Visualisation & Grid Applications of Electromagnetic Scattering from Aircraft

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The physical problem

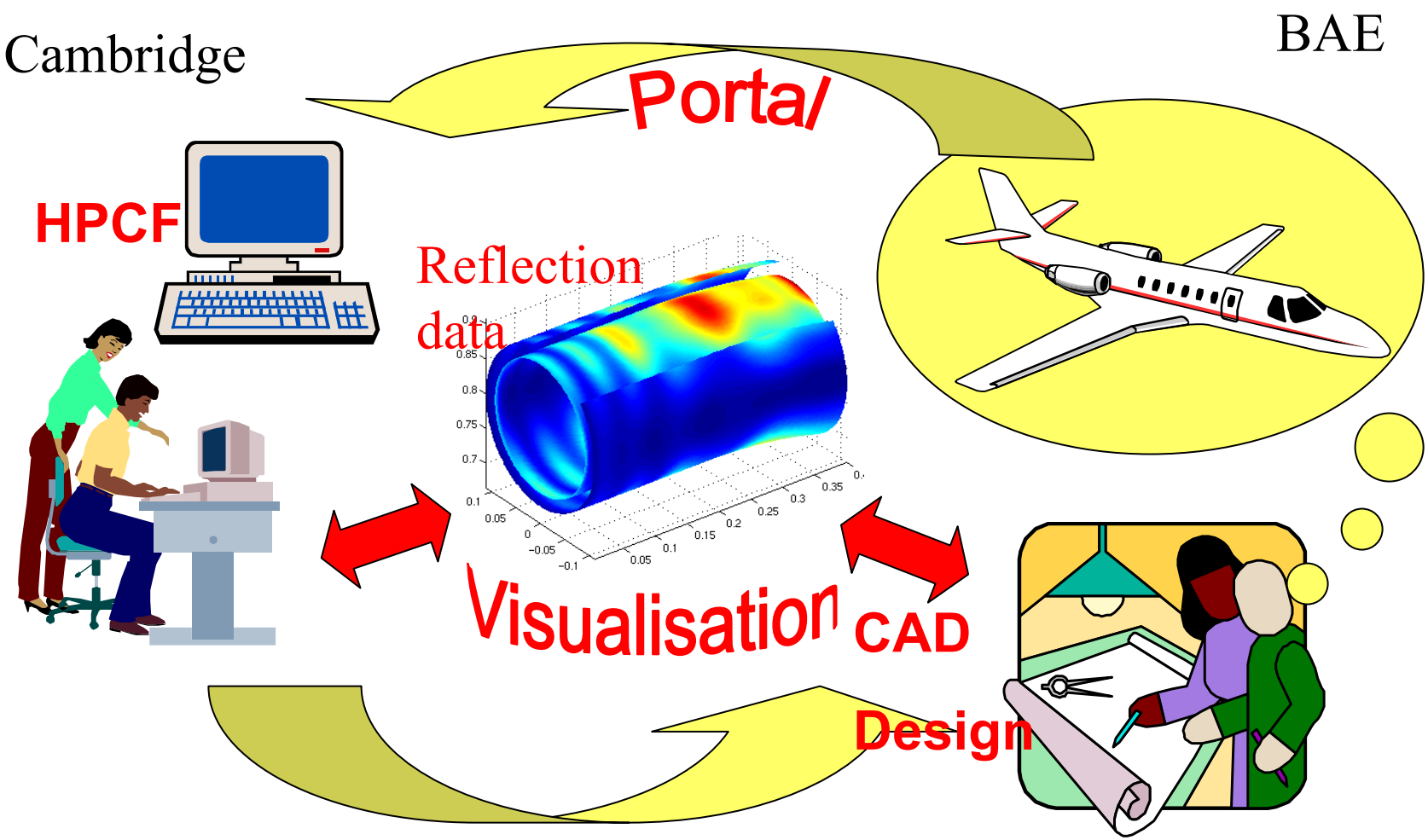
Simulate radar scattering from aircraft components
(and eventually whole aircraft)

The calculated radar cross-section is dependent
on physical shape and material properties of the object.

Results are fed back into the design process.

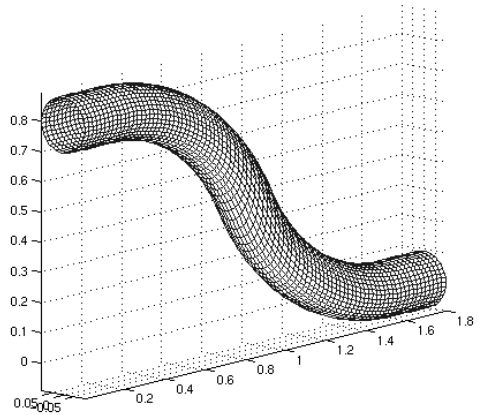
Similar applications: acoustics, non-destructive testing,
noise & vibration, medical imaging, meteorology.

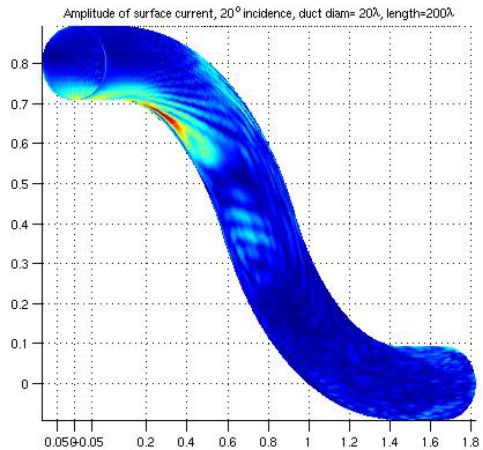
Workflow


Cambridge
BAE
Portal
HPCF
Reflection data
Visualisation
CAD
Design

Stages of the computation

- Define geometry of the object
- Calculate surface currents (2D)
- Evaluate electromagnetic field (3D)





Why is this a hard problem?

Small localised changes in the geometry or material properties will cause global changes in the scattered fields

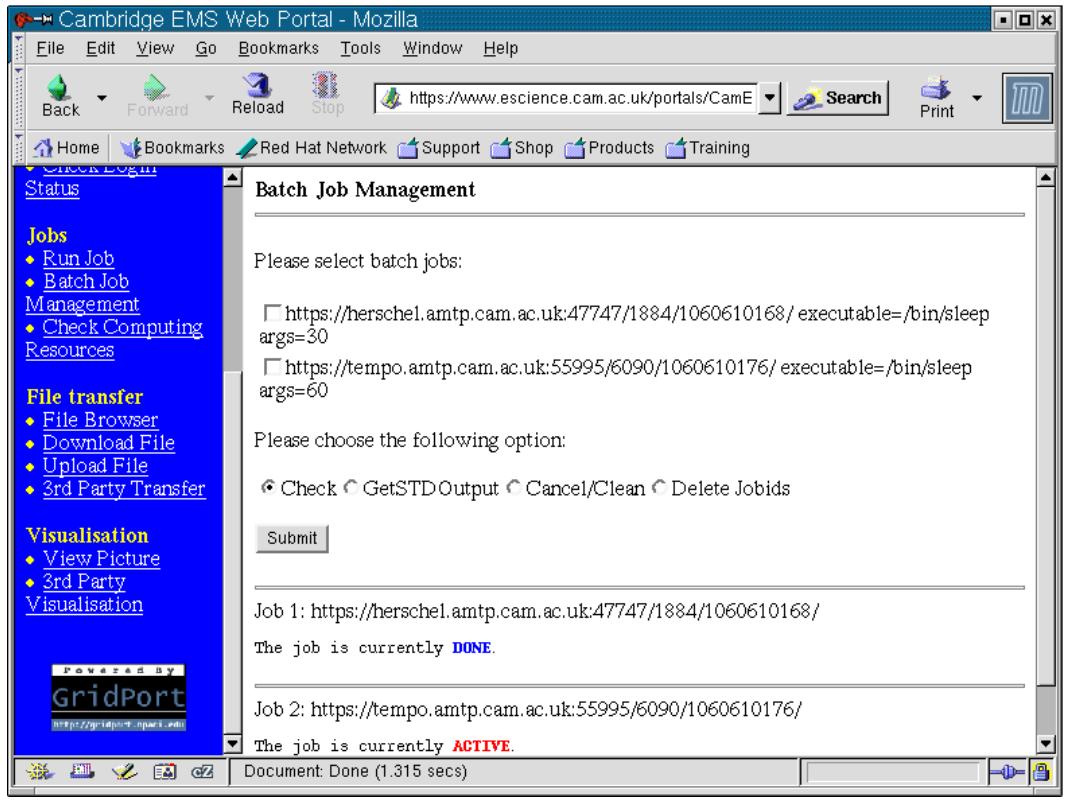
The geometry for e.g. a small engine duct is specified at 1.5x10^6 points… with a 3D complex-valued surface current at each point, giving a matrix with 10^12 elements.

The time required for an “exact” solution grows as the 6th power of the dimensions of the object

Need TeraFlop-class machines (HPCF) to solve realistic problems

Portal user interface

- Login (MyProxy)
- Submit batch jobs
- Transfer of results
- Launch visualisation

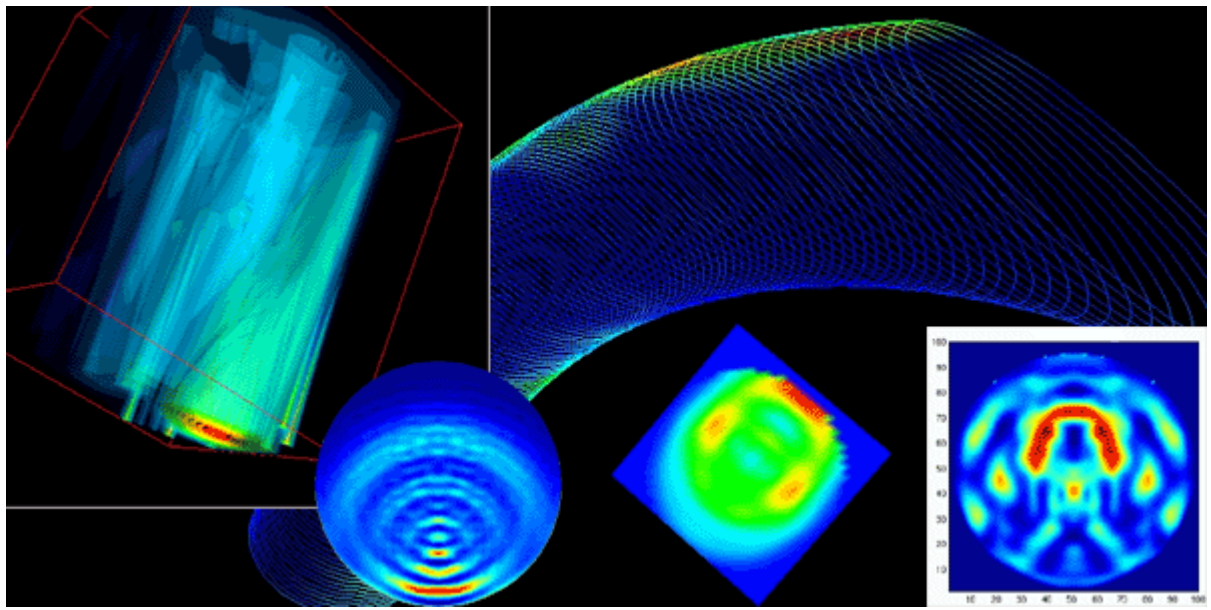


Based on GridPort v2.2 - http://gridport.npaci.edu/

Visualisation tools

Based on the Visualisation Toolkit - open source C++ library
cross platform, extendable, large user base - http://www.vtk.org

Surface currents, virtual fly through, looking for “hot-spots”



eScience components

• Portal interface to Globus-accessible compute resources: linux clusters (+HPCF & SGI O2000 at BAE)

• GridFTP of results back to visualisation workstation

• XML schema to specify & validate input parameters, plus metadata annotation of results

•Security: VPN between Cambridge & BAE

Future work

- Improved user interface for specifying geometry
- Volume rendering of electromagnetic fields
- "Patching" of surface currents to generate a quick preliminary sln
- Grid service interface to code running on HPCF
- Larger objects up to and including whole aircraft