

E-infrastructure, “Big Data” and the Economic Impact Opportunity The UK’s Experience

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by

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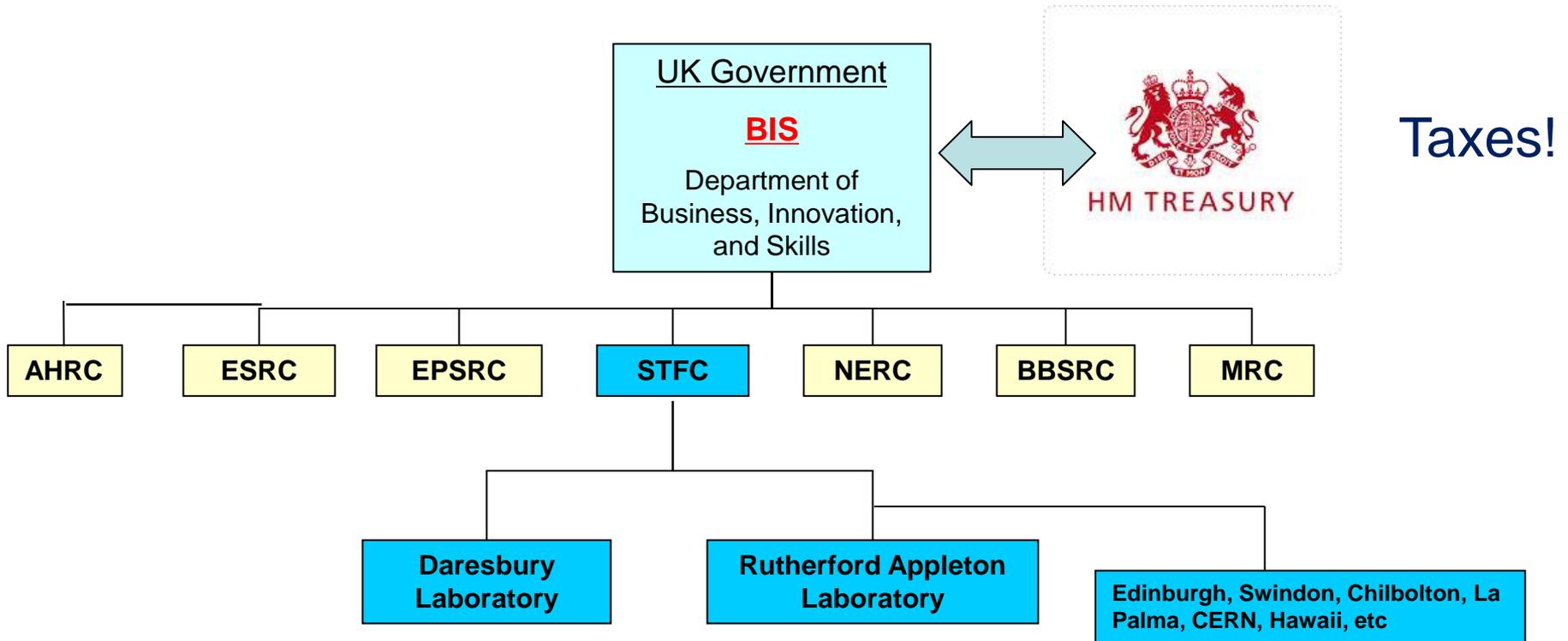
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Contents

- Introduction to STFC, the UK e-ecosystem and the position and role of the E-Infrastructure Leadership Council
- Background to the UK e-infrastructure investments (the Hartree Centre)
- Background to the UK's Big Data investments (energy efficient computing and “Square Kilometre Array” (SKA) platform development
- Consortium building across EU, ANZ, Asia-Pacific and the economic impact opportunity offered by Big Science and Big Data.....e.g. The SKA Project
- Examples of multi-use: UAVs, security, medical instruments, environmental monitoring, process monitoring, autonomy, smart cities/infrastructure, formulation chemistry



Position and Role of STFC



A key part of our mission is to ensure that investment in major facilities and peer reviewed funding for R&D *has a positive impact on the economy through innovation.*"



Major STFC Activities

UK Astronomy Technology Centre
Edinburgh, Scotland



Polaris House
Swindon, Wiltshire



Chilbolton Observatory
Stockbridge, Hampshire



Daresbury Laboratory
Daresbury Science and Innovation Campus
Warrington, Cheshire



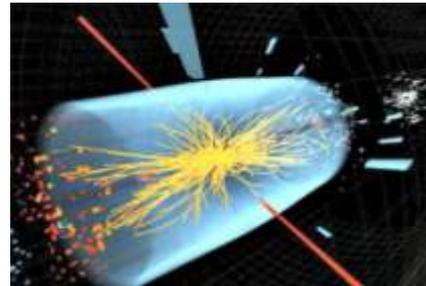
Rutherford Appleton Laboratory
Harwell Science and Innovation Campus
Didcot, Oxfordshire



Joint Astronomy Centre
Hawaii



Isaac Newton Group of Telescopes
La Palma

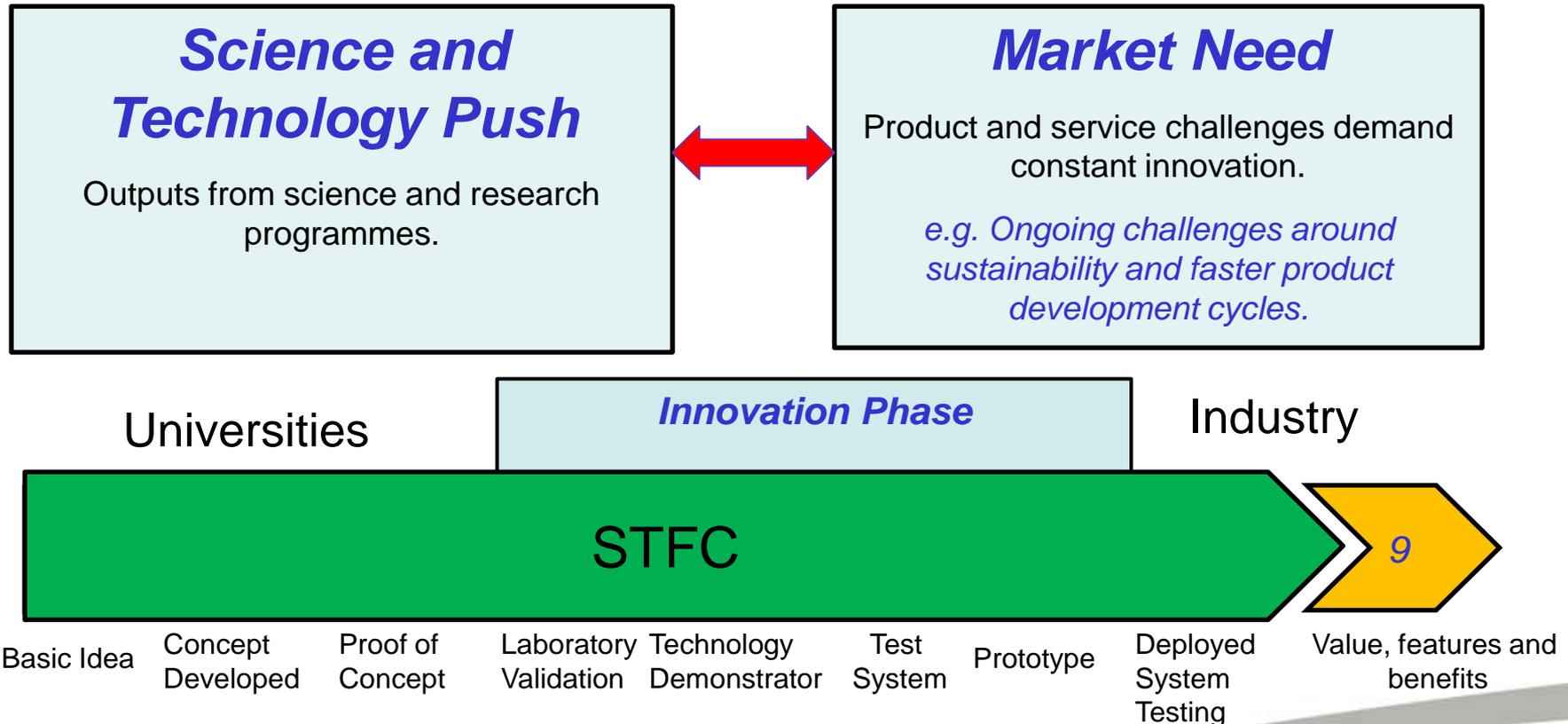


ATLAS detector
CERN

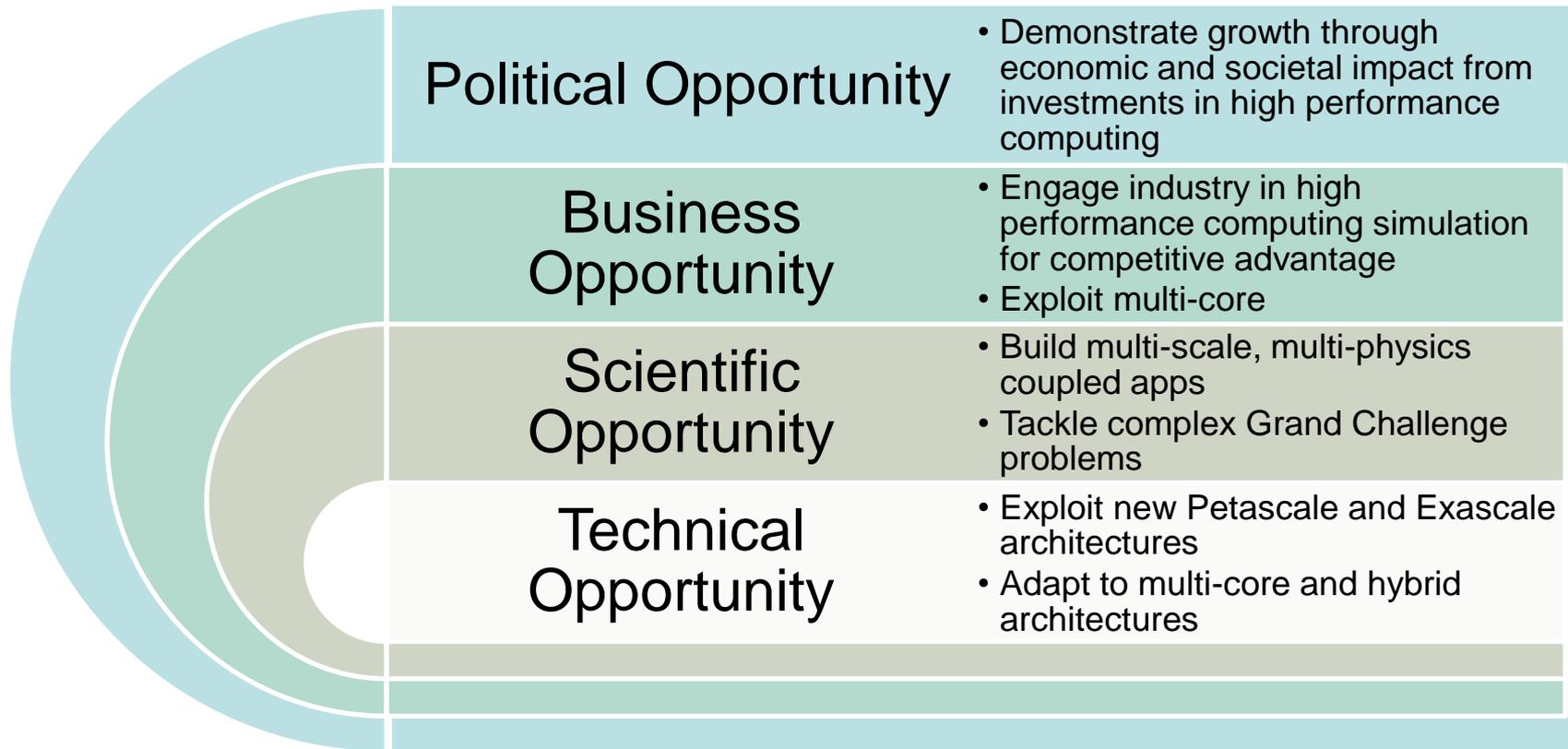
- Astronomy
- Particle Physics



STFC operates across many technology readiness levels



Background to the UK e-Infrastructure Investment

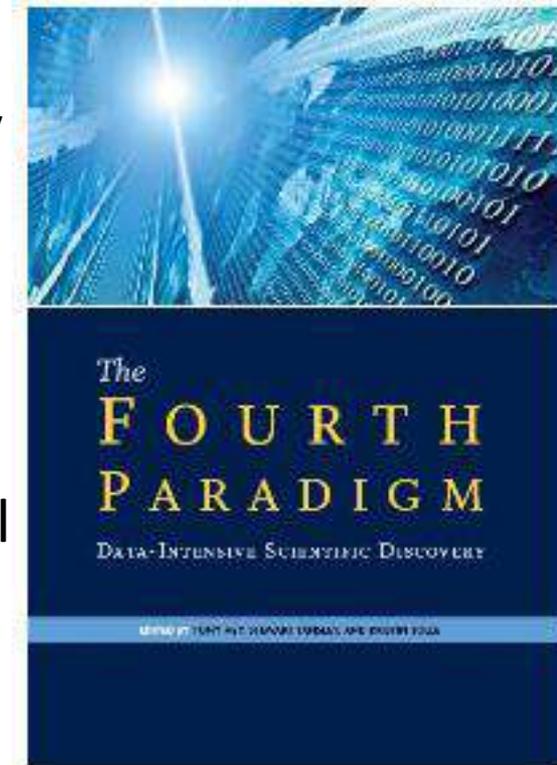


HPC can add 3% to GDP.....by making it “easy”!
Remember the 1980s....IBM PC + Windows
...% increase in GDP?



e-Infrastructure

- Key national asset in its own right
- Not just an academic tool – essential for business and industry and can add significantly to GDP
 - Increase competitiveness
 - Reduce time to market
 - Shift to higher value, higher skills
- Along with traditional theory and experimental approaches, now need e-Science to test complex theories, manage large data volumes and handle distributed collaborations



UK e-Infrastructure Investment 2011

- £145M funded by BIS covering 6 strands:
 - Skills and training
 - High capacity network (JANET)
 - Data storage and curation
 - *Advanced software development (+ISVs)*
 - Security and resilience
 - HPC hardware
 - National facilities (ARCHER)
 - Distributed facilities (e.g. DiRAC)
- Formation of an advisory Council for the Minister the “ELC”



UK Big Data Investment 2012/13

- A total of £600M across all the Research Councils:
- Of which £30M came to STFC to cover:
 - *£19M to the Hartree Centre for research into energy efficient computing (including for the SKA Project)*
 - *£11M to STFC's Astronomy Budget for the development of Platforms for the SKA Project*



The E-infrastructure Leadership Council

The E-infrastructure Leadership Council (ELC) advises government on all aspects of e-infrastructure including networks, data stores, computers, software and skills.

The ELC is responsible for developing a strategy to provide a world class e-infrastructure and High Performance Computing (HPC) capability for the UK. It works in partnership with stakeholders across the academic community, industry, government and society. The council was established in March 2012 following recommendations from the report:

[A strategic vision for UK e-infrastructure](#)

The ELC's Terms of Reference:

1. make recommendations to government on all aspects of e-infrastructure
2. be a forum in which stakeholders can exchange views and discuss all aspects of the development of e-infrastructure
3. create an action plan, including costs, setting out the elements of e-infrastructure needed in the UK
4. be open and transparent to the communities it serves



Current ELC Membership

- Minister, The Rt Hon David Willetts MP - Department for Business Innovation & Skills (joint chair)
- Dominic Tildesley – CECAM (formerly Unilever) (joint chair)
- Minister, The Rt Hon Ed Vaizey MP - Department for Culture Media & Sport
- Prof John Bancroft - Science and Technology Facilities Council (STFC)
- Prof Douglas Kell - Biotechnology and Biological Sciences Research Council (BBSRC)
- Dr Lesley Thompson - Engineering and Physical Sciences Research Council (EPSRC)
- Dr Stuart Bell - Met Office
- David Bott - Technology Strategy Board
- Dr Bob Day - Janet UK
- Paul Best - Frazer-Nash Consultancy
- Ian Dix - AstraZeneca
- David Docherty - Digital Television Group
- Darren Green – GlaxoSmithKline
- Andy Searle - Jaguar Land Rover
- Kaitlin Thaney - Digital Science
- Andy Grant - IBM
- Prof Tony Hey - Microsoft
- Sean McGuire – Xyratex (formerly Intel)
- Prof Mike Payne - University of Cambridge
- Dr Oz Parchment - University of Southampton
- Prof Peter Coveney - University College London
- Prof Robert Glen - University of Cambridge
- Prof Richard Kenway - University of Edinburgh



STFC's contribution to the UK e-infrastructure initiative

A home at Daresbury....

£3M/yr recurrent funding for 3 years....

for the creation and operation of a new UK software development and demonstration Centre dedicated to:

- Operating across all application areas
- Improving application functionality, scalability and accessibility

to enable the widest possible exploitation of the hardware provided in the capital investment.....

“The Hartree Centre”



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Douglas Rayner Hartree

The model differential analyser built at Manchester University in 1934 by Douglas Hartree and Arthur Porter made extensive use of [Meccano](#) parts: this meant that the machine was cheaper to build, and it proved "accurate enough for the solution of many scientific problems".^[25]

A similar machine built by J.B. Bratt at Cambridge University in 1935 is now in the [Museum of Transport and Technology](#) (MOTAT) collection in [Auckland, New Zealand](#).^[25]

“It may well be that the high-speed digital computer will have as great an influence on civilization as the advent of nuclear power.”



“~ 0.1 Flop”

Douglas Hartree with Phyllis Nicolson at the Hartree Digital Analyser at Manchester University, 1934

Douglas Hartree, 1936



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Facilities and Resources of the Hartree Centre



- BlueGene/Q 98,304 computer cores (~1.2PFlop)
- iDataplex cluster 8,192 Sandybridge cores (~200 Tflop)
- Over 5 PB disc and 15 PB tape stores
- ScaleMP enabled data Intensive system
- 54 Seat Training Centre
- 4 Visualisation suites



Overview of Daresbury Campus

- One of two National Science and Innovation Campuses
 - Co-location of science & business
 - Embedded science facilities
 - Open innovation
 - 108 High Tech companies
 - Nearly 20% international companies
 - Nearly 10% originated from universities
 - “Silver-haired brigade”



- New Campus Joint-Venture established in December 2010:

- The Campus currently consists of:
 - STFC Daresbury Laboratory
 - Hartree Centre
 - Cockcroft Institute
 - Daresbury Innovation Centre
 - Vanguard House
 - I-TAC Laboratory
 - About 900 people on the campus



“Internationally-recognised for world-class science, innovation & enterprise”



The Virtual Engineering Centre

Virtual Test & Engineering Reliability

Autonomous & Intelligent Systems

Digital Design & Manufacture

Design integration

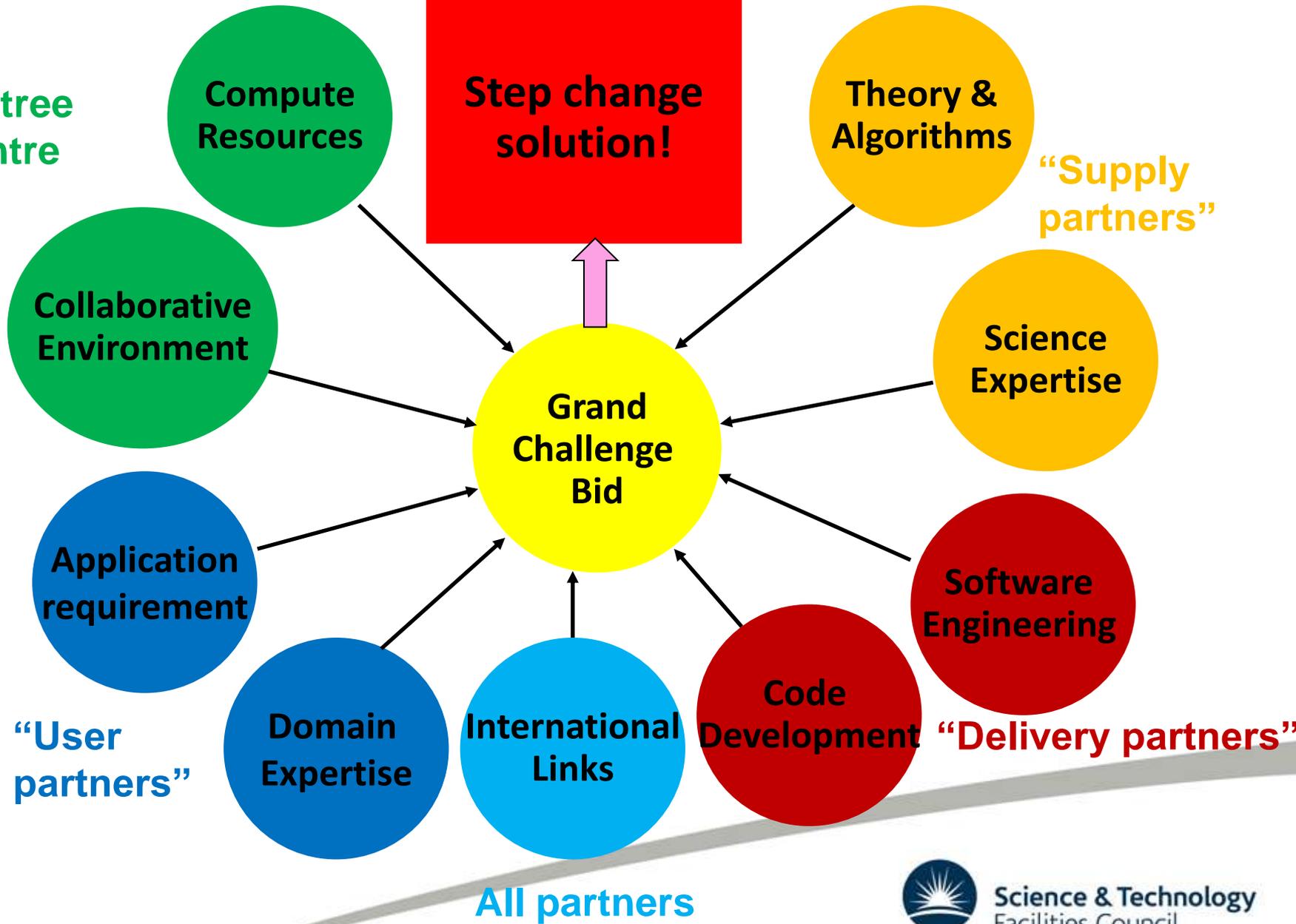


Business Model

- **Identify Scientific and Societal Grand Challenges**
- **Generate technological route-maps**
- **Define initial technology steps**
- **Identify Strategic commercial partners**
- **Identify Apps needed.....(proprietary/open?)**
- **Build multi-client consortia around defined technology steps**
- **Identify and seek Public co-funding**
 - **Government co-funded**
 - **Academic co-funded**
- **Target quick fixes wherever possible**
- **Ensure long term revenue and benefit share**



Hartree
Centre

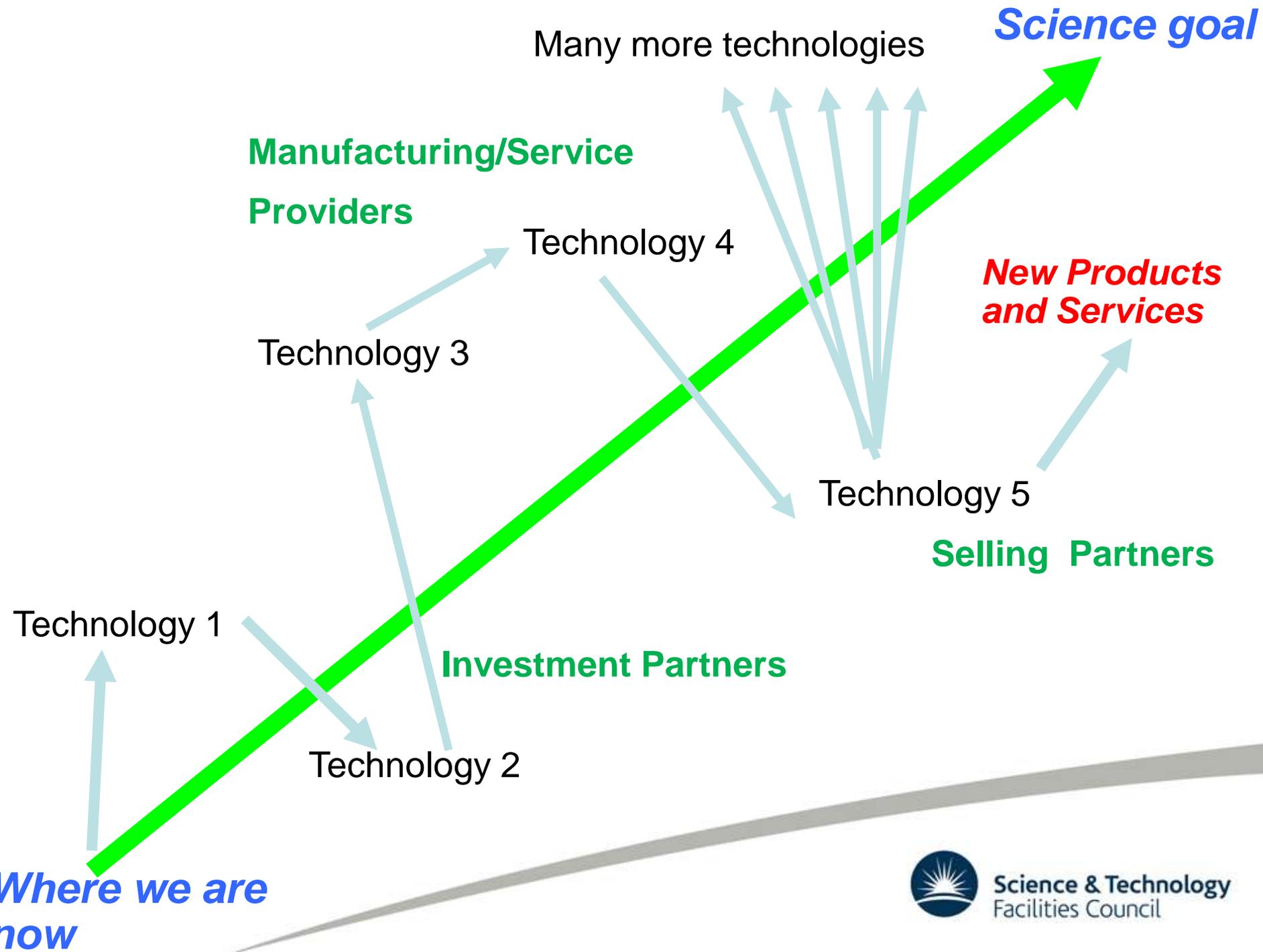


All partners



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Where we are now



Manufacturing/Service Providers

Many more technologies

Science goal

Technology 3

Technology 4

New Products and Services

Technology 5

Selling Partners

Technology 1

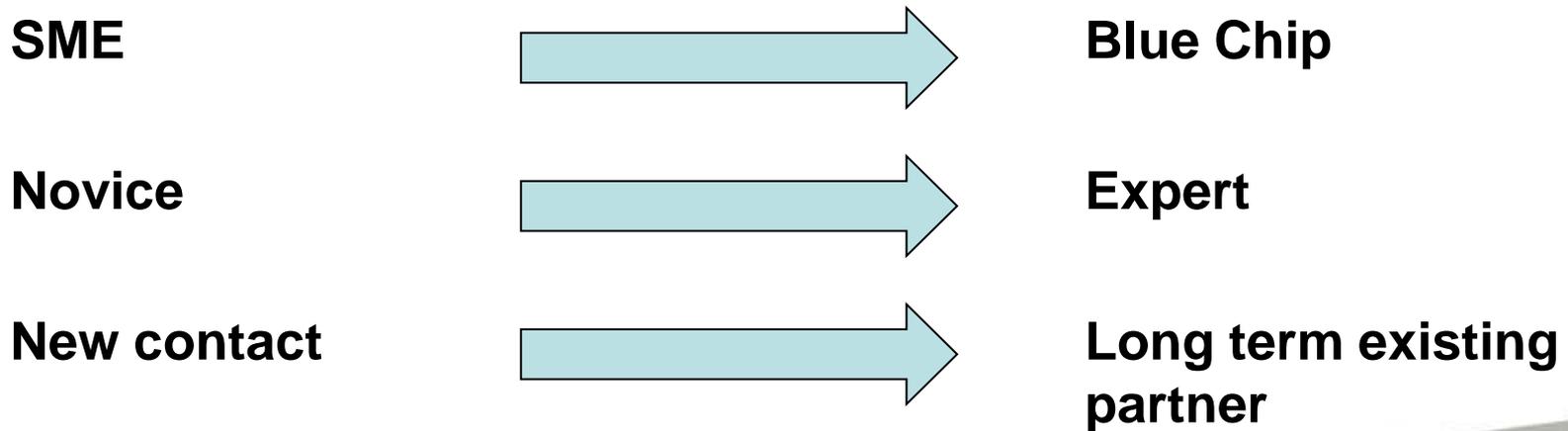
Investment Partners

Technology 2



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Partner Segmentation



Approach

Find the value.....often client specific, but categories do exist

Industry

Blue chips



access to cycles (the Cloud), training

SMEs



access to "on-ramps", access to Blue Chip customers, consultancy

Academia



added functionality, scalability

Government



economic impact!



Engaging SMEs



Growing Autonomous Mission Management Applications (“GAMMA”)

Aimed at developing [enhanced value supply chains of SMEs](#)

Adapting existing software applications (‘apps’) supported by sensor integration for managing mission management systems for autonomous unmanned vehicles.

Lead Partners include:- North West Aerospace Alliance (NWAA), BAE Systems, Universities of Manchester, Lancaster, Salford, UCLAN, Liverpool (including the Virtual Engineering Centre), National Nuclear Laboratories Ltd, Lancashire County Council.

<http://gammaprogramme.co.uk/>

Supported by the
 Regional Growth Fund



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SKA Requirements

- Dishes, feeds, receivers (N=2500)
- Low and mid aperture arrays (N=250)
- Signal transport (10 petabit/s)
- Signal processing (exa-MACs)
- Software engineering and algorithm development
- High performance computing (exa-flop capability)
- Data storage (exa-byte capacity)
- (Distributed) power requirements (50 -100 MW)

**INDUSTRY ENGAGEMENT IS CENTRAL TO
THE SKA**



Economic Impact Opportunities

- **SKA Project.....a good example**
 - **CSP**
 - **SDP**

Other applications for the technology roadmap

- **Antennas**
 - **Printed**
 - **Auto-industry (auto-radar)**
- **Remote sensing (UAVs)**
 - **Environment**
 - **Pollution**
 - **Condition monitoring**
 - **Infrastructure**
 - **Asset: property, process plant, herds, crops**
- **Data fusion and mining for decision support**
 - **Smart government**
 - **Smart cities, infrastructure**



Example: “Cloud” accelerated formulation

Smart Middleware-enabled.....

The development of novel computational model - Dissipative Particle Dynamics (DPD) for use in industrial R&D for formulated products

- Accelerate new discovery and reduce time to market in >3 Markets
- Design virtually, verify experimentally



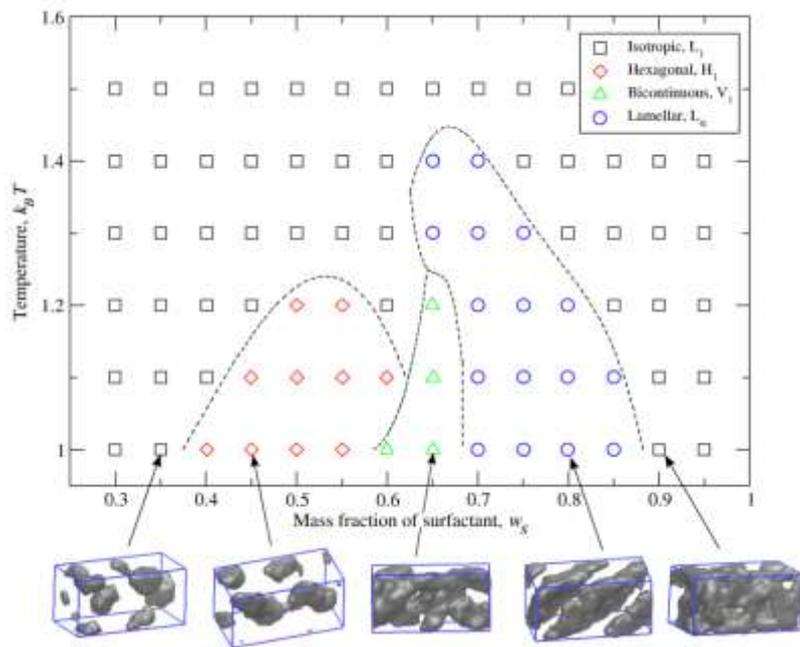
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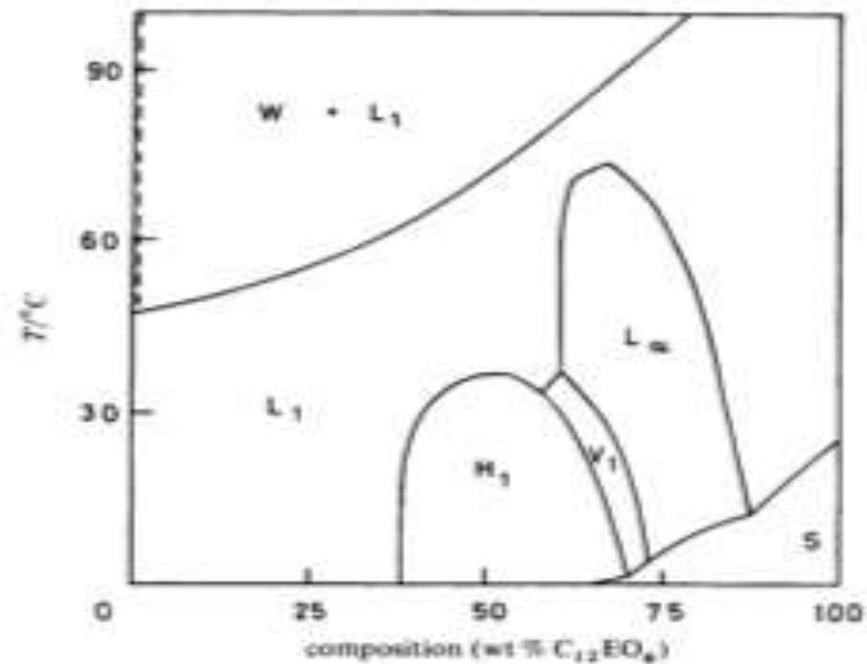
UNIVERSITY OF LEEDS



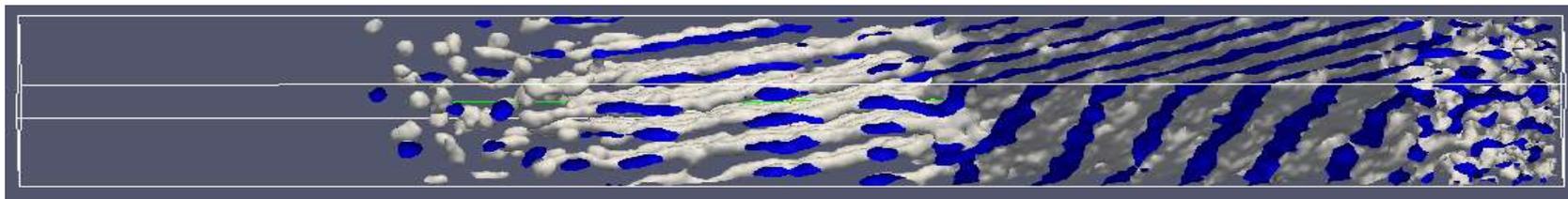
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Calculation



Experiment



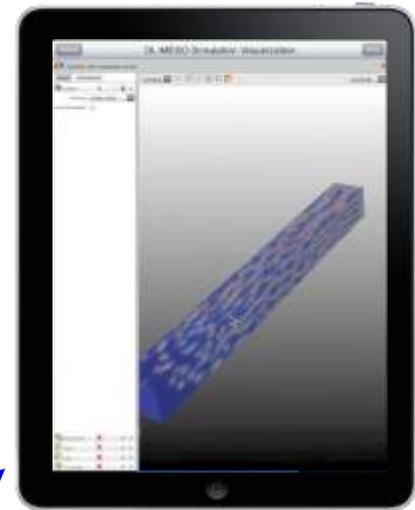
Multiple Inputs



Scenario: Chemists consult – change experimental design, run multiple simulations from mobile device in the lab to see what best choices of chemicals.

Parameters changed at bench on mobile device and results sent back to mobile device.

Results



Consumable HPC



Logs of Jobs

Overview of Running Jobs



Summary

- The UK is committed to exploiting HPC, to exploit Big Data in particular, to help to rebalance its economy
- New software is absolutely vital
- A new licensing model is needed from ISVs
- Software development is needed to:
 - Enhance functionality and scalability of Applications
 - Enhance the accessibility and usability of hardware (especially the Cloud-provided)and so enable academia, industry and commerce to exploit the latest e-infrastructure computing technologies in their activities and Businesses
- We need to make “HPC” into just “C”
.....make it “normal”
- The e-infrastructure initiative is key to this effort
as it is everywhere!

