E-infrastructure, "Big Data" and the Economic Impact Opportunity The UK's Experience

October 2013

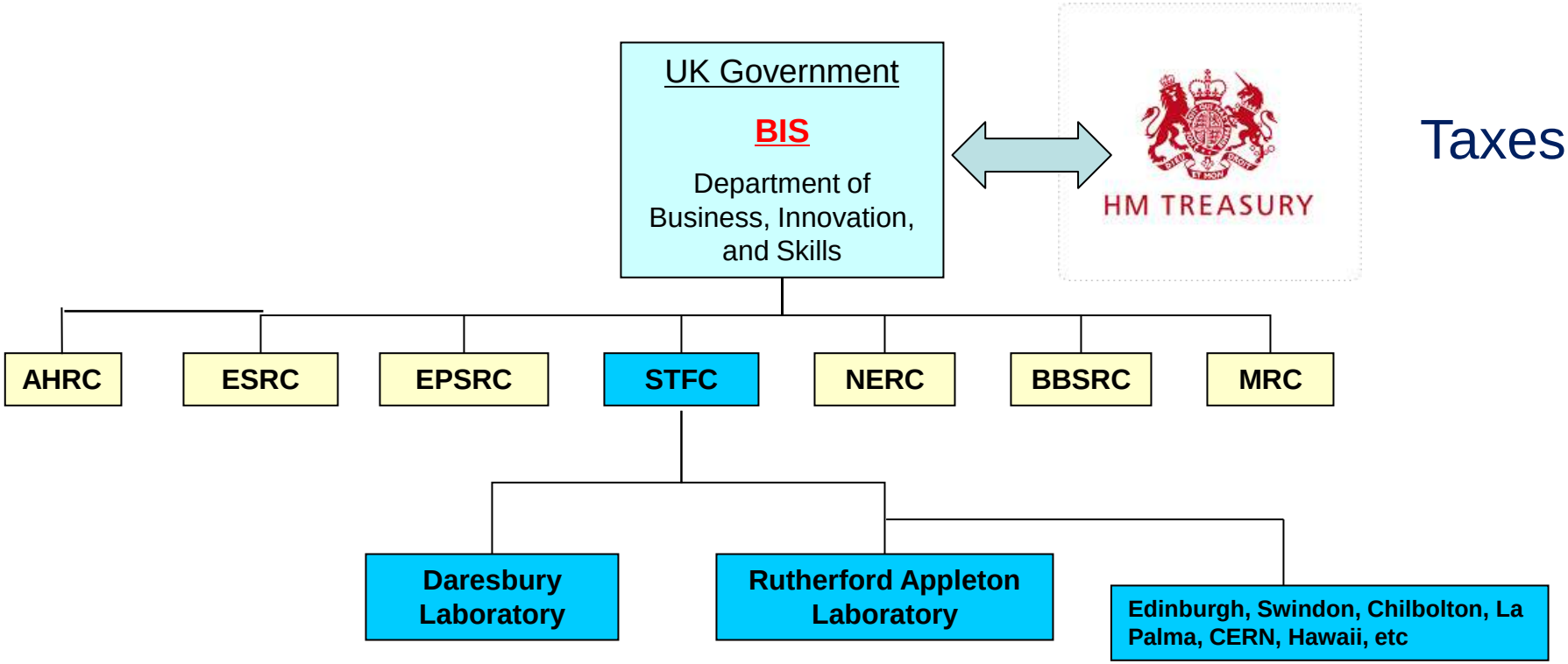
by
Professor John Bancroft
Head of Project Development in Asia-Pacific, STFC
Head of SKA Commercial Interactions, The Hartree Centre
Head of International Partnerships, The Hartree Centre

Science & Technology Facilities Council

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*."

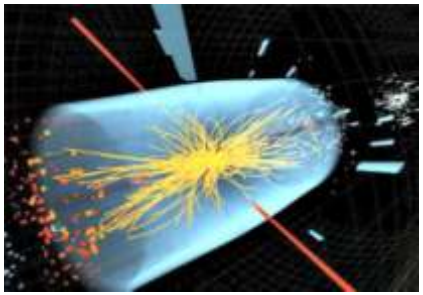
Science & Technology Facilities Council

Major STFC Activities

- Astronomy
- Particle Physics

Joint Astronomy Centre
Hawaii

Isaac Newton Group of Telescopes
La Palma



ATLAS detector
CERN

Science & Technology Facilities Council

STFC operates across many technology readiness levels

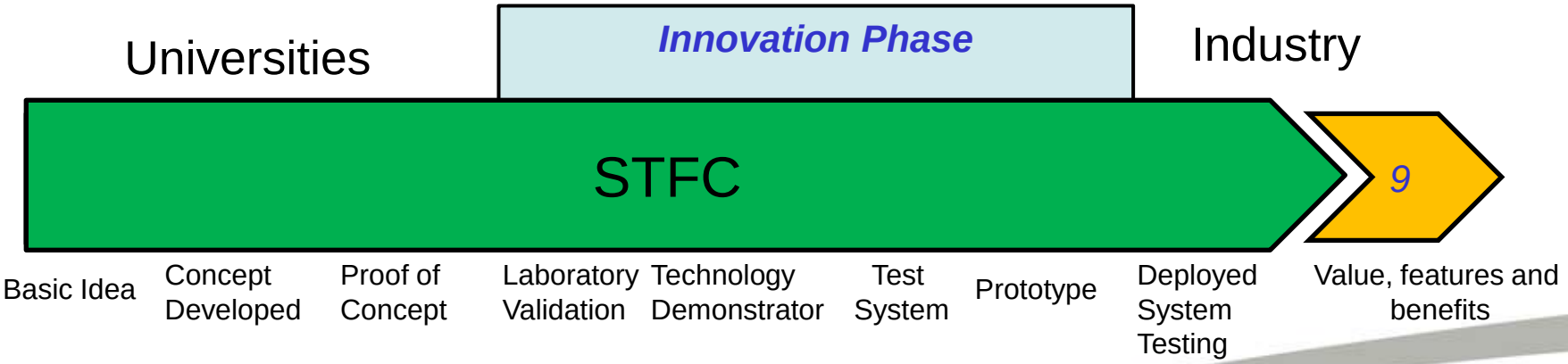
Science and Technology Push

Outputs from science and research programmes.

Market Need

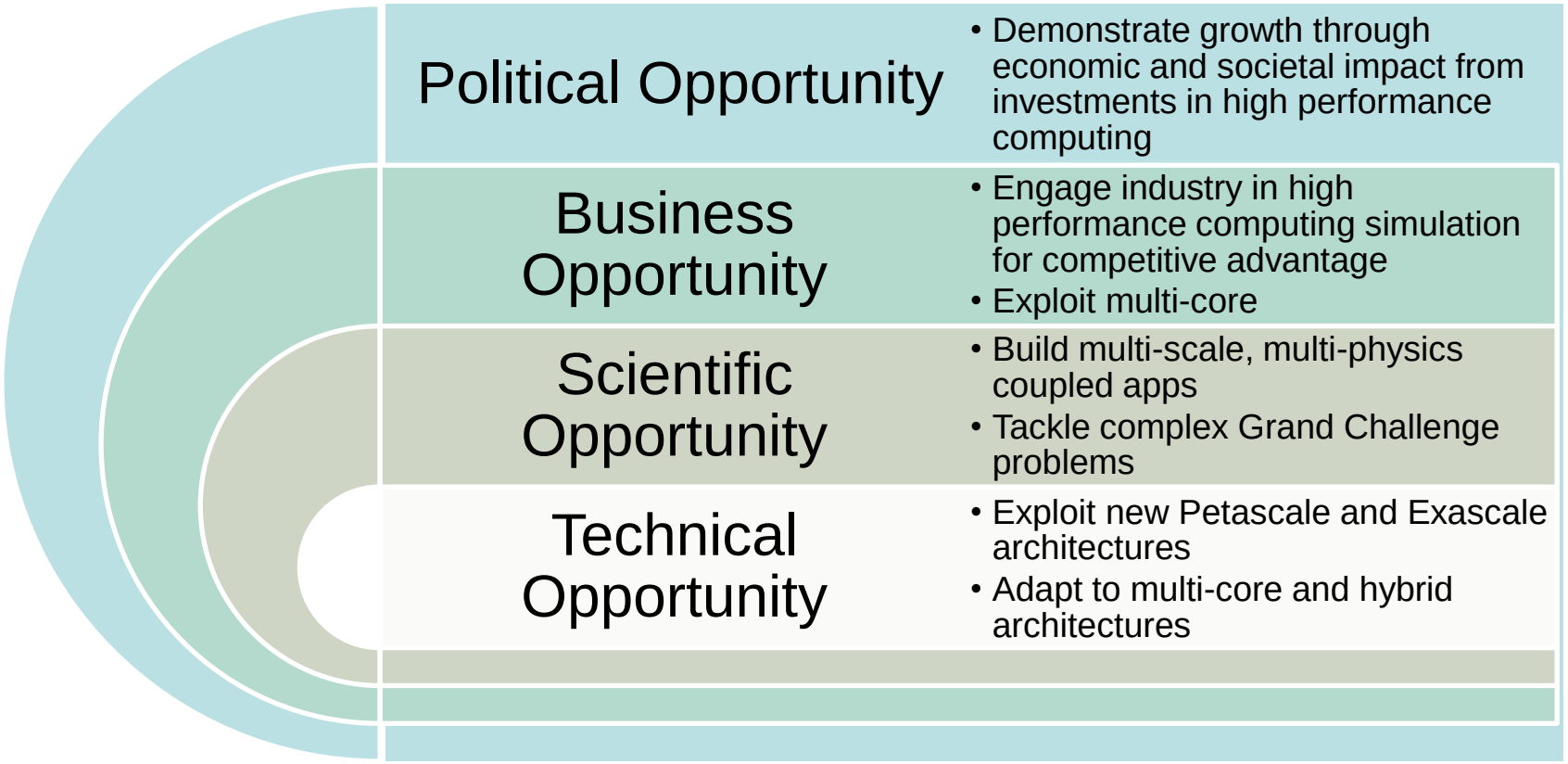
Product and service challenges demand constant innovation.

e.g. Ongoing challenges around sustainability and faster product development cycles.



Science & Technology Facilities Council

Background to the UK e-Infrastructure Investment

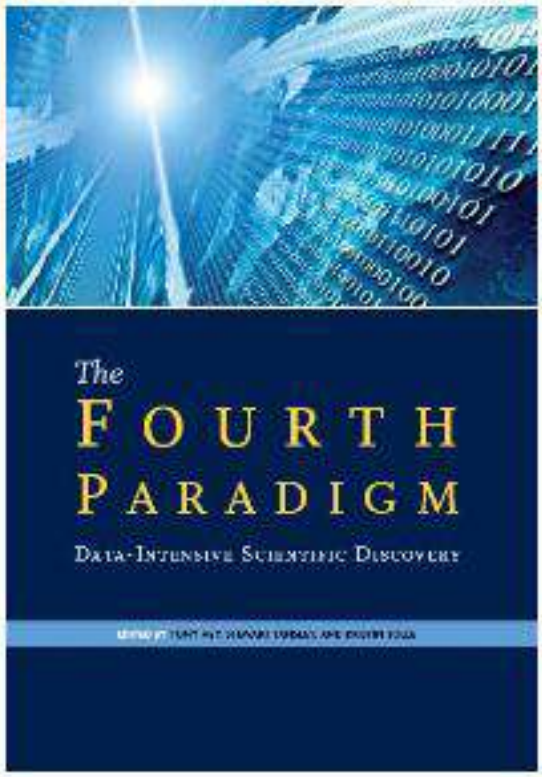


HPC can add 3% to GDP.....by making it “easy”!
Remember the 1980s....IBM PC + Windows
...% increase in GDP?

Science & Technology Facilities Council

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



Science & Technology Facilities Council

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”

Science & Technology Facilities Council

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***

Science & Technology Facilities Council

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

Science & Technology Facilities Council

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

Science & Technology Facilities Council

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"

Science & Technology Facilities Council

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."

Douglas Hartree, 1936

"~ 0.1 Flop"

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

Science & Technology Facilities Council

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

Science & Technology Facilities Council

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"

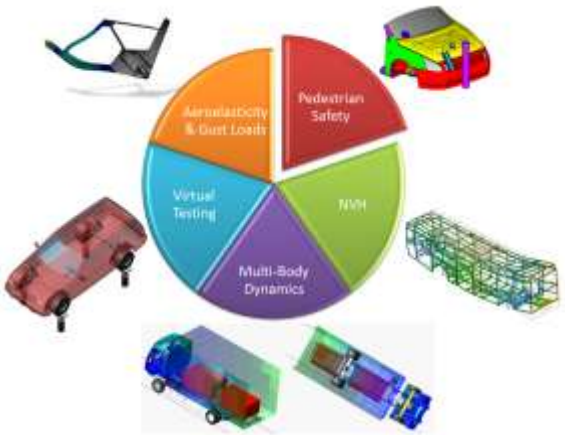
The Virtual Engineering Centre

Virtual Test & Engineering Reliability

Autonomous & Intelligent Systems

Digital Design & Manufacture

Design integration



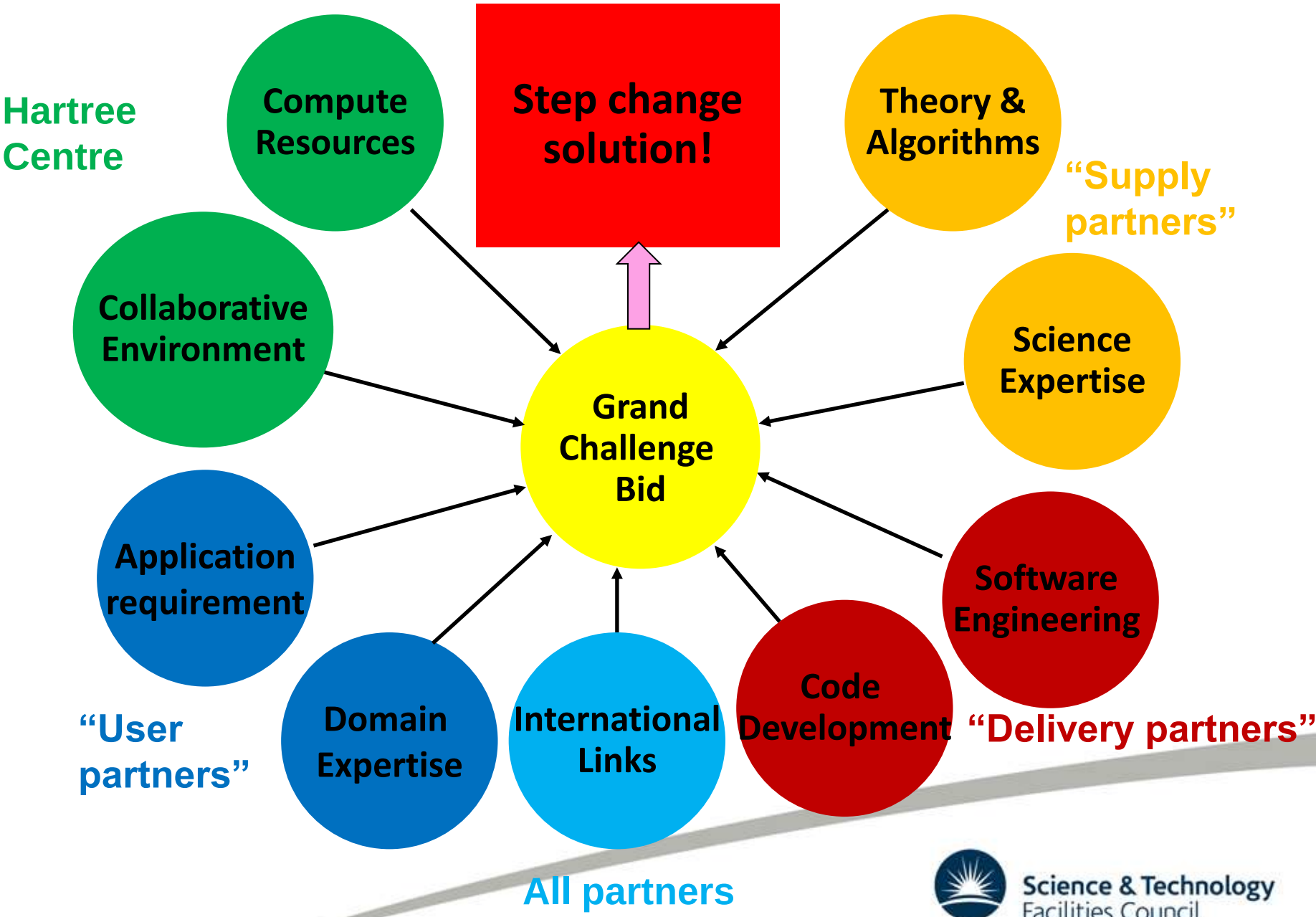
Virtual Labs

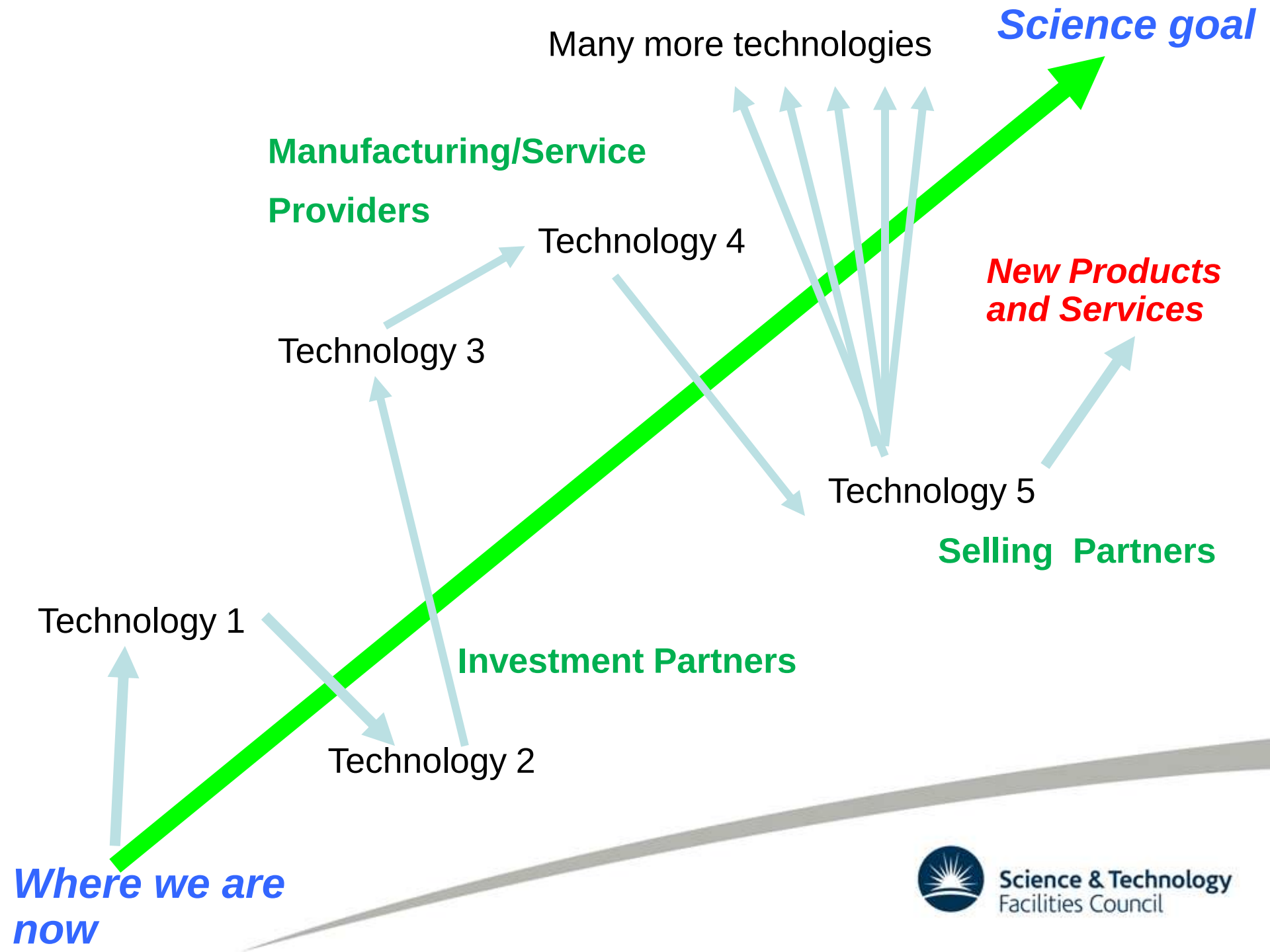
Science & Technology Facilities Council

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

Science & Technology Facilities Council


Hartree Centre
Compute Resources
Step change solution!
Theory & Algorithms
"Supply partners"
Collaborative Environment
Science Expertise
Grand Challenge Bid
Application requirement
Software Engineering
"User partners"
Domain Expertise
International Links
Code Development
"Delivery partners"
All partners
Science & Technology Facilities Council


Science goal
Many more technologies
Manufacturing/Service
Providers
Technology 4
New Products
and Services
Technology 3
Technology 5
Selling Partners
Technology 1
Investment Partners
Technology 2
Where we are
now
Science & Technology
Facilities Council

Partner Segmentation

“Supply”	“Delivery”	“User”
Academia	Public sector	Industry

SME	Blue Chip
Novice	Expert
New contact	Long term existing partner

Science & Technology Facilities Council

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!***

Science & Technology Facilities Council

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

Science & Technology Facilities Council

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**

Science & Technology Facilities Council

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

Science & Technology Facilities Council

UNIVERSITY OF LEEDS

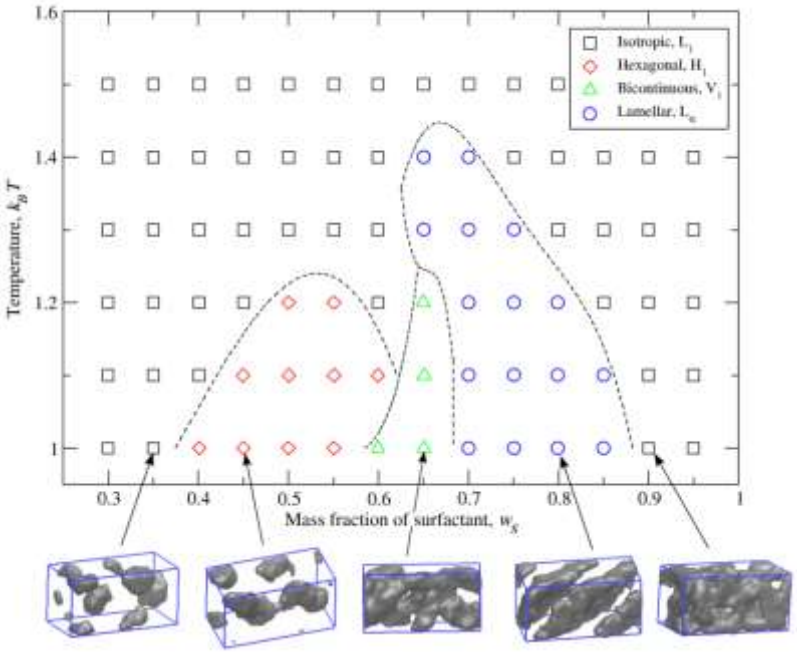
Novidec
Data Driven Decisions

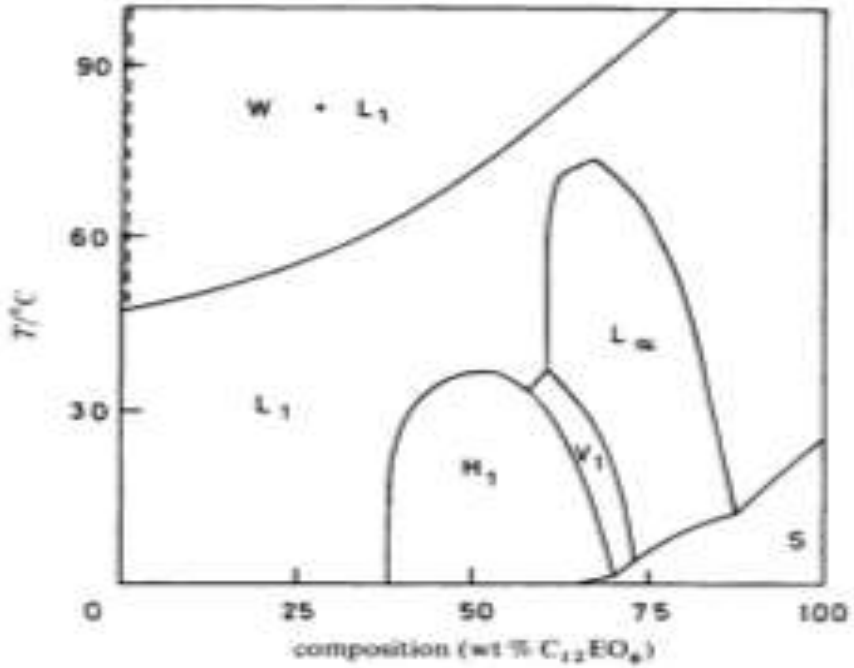
Unilever

syngenta

Infineum

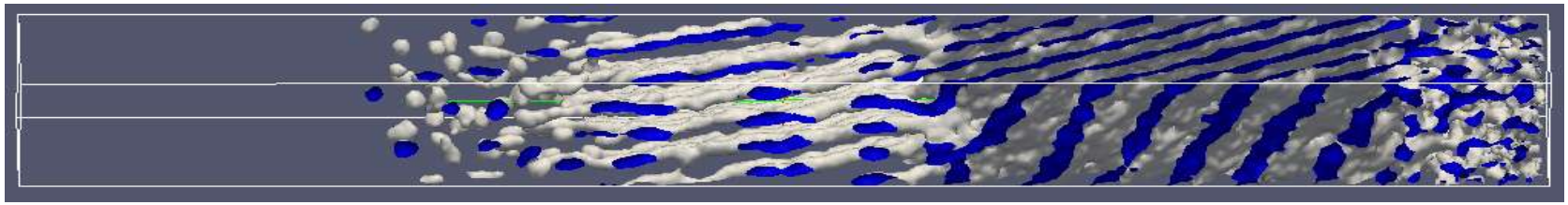
Science & Technology Facilities Council





Calculation

Experiment



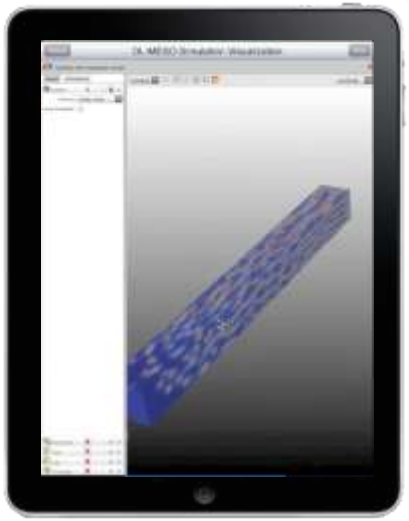
Science & Technology Facilities Council

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

Science & Technology Facilities Council

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!

Science & Technology Facilities Council