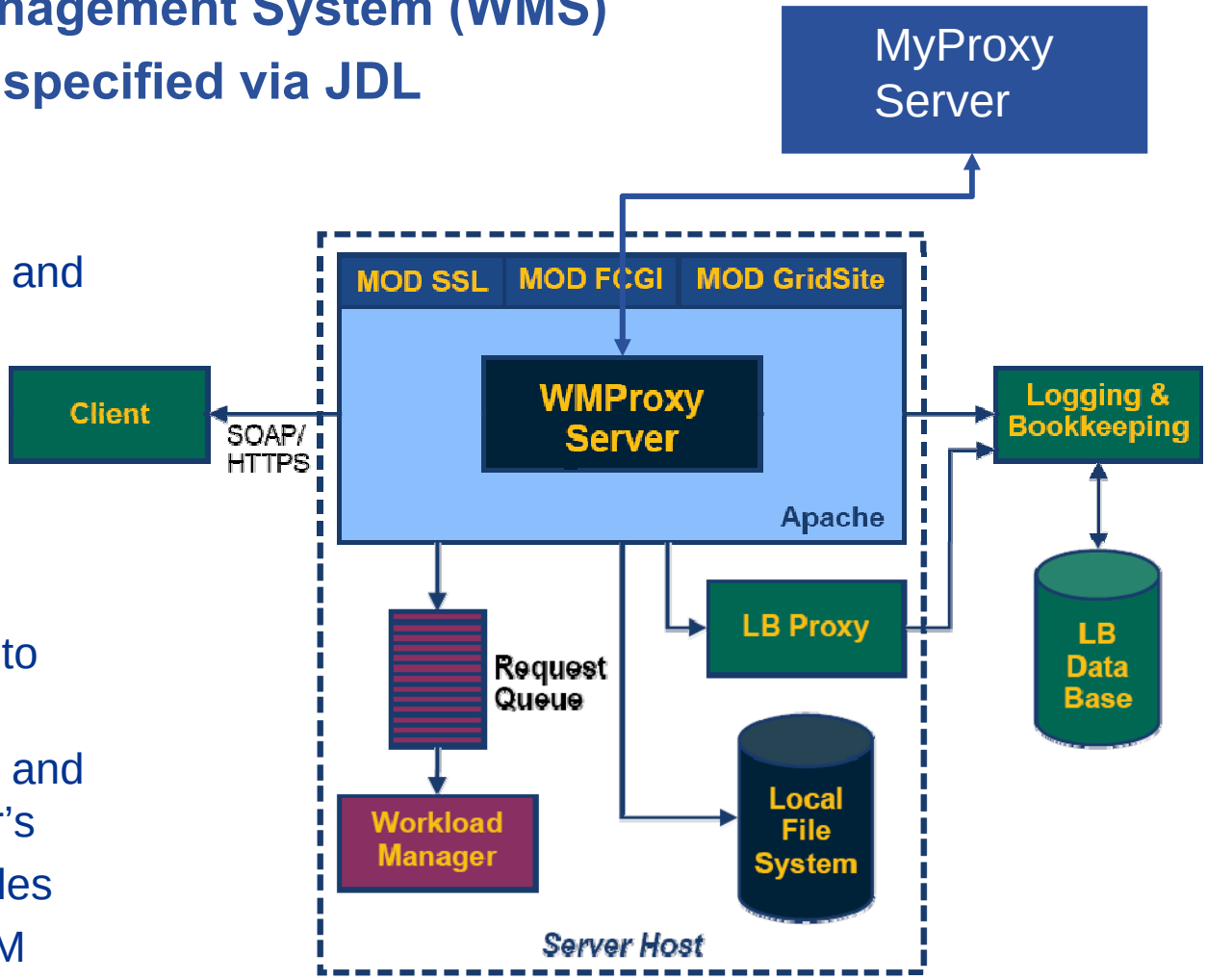
- **During this afternoon focus is on:**
  - New functionality in gLite 3.0 Workload Management
  - Integrating workload and data management
  - Accessing data on SEs
    - Can have massive files, too big to copy
    - How to access these?
  - Management of metadata
    - May have many thousands of files
    - Need to access and re-use based on characteristics… more than by their logical file names.
  - Monitoring of applications
    - May be running many long jobs
    - What's happening?!

Workload Management System

- **Helps the user accessing computing resources**
  - resource brokering
  - management of input and output
  - management of complex workflows
- **Support for MPI job even if the file system is not shared between CE and Worker Nodes (WN) – easy JDL extensions**
- **Web Service interface via WMProxy**

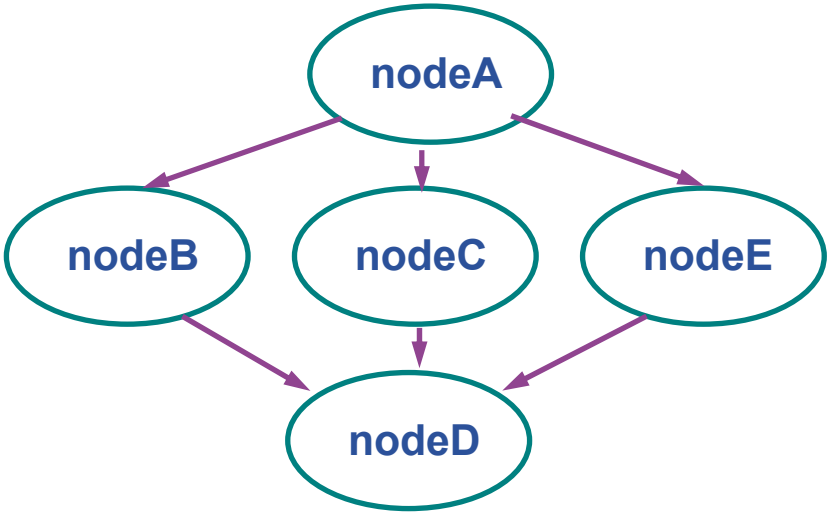
WMProxy

- **WMProxy is a SOAP Web service providing access to the Workload Management System (WMS)**
- **Job characteristics specified via JDL**
  - jobRegister
    - create id
    - map to local user and create job dir
    - register to L&B
    - return id to user
  - input files transfer
  - jobStart
    - register sub-jobs to L&B
    - map to local user and create sub-job dir's
    - unpack sub-job files
    - deliver jobs to WM



Complex Workflows

- **Direct Acyclic Graph (DAG) is a set of jobs where the input, output, or execution of one or more jobs depends on one or more other jobs**
- **A Collection is a group of jobs with no dependencies**
  - basically a collection of JDL's



- **A Parametric job is a job having one or more attributes in the JDL that vary their values according to parameters**
- **Using compound jobs it is possible to have one shot submission of a (possibly very large, up to thousands) group of jobs**
  - Submission time reduction
    - Single call to WMProxy server
    - Single Authentication and Authorization process
    - Sharing of files between jobs
  - Availability of both a single Job Id to manage the group as a whole and an Id for each single job in the group

WMProxy: users' view

- **glite-wms-job-submit will supercede glite-job-submit**
- **Its support for compound jobs will simplify application software**
  - WMProxy manages sub-jobs
  - Shared Input and Output "sandboxes"
- **MUST establish MyProxy delegation before this can be used!**
- **(Today we are not using WMProxy)**

Overview of practicals

Overview of the practicals

- **Previous gLite tutorial introduced basic services.**
- **Today: building more complex applications**
  - Use of script to submit multiple jobs
  - Coordinating Workload Management with Data Management
  - Parallelism using MPI
    - Within a CE – not across domains
  - Use of GFAL functions to access files on SEs
- **Use of AMGA: metadata service**
- **Use of R-GMA: monitoring service**

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