

Grid deployment of Computational Fluid Dynamics

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Background

- Fluent supplies software for simulation of fluid flow
 - Computational Fluid Dynamics (CFD)
 - “virtual wind tunnel”
 - “design by analysis”
- Customers include large and medium engineering companies, consulting businesses, research organisations and universities
- Most customers buy software on annual licences:
 - Run on PCs, workstations and PC clusters
 - Unlimited free technical support provided with licence

Customer base

- Customers work in many industrial sectors
 - Aerospace, automotive, power, oil & gas, marine & offshore, electronics, building, biomedical, chemical and process, domestic appliances, food, water, plastics, metals, glass, etc.
- Applications are very diverse:
 - Aerodynamics, hydrodynamics, ventilation and dispersion, heat transfer and cooling, combustion, mixing and chemical reactions, air movement, droplet and particle transport, etc.

Computing requirements

- Accuracy requires high resolution of geometry – fluid region meshed to create many small cells (typically 1 to 10 million)
- Large processing requirements (2 to 500 CPU-hours per case)
- Moderate RAM requirements (up to tens of Gb)
- Moderate disk storage requirements (but growing rapidly due to increasing use of transient and unsteady simulations)
- Elements of calculation are closely coupled – not capable of parallel processing without extensive communication between processors

Towards Grid deployment

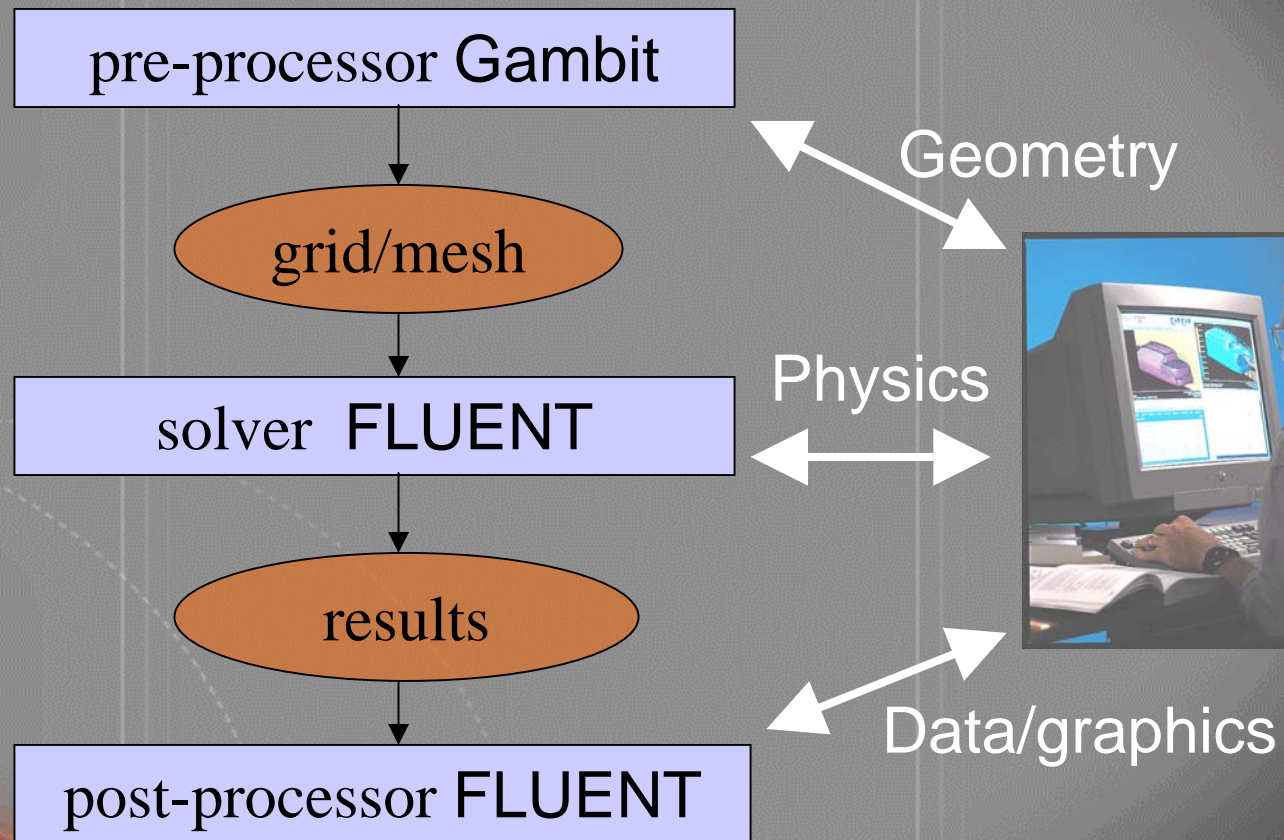
- Remote Simulation Facility
- Geodise – Grid enabled optimisation
- Virtual power plant demonstration



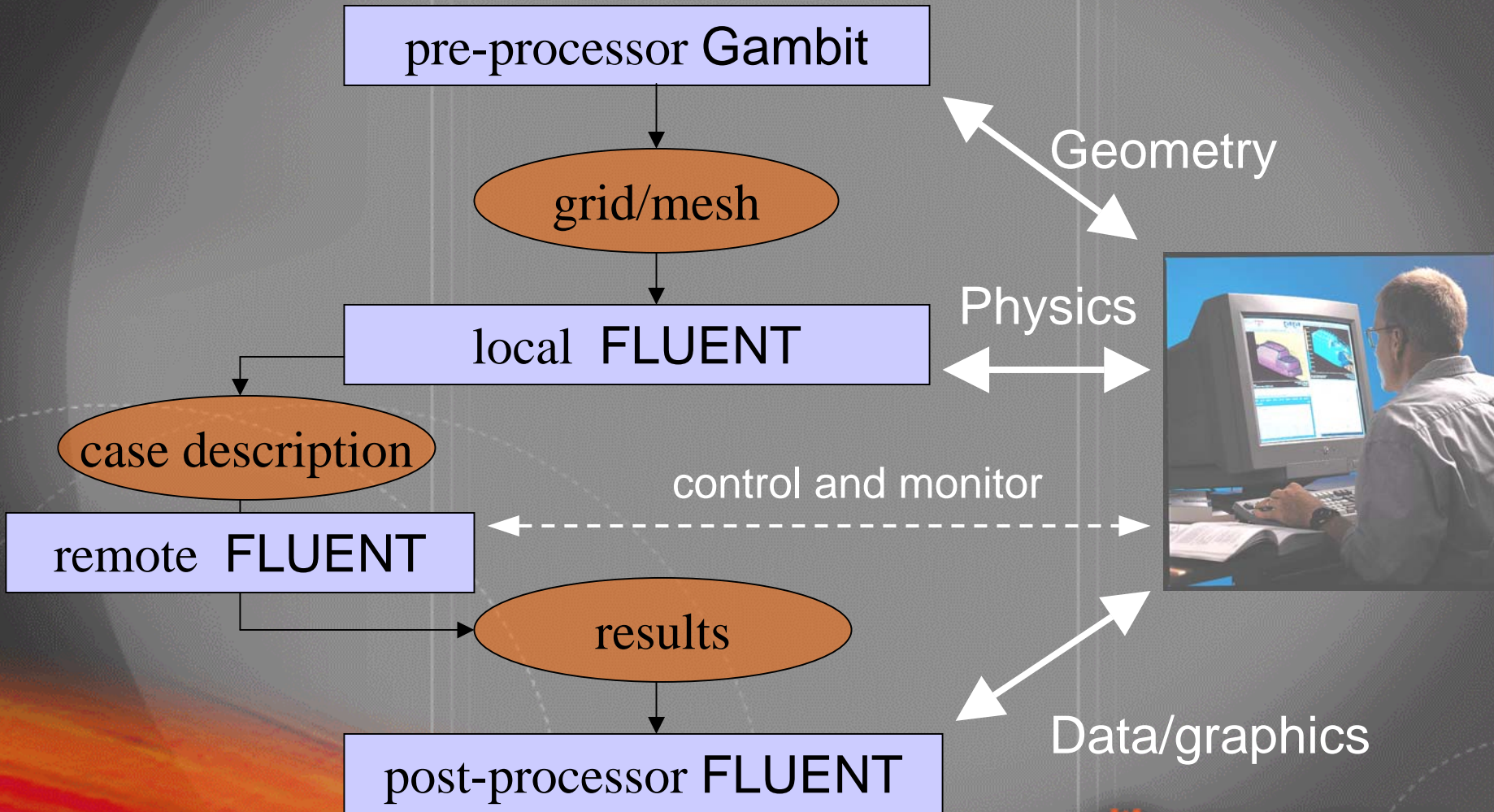
Remote Simulation Facility (RSF)

- Fluent operated compute server available via web
 - “Surge capacity” for existing licence holders
 - Powerful facility for occasional users of CFD
- 16 x 3GHz processors in Linux cluster
- Heavy emphasis on security systems
- Automatic load balancing
- Price per CPU-hour includes hardware and software
- Facility used internally as background resource for consultancy projects and development testing

Fluent software – local usage



Fluent software – RSF usage



Geodise project

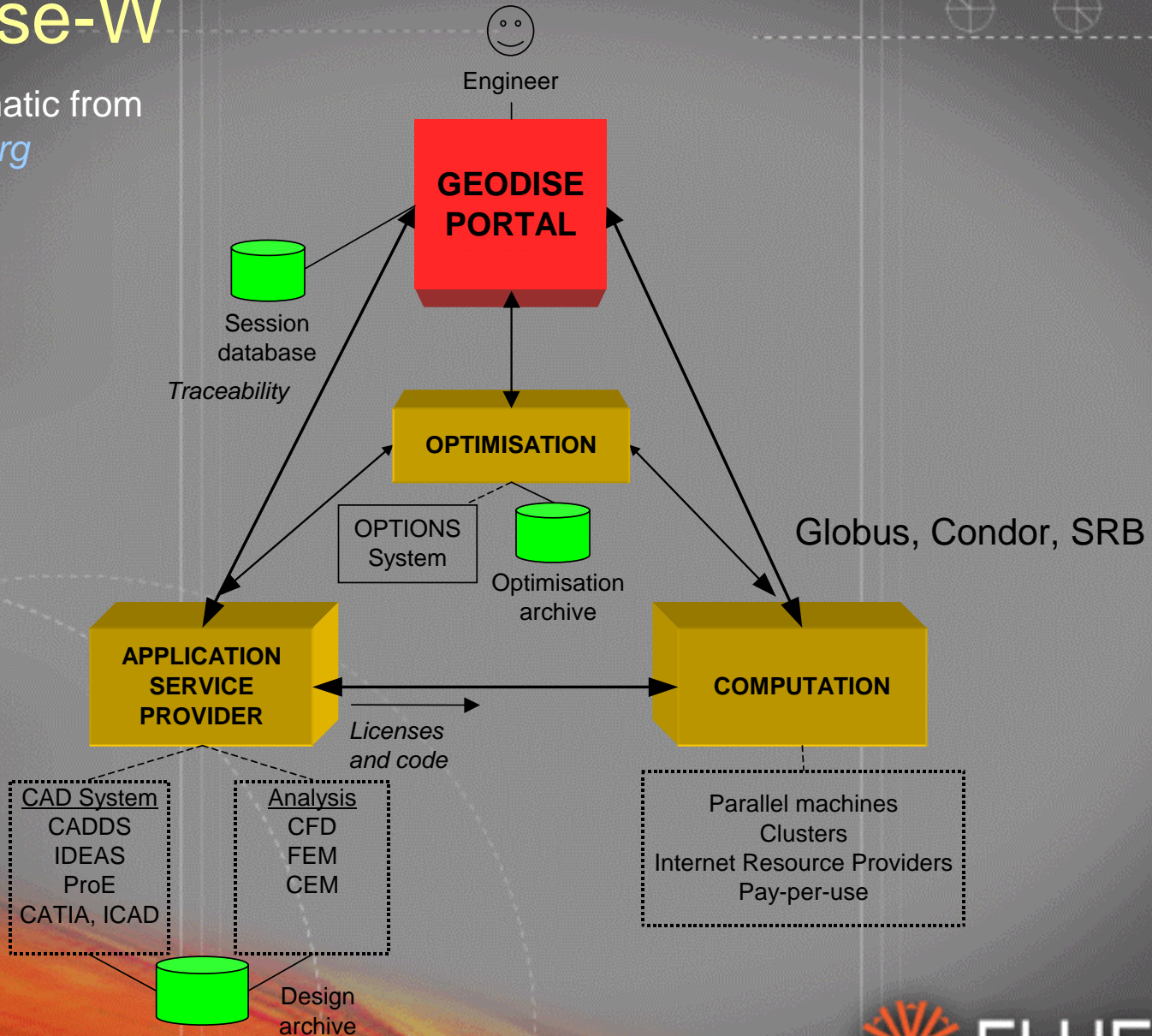
- Grid enabled optimisation and design search for engineering
- Centred at Southampton University, with input from Oxford and Manchester
- Industrial/engineering partners: BAeSystems, Rolls Royce, Fluent
- IT partners: Microsoft, Intel, Compusys, Epistemics, Condor
- Full information at www.geodise.org

Geodise objectives

- *"To bring together and further the technologies of Design Optimisation, CFD, GRID computation, Knowledge Management & Ontology in a demonstration of solutions to a challenging industrial problem"*

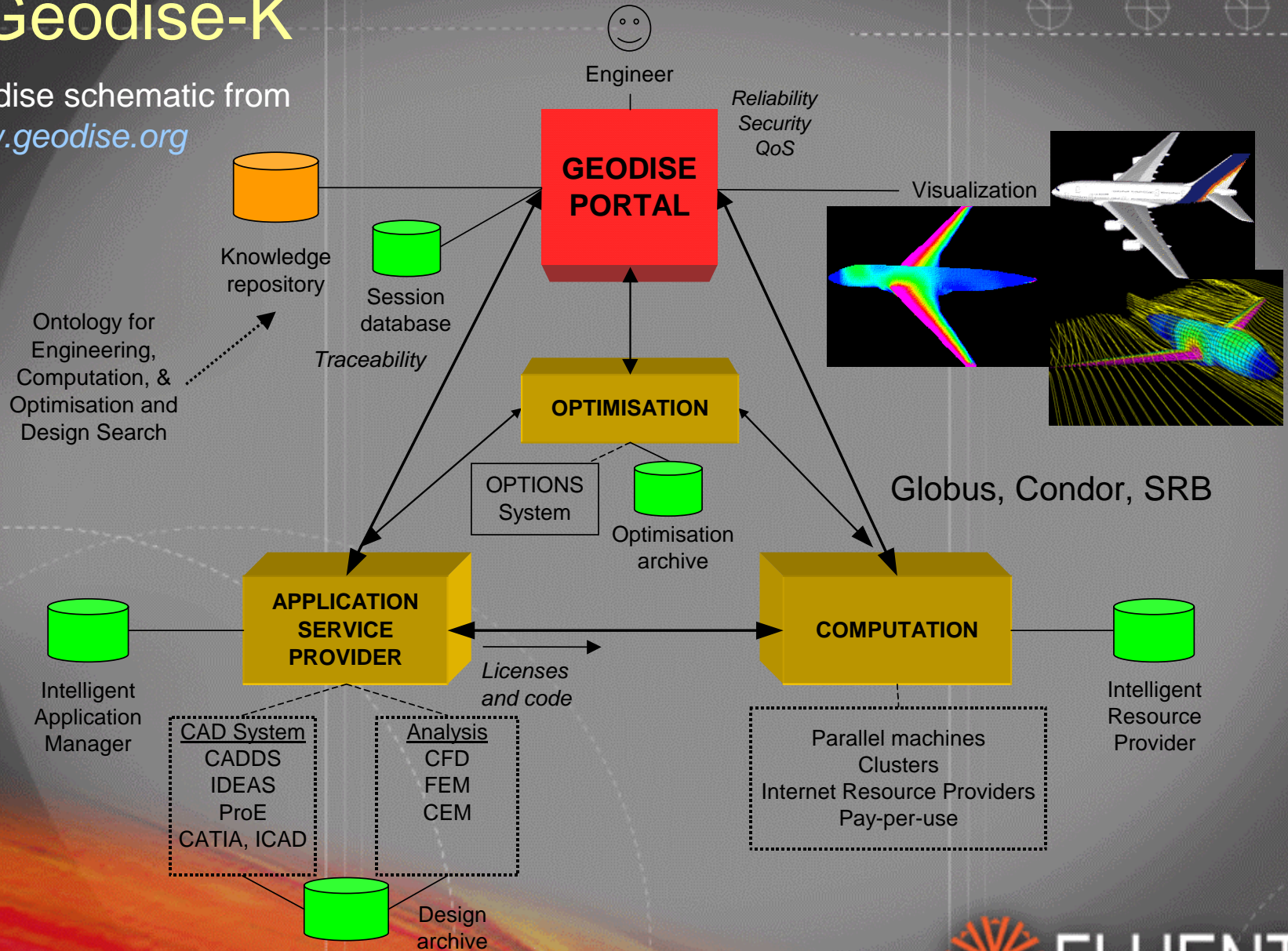
Geodise-W

Geodise schematic from www.geodise.org



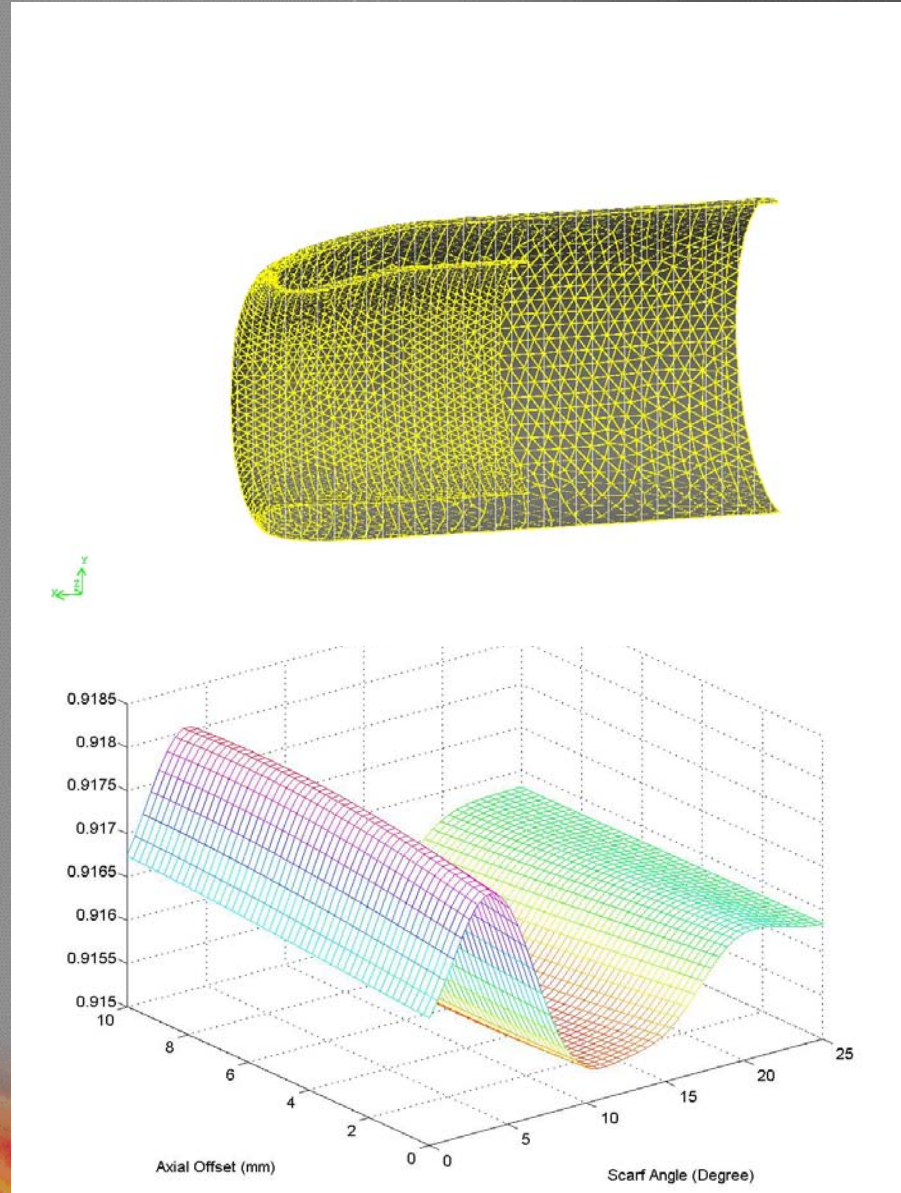
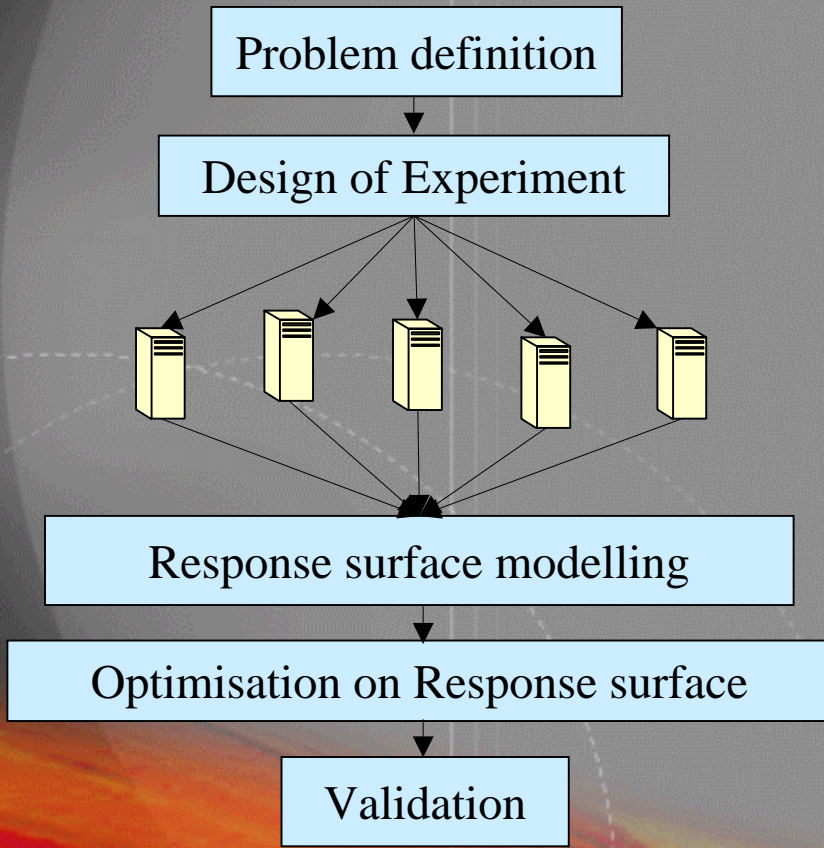
Geodise-K

Geodise schematic from www.geodise.org



Geodise example application using CFD

Figures from www.geodise.org



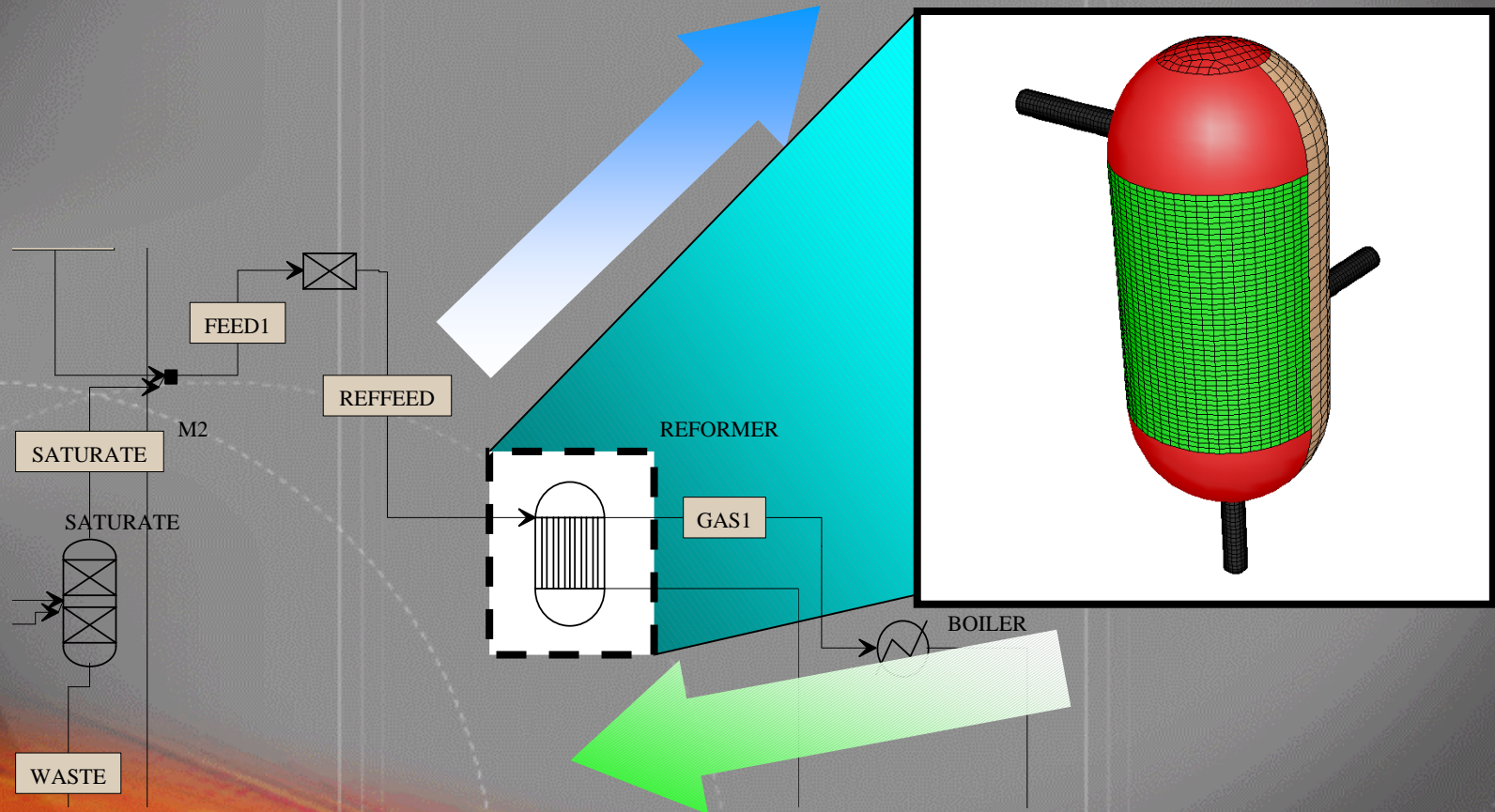


Power and process plant simulation

- Costs of demonstrators for novel full scale plant are prohibitive
 - exposes investor and constructor to high risk
 - delays introduction of new technology
- Initiatives to explore deeper use of plant simulation
 - reduce risk
 - optimise plant and equipment
 - investigate component integration
- Plant components can be simulated in different ways
 - “Performance-based” models using existing data
 - “Analysis-based” models for novel (untested) designs



CFD model embedded in plant simulation



Scheme

- Controlling software to simulate whole plant and integrate components
- Use mixture of performance and analysis based models
- Each collaborator/OEM maintains and deploys models of its components on its own server
 - does not have to release commercially sensitive performance data or models
- Controller accesses component models using appropriate secure protocols



Concluding remarks

- CFD applications have large CPU requirements and scope for exploitation of Grid technology
 - but individual simulations are best deployed on clustered processors rather than distributed networks
- Alone and in partnership, Fluent is exploring CFD applications which can take advantage of the technology
 - surge capacity, collaborative working, design optimisation
- Widespread exploitation depends on building confidence in security among clients, and developing new commercial models for service provision