

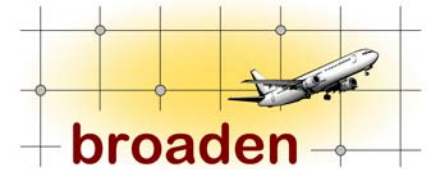
DAME and BROADEN - visualization and searching distributed aero-engine data.

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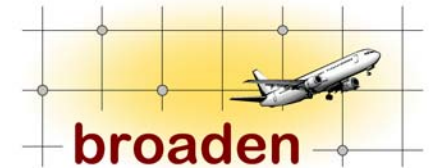
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- Overview of DAME
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Overview of DAME

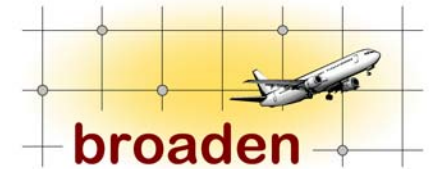


- DAME – *Distributed Aircraft Maintenance Environment*
- EPSRC Funded, £3.2 Million, 3 years, commenced Jan 2002.
- UK pilot project for e-Science (£220 million programme)
- 6 initial pilots were selected to 'kick start' Grids in the UK.
- Mostly Scientific studies
- DAME was more industrially oriented.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





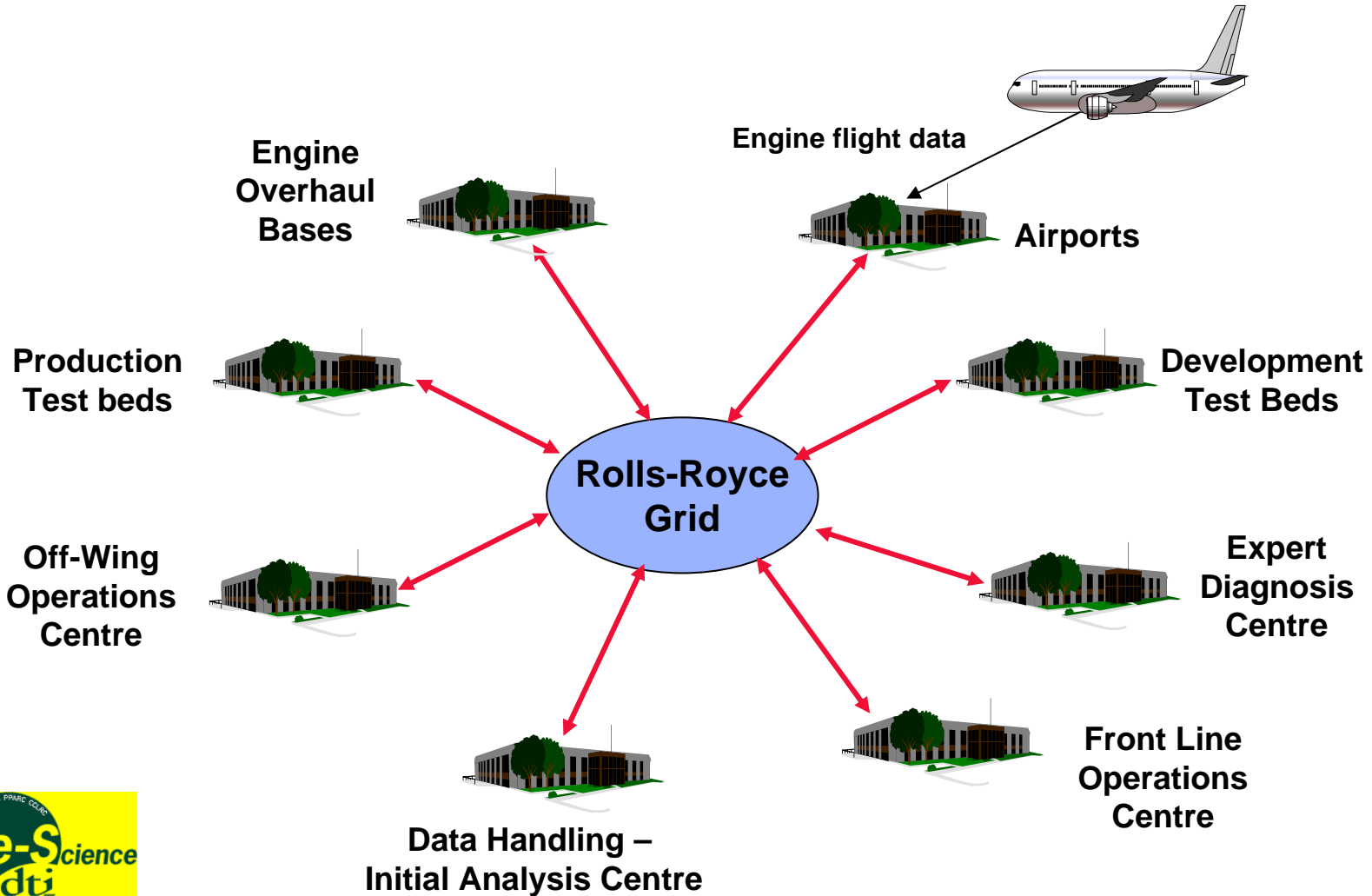
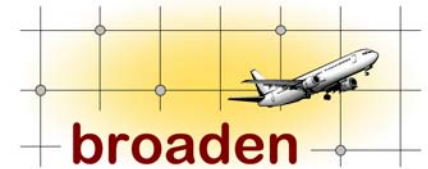
The Problem



- 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.

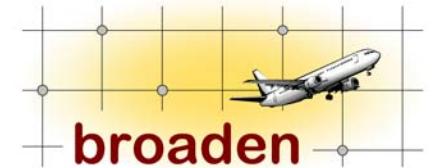


The Vision





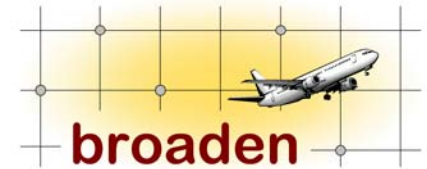
DAME Objectives



- 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



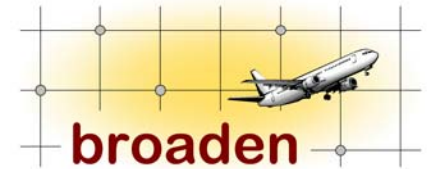
Vibration (broadband) and performance time series data.

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.
- $36 \times 3 \times 1 = 108\text{GB}$ raw engine data per hour.
- Factor in the working day and the rest of the world...
- ...Terabytes and up!

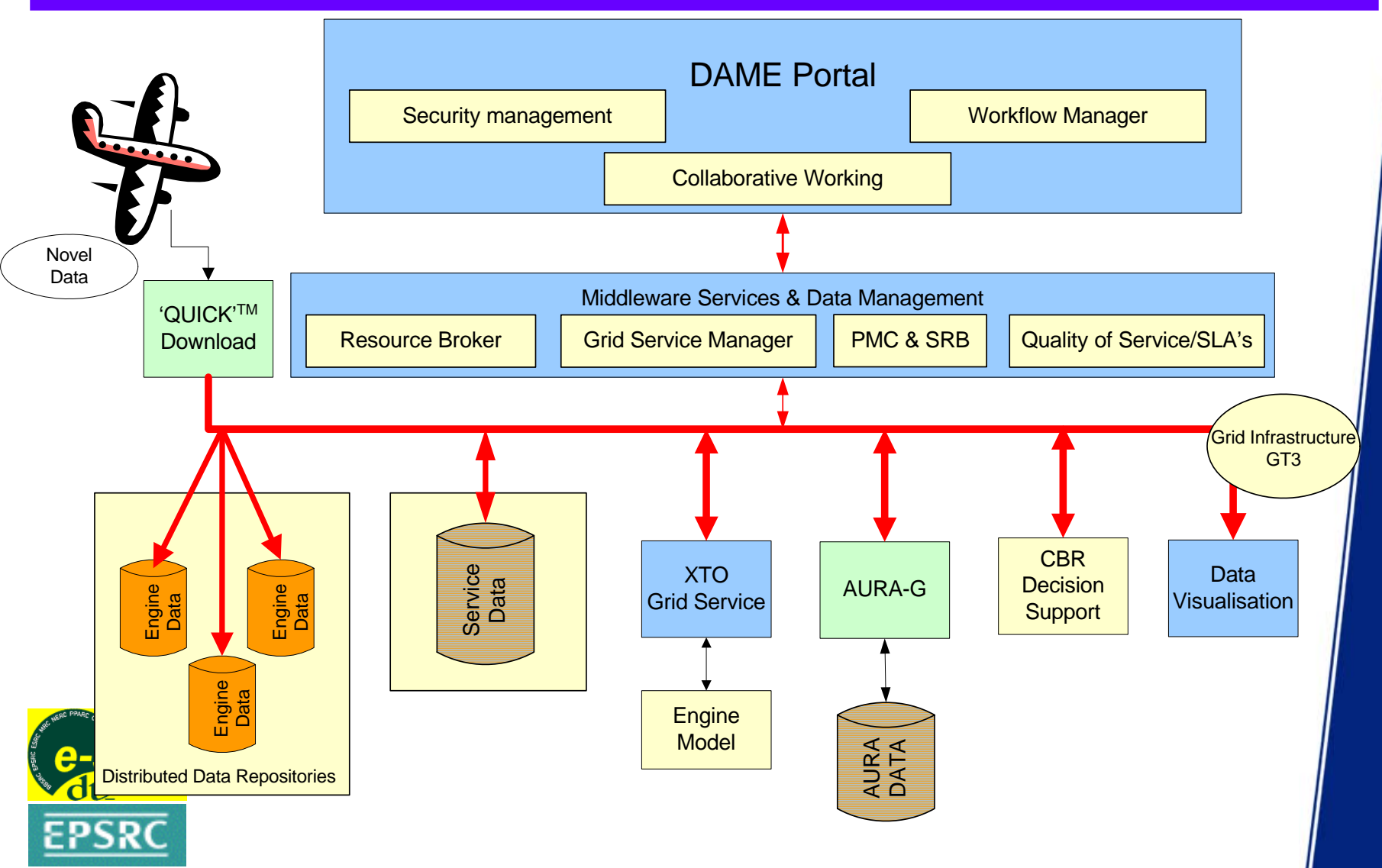


The Infrastructure



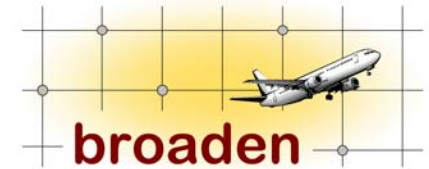
- Provides for collaboration of geographically dispersed users
- Provides for appropriate access by users to the current and historical engine.
- Provides a range of tools:
 - Visualization and rapid searching of the vast stores of historical vibration and performance data.
 - Case based reasoning techniques.
 - 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

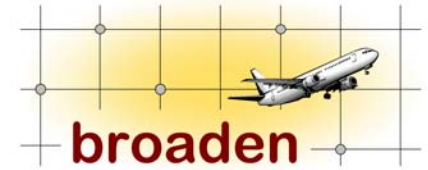


The DAME demonstration system provides a diagnosis workbench (portal) which brings together a suite of analysis services via Grid technology;

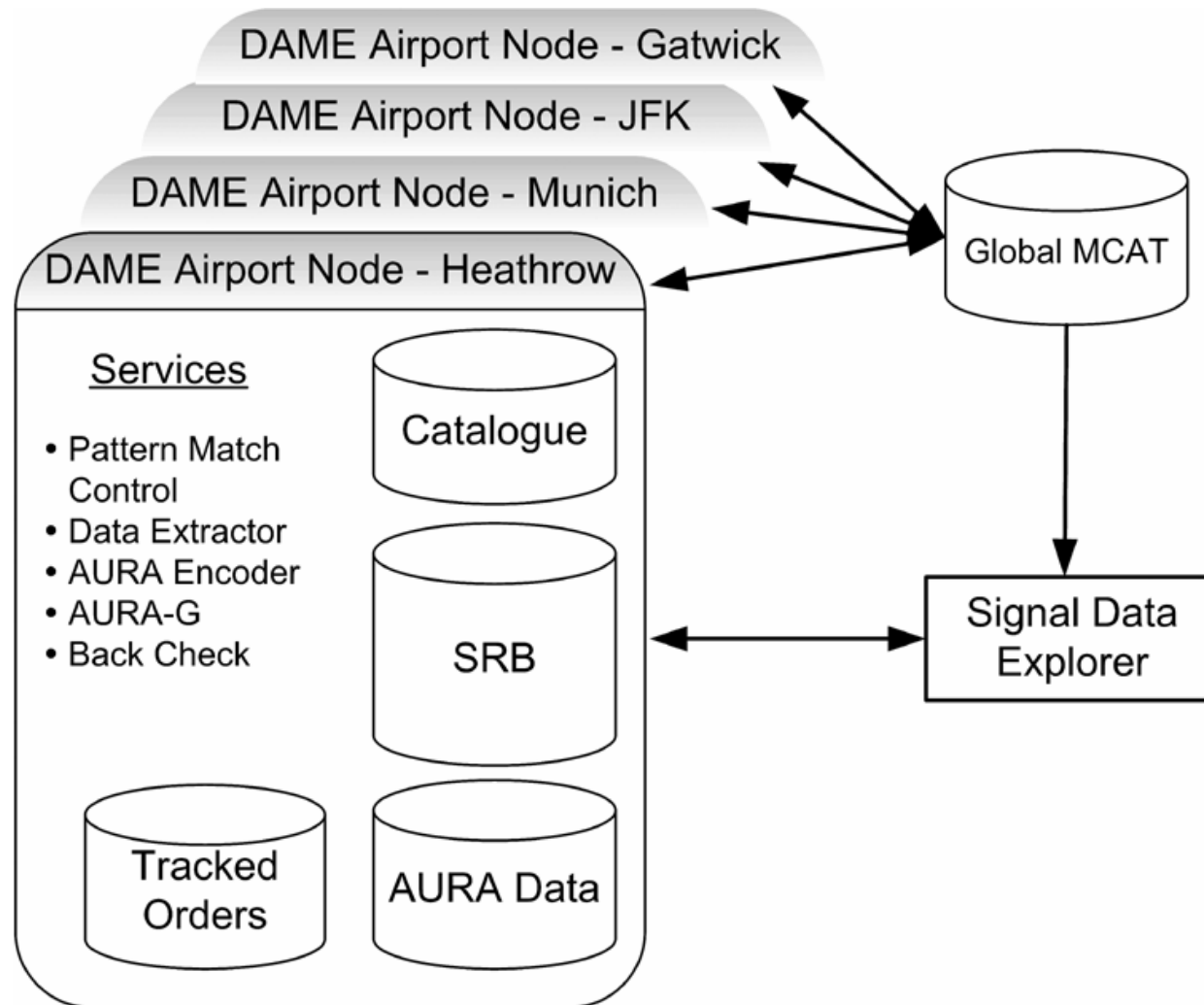
- Provides access to a range of analysis tools for the engine diagnosis process
- Will act as central control point for automated workflows
- Manages issues of distributed diagnosis team and virtual organisations
- Manages issues of security and user roles.



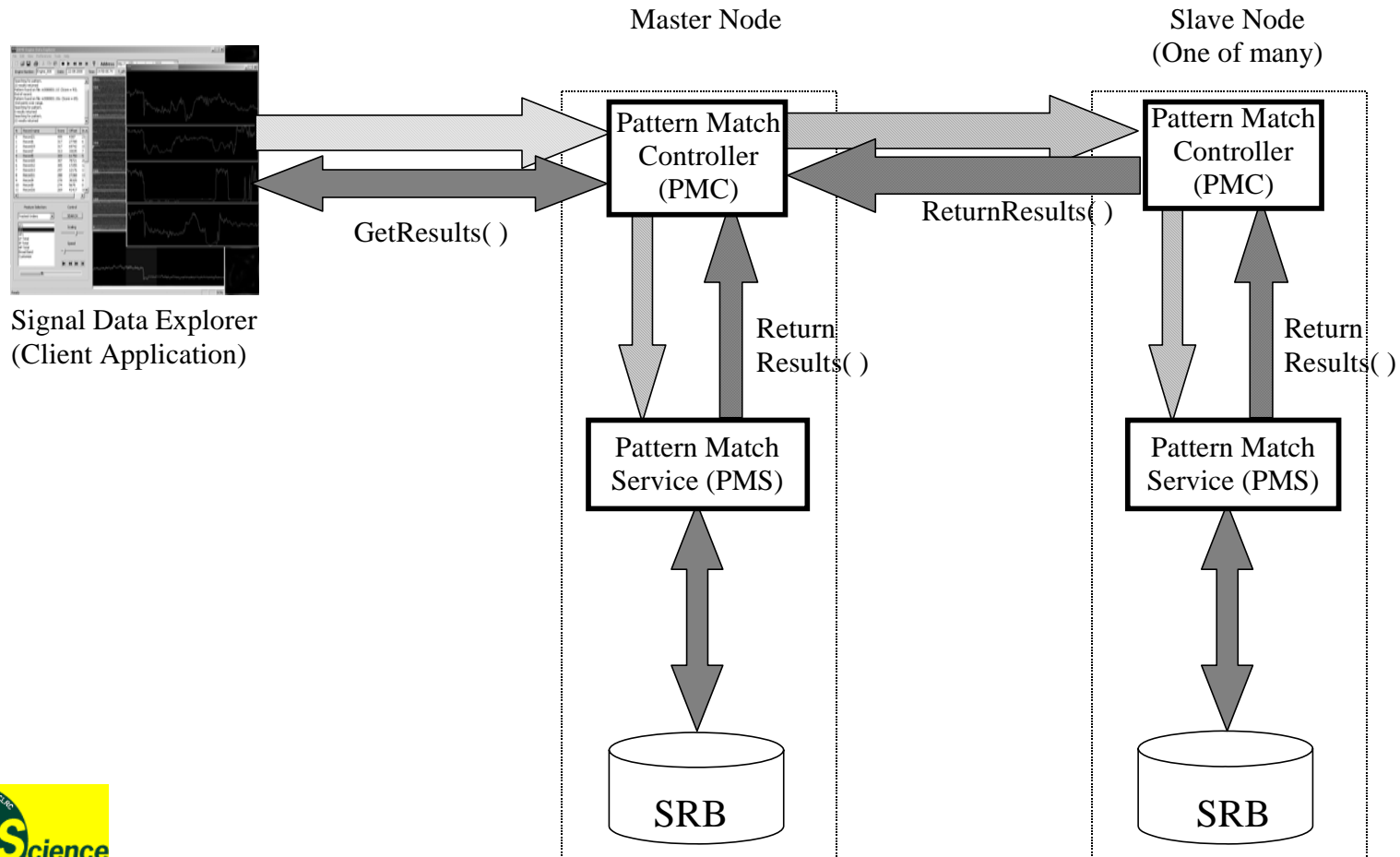
Data Visualization and Searching



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

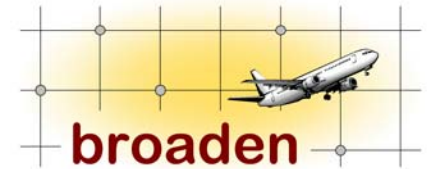


The Pattern Match Search Architecture





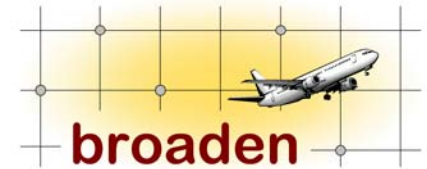
The Pattern Match Controller



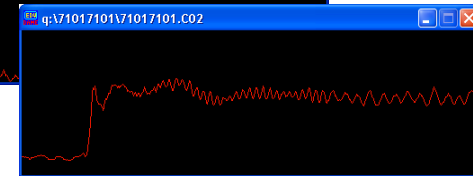
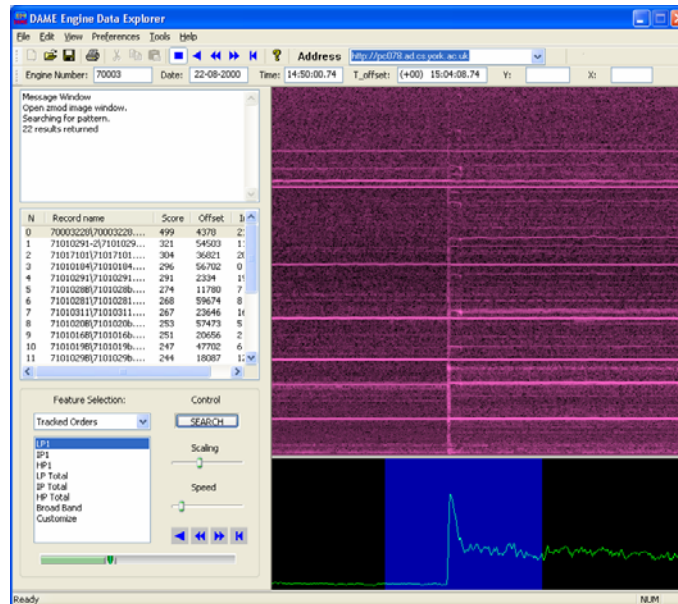
- The SDE interfaces to the PMC middleware;
- The PMC provides:
 - Distributed search (using Advanced Uncertain Reasoning Architecture - AURA)
 - Interface to data archive system (Storage Resource Broker [SRB] or other)
 - Scalability
 - Robustness



The Signal Data Explorer

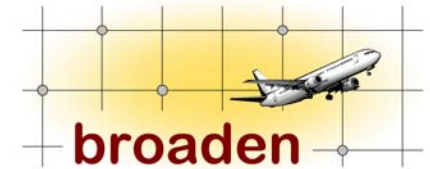


- Providing web-enabled search tools was critical to success of demonstrator
- Signal Data Explorer provides interactive environment for visualization and search across large scale, time series data sets – using AURA





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

DAME Signal Data Explorer

File Edit View Preferences Tools Help

Address: pascali.wrg.york.ac.uk

Engine Number: Engine_000 Date: 22-08-2000 Time: 14:50:00.74 T_offset: (Points) 4198 Go Y: 0.19750 X: 413

Message Window
Open zmod image window.
Searching for pattern.
22 results returned

N	Record name	Score	Offset	In
0	Record22	499	4405	2
1	Record21	360	36848	2
2	Record12	347	54530	1
3	Record8	327	13009	8
4	Record19	318	17	19
5	Record1	307	56729	1
6	Record20	302	2361	20
7	Record9	292	59701	9
8	Record3	289	27951	3
9	Record7	284	47729	7
10	Record17	280	23673	17
11	Record18	266	34247	18

Feature Selection: Tracked Orders

- LP1
- IP1
- HP1
- LP Total
- IP Total
- HP Total
- Broad Band
- Customize

Control: SEARCH

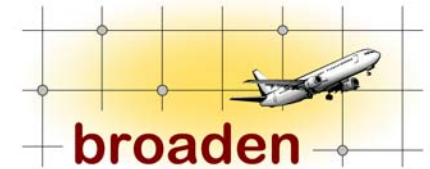
Scaling: [Slider]

Speed: [Slider]

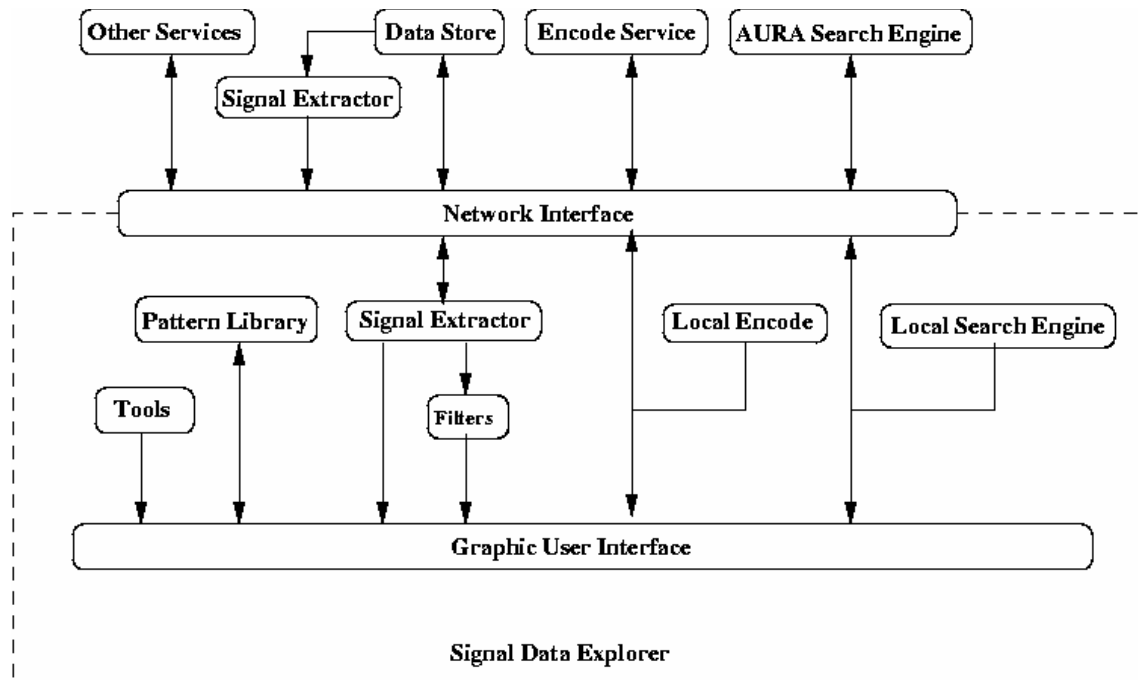
Ready



The Signal Data Explorer: Architecture

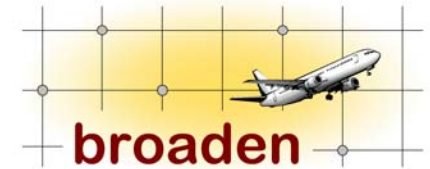


- Tool architecture WS compliant & modular structure
- Supports local and remote search
- Any search algorithm can be supported via WS API
- Parallel search capability





The Signal Data Explorer: multiple parameter searches



Task Planner

File View

Task View Results View 1

Tasks/Patterns	Variable Name	Filter	Measures	Thres	Tw (sec...)	Condition
- Multiple Signature Search				-1	300	Distance
Step down	N1	ON	Similarity	388		
Step up	N1	ON	Similarity	388		

Task

New

Add

Load

Save

Library

Insert

Delete

Sources

Pattern Segment

Library Pattern

Draw pad

Import

Pattern Name

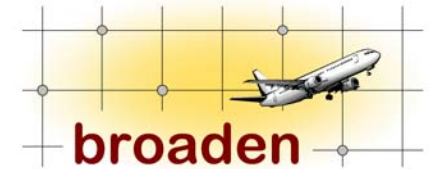
Acceleration

Engine Start

Testing pattern



The Signal Data Explorer: viewing ECG data



DAME Signal Data Explorer

File Edit View Preferences Tools Help

Address <http://pc022.ad.cs.york.ac.uk:8080>

Engine Number: SDEiaf1_afw Date: Time: T_offset: (Points) 0 Go Y: 1.15596 X:

Call Remote engine on: <http://pc022.ad.cs.york.ac.uk:8080>

14:13:48 28-11-2005
Remote searching "II_iaf1(mV)", search complete.
URL: <http://pc022.ad.cs.york.ac.uk:8080>
Query length = 137; Results count = 7
Get_result Request received.
Remote search complete.

14:12:30 28-11-2005

N	Record name	Score	Offset	Index
0	Record-000	500	199	0
1	Record-001	441	40862	6
2	Record-002	437	47597	2
3	Record-003	428	39464	4
4	Record-004	422	51837	5
5	Record-005	276	38959	3
6	Record-006	271	56664	1

Feature Selection: Performance data SEARCH

- II_iaf1(mV)
- V1_iaf1(mV)
- aVF_iaf1(mV)
- CS12_iaf1(mV)
- CS34_iaf1(mV)
- CS56_iaf1(mV)
- CS78_iaf1(mV)
- CS90_iaf1(mV)

Control: Scaling Speed

Ready Remote

vector view
Feature Name: II_iaf1(mV) Amp=-0.16962 Offset=205

vector view
Feature Name: II_iaf3(mV) Amp=-0.13597 Offset=47603

vector view
Feature Name: II_iaf5(mV) Amp=-0.02776 Offset=39470

000: Feature-00 -0.17600

001: Feature-01 0.04600

002: Feature-02 -0.10800

003: Feature-03 -0.03100

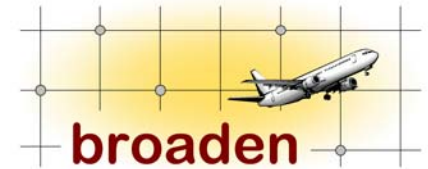
004: Feature-04 0.06500

005: Feature-05 0.05600

Feature Name: II_iaf1(mV)



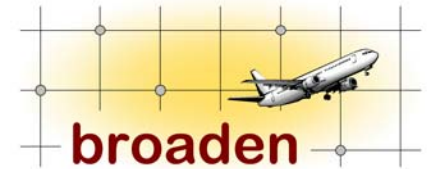
Overview of BROADEN



- 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



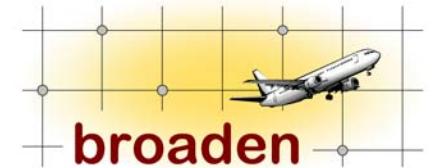
Overview of BROADEN



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



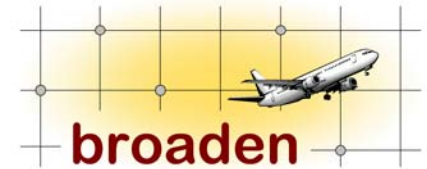
BROADEN Objectives



- 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.



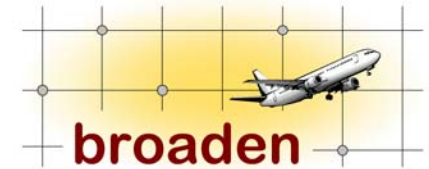
Summary



- 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.