Distributed Aircraft
Maintenance Environment
DAME

Distributed Diagnostics on the Grid: DAME

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Project Partners

- EPSRC Funded, £3.2 Million, 3 years, commenced Jan 2002.
- UK pilot project for e-Science (£120 million programme)
- 4 Universities:
  - University of York, Dept of Computer Science
  - University of Sheffield, Dept of Automatic Control and Systems Engineering
  - University of Oxford, Dept of Engineering Science
  - University of Leeds, School of Computing and School of Mechanical Engineering
- Industrial Partners:
  - Rolls-Royce
  - Data Systems and Solutions
  - Cybula Ltd

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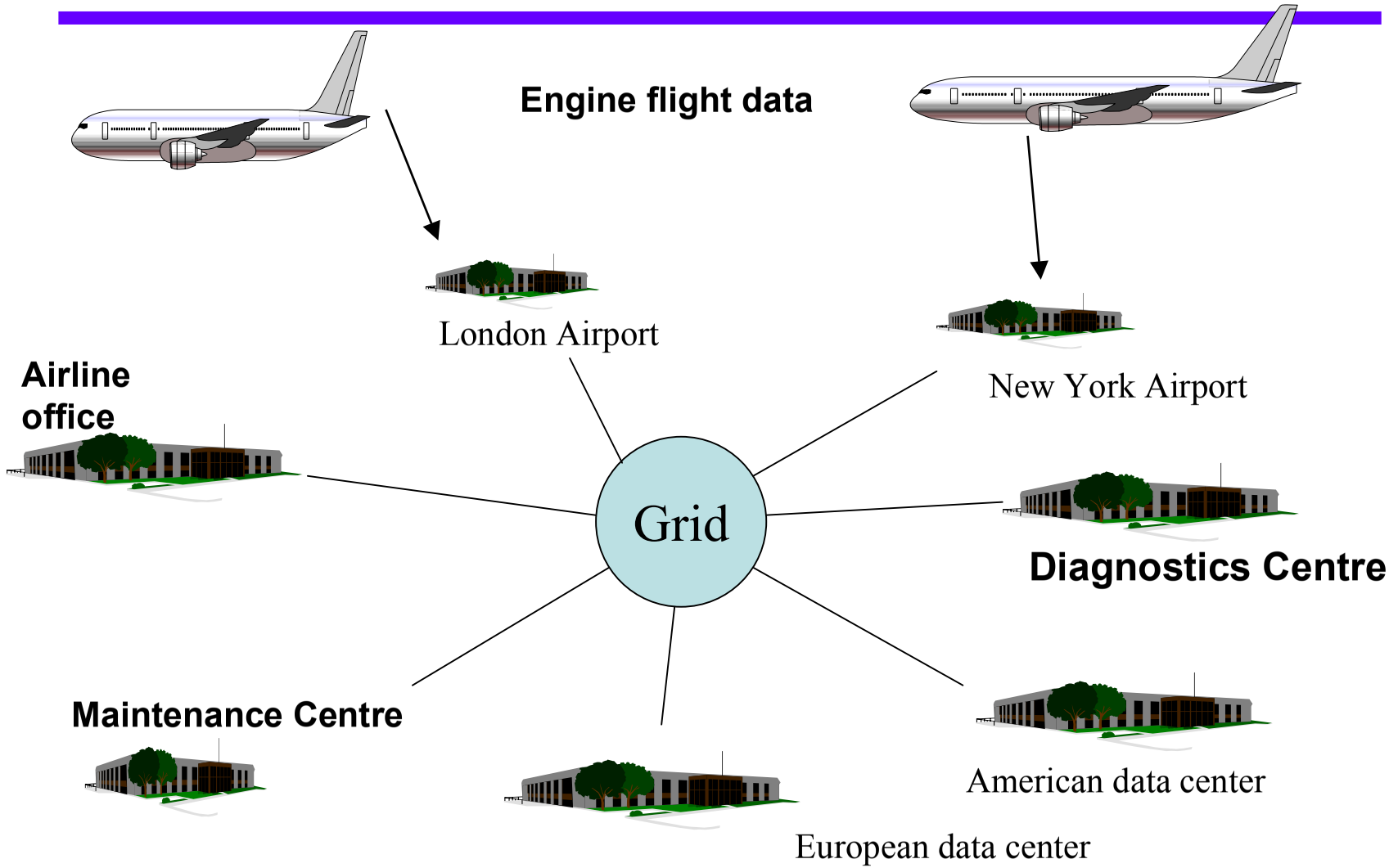
Operational Scenario

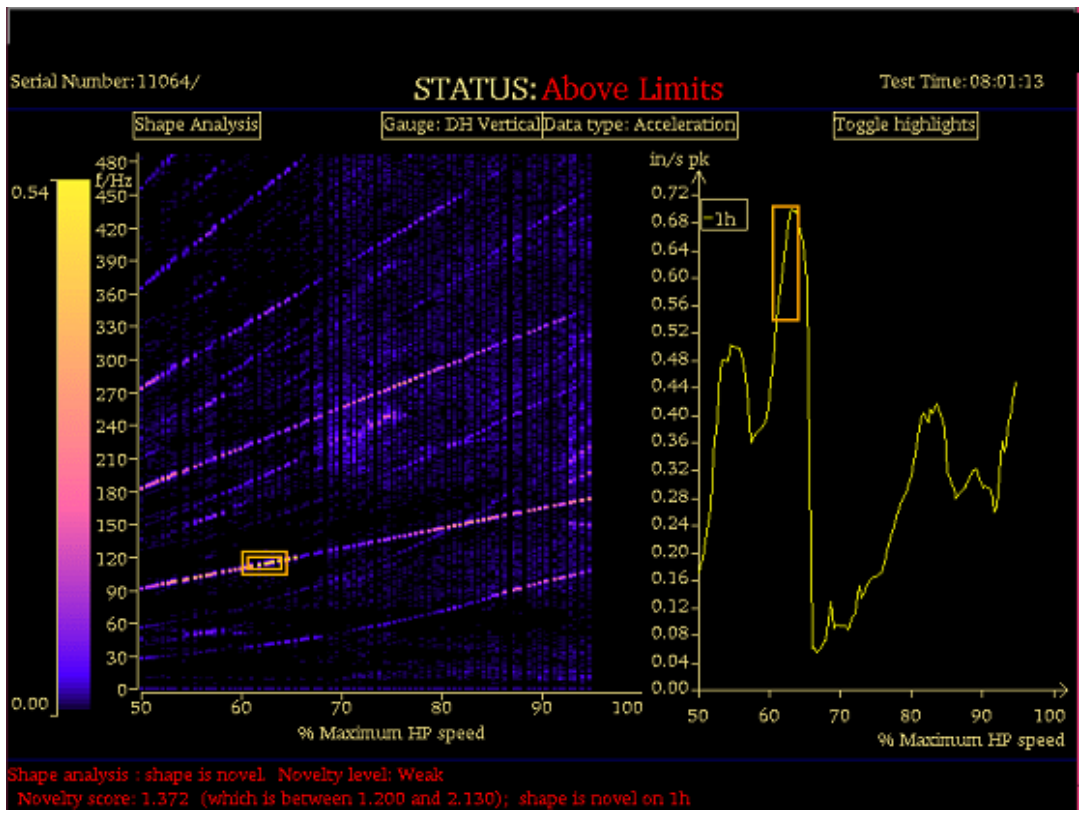


DAME Grid Challenges

- Building a demonstration system as proof of concept for Grid technology in the aerospace diagnostic domain.
- Two primary Grid challenges:
  - Management of large, distributed and heterogeneous data repositories;
  - Rapid data mining and analysis of fault data;
- Other key (commercial) issues:
  - Remote, secure access to flight data and other operational data and resources;
  - Management of distributed users and resources;
  - Quality of Service issues (and Service Level Agreements)

The Data

- Each flight could produce up to 1GB of vibration data
- This is archived in distributed data repositories (EDS)



Demonstrator Objectives

The DAME demonstration system will provide a diagnosis workbench (portal) which brings together a suite of analysis services via Grid technology;

- Provides access to a range of analysis tools for the engine diagnosis process
- Will act as central control point for automated workflows
- Manages issues of distributed diagnosis team and virtual organisations
- Manages issues of security and user roles.

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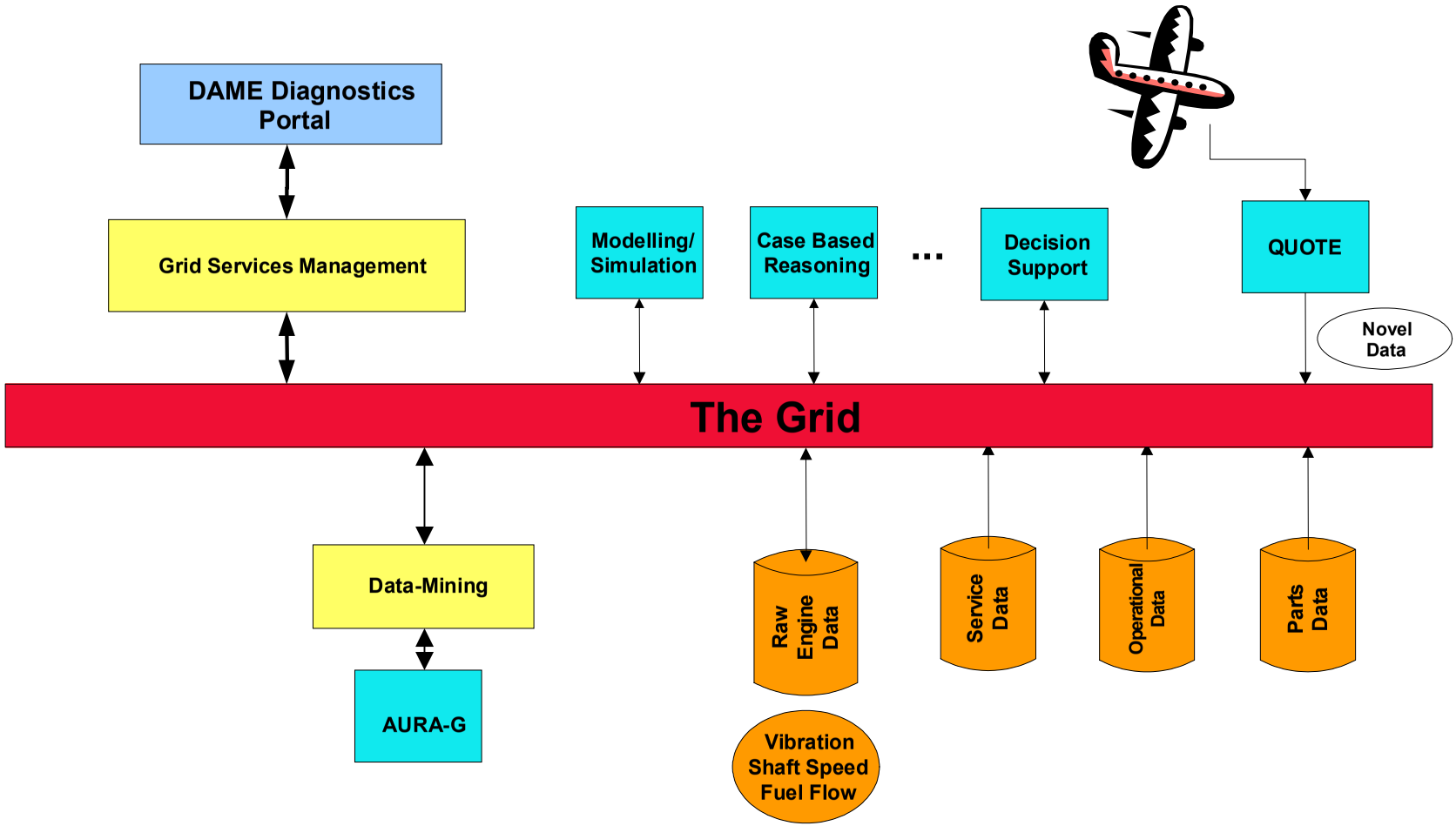
DAME Service Overview



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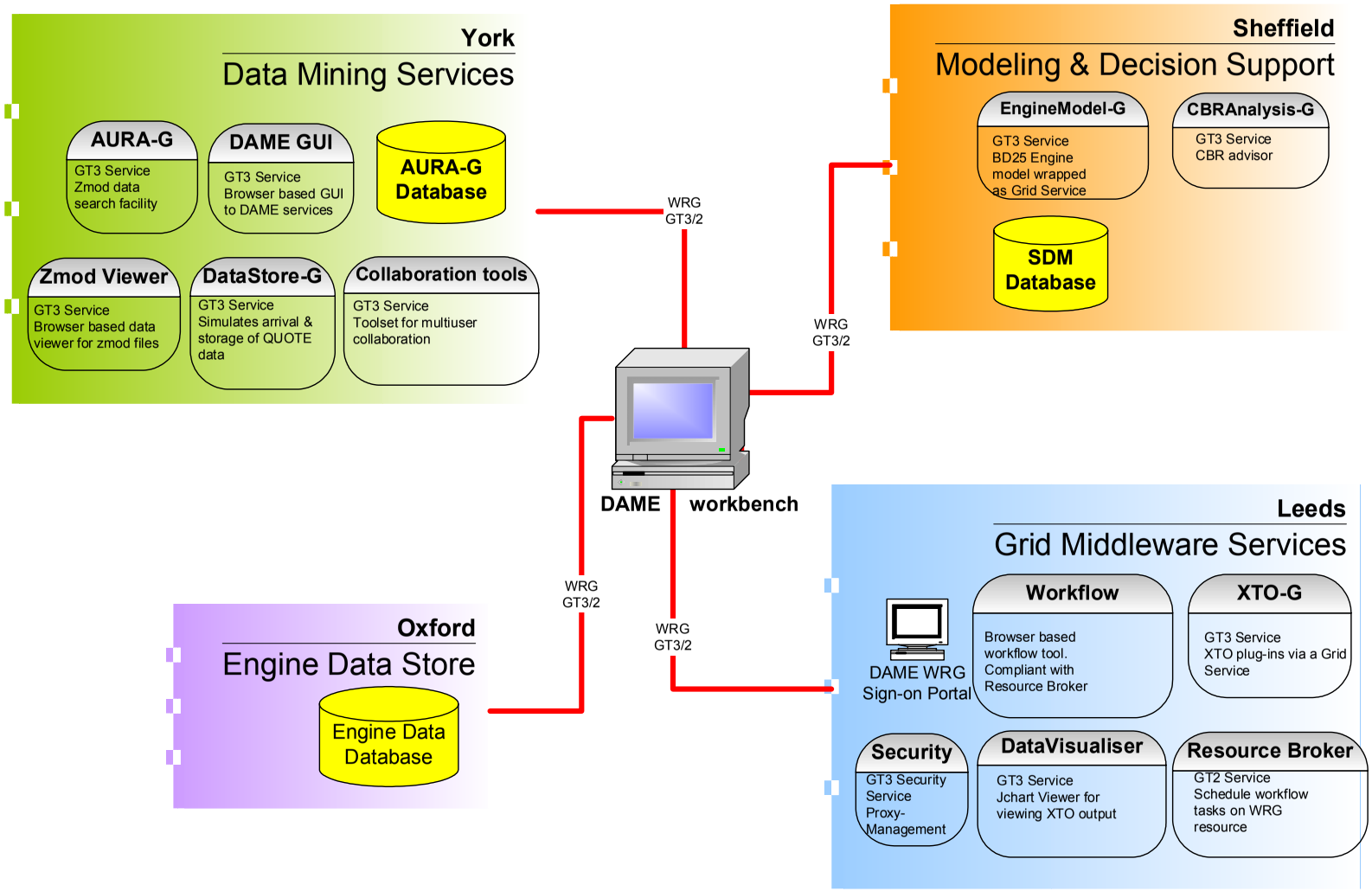
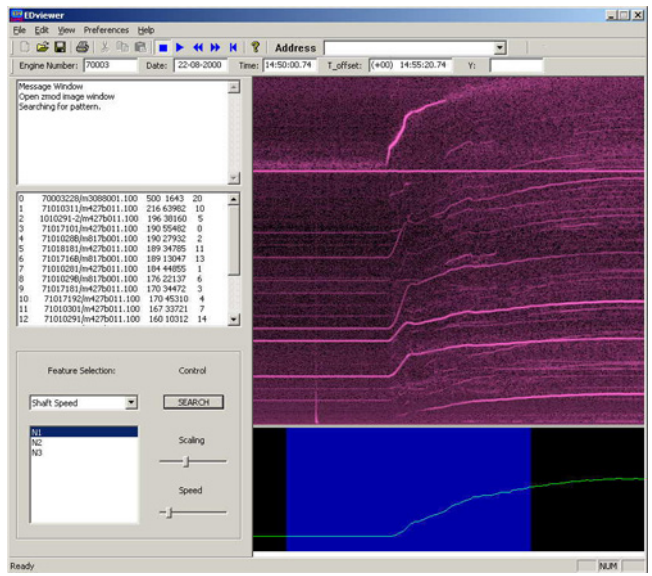
White Rose Grid Distribution

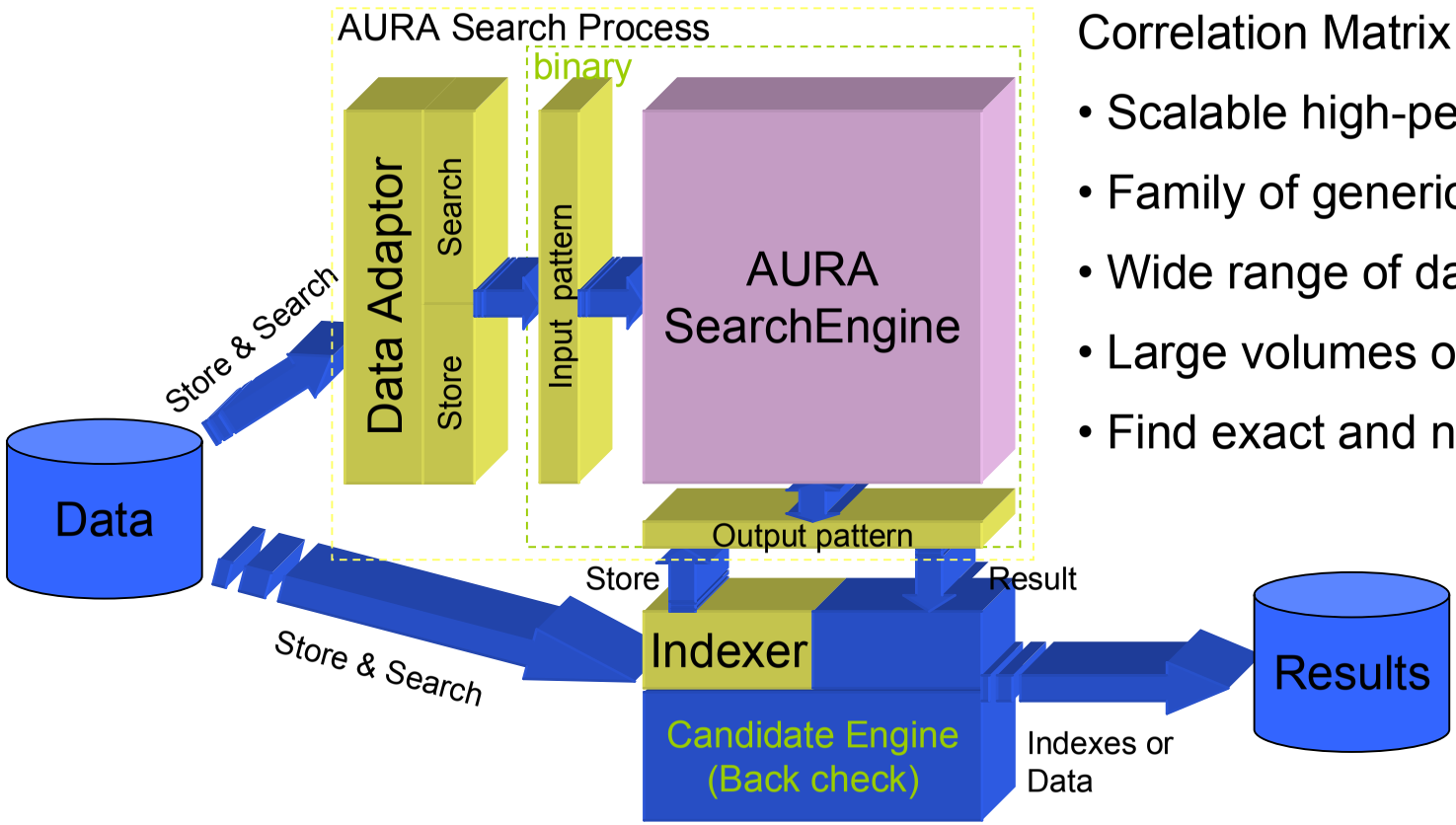


Data Mining Services

- The AURA correlation matrix technology is used for rapid pattern matching;
- Two-tier Grid Service architecture.
  - First tier hosts a generic AURA service
  - Second tier containing application specific code
- Clients interact directly with the second tier, allowing application developers to abstract away from the pattern match domain.



AURA Technology



Correlation Matrix Memory (CMM).

- Scalable high-performance.
- Family of generic techniques.
- Wide range of data types.
- Large volumes of data.
- Find exact and near-matches.

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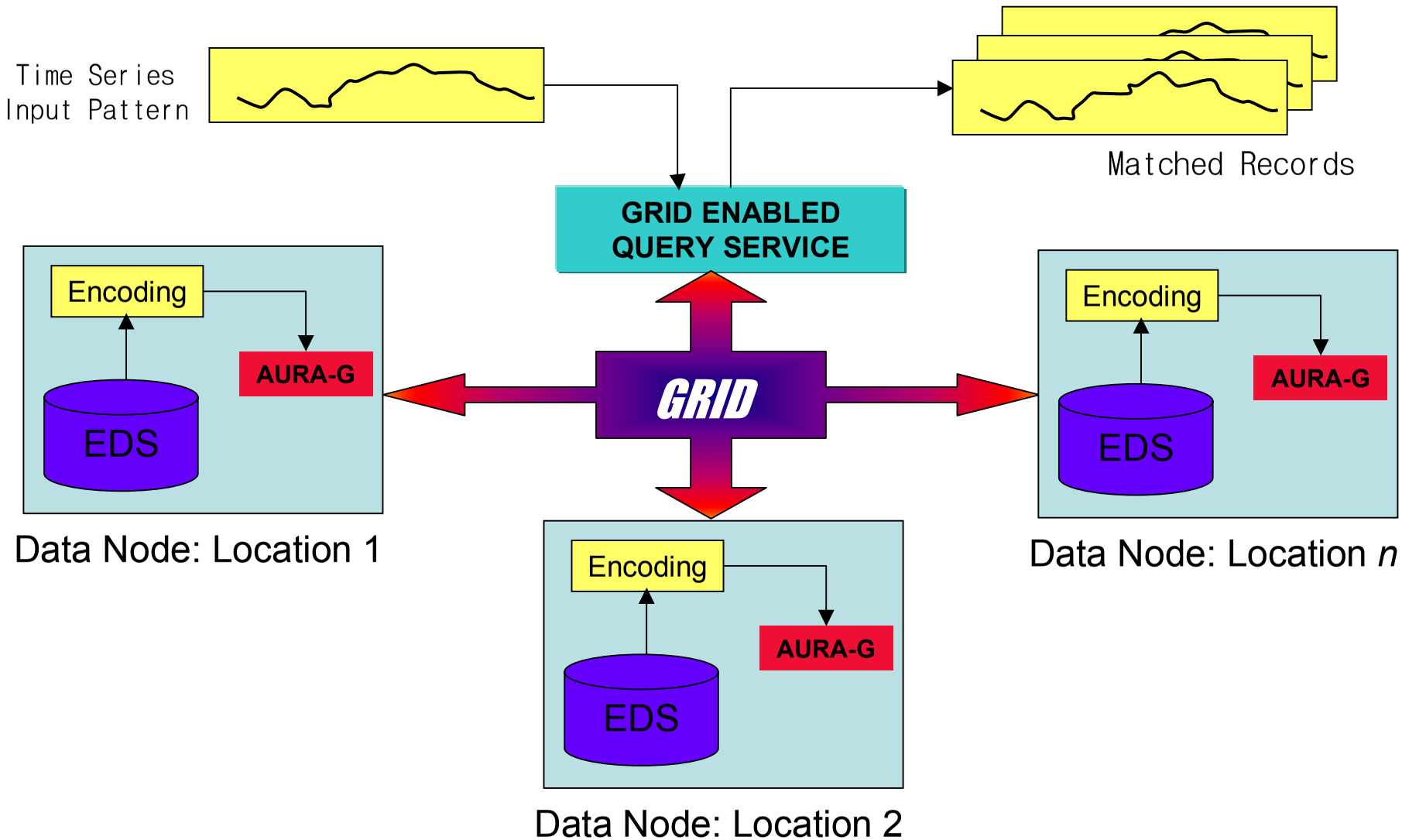
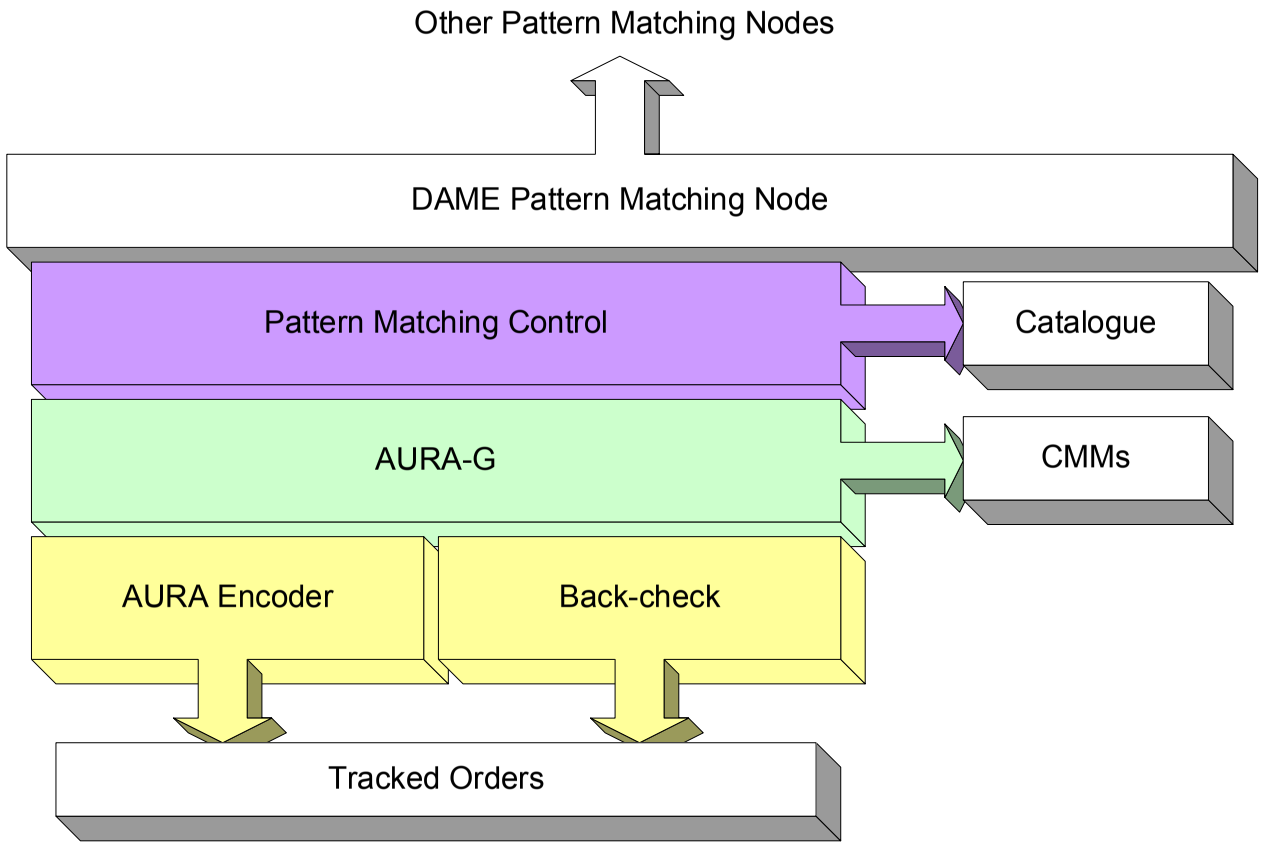
AURA Grid Deployment



Data Node Detail



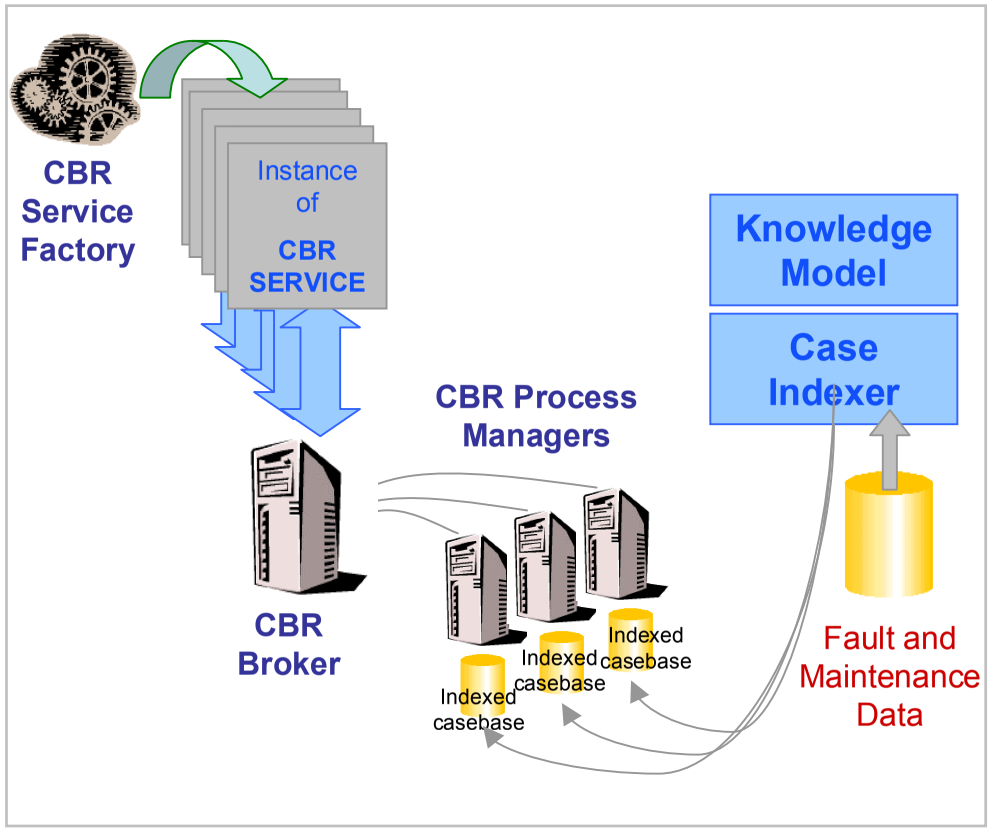
Case Based Reasoning

CBR service is provided via a Grid service interface to a commercial CBR package;

A *Service Factory* supports the creation of multiple CBR instances

- Permits many CBR processes to be executed in parallel from a single service access point

CBR provides decision support for fault ranking and workflow advice;



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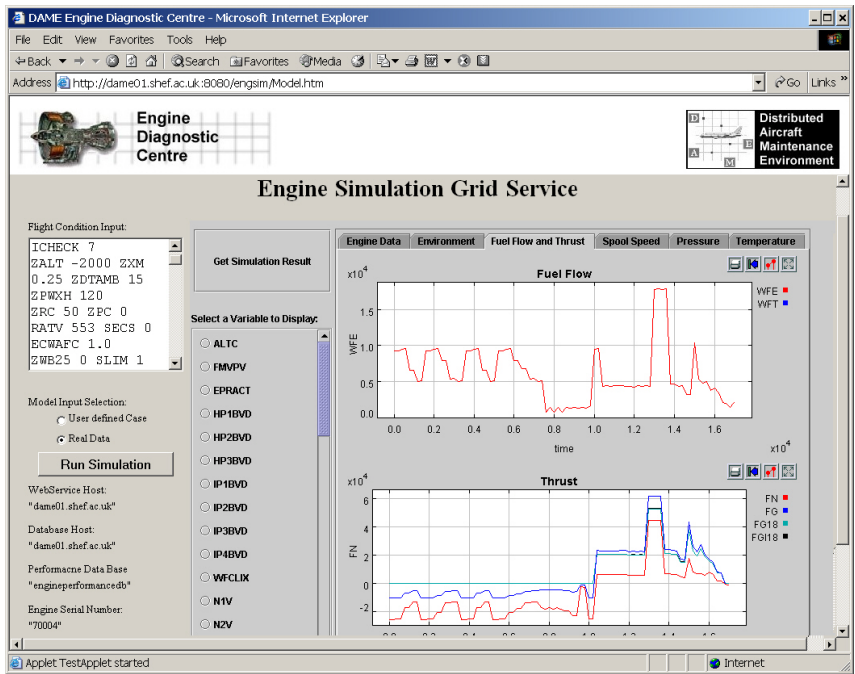
Engine Model Service

GSI enabled engine performance simulation for different flight operational conditions and requirements, e.g. Idle, Take-off, Climb

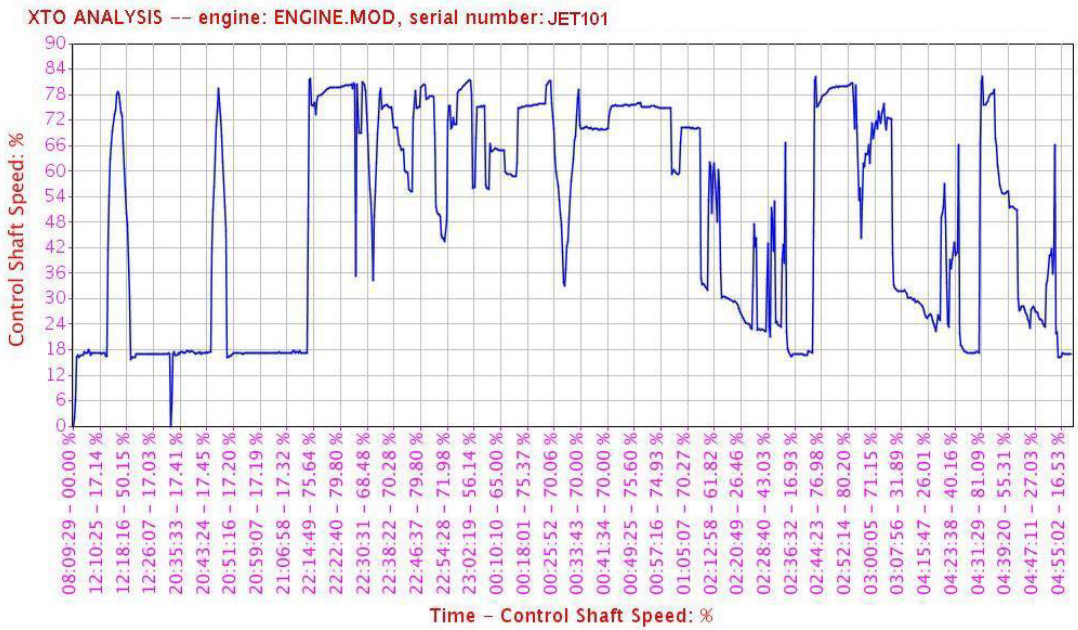
The Factory Service can generate a group of engine simulation instances for different client requirements.

Both Transport Level and Message Level Security are implemented to protect the secure sensitive engine model and user data.



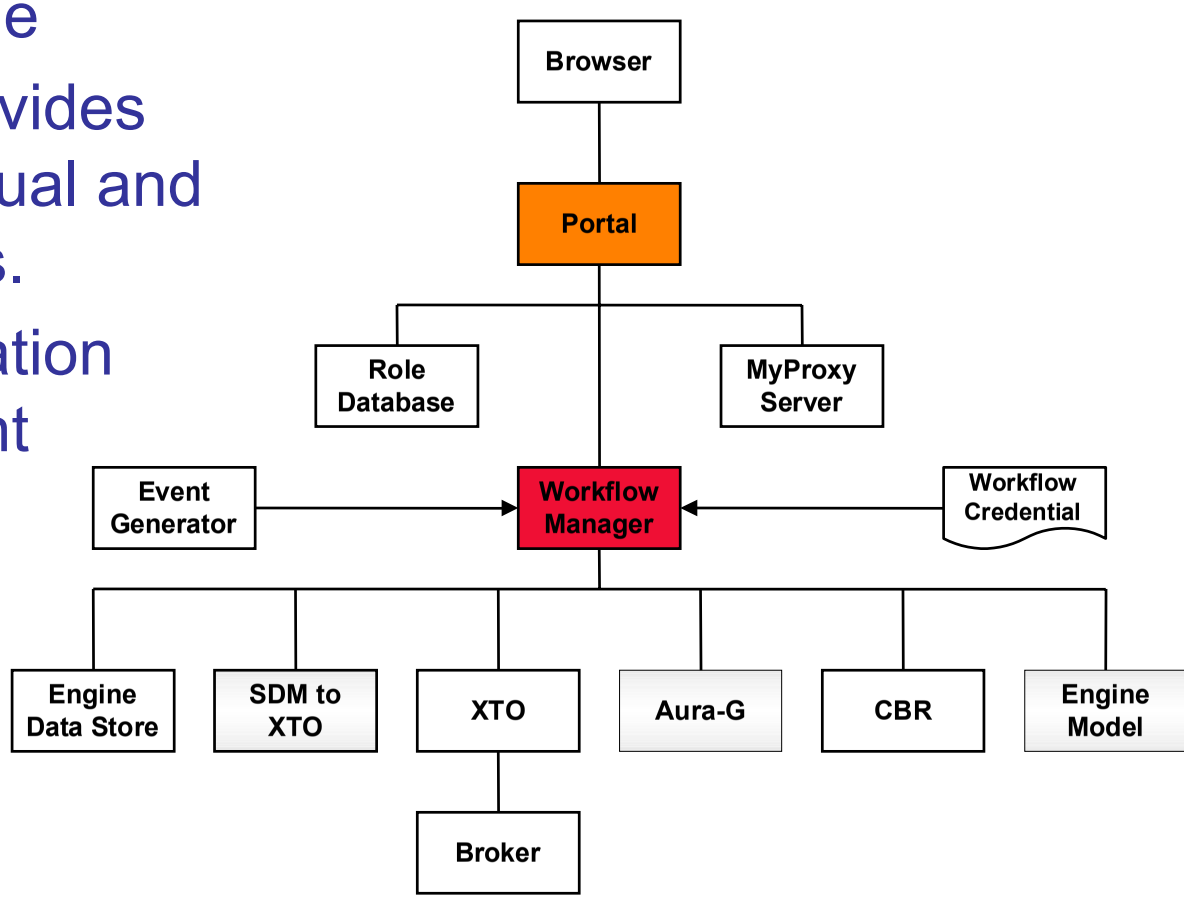
Signal Processing Services

- Grid based deployment of the vibration analysis algorithms:
- Provides:
  - Opportunity for finer grain analysis;
  - More powerful algorithms;
  - Testing environment for development of new algorithms;



Workflow Engine

- Services are managed at the portal via a Workflow Engine
- Workflow Engine provides management of manual and automated workflows.
- Also handles certification and role management

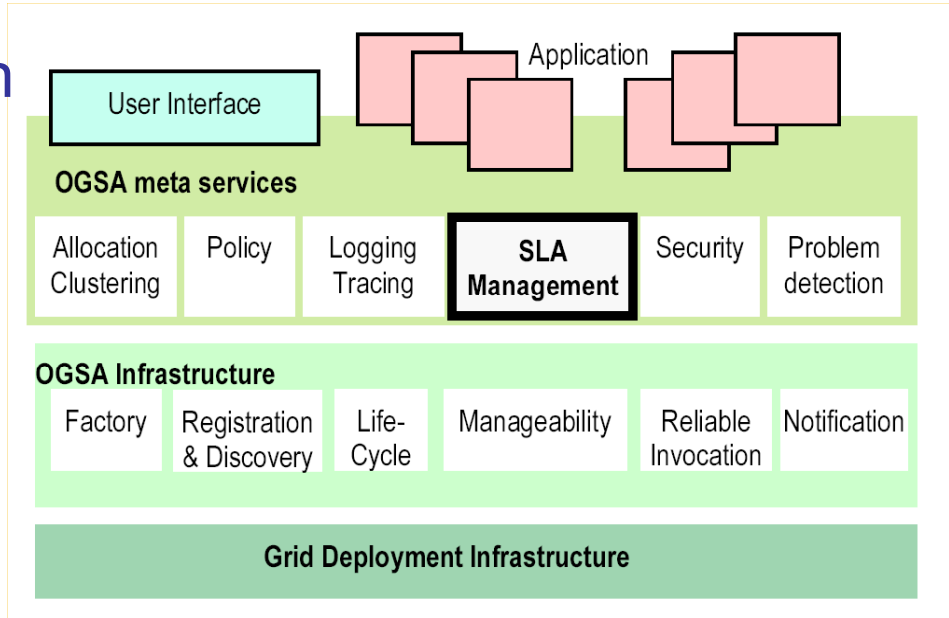


Commercial Drivers

- Security of services, process and data are critical:
  - Investigating optimal security architecture based on emerging GT services
  - Security is tightly coupled to role definition and user access rights
  - Complex cross border, cross domain issues;
- Quality of Service aspects are major commercial driver:
  - Investigating mechanisms for service level agreements
- Both of the above underpinned by detailed dependability analysis

Brokering and SLA's

- Brokerage system is used for job allocation on available Grid resource
- Due to commercial application domain, broker should also demonstrate capability to manage QoS issues, and specifically Service Level Agreements (SLA's)
- Integrates with GGF Grid Economic Architecture



Dependability Issues

- Contribute to the GRID community dependability and security studies, where possible.
- Provide dependability and security analysis to support the ultimate deployment of DAME as a working engine diagnosis environment.
- If possible, provide a basis (identify good practices) for dependability and security analysis for the deployment of DAME as a working diagnosis environment for other domains e.g. medical.
- Dependability analysis has meant need for business process analysis, asset identification, risk identification.

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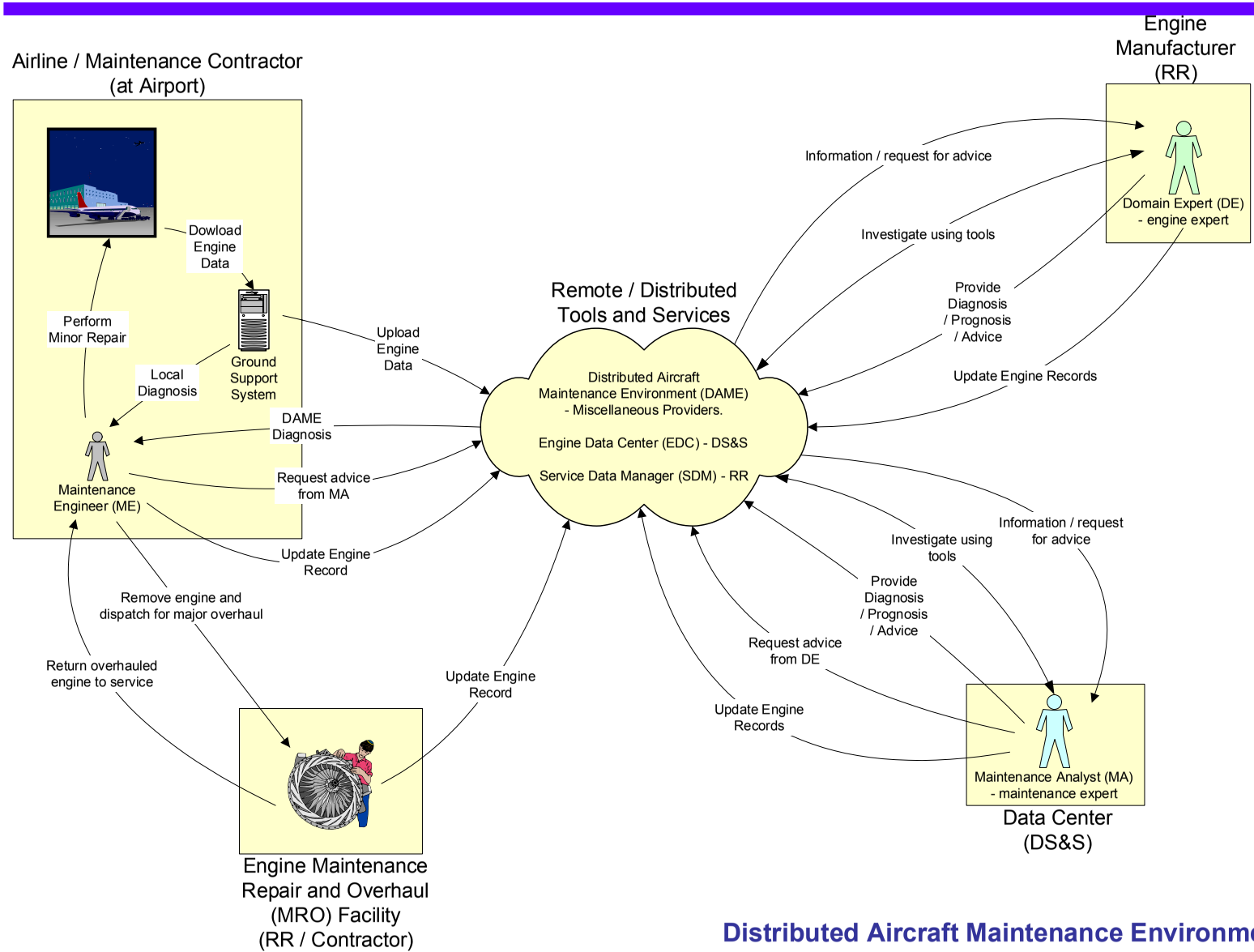
Dependability Issues, cont



Future Work

- Addition of workflow ‘creator’ in the portal, for flexible workflow configuration;
- Further analysis of dependability properties, including detailed studies on timeliness properties and security issues;
- Larger scale database deployment, and SRB integration;
- Further development of Grid monitoring services as basis for SLA and brokering;
- Continued development of data mining (AURA) capability;

Thanks…

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Further info: http://www.cs.york.ac.uk/dame