National Space Technology Programme (NSTP)

Delivery Plan – June 2011

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1. Introduction and Background

The 2011 Budget included a £10million provision for the UK Space Agency to support the development of space technology in the UK. This document presents an overview of the programme plan through which it is intended to deliver this funding with the clear aim of supporting future growth in the UK space economy. It also articulates how this support fits in with, and develops, other existing funding in this area. The factors and issues involved in governance, management and monitoring of this programme are also set out. It is intended that within this matrix defined by setting out the individual elements of the programme on the one hand, and the necessary procedural considerations on the other, the detailed design of the programme can be speedily and effectively accomplished.

This document has also taken account of informal inputs responding to the announcement of NSTP funding and FAQs put up on the UK Space Agency website in April 2011. Annex 9 reproduces these FAQs, with annotations showing where inputs have influenced the present document. The announcement also stated that the space community would be consulted on the programme – it is hoped that the plan presented here provides the necessary information and context for this consultation.

The background to this programme lies in a variety of existing and previous public funding schemes for space technology in the UK, together with the various strategic and policy documents, and advisory groups that have sought to guide them. Underpinning UK Civil Space Strategy in the UK was BNSC's 'UK Civil Space Strategy' – an updated version of which is about to be issued by the UK Space Agency. This update draws heavily upon the independent input from the recent Space Innovation and Growth Team (IGT), the recommendations of which have been largely accepted by Government. The IGT has resulted in a range of very valuable continuing activities and engagement from the space community in the UK.

An independent Space Leadership Council has been established to advise the Minister of State for Universities and Science, itself advised on technology matters by the National Space Technology Steering Group (NSTSG) which has continued to direct the technology road mapping activities done by the IGT's Capabilities Working Group. This working group itself drew upon earlier experience and work by BNSC advisory groups and industry and academic bodies that had informed previous public space technology funding, most notably in the run up to the 2008 ESA Ministerial Meeting. The proposal for a UK national space technology programme incorporating UK national and ESA GSTP elements produced at this time –- though never funded – has been influential in shaping the subsequent thinking that has lead to the current programme. It emphasizes the value of continued effort and iteration in shaping technology road maps.

The current technology road maps, the first iterations of which were published in March 2011, represent a central input to the National Space Technology Programme described here. The range of UK delivery mechanisms associated with space technology funding also provides a valuable heritage upon which to draw. Central here is the STFC and NERC experience inherited by the UK Space Agency, and access to the wealth of wider TSB practice through their involvement in UKSA programmes. The programme will be harmonised with, and use where relevant, existing procedures. A working level committee to advise on the programme will be established, mirroring those successfully used in existing science and other programmes.

2. The Need for NSTP

The UK Space Agency's strategy states its core remit *'To lead and sustain the growth of the UK Space Sector'*. The National Space Technology Programme is a fundamental tool through which to do this. It provides the pump priming that new technologies need to enter new markets, to be considered for new commercial and scientific applications, or to attract mainstream private investment. The current programme, described here, is particularly significant because – for a variety of different reasons – there are gaps in existing public and private funding mechanisms in the UK. These gaps have been highlighted in the IGT strategy and elsewhere, and their impact evidenced in various economic analyses over recent years. The Programme described here provides a template for the individual elements of the £10million that will be committed during 2011. It also establishes a basis for planning future programmes, should funding become available, and for articulating national and ESA funding in planning for the 2012 ESA Ministerial meeting.

Planning such a technology support programme needs knowledge of three things – the market the technology will service, the existing UK capabilities upon which development of new technology can be based, and existing funding that is already available to support such technology. This section very briefly summarises these three areas in order to provide the context within which the elements of the current programme have been selected, and from which future programmes can be developed.

2.1. UK Space Technology Capabilities and Markets

There is a wealth of analysis dealing with space capabilities, and the markets that they allow industry to target – global, European and national. The IGT exercise was a useful stimulus for the UK space community to review and update this important resource as will be preparation for the forthcoming 2012 ESA Ministerial meeting. Particularly relevant in the present context is the way that the IGT re-energised the UK's technology road mapping activities.

The complete body of available evidence, and its limitations, are too complex to review here. However, it is important to consider how such evidence needs to be used in delivering the remit of the technology programme outlined below. Guidelines for, and appraisals of, applications for technology funding need evidence of how they grow, and do not duplicate, important UK

capabilities and markets, and of the key gaps and priorities that need to be targeted. Evidence needs to be objective, rigorous, and current, whereas much of the material available is often partial, anecdotal, out of date, or intended to lobby rather than inform. In basing investment decisions on this category of evidence, NSTP needs to be aware of these limitations and must also try to assist where it can in stimulating rigorous standards in its future collection and analysis.

Two key exercises help greatly in this context – the UK technology road maps, and – at the European level – ESA's technology harmonisation activities. Both aim to provide broadly based objective assessments through involving the full relevant space technology communities. Taken together they contribute to broad comparisons of UK capabilities with those in competing countries. Key themes in the UK roadmaps are outlined in Annex 3, these represent the first iteration of the recent exercise – guidelines for the current programme will be developed with the assistance of a newly constituted Technology Advisory Group from the underlying material developed by the working groups. It is also important that the road mapping exercise continues; UKSpace Agency will continue to work very closely on the exercise, particularly with the Space SIG and NSTSG and with UK Space to facilitate this.

2.2. UK Space Agency Technology Funding Mechanisms

A range of existing UK national space technology funding mechanisms previously run by the BNSC partners have been consolidated within the UK Space Agency. It is intended that future development of these mechanisms will be integrated within future development of the National Space Technology Programme - the present programme described here takes full account of, and aims to be broadly harmonized with, the way in which they operate.

There are several main programmes in this context. CEOI (Centre for Earth Observation Instrumentation) and CREST Collaborative Research in Exploration Systems and Technology) provide early stage support for technologies in earth observation and space science respectively. UKube-1 provides small scale flight opportunities for payloads, and the Cosmic Vision and Aurora National programmes serve as routes into the respective ESA programmes. The ESA elective GSTP programme also serves as a route into other ESA programmes for a broad range of general technologies, and UK involvement should also be noted here. All of these are briefly summarised in Annex 5.

In the context of earth observation it is also worth noting experience derived from the successful early stage GIFTSS programme, and UK involvement in the Disaster Charter. UK Space Agency's Education, Skills and Outreach Programme has also developed significant relevant funding experience.

2.3. Other UK Space Technology Funding Mechanisms

Two projects have also recently been established by the Technology Strategy Board – Feasibility Study for Innovation in Space (IIS), and TechDemoSat-1

(TDS-1). The Technology Strategy Board (TSB) are the main funder, but both also utilise residual funding from SEEDA – committed prior to the Regional Development Agencies being abolished (SEEDA also lead previous RDA support for the AlphaSat programme).

IIS has funded the investigation of early stage technologies to establish their innovative and commercial potential. TechDemoSat-1 aims to operates at the other end of the readiness spectrum –provide a small demonstration satellite on which new and innovative payloads can be flown in order to make them more attractive for commercial development. This follows the very successful BNSC TopSat model. UK Space Agency is engaged in facilitating launch and operation of TDS-1, and will, it is hoped, promote further TechDemoSats. Both programmes are briefly summarised in Annex 5 – they represent a valuable potential link with wider non-space technology areas – particularly those supported by TSB.

The final major development very closely associated with NSTP is the International Space Innovation Centre (ISIC) at Harwell. Constituted as a not-for-profit company, ISIC has received major funding and support from both Government and the Space Industry. It aims to drive commercial growth in the UK space sector by forging links between key resources and organizations, and by promoting access to relevant facilities, including its own linking. Annex 4 summarises the infrastructure and resources currently being developed at ISIC. ISIC is a flagship for the development of UK space technology, and its facilities and resources will be a major focus where appropriate for the delivery of NSTP funded projects.

2.4. Other UK Technology Funding Mechanisms Relevant to Space

A range of public technology support measures not specifically aimed at space are nonetheless relevant to the development of technologies with a possible space application. As just noted, these include some of the areas of innovation in which TSB is active. Other programmes overseen by TSB are also of considerable interest – particularly SBIR, GRD and KTPs. There are also a variety of research council funding mechanisms relevant to technology areas close to space. The UK National Space Technology Programme described here has the potential to forge links with such mechanisms and it is intended to do this wherever possible.

In this context, it is also worth noting other specific public areas that are involved in using and developing space assets – particularly for defence purposes. MoD has major investment in space assets, notably via the Skynet programme operated by Paradigm, and through the Met Office. The UK Space Agency has, and is further developing, useful links with such areas which it will engage in developing NSTP as appropriate.

2.5. Gaps and Priorities

The above brief discussion of existing activities provides a clear context for defining the urgent areas within which any new funding needs to be applied.

The technology road maps, particularly as they continue to be developed, define existing and needed capabilities for the UK. The areas of existing funding need to be maintained, but also highlight the areas where there are gaps – particularly funding for general technologies in mid TRL areas, funding for (or to facilitate) demonstration of technologies, funding to investigate tomorrow's technologies (particularly potential new breakthroughs), and finally funding to forge two-way links with technologies in non space areas.

For the present, the programme outlined below is aimed at closing these gaps and allowing promising UK technologies to meet their full potential. For the future, it is important to maintain funding in both the existing areas discussed above, and the new areas discussed below – this document, as summarised in Annex 8 also therefore stands as a template for a continuing national space technology programme that encompasses both in a balanced portfolio of measures capable of driving growth in the future UK space economy.

3. NSTP Meeting the need

The activities described below will comprise the elements of the current UK National Space Technology Programme. Where appropriate they will augment and draw upon the existing funding mechanisms just described, and will be planned so as to form the basis for continuation of the programme as any additional funding from future budgets becomes available. Annex 8 summarises the desirable principles and scope for future national programmes.

The two sections below detail the current programme. The first describes the activities themselves and the funding split between them. The second describes the way in which the programme will be operated, and in particular the principles that will guide the criteria for selection, including the need for funding, the fit with desired economic, scientific and societal outcomes, and in particular with the framework established by the continuing UK technology road-mapping exercise.

3.1. NSTP Funding

The following Table summarises the individual elements that will comprise NSTP. Each element is then described in more detail, including a very brief discussion of the arguments and counter-arguments underpinning their selection:

	Allocation £K	Intervention Rate
1. Core Programme	6,000	50%
2. Future Technology Pathfinder Programmes	500	100%
3. Demonstration Programmes	500	100%
4. GSTP Additional Funds	1,000	50% or 100%
5. Collaboration with other Public Funding Providers	1,000	as required
6. Focused co-located team projects at ISIC ('Star Tiger' model)	500	100%
7. Horizon Scanning Studies / Management	500	n/a
TOTAL	***10,000***	

3.1.1. CORE PROGRAMME

A core programme will provide grant aid to cover all areas of technology. This will include large (£1million plus) as well as smaller projects - all funded at 50%. The aim is to provide a balanced funding mechanism covering all the areas of technology highlighted in the last section, and in particular the technology roadmaps. This will be accomplished through the development of a clear set of criteria - as discussed in the next session. Consistency and transparency will be underwritten through the use of independent expert advice and the experience developed by the various existing funding mechanisms discussed above in appraising, managing and monitoring projects. A call mechanism will be used to solicit proposals. Subsequent calls will be made if any funds remain uncommitted due to insufficient quantity, quality, or breadth of proposals in the first round.

The advantage of a single fund targeting all relevant areas of technology is that it allows maximum flexibility and minimises unnecessary and potentially inefficient administration. The disadvantage is that, to ensure grants cover all priority technology areas, a robust and effective governance mechanism will be needed. Splitting funds into individual areas of technology would be an attractive counter to these fears, and may be appropriate if larger funds become available in the future, but is not warranted given the current size of the programme.

3.1.2. FUTURE TECHNOLOGY PATHFINDERS

Possible future technologies and their associated issues will be investigated and evaluated in detail through a number of small pathfinder activities. Guidelines will suggest a typical expected budget of around £50 thousand for these activities. Proposals for such exercises will be solicited alongside the main call just described.

The advantage of carefully targeting a portion of funding in this way is that it will allow intelligent anticipation of future developments and

highlight the future significance of existing technologies. This will allow support for them to be better planned and adjusted in future programmes. However, breakthrough technologies and other innovations often threaten the existing commercial status quo – this element of the programme will ensure that such possibly disruptive commercial opportunities are investigated alongside closer to market technologies.

3.1.3. DEMONSTRATION PROGRAMMES

Funding will be provided to demonstrate new technologies. Breakthrough technologies need support as just discussed, but technologies at the other end of the spectrum, that have already 'broken through', still need proving in realistic operating environments such as space, in order to become commercially attractive.

Much of this activity is the proper preserve of commercial concerns, and not an appropriate area for Government subsidy. However, the costs of demonstration are often high, and there are areas where costs cannot be born by the developers of key new technologies likely radically to improve the economics or capabilities of space products and services. These are areas where existing and previous Government support has been instrumental in providing a bridge to full commercial acceptance through programmes such as Topsat, Techdemosat, UKube and others which provide key demonstration infrastructures beyond the means of individual developers.

This element of the current programme will continue to fund demonstration programmes and satellites, together with their launch and operation - albeit constrained to a low level by the current amounts of funding available. Existing operators of infrastructure – particularly commercial satellites – will also be encouraged to provide opportunities for small demonstration payloads where this is practicable. Demonstration satellites allow technology developers to fly new technologies. Such technologies - either developed at their own cost or through other elements of NSTP or other programmes – are generally chosen through a suitable call for proposals. The funding available will contribute continued development funds for the existing Techdemosat and UKube programmes, though it will not be enough to underwrite their completion (much less the initiation of follow-on programmes). It may however usefully also be used for technical and management investigations that progress the planning of future demonstration and technology development programmes.

The advantage of providing opportunities to prove new technologies is clear – it can provide a bridge to their commercial application. The disadvantages are twofold. Firstly, it is often difficult to judge where public funding is really justified for such near-to-market activities – it will continue to be imperative part of the appraisal process that proposals demonstrate why commercial funding is not available. Secondly,

infrastructure cannot easily be turned on and off – to gain maximum long term benefit facilities must be maintained and satellites require launch and continued operation. Short term funding like the actions described here can only be justified if all longer term costs are underwritten from other suitable sources.

3.1.4. GSTP ADDITIONAL FUNDS

Ten per cent of the currently available funding will be made available to increase the UK's existing low contribution to the ESA GSTP programme. This should not be seen as establishing a precedent (a full case for increased GSTP funding will be made in the proper forum of the next ESA Ministerial), but rather as a short term tactical necessity to ensure that the development of important UK technological capabilities is not curtailed within ESA. It will ensure that these are not 'locked out' of future large-scale ESA exploitation opportunities in ESA programmes that the UK does fund fully such as ARTES and certain Missions. GSTP is widely used by ESA to prepare technologies for such programmes. The contribution here will be subject to the existing stringent governance procedures of the GSTP programme and to negotiation with ESA, specific proposals that can use GSTP to leverage other ESA funding mechanisms will be considered on a case-by-case basis. Full opportunity will also be taken to influence the future direction of the GSTP programme ahead of the Ministerial.

The potential advantages and disadvantages of this element are complex - the GSTP programme is generally not well understood within some areas of the UK space community, or indeed within ESA even though it occupies a pivotal position at mid TRL levels in the technology funding path. Prior to the formation of UKSA, mixing direct UK national funding with UK funding directed via ESA programmes was difficult - multiple budget holders across Government meant that funding in one area could not readily be transferred to another. The consolidation of budgets under the UK Space Agency has now removed this structural problem. This allows the tactical disposition of small portions of funds in this way in order to remove the roadblock that the low GSTP commitment at the 2008 ESA Ministerial imposed on the development of several critical UK technologies.

The lesson for future programmes is the need actively to mitigate the disadvantages associated with ESA's development of technology through a mix of elective and core programmes – the UK needs to be as strategically astute as its main competitors amongst the other Member States. Low funding in any area where there are key national capabilities means that a technology's progression can be curtailed, its route to commercial exploitation stopped and National leadership lost.

3.1.5. COLLABORATION WITH OTHER PUBLIC FUNDING PROVIDERS

Funding is most effective if it can be put to wider use, especially if that use can leverage additional funds from other sources. The formation of the UK Space Agency allows, for the first time, such wider strategic aims to be realised. Small amounts of funding will be made available for joint programmes on the condition that they are matched. Approaches are being made to other public bodies to investigate whether there is an appetite for joint activity – these will certainly include relevant Research Councils, DSTL, TSB and the Met Office. The form of such joint programmes will be flexible to reflect joint priorities and target the right beneficiaries, but the UK Space Agency will look for outcomes compatible with its published strategy. The calls for proposals in such programmes will – as appropriate - use the mechanisms established for the core element of NSTP, or those of the collaborating partner.

The advantage of joint programmes is that they increase available funding, promote mutual understanding, and allow the partners in them to explore the relevance of space technology to their own strategic and operational concerns. The current disadvantage is that individual activities will of necessity be limited in size, given the funding available – it is hoped, however, that they will catalyse further activity and contact.

3.1.6 FOCUSED CO-LOCATED TEAM PROJECTS AT ISIC ('STAR TIGER' MODEL)

The 'Star Tiger' model has already established its worth in ESA and other projects. In such projects relevant technical experts are co-located in a fixed centre for an extended period with appropriate facilities. The exercises explore in depth issues, problems and opportunities associated with specific areas of technology, with the aim of exploring solutions and new ways forward.

The advantage of such exercises is their proven capacity to apply considerable effort in a very focused and intense way, which allows quick solutions to be arrived at. The disadvantage is the facilities and organization required – however this is exactly one of the things that ISIC is set up to do, and focusing the activities here will take full advantage of this powerful new facility.

3.1.7 Horizon Scanning / Management

It is important in planning for the future that the complete spectrum of current and future technologies are considered, and a broad look 'over the horizon' at areas where major breakthroughs may occur is a prudent measure to ensure the most effective use of future funding. This is a pre-commercial area where incumbent firms cannot justify, or are often unwilling to undertake research spending; it is therefore important that UKSA undertakes research in order to be prepared to support future national prosperity and growth. This element will be delivered through 100% funded research contracts to scan new

developments, to provide technical oversight of key new commercial developments where appropriate, or to conduct exploratory studies.

As well as such measures to inform possible future programmes, effective management of the current Programme is also vital. This element will also cover provision for commissioning additional resource needed to manage the current programme along the lines detailed in the next section.

3.2. NSTP Operation and Monitoring

The different elements of this programme will all require clear guidelines, a straightforward application procedure, an effective method of appraisal and selection, rigorous but appropriate management and budgetary control, and a mechanism to track outcomes. To ensure the right level of control is achieved without imposing excessive regulation, these requirements will need to be appropriate to the level of technology and size of grant. The guiding principles, however, will be the same:

1. Applications must demonstrate the need for funding and the capacity to deliver the outcomes stated.
2. These outcomes must be consistent with the guidelines issued, delivering the economic, scientific and societal benefits intended. Applicants should demonstrate how the technology development they propose fits with the UK technology roadmaps independently developed under the direction of the National Space Technology Steering Group (NSTSG).
3. Applications must demonstrate that they fully meet, or will follow, the guidelines in complying the State Aid requirements.
4. The development of space technology is the primary aim of this programme, but applications which deliver additional benefits specified in the guidelines will be favoured – particularly where they contribute to the continued development of ISIC and the associated network of centres to which it is linked, to exports, to the development of products and services in other economic sectors, and outreach and education.

A little more detail about how these guiding principles will be applied at the various stages involved in management of the programme is given below. The procedures used will, where appropriate, take full advantage of ones proven in existing the funding mechanisms discussed earlier. The aim will be to run the programme in the leanest and most effective way consistent with sound governance. Where necessary carefully controlled management costs will be covered from the programme budget as outlined in the last section. These costs will include essential administration and necessary items such as review meetings and the running of advisory groups and networks.

3.2.1. GUIDELINES

The overarching intention of developing space technology and capabilities is to drive growth in the UK economy as set out in the UK Civil Space Strategy. Space technology is also critical in providing UK citizens and businesses with the public infrastructure and security

necessary to underpin societal and economic wellbeing. A final key intention is to ensure that future space technologies that may come to underpin the UK economy in the medium and long term are investigated, understood and nurtured.

The programme is designed to meet these intentions. Guidelines will make clear exactly what applicants will be expected to deliver through the technology development that they propose. A central resource here is the UK's set of Technology Roadmaps – a concise statement of the technologies they detail will be included in the guidelines so that applicants can clearly indicate where their proposals fit within this framework. The current technology themes from the roadmaps, as presented in the NSTSG technology strategy, are included in Annex 3. Guidelines will also specify how State Aid requirements will be met – Annex 2 summarises the constraints here. Guidelines will also specify additional benefits as outlined above that will be taken into account in the appraisal procedure, such as engagement with ISIC if appropriate (Annex 4 outlines facilities available at ISIC).

Guidelines will be developed in consultation with a new Space Technology Advisory Committee, on the same model as that already proven in the space science and Aurora programmes (with SPAC and AurAC). Overall guidelines will be published, together with more specific guidelines relevant to individual elements as appropriate. The intention is that they will be as concise and clear as possible.

3.2.2. APPLICATION PROCEDURE

More information and data is clearly necessary to allow the thorough appraisal of large awards than is needed for small and earlier stage ones. The intention is that applicants are asked for what is needed to make a prudent decision, without imposing unnecessary burdens on them. There is no 'one-size-fits-all solution here, and different levels of documentation will appropriate to different levels of grant.

Nonetheless, consistency will be imposed across the programme by designing a simple core summary application form of no more that two pages, which will include a simple and concise summary of the proposed project, its outcomes and its cost. Additional pages will be defined, and annexes suggested, as required for larger scale projects. Where practicable, pre-application advice may be offered on the basis of the two page summary. Full use will be made of the experience gained and good practice developed in the existing funding mechanisms discussed above. Nonetheless, as stated, the opportunity will be taken to develop a new and consistent procedure across the programme and for future use.

Timescales will vary for different elements, but as implied in the last section most will be subject to a closed call procedure with clearly

defined deadlines for submission, appraisal and notification of acceptance or rejection.

3.2.3. APPRAISAL AND SELECTION

The preferred method of appraisal will be by an independent expert panel. Procedures and advisory groups already used by the UK Space Agency and its partners can form the core resource to do this. In particular the newly formed Space Projects Review Panel (SPRP) will be used as the core group from which to draw appraisal panels, as well as the retention of other specialist advice where appropriate. A small budget will be necessary to reimburse expenses of panel members and experts.

3.2.4. MANAGEMENT AND BUDGETARY CONTROL

Procedures for contracting, monitoring progress and payment will be based on existing UK Space Agency practice. Budgetary control will likewise be based on the new procedures that have been established for the Agency. Budgetary control be harmonised with other existing procedures where relevant (taking account for example of existing rules for treatment of VAT, the 80% funding of full economic for grants to universities, etc.).

3.2.5. MONITORING OUTCOMES

Good governance of public funding for technology development demands that its outcomes be effectively monitored. However, the intention is that the programme defined here, whilst complete in itself, will form the template and basis for future UK national space technology funding. This makes it doubly important that the programme is used fully to characterise the benefits such funding delivers through growing the UK economy and through enhancing UK capabilities and reputation in space technology.

A clear procedure will be established to capture this information following the completion of projects funded under the programme, and at intermediate stages where warranted by project size. This will allow impact to be evaluated – this assessment will fully involve the proposed new Space Technology Advisory Committee, and be disseminated to the wider space community.

4. Conclusion

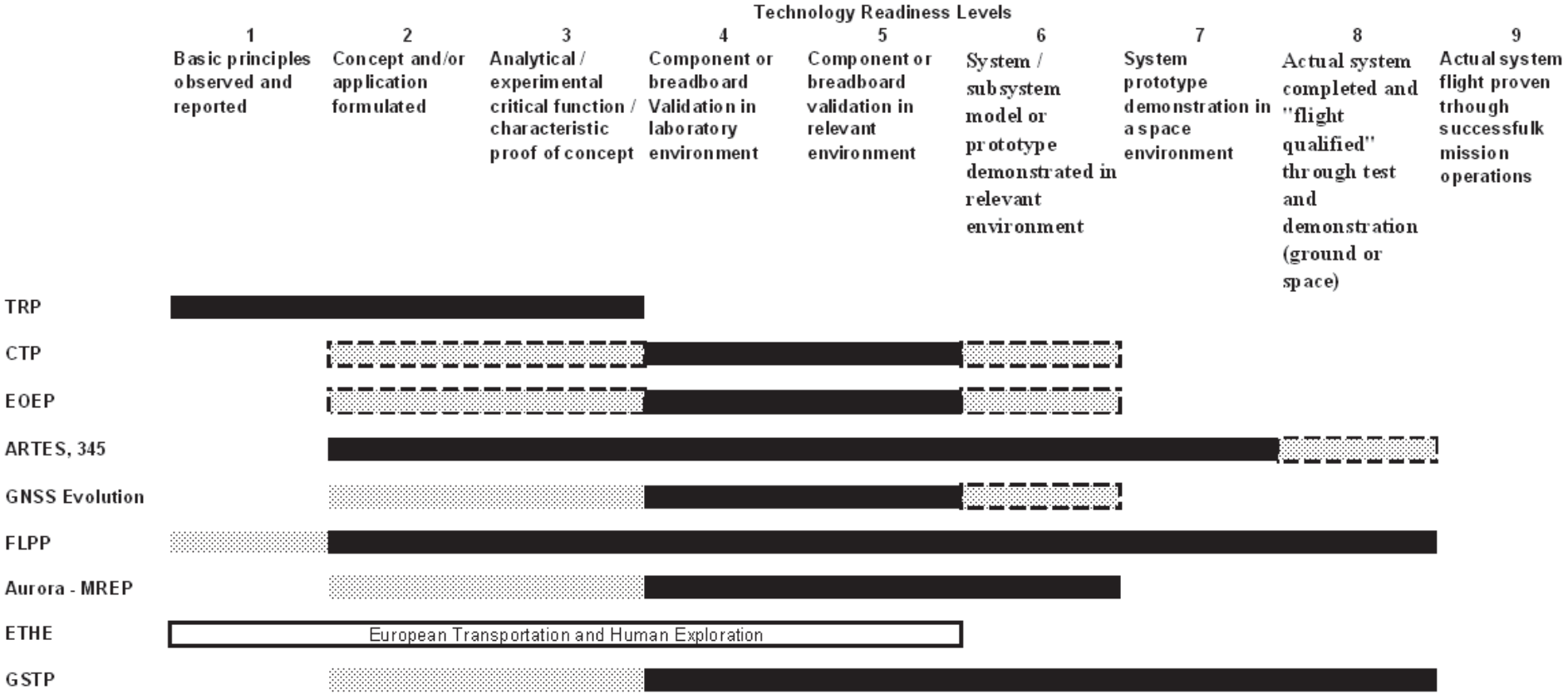
The programme outlined here, together with the discussion of the procedures necessary for its good governance, will be the basis for more detailed planning and execution. It is anticipated that the ensuing delivery of the programme will achieve three main things. It will go a significant way towards plugging existing gaps in support for the development of a robust set of UK capabilities in space technology. It will demonstrate the effectiveness of

strategic funding in this area, and provide a template for continuing rounds of such funding. But, above all, it will provide real and measurable growth in the UK space economy and its contribution to the prosperity of the UK and its citizens.

Annexes 6 and 7 present the development and delivery plans respectively for the UK National Space Technology Programme. Annex 8 provides a broader and more general context for future National programmes, should they be funded. In particular this emphasises the need for very careful and clear articulation across national funding schemes, and between them and ESA (and other multinational) funding streams. The full economic growth potential of the UK's rich space technology capabilities will only be realised through a carefully balanced portfolio of all funding streams. The UK Space Agency is committed to developing such a portfolio, and is better placed than ever before to deliver it.

ANNEX 1

ESA Definition of TRL Levels, and associated Technology Programmes
(from http://www.esa.int/SPECIALS/Technology/SEM9SRWPXPF_0.htm):



ANNEX 2

State Aids Summary:

The following table and notes are extracted from 'The State Aid Guide – BIS – October 2010':

R&D project aid -The framework allows state aid for the following levels of R&D:

Fundamental research: defined as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any direct practical application or use in view".

Industrial research: defined as "planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services or for bringing about a significant improvement in existing products, processes or services" .

experimental development: pre-competitive development category defined as "the acquiring, combining, shaping and using of existing scientific technological business and other relevant knowledge and skills for the purposes of producing plans and arrangements or designs for new, altered or improved products, processes or services". This category extends to the development of commercially usable prototypes and pilot projects where they would be too expensive to produce only for experimental purposes; where there is subsequent commercial use of the prototype any revenue generated has to be deducted from eligible costs. This category does not cover routine or periodic changes to produces and services.

technical feasibility studies preparatory to industrial research and experimental development.

Aid Intensities – Project Aid	Small enterprise	Medium enterprise	Large enterprise
Fundamental research	100%	100%	100%
Technical feasibility study preparatory to industrial research	75%	75%	65%
Industrial research	70%	60%	50%
Industrial research projects involving collaborations* or where the results will be disseminated	80%	75%	65%
Technical feasibility study leading to experimental development	50%	50%	40%
Experimental development	45%	35%	25%
Experimental development projects involving collaborations*	60%	50%	40%

* collaborations between businesses and research organisations, or business to business collaborations which are cross border or involve at least one SME, provided that no one business partner carries more than 70% of the project costs

Notes

Member states must demonstrate the incentive effect of all aid to large businesses (e.g. that the project would not go ahead at all, or to the same scale or timetable without the aid)

ANNEX 3

TECHNOLOGY THEMES EXTRACTED FROM NATIONAL SPACE TECHNOLOGY STRATEGY (NSTS)

STRATEGIC PRINCIPLES

The National Space Technology Strategy (NSTS) is governed by a set of underlying principles which have been established to meet the overarching strategic goals and vision for the Space sector as articulated in the IGS. The Strategy is detailed and implemented via a suite of market-driven Technology Roadmaps. The strategic principles are:

- Technology must meet an end objective, such as:
  - *direct economic jobs and wealth creation*
  - *indirect impact on GDP through societal or strategic needs (e.g. health, environment, resilience, defence)*
  - *longer-term scientific understanding*
- To encourage clarity of focus for the UK space industry technological capability, in order to increase competitive standing and therefore profitability
- To continue to use the technology development funding mechanisms that exist today but encouraging the UK space industry and government to look to the future structures of national, European and global markets (including new and emerging markets and those of emerging space powers)
- To utilise as appropriate to the market sector, a mix of private, national government and European funding
- To encourage innovative service-led business models recognising the growing importance of public-private partnerships, and of the EU as an operational driver for European space needs
- To recognise the linkages between the applications and services that can drive the development of cutting edge and disruptive technologies and capabilities
- To create an environment for the growth of a balanced space sector, embracing the benefits of linking prime contractors, subsystem and equipment suppliers, technology companies, SMEs, and academia
- To create greater alignment of space sector capability with Government needs and priorities
- To maximise job creation and employment of STEM trained graduates in the UK space industry and associated terrestrial applications

TECHNOLOGY THEMES AND ROADMAPS

1 Telecommunications

Research themes as highlighted below have been identified based on maintaining and improving the competitiveness of the UK satellite telecommunications industry:

- Increased telecommunications satellite capacity
- Reducing cost to manufacturer, operator and user
- Enabling new services and market opportunities

Example technology themes from the roadmap include:

- Turnkey satellite systems (e.g. Inmarsat's Paradigm and Avanti systems; with scope to expand into Earth Observation)
- Spacecraft platform, structure and composites
- Payload systems capability
- Satellite Network Operations, Business Support Systems, Services and Applications
- RF electronic equipment including telecoms, navigation, radar EO, communications for science and exploration missions.
- Space antennas covering telecoms, radar with opportunities in other sectors

2 Sensing

UK industry and academia are major providers of sensing technologies and systems into international space missions with the following identified as UK differentiators:

- Detectors – UV/visible, IR and X-ray
- Optical systems and Lidar
- Microwave sensing systems – active and passive
- In-situ instruments
- Down-stream technologies and EO applications

3 Position, Navigation and Timing

The UK capabilities can be broadly categorised as:

- Innovative application developers demonstrated by the UK attracting the single largest number of applicants in the ESA IAP programme, with almost half as many again as the next most active region.
- Social market and structure as the UK is a fertile market for LBS applications with large numbers of early adopters and mature privacy laws.
- Securing and exploiting the GNSS infrastructure for security applications.

4 Exploration and Robotics

More than 70 individual technologies have been mapped out and then grouped into a set of themes:

- Autonomous Vehicles – Technologies include autonomous mission management, navigation, science autonomy, robotic control, localisation without GPS, data fusion and multi-agent autonomy.
- Robotic Manipulators – Includes teleoperation, sampling devices, sample transfer and manipulation, rendezvous and docking.
- Penetrators – Includes modelling of de-orbit, entry and descent, flight control of high velocity objects, sensors, novel power/heating, highly rugged electronics
- Novel Locomotion Technologies – includes aerobots, under liquid propulsion, climbing robots and could spin out to military and civil dirigible programmes, low cost high altitude communications platforms and robotic access to difficult locations.
- Novel Power Technologies - nuclear power/heating sources, autonomous mission management, very low power systems, energy scavenging.
- Robotic Support of Manned Exploration – human factors, multi-agent collaboration, in-situ resource utilisation.

5 Access to Space

Space-plane/Reusable launch systems The ability to deliver a payload to orbit and return the launch system to the ground safely and efficiently presents a game-changing capability in launch systems. UK developments in this area include engine development, advanced aerospace structures, re-entry systems and automatic flight systems.
Small satellite launcher and Sub-orbital space-planes Currently, an air-launch system seems the most adaptable solution, enabling launches from recently formed 'space ports' such as New Mexico or even from a space port in the UK. This also opens up the possibility

of a space tourist industry for the UK, using sub-orbital space-planes either developed in the UK or from companies like Virgin Galactic.

Small and nano platform technologies The ability to have a capable small satellite platform requires the miniaturisation of spacecraft components, without significant degradation in performance. Expanding UK capability, the research themes for small and nano spacecraft will increase the performance of small satellite platforms, whilst at the same time putting the UK at the forefront of miniaturised space technologies.

Large platform technologies

Development themes for this roadmap include: deployable and inflatable structures, ultra stable platforms, agile control moment gyro systems and MEMS based sensors, technologies for structure assembly in space and technologies for space-based solar power generation and supply to ground.

Inter-orbital transfer capability This activity includes propulsion stages that assist platforms to transfer from one orbit to another. Applications include: transfer of communications satellites to geostationary orbit, interplanetary transfer module; transfer and deployment of constellations of satellites in LEO and space-tugs. Existing UK capability identified includes chemical propulsion, solar electric propulsion, lightweight structures, fuel tanks, rendezvous and docking, nuclear power systems, deorbiting devices and on-orbit refuelling.

ANNEX 4

BRIEF SUMMARY OF INFRASTRUCTURE AND RESOURCES BEING DEVELOPED AT ISIC

Core ISIC Resources

- *Innovation & Outreach Services* One of the most important aspects of ISIC is co-ordination, facilitation and brokerage of collaborative partnerships between business and academia. ISIC will reach out to companies that can find new ways of commercialising space derived data and services – but are not yet aware of these opportunities. This downstream sector is where the most significant growth is envisaged to take place. End-user driven applications will focus demand of the satellite industry moving forward, driving innovation in the upstream sector.
- *Earth Observation Hub* The Earth Observation (EO) Hub provides the UK with an end-to-end capability for satellite operations and payload data exploitation. With the ability to operate a variety of missions simultaneously, the ISIC EO Hub will open up new opportunities for the UK and international community in data products and user service delivery.
- *Security and Resilience Unit* Space systems have become an increasingly important part of the UK's critical national infrastructure, with both the government and commercial sectors relying on data from them. The ISIC Security and Resilience Unit (SRU) has been established as a facility to ensure the integrity of data communications to and from satellites and to help ensure the safety of information for customers who rely on data from satellite systems.
- *Visualisation and Applications Centre* The International Space Innovation Centre (ISIC) Visualisation and Application Centre has been established to offer a high profile facility to deliver interactive visualisations of Earth Observation (EO), space science and other data for scientific, economic and societal benefit. The capabilities of this unit include the ability to integrate, explore and visualise the vast amounts of EO data coming on-stream for scientific and outreach purposes and to explore ways in which this data can be used to drive future commercial applications.
- *Concurrent Design Facility* The ISIC CDF is the ideal way to carry out rigorous feasibility studies (pre Phase-A) of mission concepts but can also be used for studies on spacecraft, instruments and payloads. The CDF can also be used for project reviews and can even be integrated into Star Tiger programmes.
- *Rover Test Facility*

The ISIC network also acts as a conduit to other key UK space resources such as the GNSS development and test facilities run under the GRACE initiative, as well as proposed new facilities such as proposed new propulsion test developments currently being debated.

ANNEX 5 OUTLINE OF KEY UK SPACE TECHNOLOGY FUNDING MECHANISMS

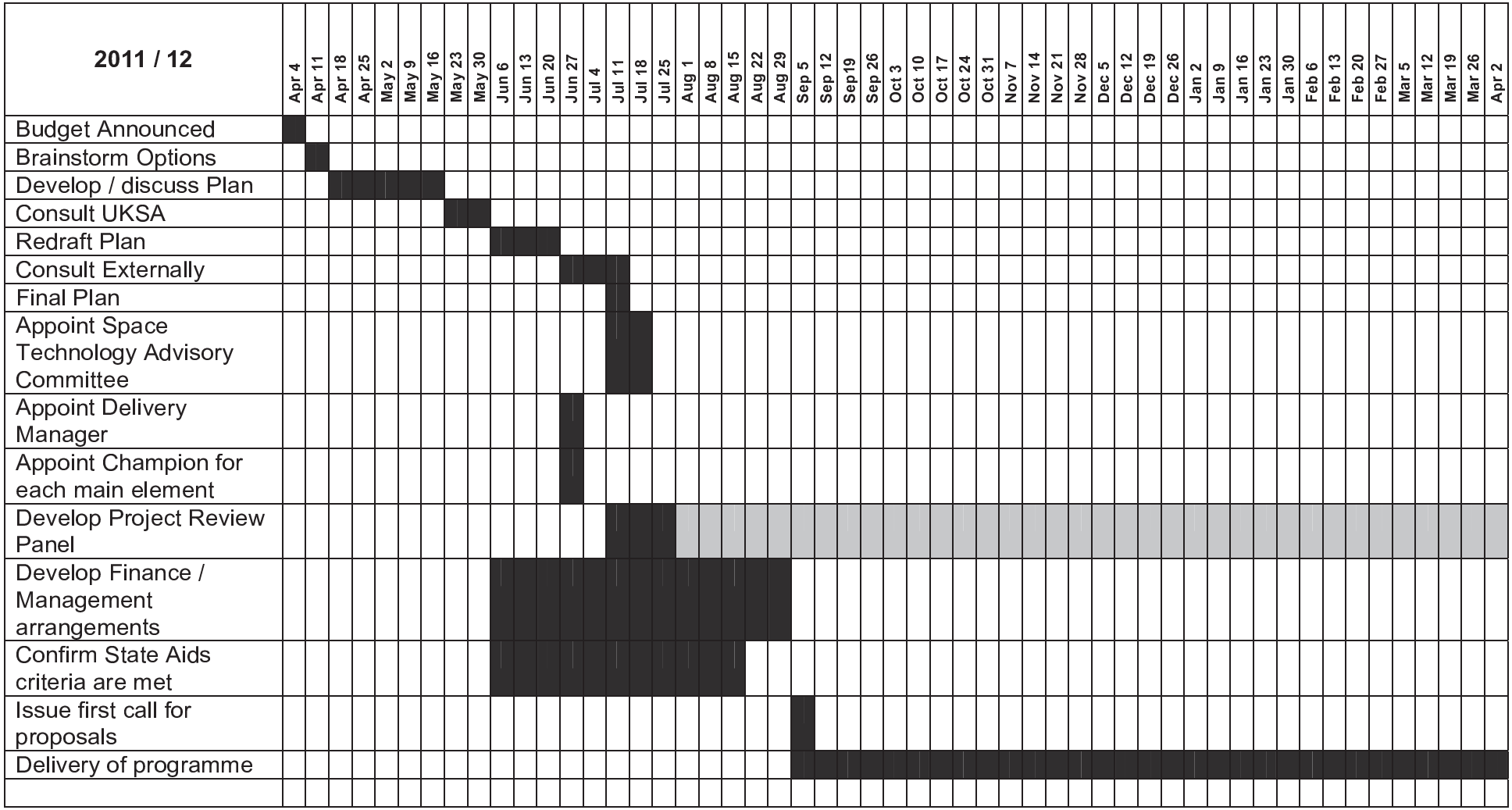
BRIEF SUMMARY OF UK SPACE AGENCY TECHNOLOGY FUNDING MECHANISMS

PROGRAMME	OBJECTIVES	TRL TARGETTED	CURRENT BUDGET	INTERVENTION RATE
CEOI	To bring together UK EO academic and industrial communities to position UK for future opportunities.	Low	£1,000,000 p.a.	100%, but 20-50% industrial match expected
CREST	To bring together UK exploration academic and industrial communities to position UK for future opportunities.	Low	£1,700,000	Up to 100%, but preference given to projects with match
UKube	To provide CubeSat flight opportunities for technology demonstration payloads.	Up to 7 or 8	£600,000 p.a.	Self funded or 50%
Cosmic Vision National	To support early stage technology for scientific payloads on ESA missions.	Up to at least 5	Past support has averaged £1,500,000 p.a.	100%
Aurora National				
GSTP	Broad ESA programme to convert engineering concepts into mature products.	4 – 8	€ 2,400,000	100% if competitive 50% if direct negotiation

BRIEF SUMMARY OF OTHER UK SPACE TECHNOLOGY FUNDING MECHANISMS

PROGRAMME	OBJECTIVES	TRL TARGETTED	CURRENT BUDGET	INTERVENTION RATE
TSB / SEEDA - Space Feasibility Studis for Innovation in Space (IIS)	To stimulate innovation in the UK space sector	low	£2,400,000 including match.	Mostly 75%
TSB / SEEDA – TechDemoSat (TDS)	Provision of an 'in orbit test bed' for innovative UK technology	Up to 7 or 8	£3,500,000 (plus approx match from SSTL)	Payload providers fully fund their equipment

ANNEX 6 Development Plan



ANNEX 7 Delivery Plan

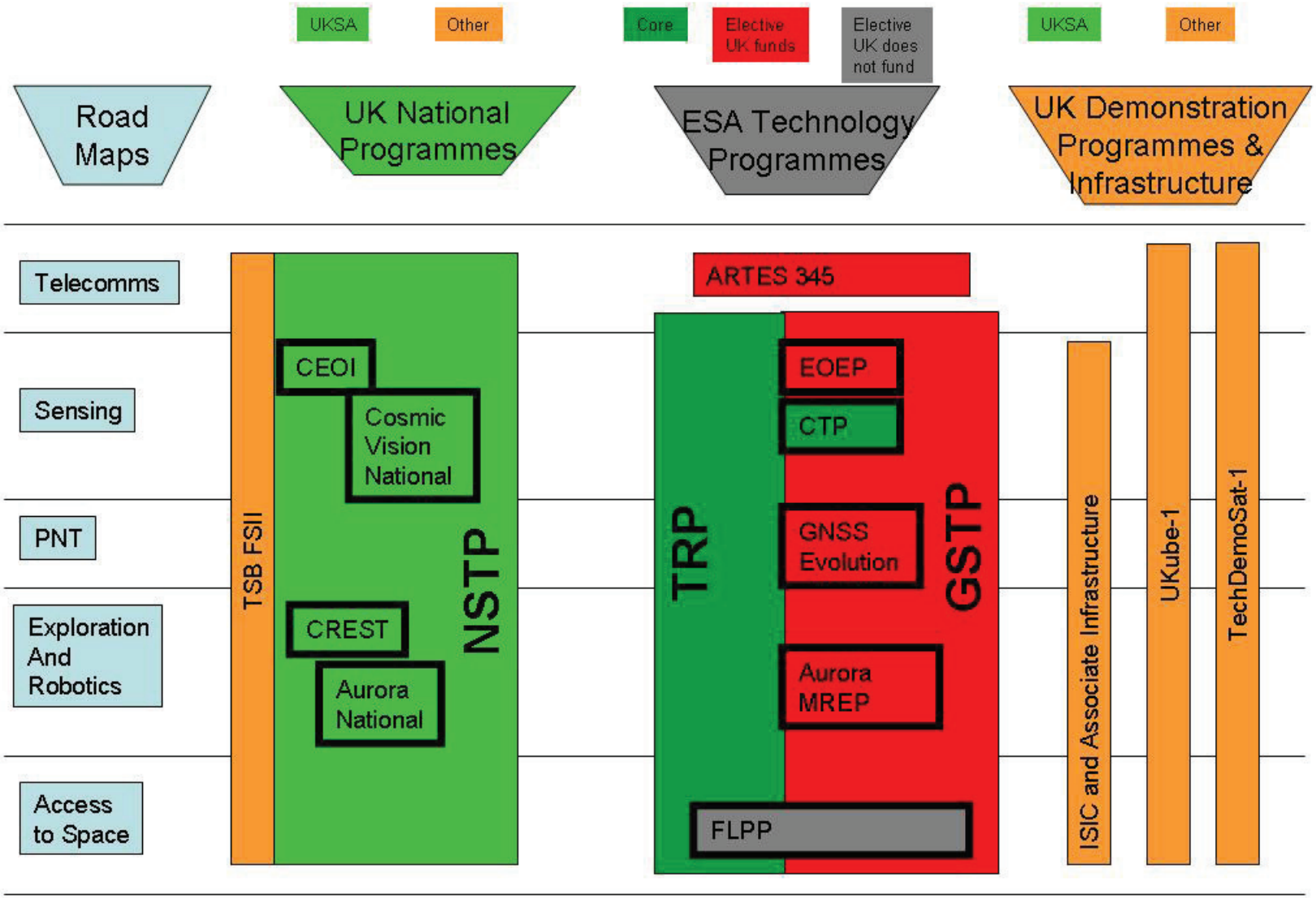
This plan represents a template for each individual element of the programme and also for any further calls for proposals.

2011 / 12	Apr 4	Apr 11	Apr 18	Apr 25	May 2	May 9	May 16	May 23	May 30	Jun 6	Jun 13	Jun 20	Jun 27	Jul 4	Jul 11	Jul 18	Jul 25	Aug 1	Aug 8	Aug 15	Aug 22	Aug 29	Sep 5	Sep 12	Sep19	Sep 26	Oct 3	Oct 10	Oct 17	Oct 24	Oct 31	Nov 7	Nov 14	Nov 21	Nov 28	Dec 5	Dec 12	Dec 19	Dec 26	Jan 2	Jan 9	Jan 16	Jan 23	Jan 30	Feb 6	Feb 13	Feb 20	Feb 27	Mar 5	Mar 12	Mar 19	Mar 26	Apr 2
Consult Technology Advisory Committee																																																				
Develop Guidelines																																																				
Appoint reviewers from panel																																																			
Agree call																																																				
Publicise call																																																				
Call for Proposals opens																																																			
Deadline for responses																																																			
Review by selected panel members																																																			
Appraisal meeting																																																			
Offer letters to successful applicants																																																			
Mid term review (larger projects																																								Timing as required														
Final Review (all projects																																									Timing as required													
Review of outcomes																																									6 months after end of project													

ANNEX 8
Planning for Future Development of NSTP

The following diagram, intended as a planning tool, provides a visual representation of the individual funding schemes relevant to the development of technology. The main relevant technology related programmes are included (though ESA missions, which pick up funding from many of these programmes at later stages, are excluded for clarity). The vertical axis roughly discriminates programmes according to the main road map area they fund. Within each group, the horizontal extent of boxess roughly indicates the TRL levels to which they are applicable.

No attempt is made to indicate the size in monetary terms of each programme – although this is of course a key factor in their effectiveness. The diagram clearly indicates the need for a balanced portfolio across all National and ESA funding streams - both in terms of coverage and funding level - if the UK is to take full advantage of its capabilities in space technology.


UKSA
Other
Core
Elective UK funds
Elective UK does not fund
UKSA
Other
Road Maps
UK National Programmes
ESA Technology Programmes
UK Demonstration Programmes & Infrastructure
Telecomms
Sensing
PNT
Exploration And Robotics
Access to Space
TSB FSII
CEOI
Cosmic Vision National
CREST
Aurora National
NSTP
ARTES 345
TRP
EOEP
CTP
GNSS Evolution
Aurora MREP
FLPP
GSTP
ISIC and Associate Infrastructure
UKube-1
TechDemoSat-1

ANNEX 9 NSTP - FAQs published on UK Space Agency Website

1. What has the Agency said it will do regarding technology ?

The draft UK Space Agency strategy identifies the plan to implement a first phase of a National Space Technology Programme. With relevance to innovation, the strategy states:

> "The Agency, working with the research councils and the Technology Strategy Board will enable an integrated approach to technology development from 'blue skies' research through to technology demonstration, pulling ideas developed in the science base through to the stage where private sector will invest. The International Space Innovation Centre (ISIC) at Harwell and the ESA Business Incubation Centre will play an important role in creating the open innovation environment where new technology, applications and services can flourish…. "Inspired by the Space IGS, a set of technology 'roadmaps' have been developed by the space community supported by the Space 'Knowledge Transfer Network' Special Interest Group. The UK Space Agency will:
>
> - use these technology road maps to prioritise investment and identify high impact, disruptive technologies;
> - launch a National Space Technology Programme co-funded with industry to help deliver the UK's space technology strategy;
> - develop strategies to take priority technologies from concept to demonstration through national, ESA, EU or bi-lateral programmes as appropriate;
> - work with other technology funders to make the most effective use of resources by identifying common technological requirements and dual-use capabilities;
> - selectively join ESA optional programmes, engaging with them at an early stage and contributing at a meaningful level to influence the programme to meet UK priorities;
> - facilitate exploitation of technology by encouraging academia-industry collaboration at all stages of the technology development cycle;
> - work with partners to ensure transferrable technologies are taken up by other sectors;
> - maximise private financing by assisting with risk reduction during the earliest phases of technology development."

The strategy recognises that the Agency is the key organisation able to drive the innovation cycle from basic research through to practical applications as it has an interface with the research councils, TSB, academia, industry and national facilities such as RALSpace, ISIC, ATC, NCEO etc.

2. How will the £10M be allocated ?

There will be one or more open calls for proposals. The size of a call and the specific topics to be addressed have not been finalised but we envisage a balanced mixture of small 'Pathfinder', medium-sized 'Core' and larger 'Flagship' projects. *[The mix of these elements has been refined and detailed in the current plan.]*

3. What is the focus of the programme ?

The goal will be to advance promising UK space technologies up the Technology Readiness Level (TRL) ladder. The majority of funding will be to support mid-TRL activities (4 to 6) *[see TRL definitions in Annex1].* A minority of funding may be used for activities at TRL 1 to 3, focusing on novel or longer term technology. Opportunities for flight demonstration activities (TRL 7-9) are primarily through ESA programmes and also through the national TechDemoSat and UKube programmes.

4. Is this a one-off programme ?
The Agency hopes that this will be a continuing programme. Whether this is possible will depend on future decisions influenced by the success of the first phase. A positive response and good quality proposals will be an essential pre-requisite for continuation.

5. Does this programme replace funding via ESA or the EU ?
No. The UK Space Agency funds several space technology programmes via ESA which are either generic (e.g. General Studies, Technology Research Programme) or focused on certain specific areas (e.g. ARTES for telecommunications; MREP for robotic exploration; EOEP for Earth observation; CTP for space science). The European Commission also funds the 'Space Foundations' programme through the Framework R&D programme ('FP7'). The focus for NSTP is on allowing UK industry to expand commercial space activities and to be a stronger player in international programmes.

6. Will projects require match-funding ?
Yes. It is expected that industrial partners will need to contribute their own funds. The detailed terms have not been determined but will need to be compatible with rules on State Aids. *[As outlined above, State Aid issues are being investigated and the most expedient route will be adopted to deliver this current plan – even if this imposes certain restraints on what can be funded in the short term.]*

7. Are there special rules for SMEs and for universities?
This is yet to be determined but we will wish to encourage involvement of SMEs and research institutions and so will identify appropriate mechanisms. *[as in 6 above]*

8. Will you be awarding grants or development contracts?
The Agency expects to award grants. *[as in 6 above]*

9. Will you use incentive schemes such as a prize fund (cf. Ansari X-Prize)?
This possibility is under discussion but no decision has been made. *[Given the timescale of the current plan, and comments received, it has been decided not to include this exciting, but necessarily complex, item.]*

10. Are there pre-defined projects that are already allocated some of the money?
No. Some existing thematic technology programmes (e.g. in space science, Earth observation) which have separate budget allocations may be aligned to be part of the overall NSTP 'family of programmes' to ensure consistency and efficiency.

11. What are the technologies that will be funded ?
The key source document will the National Space Technology Strategy published in April 2011 along with the associated technology roadmaps.

12. My technology is not in the roadmap. Will I be excluded ?
No technology that would contribute to the growth of the UK space sector is *a priori* excluded. However, it will be important to show a clear route to market or a viable business plan.

14. Will some of the funds be used as subscription to ESA's GSTP optional technology programme?
No. *[This decision has been reviewed following vocal responses to the FAQs from industry. UK Space have mediated this broad spectrum of opinion and suggested guidelines for a way forward. A limited amount is now included for GSTP in the plan, which will be delivered in line with these guidelines.]*

15. What will be the evaluation criteria ?
Detailed criteria have not been finalised yet. However, the programme will primarily respond to the Agency's growth-driven strategy. Proposals which demonstrate potential to contribute to growth in commercial and export markets will be especially welcome. Technology which helps position the UK to play strong roles in key ESA and EU space programmes will also be considered where there is good potential to commercialise the technology or the technology has multiple uses.

16. Who will manage the programme ?
The overall programme will be managed by the Technology, Science and Exploration Directorate at UK Space Agency HQ. Partners in other organisations may be used to help deliver the programme. In particular, the Agency hopes to work with the Technology Strategy Board and the Research Councils on the programme.

17. What capability and experience will the Agency use to manage the programme?
The intention is to use existing processes to ensure rapid implementation wherever possible. The programme will build on UKSA and partner (TSB, NERC, STFC) experience in managing existing sub-sectoral technology and spin-out programmes such as CEOI (Centre for Earth Observation Instrumentation), CREST (Collaborative Research in Exploration Systems and Technology), Cosmic Vision projects, Aurora Knowledge Exchange, the TSB Innovation in Space feasibility studies, TechDemoSat-1 and UKube-1 programmes. *[as in 6 above]*

18. Is the programme only open to industry?
It is expected that different elements of the programme may focus more or less on research or industrial partners but one emphasis will be on promoting interaction across the research and industrial communities. The key goal will be to contribute to the space sector's economic growth rather than to do scientific research. However, the translation of scientific research into new space technology will be encouraged.

19. Will the programme fund applications of space data or only technology ?
The focus will be on technology – other existing programmes are available to support applications work and create new businesses (e.g. IAP, ESA Business Incubator).

20. Will I have to use ISIC/other particular facilities ?
Where appropriate and value adding, use of national facilities such as ISIC will be actively encouraged. The idea of using ISIC as the location to undertake focussed projects by co-located teams of experts drawn from across industry and universities is being examined. *[The comments in the plan above and specific provision for co-located projects to use the ISIC facilities expand on this question.]*

21. How do I know what ISIC can offer?

Information on ISIC and other relevant national facilities will be provided in the call(s) for proposals. However, the community is encouraged to contact ISIC Ltd. to discuss the potential for using its facilities. *[Annex 4 above provides a little more detail of ISIC facilities.]*

22. How does the space sector get involved in shaping what the programme will do and what it will deliver ?

In addition to making actual proposals for projects, the space sector will help guide the programme in three ways.

1. The new National Space Technology Roadmaps have already involved a team of about 200 people from across the space community: these roadmaps will form the basis of the programme's work plan.

2. The Agency will consult with the space sector on the programme structure before going ahead with it. The Agency will consult via its advisory boards, UKSpace, ASTOS, SPAN and the National Space Technology Steering Group. *[The plan presented here forms the basis for this consultation.]*

3. The Agency has invited members of the space sector to join its Space Projects Review Panel, from which will be drawn the evaluators for proposals of all types of space projects including technology. [See *http://www.bis.gov.uk/ukspaceagency/news-and-events/2011/Apr/call-fornomininations-for-agency-projects-review-panel*] *[The provision of a UK Space Agency Space Technology Advisory Committee in the plan above is included to facilitate this continuing process – following the practice successfully used in other UKSA programmes.]*

23. Who makes the final decision on which projects are to be funded?

The UK Space Agency.

24. What is the Planned Schedule ?

The schedule is under development but a first call is planned within a few months.