Opportunities within the UK's Civil SPACE Programme: Presentation to Seminar on Smart Optics

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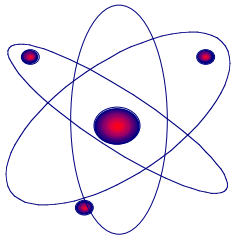
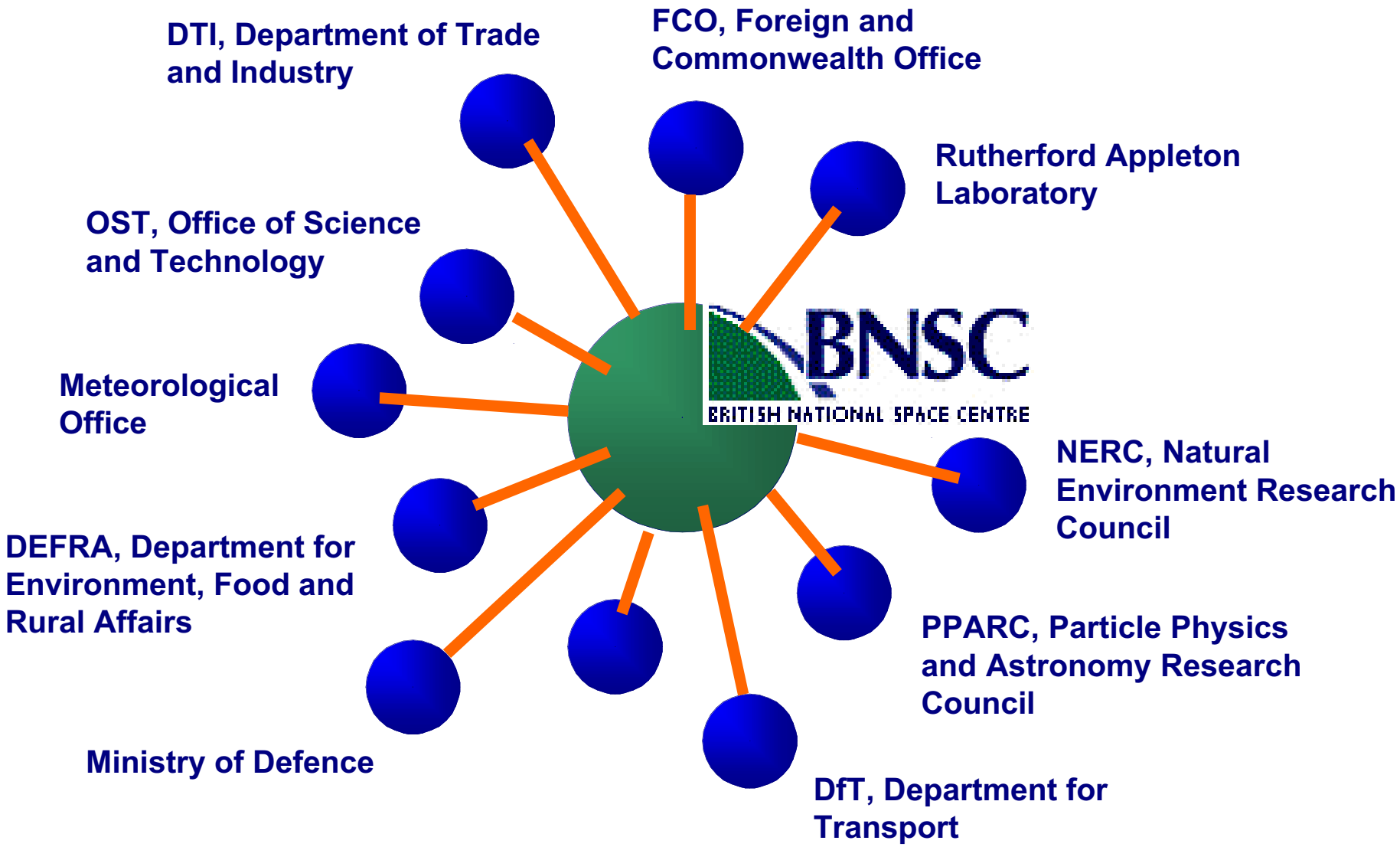


British National Space Centre

- Access to space is complex and expensive, and needs partnerships to succeed

- There is a need for a centre:
  - to co-ordinate space activity in UK
  - to evolve policy about space in UK
  - to invest in UK space industrial development
  - to represent the UK space programme to other countries and to international organisations

BNSC - FOCAL PARTNERSHIP



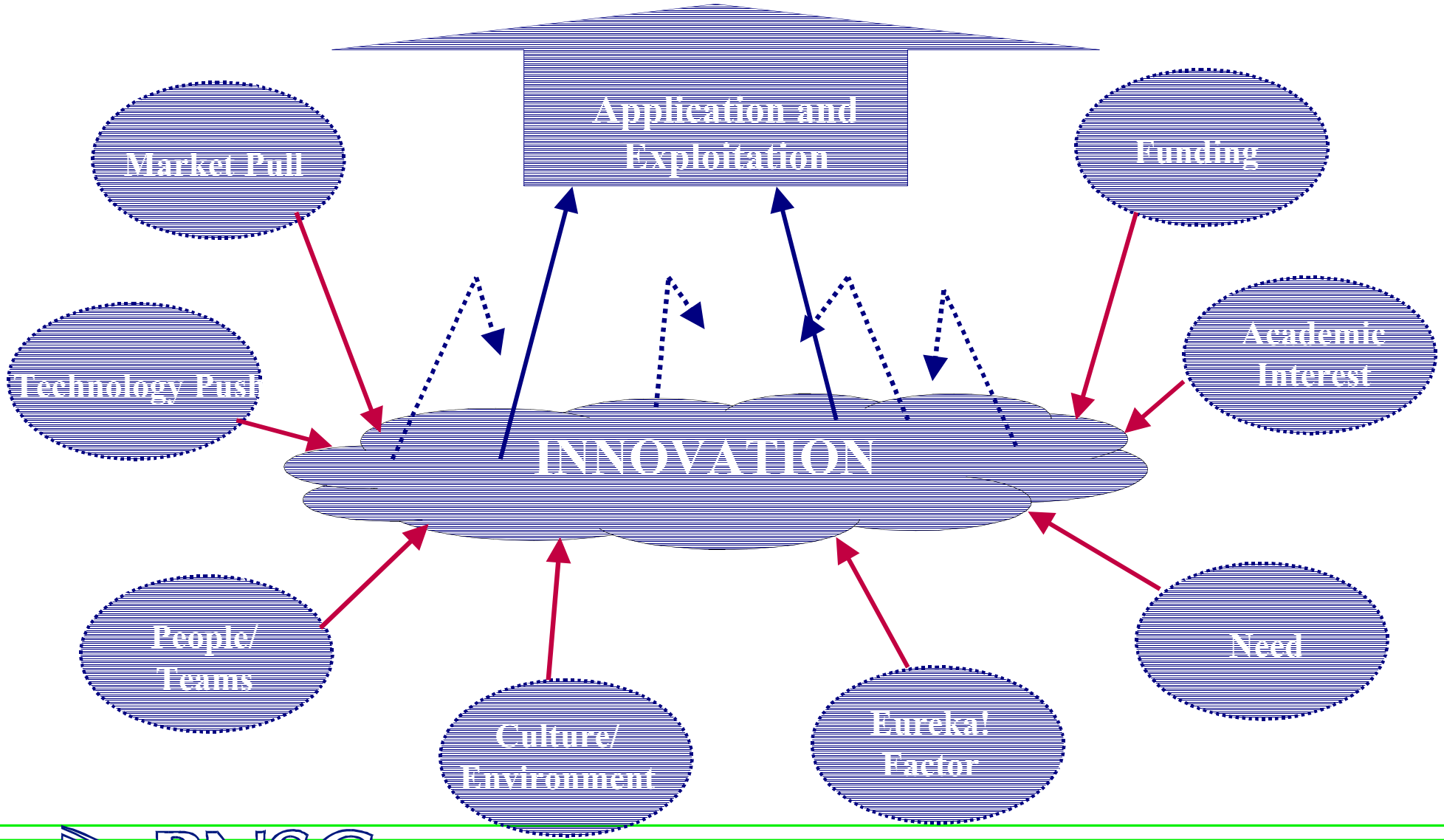
BNSC Space Partners

- **Department of Trade and Industry** (host organisation and industrial development)
- **Particle Physics and Astronomy Research Council** (astronomy and planetary exploration)
- **Natural Environment Research Council** (earth-observation science)
- **Ministry of Defence** (military/civil interface)
- **Met Office** (weather forecasting and impacts)
- **Office of Science and Technology** (science policy)
- **The Universities** (analysis and instrument development)
- **Department for the Environment, Food & Rural Affairs** (climate change, agriculture, national environmental issues)
- **Department for Transport, Local Government and the Regions** (transport, navigation)
- **Rutherford-Appleton Laboratory** (space science, earth observation projects)
- **Foreign and Commonwealth Office** (foreign policy issues)
- **Industry** (technology development and commercial issues)

'Putting Space to Work'

- Britain has **no executive space agency**
- It is **not** a stand-alone objective of the UK to develop a role in space
- It **is** an objective of the UK to carry out national objectives using space as appropriate
- Many UK organisations use space as a **tool** (perhaps more should consider the possibility)

Stimulating and Applying Innovation - Overview



A Space Strategy for the UK: Core objectives

- Maximise profitable opportunities
- Exploit innovative technology
- Achieve highest quality science
- Understand the environment
- Communicate the results

Consultation about a New Three Year Space Strategy for the UK

- Draft document issued on 22 Jan 2003 as a basis for that consultative process : download from www.bnsc.gov.uk
- Public meeting at QMC on 11 March
- Comments to ukspaceconsult@bnsc.gov.uk
- Publication of new strategy early summer 2003

Draft Plan: Top Level objectives

- Enhancing the UK's standing in Astronomy, Planetary and Earth Sciences
- Stimulating increased productivity throughout the UK economy by
  - promoting the use of space in Government, science community and commerce;
  - and, developing innovative space systems, to deliver sustainable improvement in quality of life

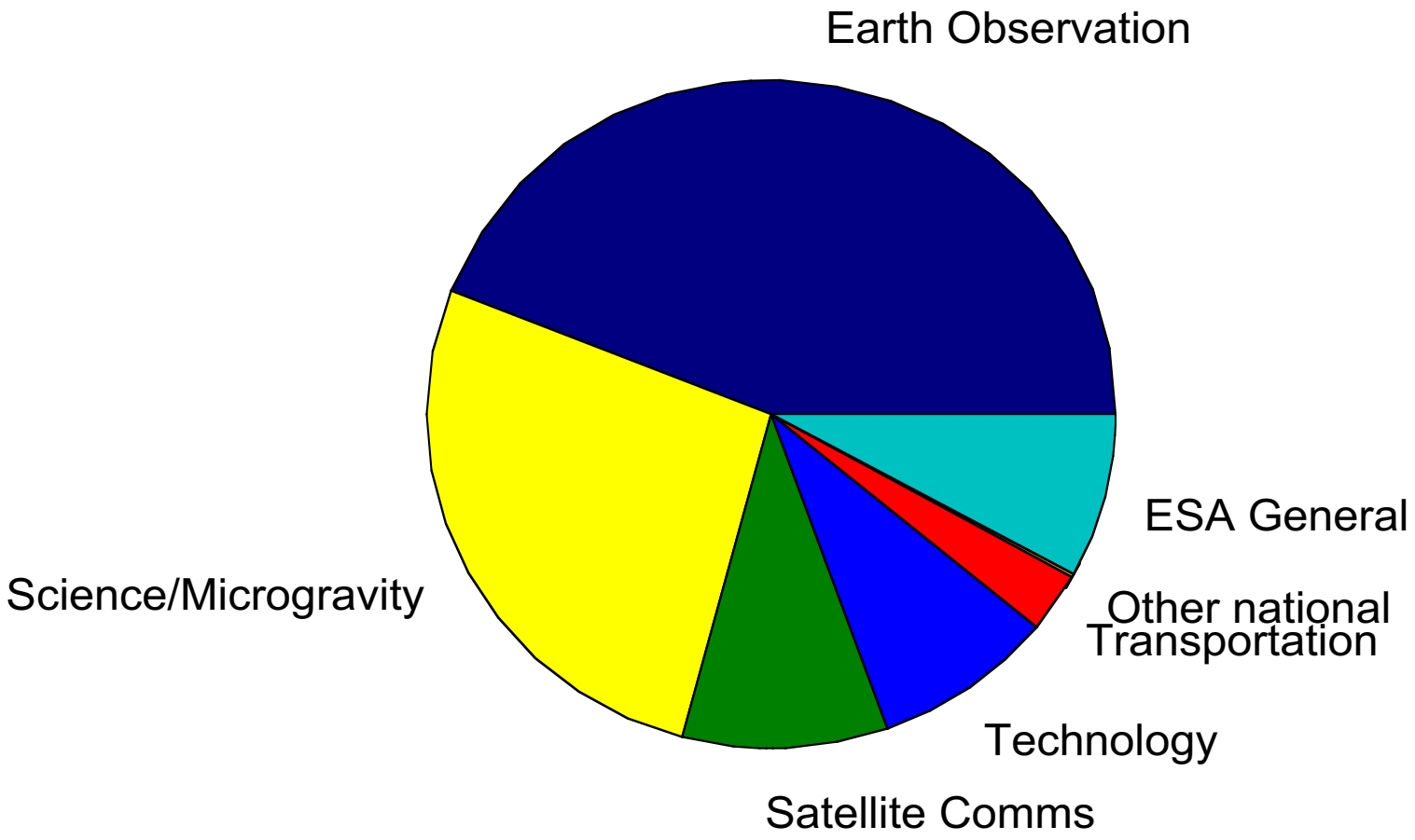
Draft Plan: Sources of Advice

- Space Strategy Council (BNSC partners and industry)
  - includes OST, Research Councils and Industry
- Four Advisory Boards to BNSC
  - Space Technology Advisory Board
  - EO Advisory Board
  - Telecommunications and Navigation AB
  - Space Science Advisory Council
- Trade Associations (UKISC,BARSC,ASTOS)
- European Space Agency and National Agencies
- The entire UK Space community and the General Public

Advice from the STAB through its Technology Working Group

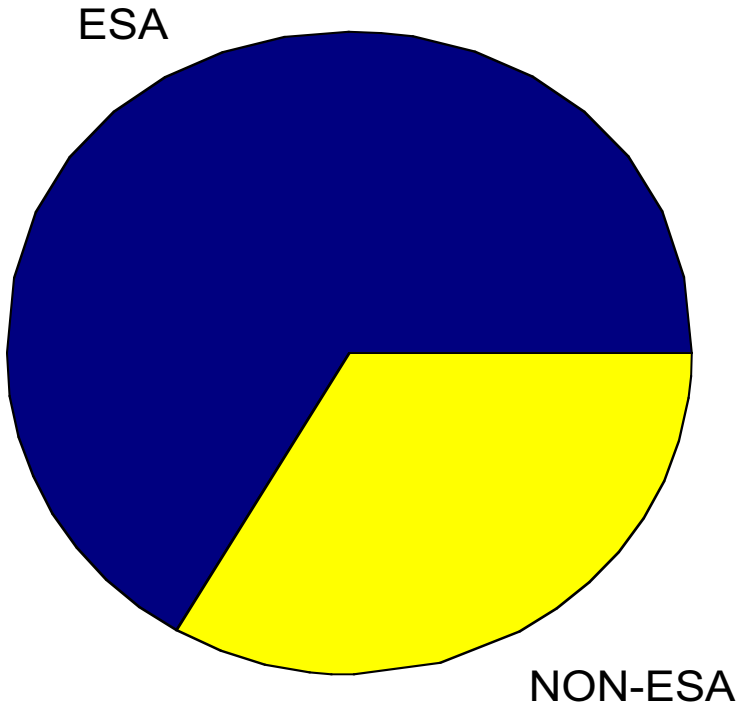
- Suggests focus on the following themes;
  - Integrated Mission Systems (linking avionics, software.)
  - Low Cost Systems (novel systems, small satellites)
  - Information processing (eg instrument technologies)
  - Widening user access (exploit the Web tech.)
  - Essential technologies
  - capitalising on unique strengths (*NB Radar more so than Optics is the current 98-2001 strategy*)
  - policy support

RESOURCES BY SECTOR (£m) 2001/2



TOTAL BUDGET £178M

RESOURCES: ESA/non-ESA 2001/02



ESA £118M
non-ESA £60M (about 20M in form of a National programme in EO, Comms and Nav and Technology)

ESA - a UK perspective

- UK a committed, critical founder member
- Membership gives access to outstanding programmes of a scale impossible on national/bilateral basis
- ESA is succeeding in managing change:
  - more cost effective procurement
  - more competition (less *juste retour*)
  - lower costs
  - more user-driven approach

ESTEC - EUROPEAN SPACE RESEARCH & TECHNOLOGY CENTRE

- ESA's largest establishment.
- Principal functions:
  - Project Management
  - Future studies
  - Space science
  - Conception & management of ESA's space technology programme
  - Spacecraft testing
  - Provision of technical expertise & laboratory facilities

Space Science Missions

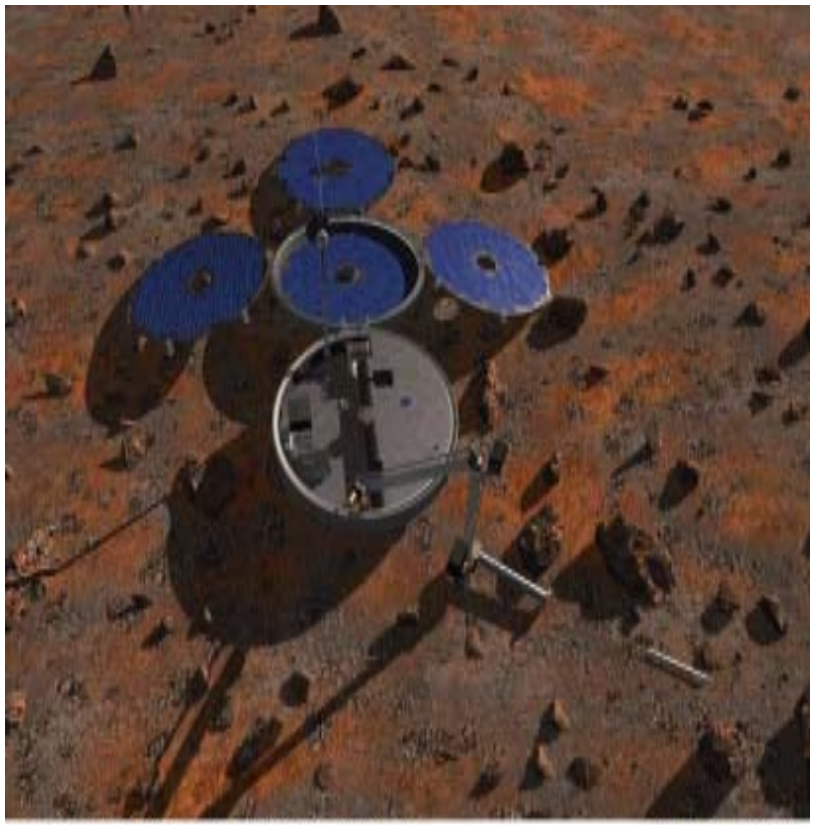
A period of very exciting space and planetary exploration:

- Rosetta, to be launched in 2003, which will tell us about the nature of comets, carries UK instrument Ptolemy.
- Huygens, which will arrive in 2004 at Saturn's moon Titan to examine its atmosphere and surface, the closest analogue in the Solar System to the Earth before life began.
- Mars Express, with UK-led Beagle 2 lander due to land on Mars at Christmas 2003, which will study the planet's geology and investigate whether conditions for life exist or existed.

UK interested in the ESA proposed 'Aurora' mission to bring its planetary programmes together. But remain **sceptical on manned space**.

Commercial/Academic Partnership with BNSC: Beagle 2

- Intense public and media interest facilitates innovative funding through private and public sponsorship of a science payload
- Innovative solutions allow lower cost approach to Mars exploration
- Highly integrated payload and lander infrastructure
- Full integration of industry and academic teams



Beagle 2 opens up to expose its solar panels and deploy its instruments Image: Beagle 2 consortium

ESA: Robotics for Exploration

- Mars Express
  - Beagle 2 Lander: OU/UoL/Astrium(UK)….
    - Launch June 2003, land January 2004
- Aurora programme
  - 14 mEuro programme Edinburgh Nov 2001
  - Feasibility studies and key technology efforts commencing now...

ESA Aurora Technology Themes

- Auto guidance, navigation and control
- Micro-Avionics
- Data processing and communications
- Entry descent and landing
- Crew aspects and exploration *
- In-situ resource utilisation
- Power
- Propulsion
- Robotics and mechanisms
- Structures, materials, and thermal control

Conclusions re Aurora

- Opportunities exist in Aurora (augmented by a successful Beagle 2)
- Future investment in Aurora is TBD
- ESA is currently at feasibility stage on Aurora
- opportunities for;
  - direct support from ESA
  - indirect (in-kind support) via PPARC, BNSC, EU
- UK emphasis on robotics and not manned space
- UK space policy consultation offers opportunities to influence outcomes

Advice to BNSC: National Technology Initiatives

- Awareness of Technology as an instrument of Space Policy
- Integrated Mission Systems
  - Formation Flying, Autonomous Constellation management, autonomous low cost ground control systems, intelligent control and autonomous systems
- Low Cost Systems
  - refined processes, management and technologies
- Information Provision (applied sensing technologies)
  - RF technologies (Active microwave, e.g. architectures and technologies for next generation wide band SARs, Passive microwave
  - Optical technologies e.g extension of low cost systems into infrared
- Essential technologies (O/B and G/S Software, DSP, AOCS & Avionics)
- Greater user access: e.g. through Internet delivery technologies
- capitalising on unique UK strengths
  - electric propulsion, micro-nano technologies, microsatellites, robotics

Academic Links

University-based work is supported by three of the UK's Research Councils:

- PPARC – Space-Based Science and Astronomy

- EPSRC – Space-Related Technology and Engineering

- NERC – Earth Observation-Related Science

• Many of the UK-supported science payloads are specified and developed by the academic community.

• Research grant schemes encourage collaborative work with industrial companies.

• The UK is encouraging more structured Partnerships aimed at supporting innovation in technology through collaboration between academia and industry.

ESA Technology Programmes

- Technology research programme TRP
  - long term actions: part of UK mandatory contribution
  - reserved portion for science, but this is not a science programme!
- General Support Technology Programme GSTP
  - optional programme (modest UK budget, mainly aimed at generic (multiple) applications
- General Studies Programme
- Preparatory actions by Manned Space Directorate (UK not a contributor)

Small Satellites

Small satellites widen potential access to space away from rich nations, government agencies, and multinationals towards new users:

- 'Smaller, faster, cheaper, better' for some applications
- UK expertise in small satellites (below 300kg)
- Surrey Satellites is a major exporter of microsatellites (~50kg with 20 launched)
- QinetiQ - STRV (Space Technology Research Vehicles)
- MOSAIC: BNSC's national small satellite programme: budget £15M over three years, three bids selected in June 2000 (TopSat, Gemini, DMS)
- ESA small satellites: SMART1, PROBA 1 & 2, CryoSat.

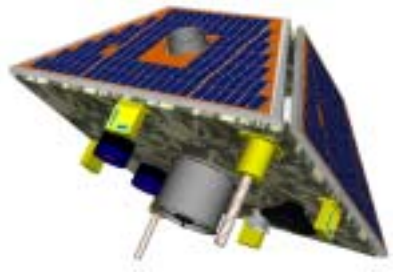
ESA Small Satellites

- PROBA 1:
  - Bus from Belgium
  - Hyper-spectral instrument from UK (SIRA)
  - DSP and Star Tracker from UK
- SMART 1
  - Special Measures!
- Smart 2 and Proba 2, 3 remain Opportunities

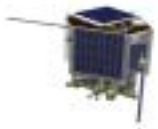
UK National Programmes

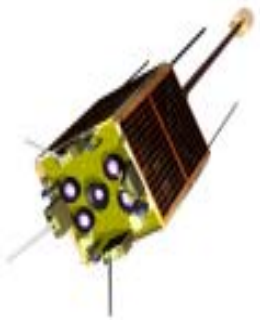
- BNSC Application Technology Support programme (ATS)
  - mainly supports generic technologies, eg avionics, power, small propulsors (electric propulsion), but works on applications, small satellites, high resolution cameras
  - **announcement of opportunity** actions, approx twice per year
- BNSC Earth Observation Programme
  - Past support for Instrumentation (eg CHRIS/ PROBA1)
  - Stronger links through NEWTON/NOTR with NERC
- PPARC / NERC
  - prospect of support to small missions eg SIMONE, Earth Shine: peer competition

UK History



- 1960/70s X1 –X3 1st UK t-sats. X3 (Prospero) - Black Arrow
- 1981 (UoSAT-1): 1st UK microsat (µsat) launched
- 1984 (UoSAT-2): 1st digital store/forward payload
- 1991 (UoSAT-5): 1st remote sensing imagery from µsat
- 1993 (PoSAT-1): 1st µsat to fly GPS receiver
- 1994 (STRV 1a & 1b) 1st Euro. CCSDS
- 1996 (TMSAT): 1st small satellite multi-spectral imager
- 2000 (UoSat) MiniSat
- 2002 AlSat 1 First MicroSat in the DMC Constellation



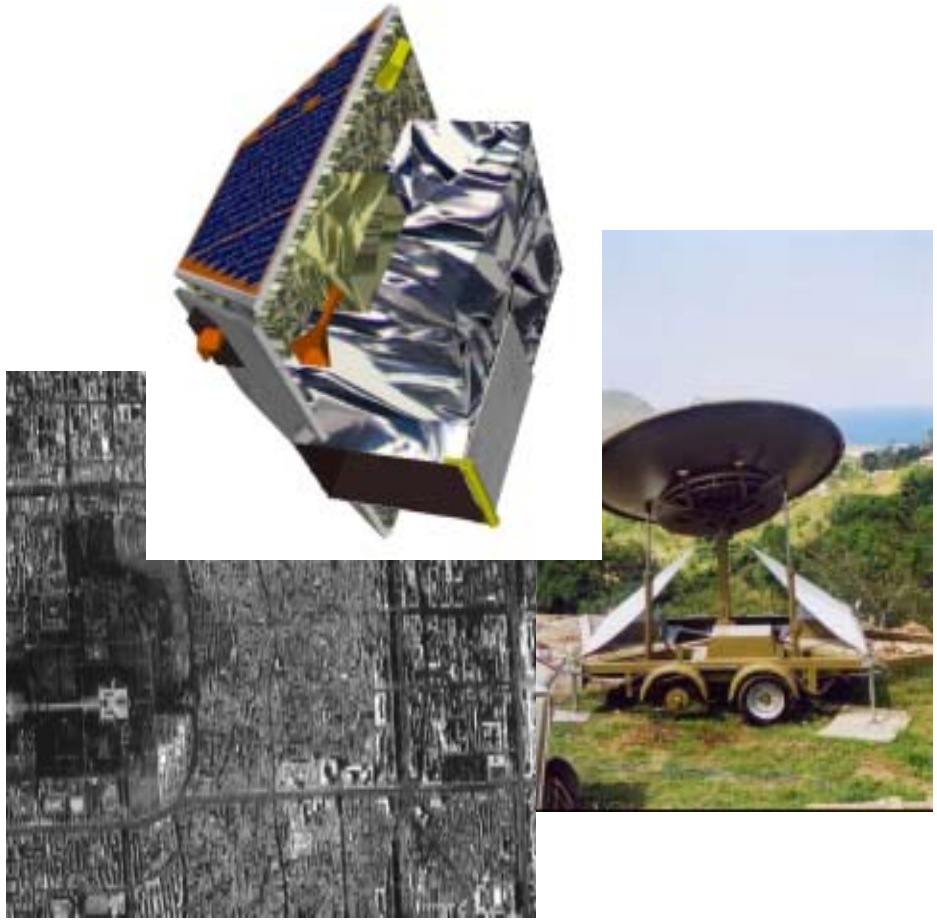


BNSC MOSAIC Programme

- Objective to ensure full commercial & user exploitation of UK small satellite capability
- £15m support by BNSC over 3 years to co-fund initial demonstration missions
- MOSAIC 1: 2000-2004
  - Topsat: Direct Broadcast Hi-Res Imagery
  - DMC: Disaster Monitoring Constellation
  - Gemini: Low Cost Geostationary Comms satellite

MOSAIC: Topsat

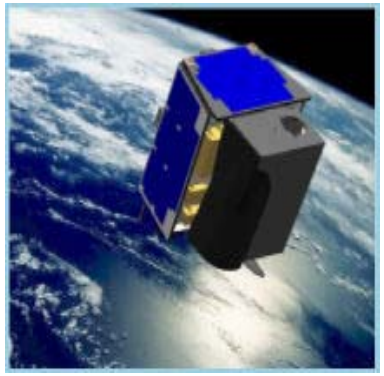
- Low cost, 120 kg micro-satellite
- 2.5m high resolution panchromatic imagery
- BURS mobile station
- Image delivered direct to local user
- Planned launch 2003
- Co-funded by UKMOD
- Collaboration of QinetiQ/SSTL/RAL/Infoterra

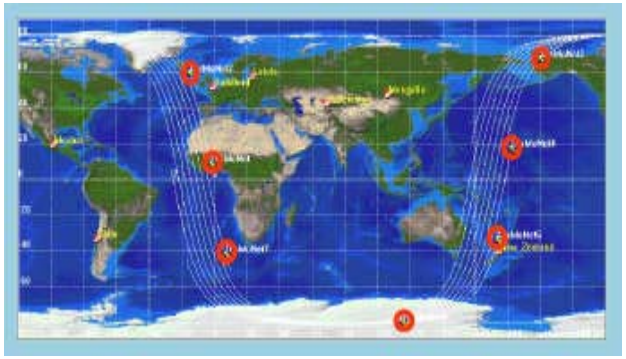


Industrial Teaming - Mosaic

- BNSC sponsored small satellite programme
  - Focus on innovative applications exploiting current small satellite technology
- 3 Innovative missions selected in first phase of Mosaic
  - TOPSAT
    - 2.5m EO microsatellite
  - Disaster Monitoring Constellation
    - 5 agile microsatellites provide daily revisit of disaster zones
  - Gemini
    - Geostationary Minisatellite providing rapid low cost comms solution

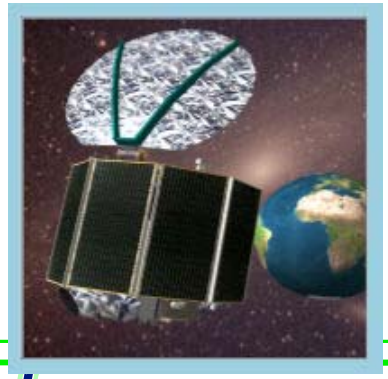
Topsat Miicrossatellite Mission led by Qinetiq with RAL and SSTL





DMC microsatellite constellation Led by SSTL

Gemini GEOstationary Minisatellite programme Led by SSTL



Some Challenges for the Smart Optics Community

- Small Satellites:
  - lightweight high res. optics (2.5m TopSat)
    - some customers seek 1m or better in same volume, with less mass, with larger swath at same orbital distance, and crucially with thermal stability, easy alignment pre-launch and .....
      - Keys are (?)
        - » lightweight materials, smart structures, adaption through actuators, clever passive designs, post /real time processing
    - inter-satellite communication and precision positioning to achieve constellations, clusters, long baselines/apertures
  - agility and precision guidance and control to enable: image alignment, stereo processing, multiple looks...

Further Challenges

- ESA/NASA Missions
  - James Webb Telescope (NGST)
    - very large optics
      - reducing mass, and cost of production (segmentation)
      - is there a place for sparse apertures, adaption etc ?
      - Non metallic structures, hybrids, smart structures
    - Science and resource politics
      - access for industry and academic interests within European and UK levels of participation

Establishing a Road Map

- Smart Optics Faraday
  - making the expertise more accessible
- BNSC
  - establishing user requirements
  - facilitating identification of key enabling technologies
  - National Programme support for technologies on the agreed map
- ESA
  - doing the same at European scale, in partnerships and Euro supply chains.

BNSC ATS: Announcement of Opportunity in Space Related Technologies

- 140 plus bids received by 3rd January deadline
- good distribution across themes proposed by STAB
- some successful bids in Optics domain
- Lessons learnt:
  - lack of a broadly agreed roadmaps aimed towards mission and commercial opportunities
  - need more time for expert/user assessment; exacerbated by need for independence in a small community
  - nevertheless a success
- Contracts to winners will be in the post this week.