Distributed Aircraft Maintenance Environment
DAME

broaden

DAME and BROADEN - visualization and searching distributed aero-engine data.

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dti
EPSRC

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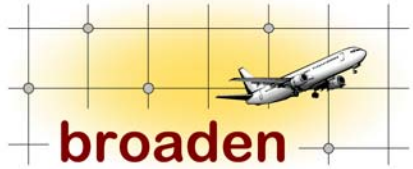

- Overview of DAME
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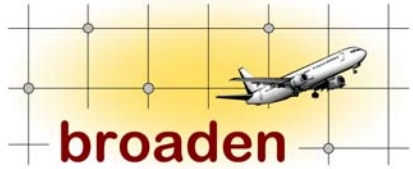
Overview of DAME

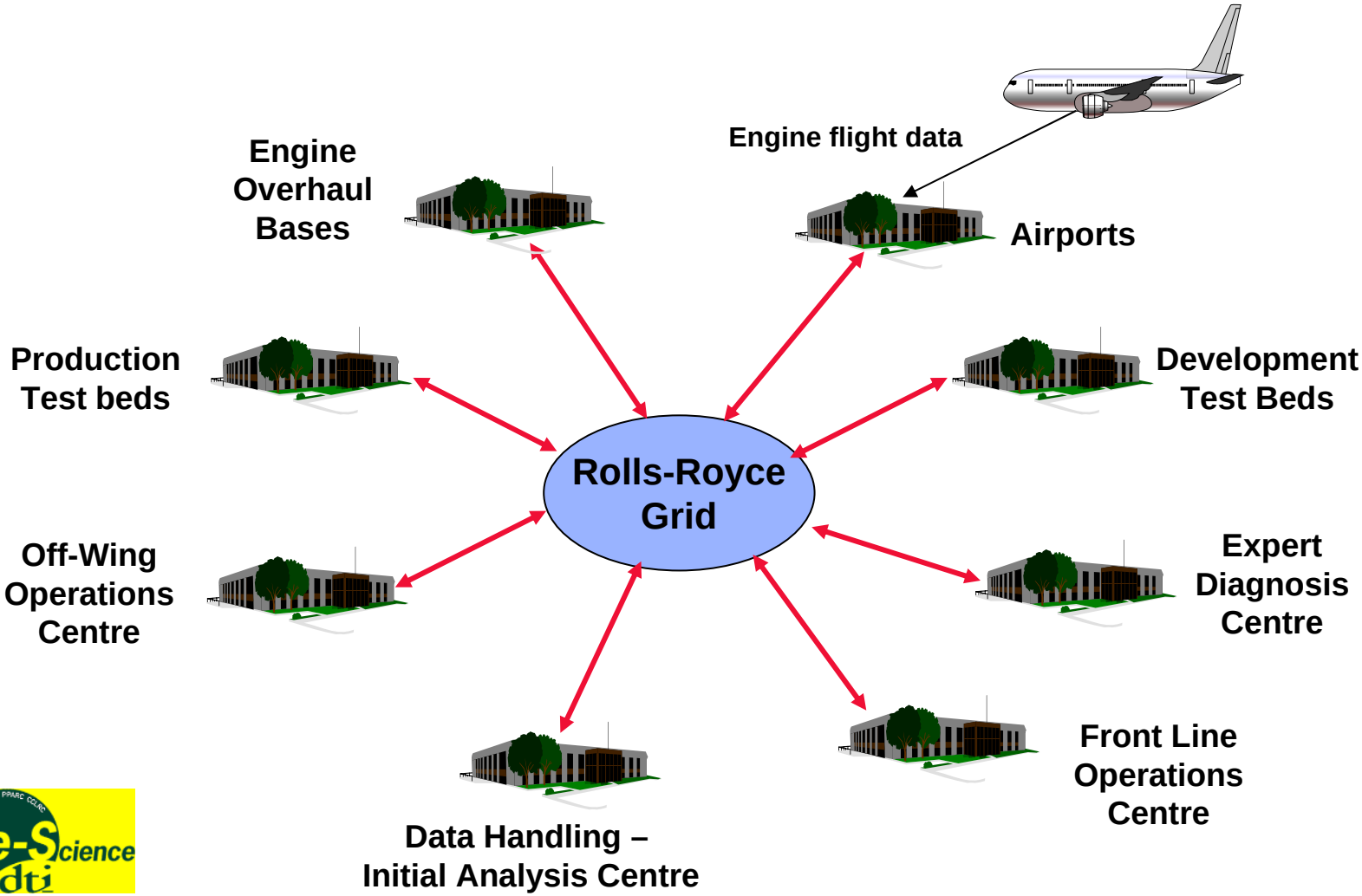
- DAME – *Distributed Aircraft Maintenance Environment*
- EPSRC Funded, £3.2 Million, 3 years, commenced Jan 2002.
- UK pilot project for e-Science (£220 million programme)
- 6 initial pilots were selected to ‘kick start’ Grids in the UK.
- Mostly Scientific studies
- DAME was more industrially oriented.
- 4 Universities:
  - **Universities of York, Sheffield, Oxford and Leeds.**
- Industrial Partners:
  - **Rolls-Royce plc**
  - **Data Systems and Solutions LLC**
  - **Cybula Ltd**

The Problem



- To reduce the cost of maintenance of Aero engines in Rolls-Royce fleet
- Increase effectiveness of the diagnostic process:
  - Allow data sharing between data centres
  - Achieve this using Grid technology.

The Vision


Engine flight data
Engine Overhaul Bases
Airports
Production Test beds
Development Test Beds
Rolls-Royce Grid
Off-Wing Operations Centre
Expert Diagnosis Centre
Front Line Operations Centre
Data Handling – Initial Analysis Centre

DAME Objectives

- Build a demonstration diagnosis infrastructure - as proof of concept for Grid technology in the aerospace diagnostic domain.
- Three primary Grid challenges:
  - Management of large, distributed and heterogeneous data repositories;
  - Rapid data mining and analysis of fault data;
  - Information management and data fusion for diagnosis/prognosis applications;
- 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

Vibration (broadband) and performance time series data.

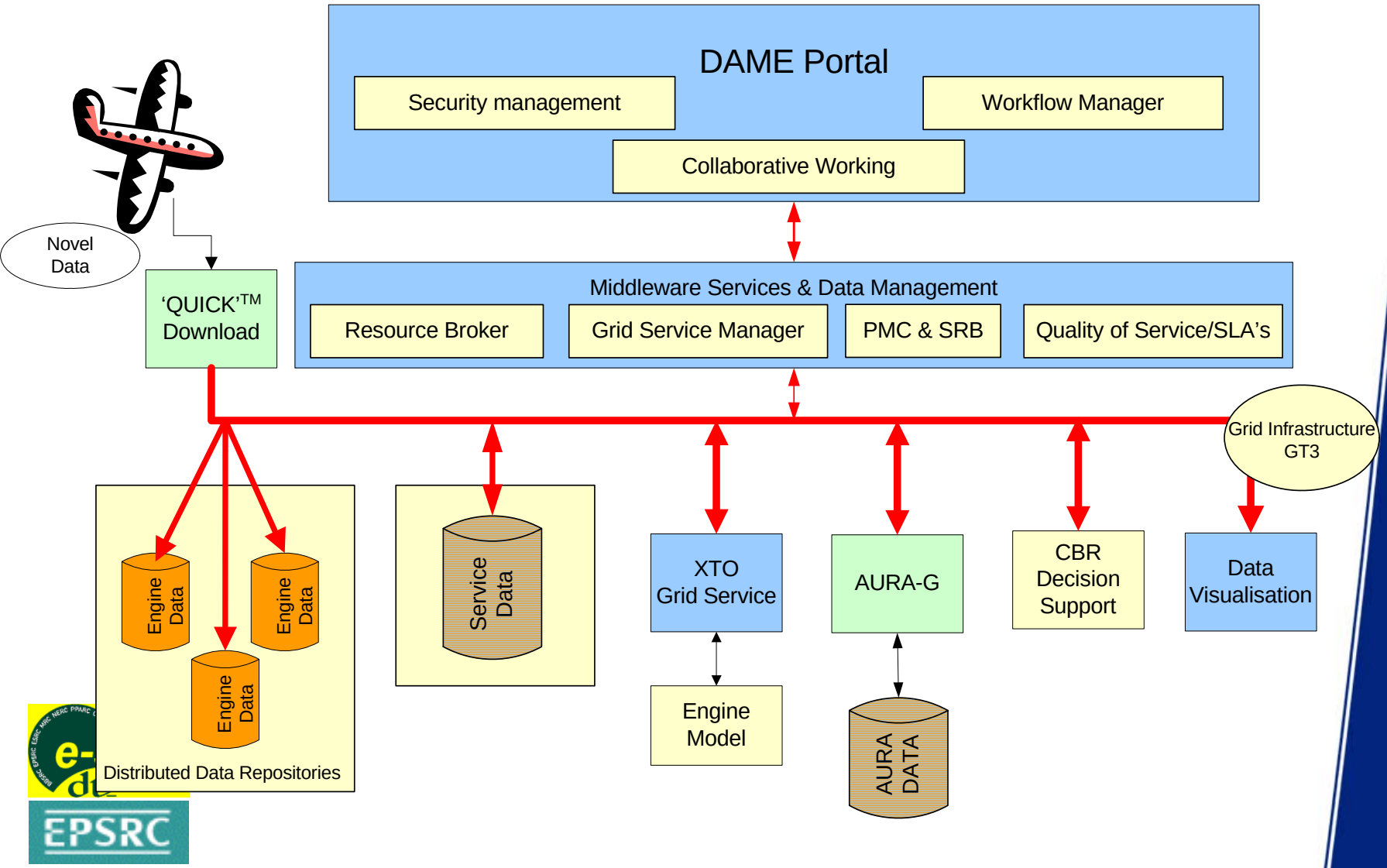
Data volumes:

- Heathrow - 36 landings per hour.
- If half have 4 engines and half have 2, average aircraft carries 3 engines.
- Each engine generates around 1GB of data per flight.
- 36 x 3 x 1 = 108GB raw engine data per hour.
- Factor in the working day and the rest of the world…
- …Terabytes and up!

The Infrastructure

- Provides for collaboration of geographically dispersed users
- Provides for appropriate access by users to the current and historical engine.
- Provides a range of tools:
  - Visualization and rapid searching of the vast stores of historical vibration and performance data.
  - Case based reasoning techniques.
  - Signal processing.
  - Engine simulation tools using data from the engine or historical data.
- Allows creation, editing and execution of diagnostic workflows.

The Architecture

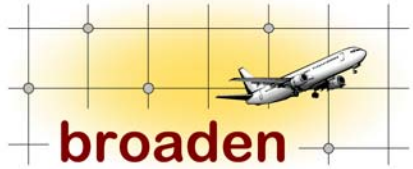


DAME Demonstrator

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

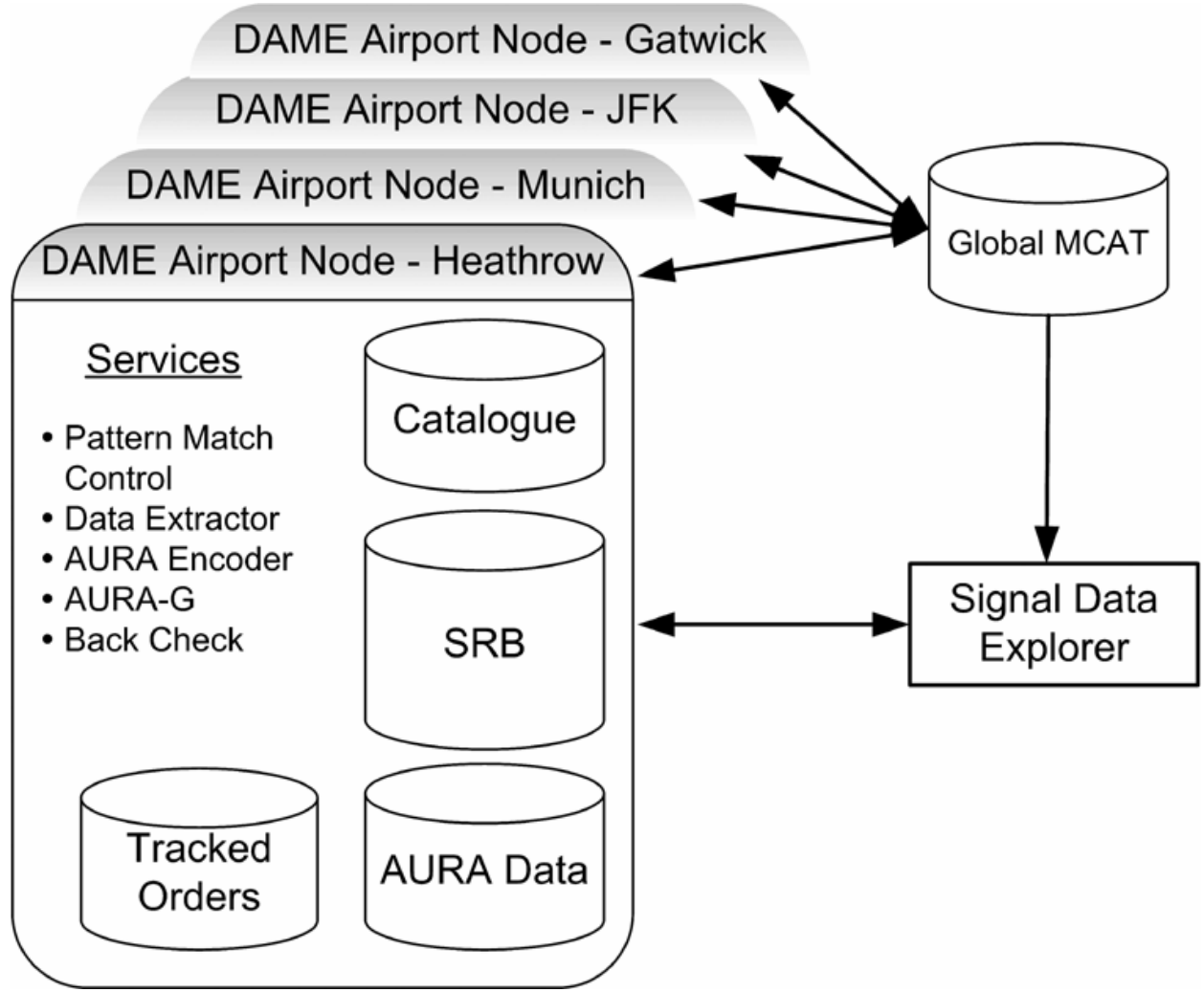
- Provides access to a range of analysis tools for the engine diagnosis process
- Will act as central control point for automated workflows
- Manages issues of distributed diagnosis team and virtual organisations
- Manages issues of security and user roles.

Data Visualization and Searching

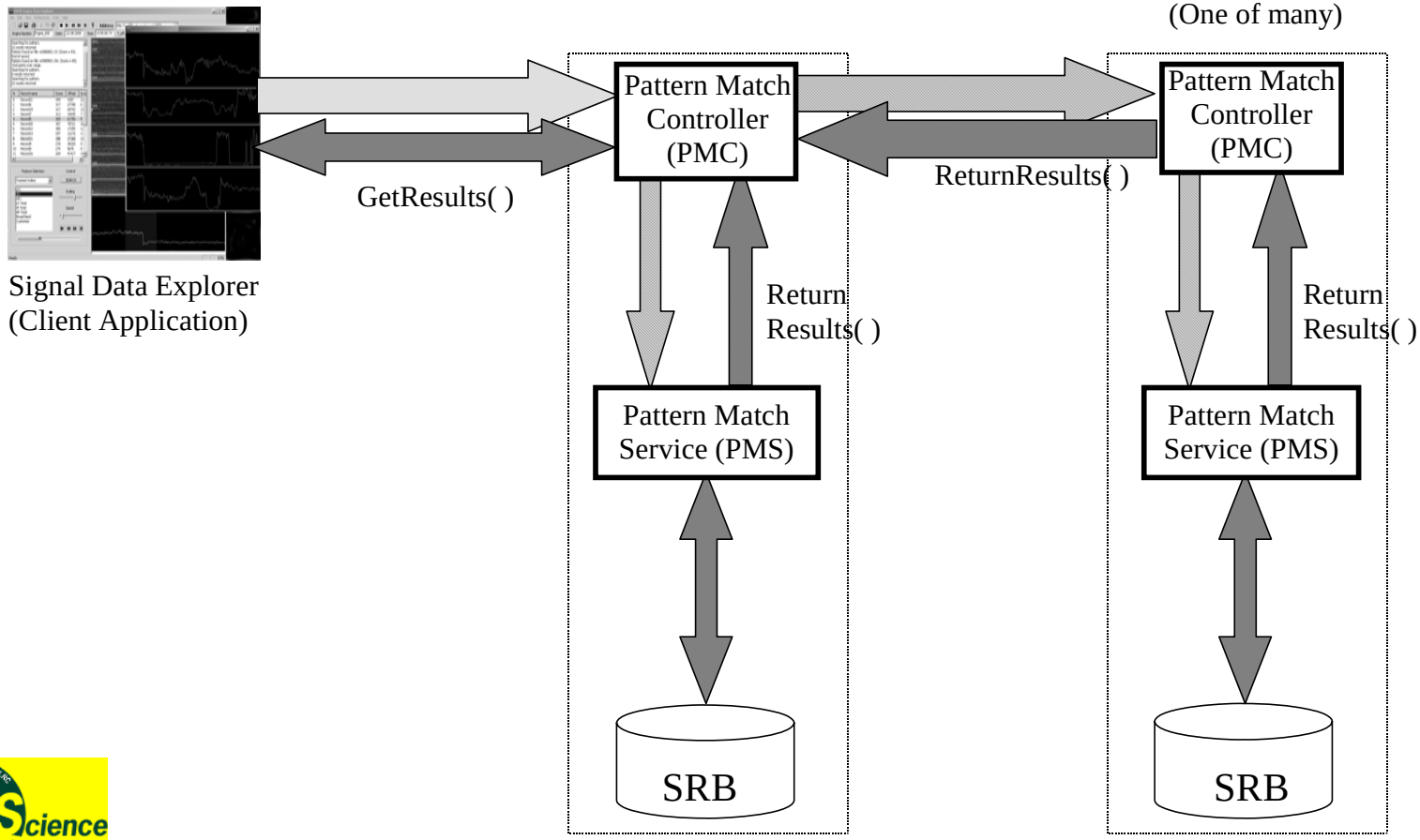


- Large data volumes (Terabytes):
  - Leave the data, distributed at the airports, data centres, etc.
  - Take the tools to the data

The Distributed Data Architecture



The Pattern Match Search Architecture

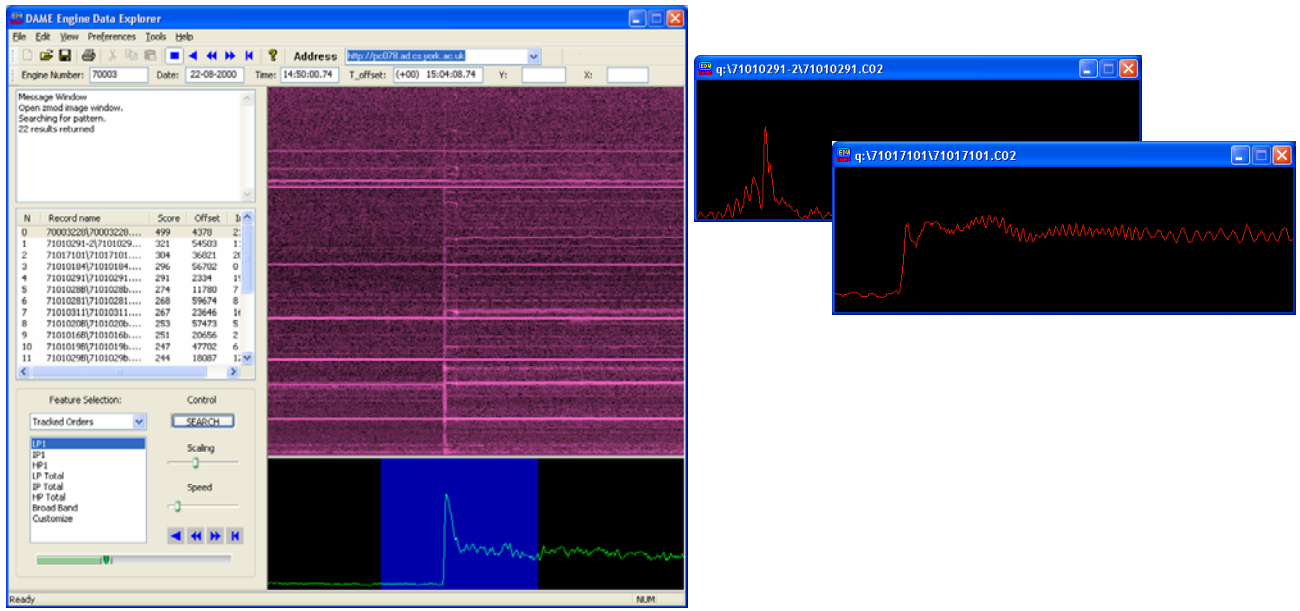


The Pattern Match Controller

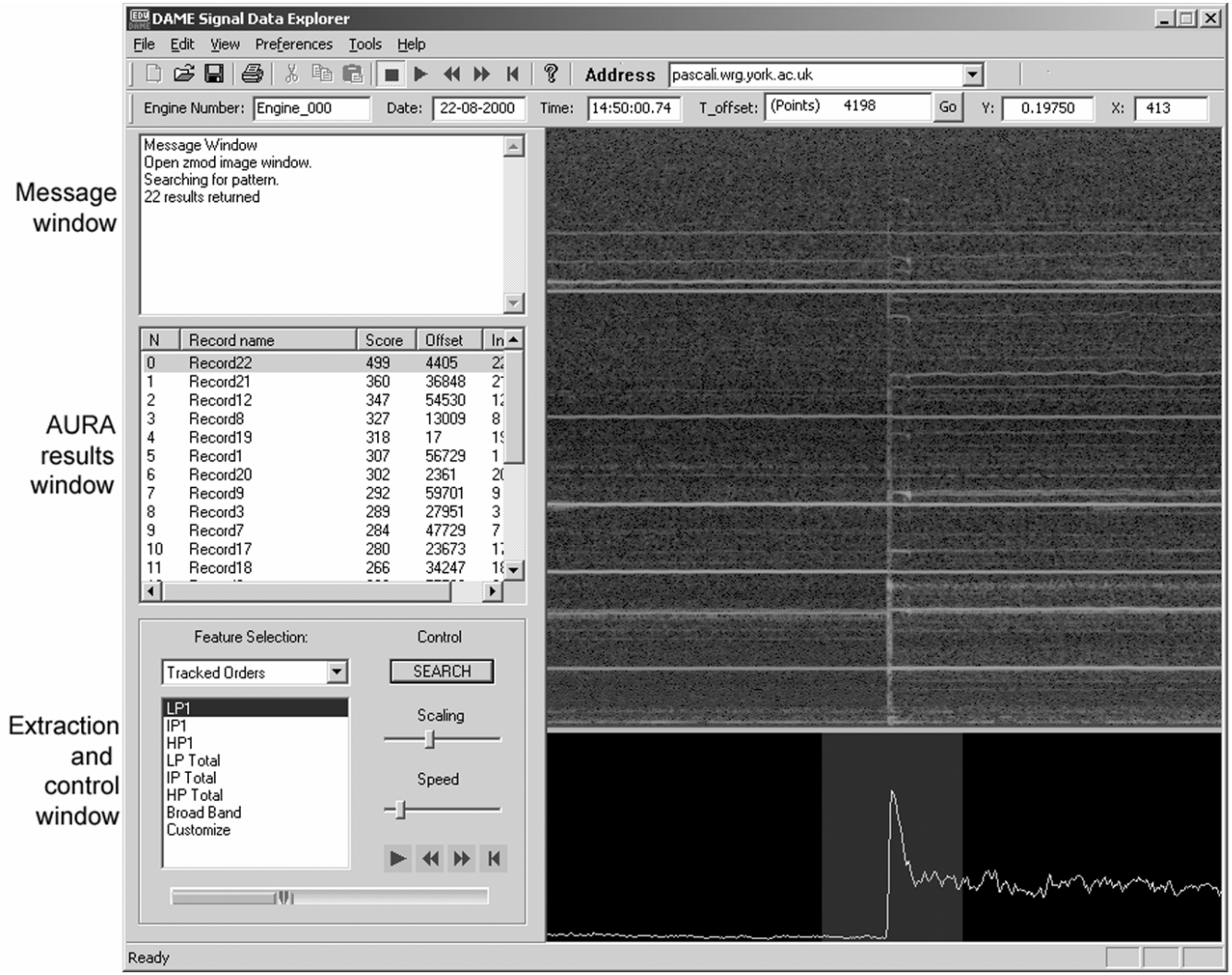
- The SDE interfaces to the PMC middleware;
- The PMC provides:
  - Distributed search (using Advanced Uncertain Reasoning Architecture - AURA)
  - Interface to data archive system (Storage Resource Broker [SRB] or other)
  - Scalability
  - Robustness

The Signal Data Explorer

- Providing web-enabled search tools was critical to success of demonstrator
- Signal Data Explorer provides interactive environment for visualization and search across large scale, time series data sets – using AURA



The Signal Data Explorer: viewing Engine Data



Message window

AURA results window

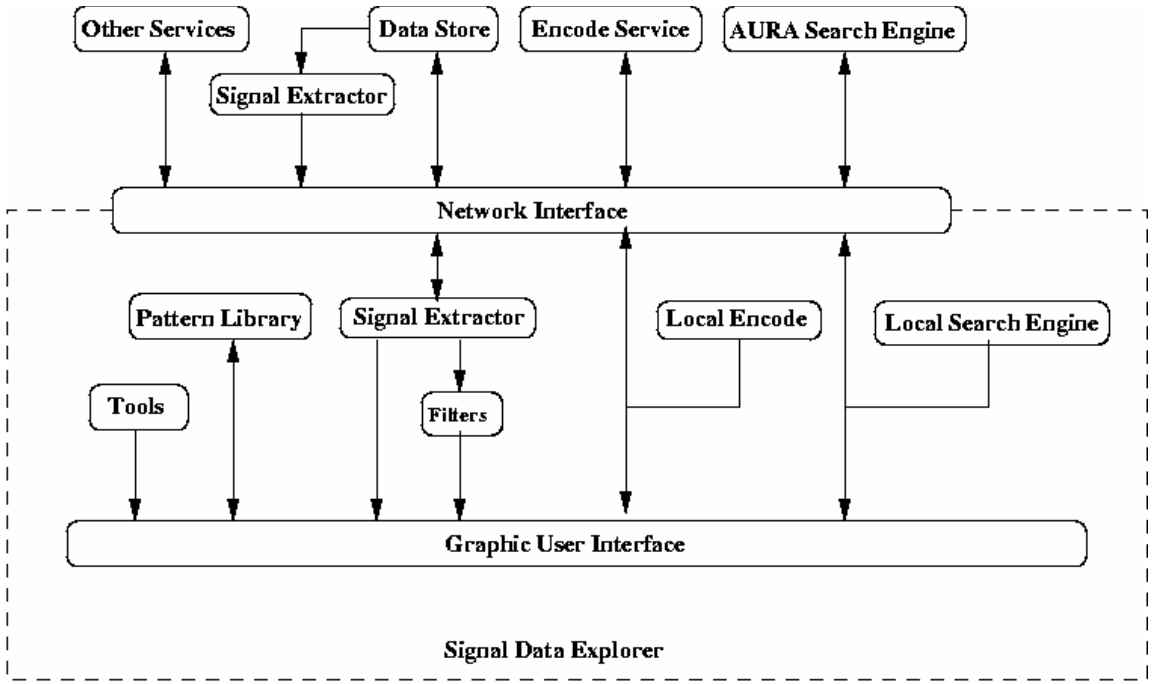
Extraction and control window

Zmod data window

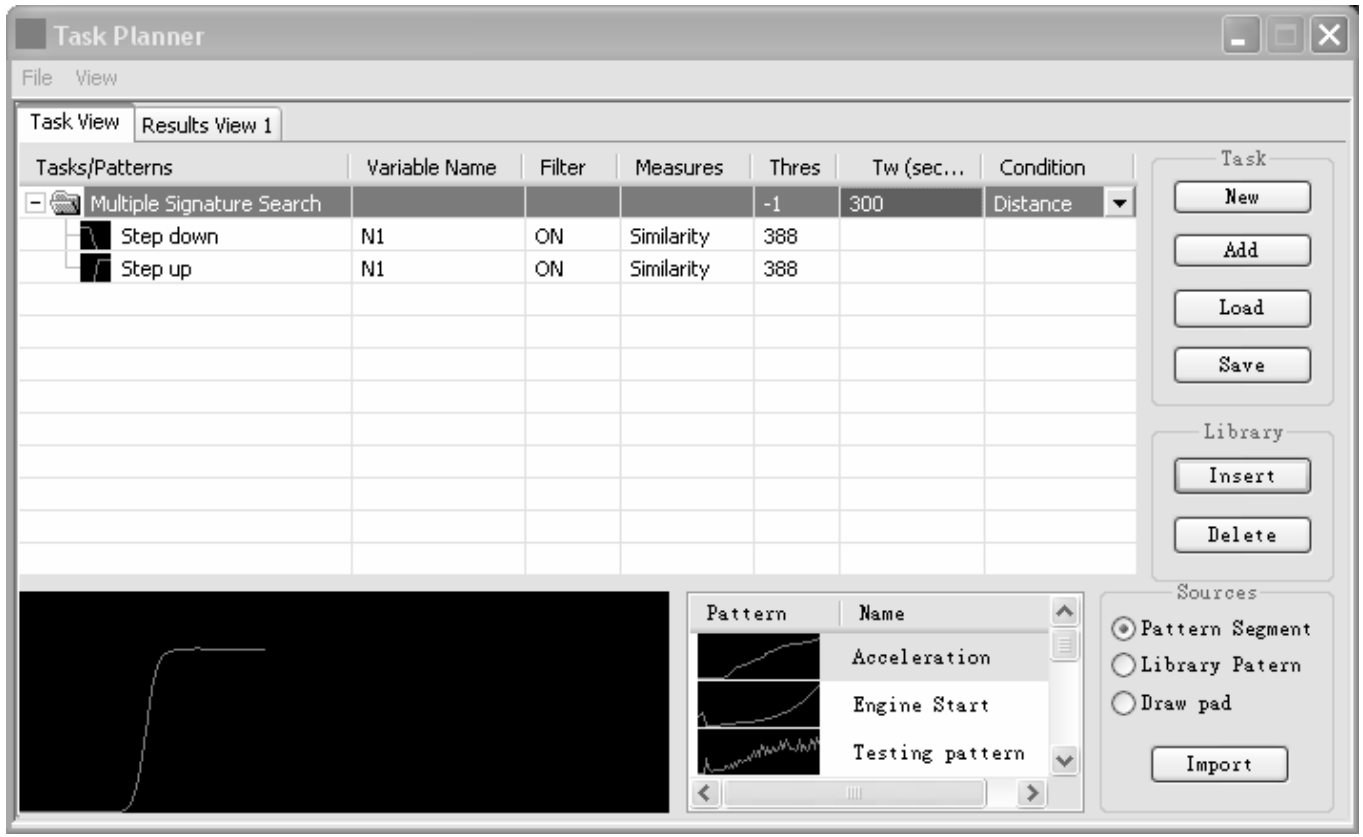
Tracked Order window with selected pattern

The Signal Data Explorer: Architecture

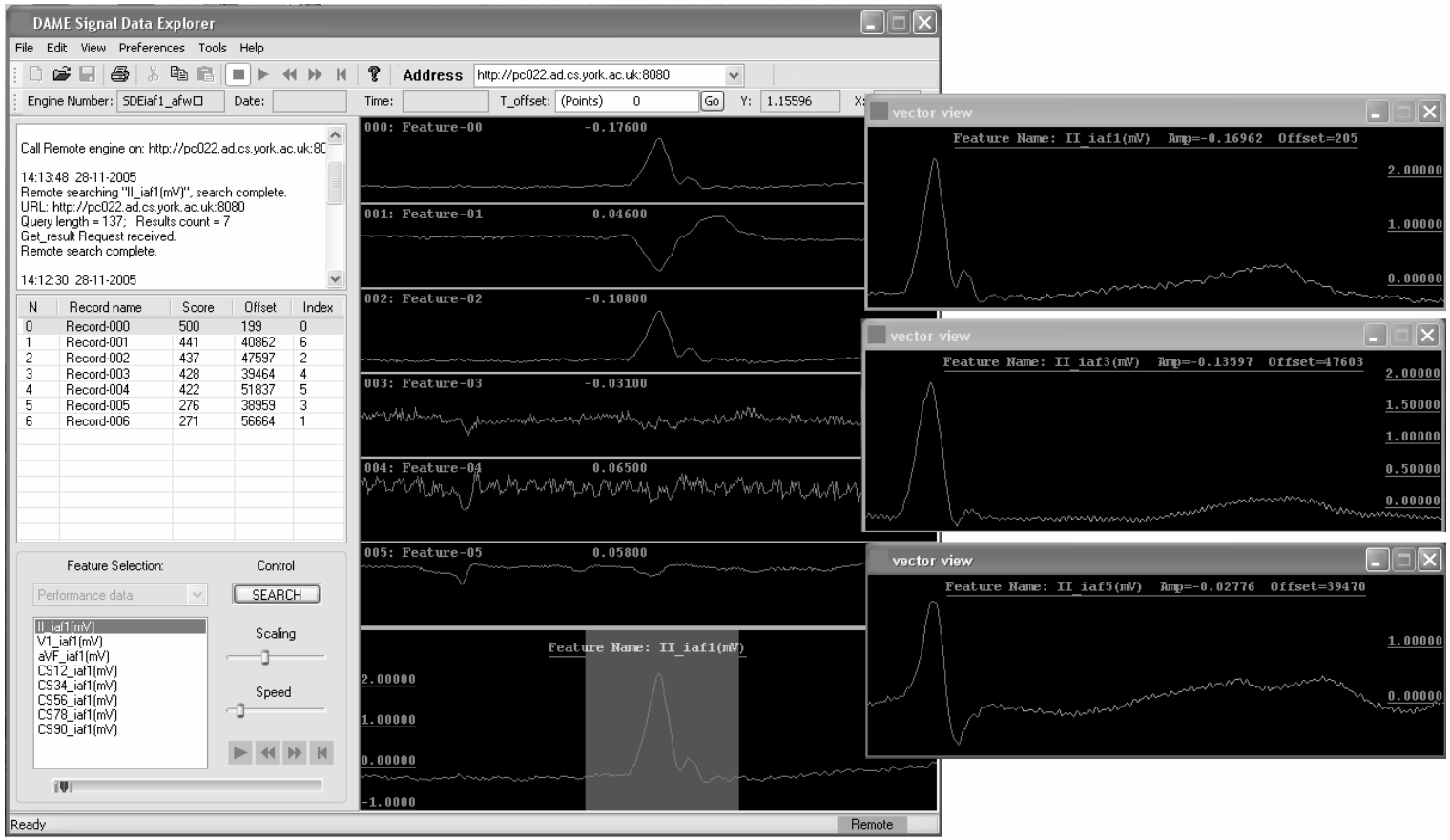
- Tool architecture WS compliant & modular structure
- Supports local and remote search
- Any search algorithm can be supported via WS API
- Parallel search capability



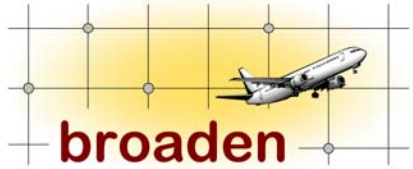
The Signal Data Explorer: multiple parameter searches



The Signal Data Explorer: viewing ECG data

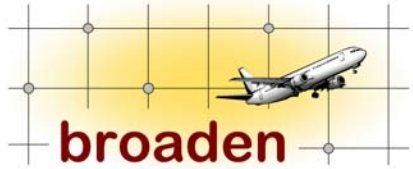


Overview of BROADEN



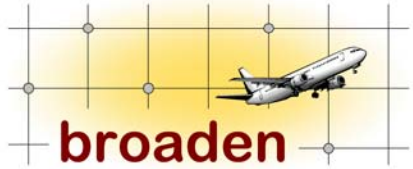
- BROADEN - *Business Resource Optimisation for Aftermarket and Design on Engineering Networks*
- DTI Inter Enterprise Computing Call
- DTI / Industry Funded, £3.49 Million, commenced January 2005 – four work packages:
  1. Formulation of a strategy to transfer proven Grid technology to production LANs.
  2. Computing for design
  3. Distributed diagnostics for engine health monitoring, high-performance
  4. Agent-based software development for business modelling

Overview of BROADEN



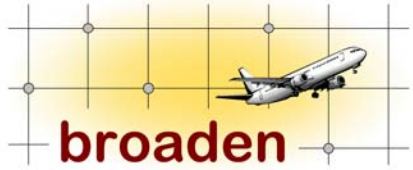
- WP3 – DAME follow on
- WP3 - three Universities:
  - **Universities of York, Sheffield and Leeds.**
- WP3 - Industrial Partners:
  - **Rolls-Royce plc**
  - **Oxford BioSignals**
  - **Cybula Ltd**
  - **EDS**

BROADEN Objectives



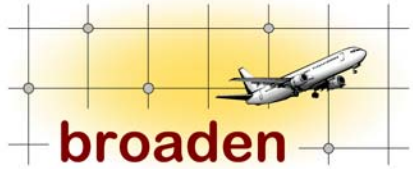
- Deliver an implementation of DAME within Rolls-Royce – on the Rolls-Royce BROADEN Grid.
- Enable optimised engine design by delivering the high-performance computing necessary for extremely complex scenario simulations.
- Help drive logistics and supply chain software development by modelling on a large scale the very important and complex demands of Rolls-Royce's global aftermarket.

Summary



- DAME has developed both Rolls-Royce specific tool sets and generic capability for high volume, distributed search
- Tools and capabilities have been strongly influenced by end-user requirements
- Deployment continues in other diverse domains, e.g. ECG demonstrator for WUNGrid
- Strong potential for exploitation in other domains
- BROADEN is now implementing the tools on the Rolls-Royce Grid

Demonstration



- Demonstration of the Signal Data Explorer used to:
  - Visualize engine data.
  - Search engine data.