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COMMERCIAL DEVELOPMENT & PPP FOR THE US-UK LUNAR INITIATIVE

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ABSTRACT

Under an early stage of a US-UK agreement to work together on lunar missions, the UK's experience in Public Private Partnerships (PPP) is helping guide the creation of an agency-level Commercial Development Policy (CDP) for NASA, which can be of use to the US-UK collaboration. An existing CDP, which was adopted by the NASA Exploration Systems Mission Directorate, seeks to develop industrial capability and markets to achieve exploration at lower cost with fixed price contracts. In PPPs, private capital is secured to finance the construction of an asset which is then used for the private operation of a public service delivery. Two notable European PPPs in the space sector (Skynet 5 and Galileo) provide valuable lessons. Commercial lunar opportunities include services and products of use in both robotic and manned phases and are expected to grow as the lunar programme builds up.

1. INTRODUCTION

The Exploration Systems Mission Directorate (ESMD) at NASA Headquarters (HQ) adopted the ESMD Commercial Development Policy (ECDP) to encourage the development of commercial space capability markets and industries. Individuals from other mission directorates and mission support offices at NASA HQ helped support and develop this policy. Other significant contributions came from ESMD personnel located at NASA field centers throughout the country.

For the UK, a Public/Private Partnership (PPP) exists when a private sector company commits to the delivery of a government service and takes a commercial risk in doing so. Private financing, usually known as PFI for Private Finance Initiative, is a type of PPP in which the private sector risk includes funding of the project to build the infrastructure which enables the service. The UK's experience of PPP/PFI includes over 700 contracts now in place which altogether have raised over $130Bn of private investment, and the experience is increasingly being used abroad.

Following an agreement last year between NASA and the British National Space Centre to investigate collaboration in space exploration[i], a joint working group reported on lunar cooperation earlier this year[ii], including the prospect of using the UK's

experience in PPP to help craft NASA's Commercial Development Policy. That suggests the use of private sector risk capital for public sector lunar missions.

2. ESMD COMMERCIAL DEVELOPMENT POLICY

2.1 "Technology Commercialization" and "Commercial Development"

Created in response to statutory requirements[iii], the "NASA Technology Commercialization Policy"[iv] defines the term "technology commercialization" as "the development of NASA Aeronautics and Space mission technology in commercial technology partnerships, and the application of NASA technological assets in non-aerospace and aerospace markets which result in economic benefit to U.S. economy or improvements to the quality of life."

"Commercial development" is the identification and support of commercial space capability industries (goods and services) acquired for NASA's benefit. With commercial development, the role of "supplier" and "customer" reverses for both the government and the private sector.

In reversing these roles, NASA positions itself as the customer. The ECDP strives to meet NASA needs through direct acquisition of existing goods or services from one or more private industry suppliers.

2.2 Objective

The ECDP strives to achieve the following objectives:

- Encourage the development of commercial space capability industries with substantial and significant history of operational capabilities. The U.S. tax-payer will best benefit by an American industry-base that includes many companies which fill a wide variety of demand niches for space services and products.
- Meet and fulfil NASA's exploration mission goals and requirements (as defined by NASA program managers) at a lower cost and cost risk when met by the commercial market.
- Purchase space capabilities using "fixed price" acquisitions whenever practicable. For example, utilize contracts for "acquisition of commercial items"[v] more widely than a "contracting through negotiation"[vi] acquisition. The latter is currently the predominant type of procurement contract used by NASA with its prime contractors for these types of space capabilities.

2.3 Goals

The ECDP goals are:

- To encourage the development of commercial space capabilities and markets.
- To encourage "Buy Commercial" instead of "Government Provided" decisions.
- To encourage commercial representation and opportunities in NASA's exploration architectures.

2.4 Approach

The ECDP embodies a coordinated set of policy elements that encourage the private sector to develop, demonstrate, provide, and support commercial space capabilities. Execution of all policy elements in fair, open, and non-intrusive ways would not interfere with other sales or transactions of the company. Steps will be followed to

ensure that architecture development for ESMD programs are open and can utilize commercial space capabilities to the maximum possible extent.

The ECDP encourages commercial companies to bring their existing technology to the table by encouraging the funding of capability demonstrations (the application of mid-level Technology Readiness Levels, typically five or six, to a specific system, and bringing that system to operational status). This provides commercial companies the opportunity to license pre-existing technology to the government in exchange for a royalty, or permit the fixed price acquisition of the eventual operational capability by NASA. The ECDP encourages NASA to rely on the emerging space business community to identify which commercial sectors are likely to remain viable and to identify viable candidates for ECDP application. Likewise, NASA should not let high-priority exploration mission goals determine which market sectors are to be encouraged, because those sectors may not be commercially viable in the absence of significant NASA involvement.

2.5 Rationale

Through the Global Exploration Strategy activities conducted since April 2006, NASA has identified specific objectives that will guide the space agency's exploration mission to the Moon, on to Mars, and beyond. Some of these objectives are in the "critical path" of mission success and will be accomplish by NASA programs with ESMD. The ECDP anticipates fulfilling all objectives, including those on the critical path, with the commercial sector, either in partnership with NASA or through independent development.

ESMD management at NASA HQ has been working closely with its programmatic counterparts at the pertinent NASA centers, as well as with members of the nascent space exploration industry, to develop an effective strategy to encourage commercial space capabilities. If the goals of the ECDP can be achieved, the NASA exploration mission will be impacted in the following significant ways:

- More exploration goals will be accomplished sooner. Goal for goal, and accomplishment for accomplishment, the overall program will be accomplished with a lower budget.
- The development of a commercial space exploration industry, one that does not rely solely on NASA as the sole or primary customer, will be greatly accelerated, and this will represent a major step toward long-term sustainability of NASA's exploration program.
- Implementation of the ECDP will be consistent with NASA’s charter, strategic goals, and other stated policies.

It should be noted that the ECDP does not constitute a NASA-wide policy. However, at the time of this writing, efforts were underway to promote this policy to an agency level.

3. THE UK’s PPP

3.1 History

The PPP/PFI concept has its origins in the 1970s French road-toll concession contracts. Following its notable use for the Anglo-French Channel Tunnel in the 1980s, the UK government in the early 1990s decided to apply private finance as a default for practically all new public infrastructure, driven by the UK finance ministry’s PFI programme. This was later expanded into a more comprehensive PPP approach, but the

emphasis remains the acquisition of private investment to finance the infrastructure and deliver the service.

3.2 Types of PPP/PFI

Generally a PPP without private financing is simply a form of outsourcing, when the private sector may rely on a government infrastructure to provide a service and charges for service availability and/or usage. Occasionally the private sector is given a government asset to exploit in the market, and shares the subsequent revenues with the public sector.

Under PFI, private financing is used to design, build and operate the infrastructure to deliver the service. The private sector usually owns the assets and its operational charging is designed to include the recovery of its investment. Examples where private financing can be efficient include:

- internal government use (e.g. defence facilities, schools, government computer services), where charging is based on availability and/or usage;
- a public service direct to citizens (e.g. roads), where charging is as above, but with the option of direct payment by users;
- a market service needing significant government involvement and permission (e.g. national lottery), with normal market pricing mechanisms;
- a mixture of the above.

Variations on private financing include:

- where public funding exists up to design & test, and private funding is used for building & operations;
- where there is joint public/private funding via an investment payment subsidy or joint ownership of the implementing organisation.

If the private sector provides funding for asset construction which is without operational risk to the private sector because of government guarantees to repay the investment even if the private sector fails during the operations phase, then this is not considered private financing. In this case, the public sector could have raised debt funding directly from the financial markets.

In practice, the balance of investment risk between public and private sectors varies from project to project. The risk could in theory range between full 100% risk on either side. UK government procurement authorities usually retain the fall-back option of a conventional procurement in which they contract for the build and then separately contract for the operation. This can be evaluated for comparison with the private financing option, in which case it is known as the Public Sector Comparator.

3.3 How it works

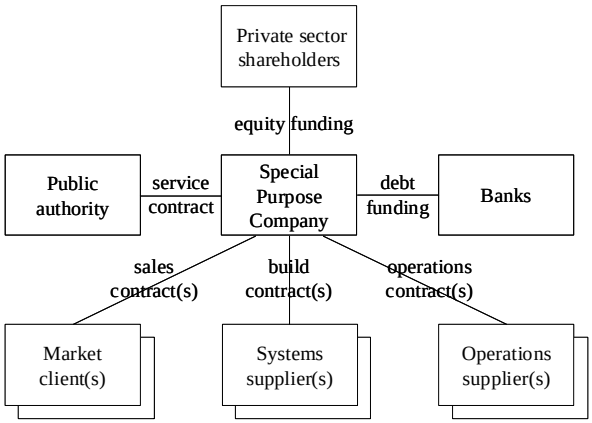

Figure 1: A standard PFI model.

As shown in Fig. 1, a *public authority*, sometimes via a procurement agency, negotiates a *service contract* with a *Special Purpose Company* (SPC). The service contract includes full provision for the private sector to finance, build and operate

the service, from the date of the contract to its end. To ensure the private sector takes on risk, payments should at least be dependent on service delivery. The SPC is created with *equity funding* by its *shareholders* for the sole purpose of the service contract.

The SPC is the most important component of the private sector for the public sector to deal with. A joint venture (JV) if it has more than one corporate shareholder, it is a commercial entity for the most efficient contracting for financial, material and human resources, for selecting and optimising the allocation of risk, for balancing capital expenditure with operating expenditure, and for limiting to the project the risks and liabilities of those who contract with it.

In addition to having equity funding, the SPC negotiates: with *banks* for the provision of low risk *debt funding* to be repaid with low cost interest; with *systems suppliers*, perhaps with a single lead supplier, for the build and delivery of the required assets which are paid for by the SPC; with *operations suppliers*, perhaps with a single lead supplier, for operating the assets to deliver the service, and paid by the SPC according to a Service Level Agreement; and with *market clients* such as service providers and end users, for whatever deals the SPC can arrange, having a concession within the service contract to do so and often sharing its revenues with the public sector as a consequence.

Although the main contracts shown above are with the SPC, extra agreements will be needed to improve the robustness of the commercial arrangements. For example, banks expect to have recourse to the other parties in case matters go wrong. They might have a direct agreement with the shareholders or the lead supplier if the build phase goes badly, and with the public sector in case the SPC fails during operation. The private sector will insure against failure of some of its responsibilities.

3.4 Advantages & disadvantages

The advantages of private financing stem from the private sector's almost unlimited access to capital (although transaction costs can limit the minimum amount of funding), its continual investment decisions based on NPV (net present value) rather than cost, its balancing of early capital expenditure with long term operational expenditure via value based deals across the supply chain, and the alignment of interests of the providers of capital with the users of capital, particularly the alignment of financial incentives with public benefits.

For public sector bodies an important advantage of private financing compared to conventional procurement is that the public sector financial commitment is defined in the service contract for the duration of that contract. Forward planning by public sector bodies is therefore simplified due to the removal of cost uncertainty.

The disadvantages of private financing include the higher cost of investment money the private sector has to pay compared with government, and the fact that developing a private financing contract takes longer, is more expensive, and needs a greater skill, for both sides.

3.5 Space PPP Examples

Two space sector PPP examples stand out. One is Skynet 5, providing the UK military with secure satellite communications. Skynet 5, the largest MoD (Ministry of Defence) PPP contract until only recently, is now in full operation with three geostationary satellites and has become a successful reference for other projects. The second PPP is Europe's Galileo project, an equivalent to America's Global Positioning System (GPS).

3.5.1 Skynet 5

A service contract between the MoD and Paradigm, a Special Purpose Company owned by EADS, is put into practice by a catalogue of communications services which can be bought at a fixed price over a secure web intranet anywhere around the world. Services include a range of radio signal types and bandwidths, from personal satellite phones to secure tactical nets and major trunk links, and extend to remote terminals and networking. They even include welfare links to service families and general internet connections.

The service contract contains service level agreements and the price varies with achieved service performance. Budgeting by the MoD can be at any level down to an operational unit. Underpinning the contract are Government guarantees for overall usage.

Paradigm can use its spare bandwidth for non UK defence sales under a profit sharing agreement with the MoD, and already has a number of additional client contracts, e.g. with NATO, Canada, Portugal and Holland.

Its satellite and ground systems supplier is a prime arrangement led by EADS Astrium, and operational services is led by another specially created EADS subsidiary, Paradigm Services. Paradigm Services can provide bandwidth from other commercial satellite operators to enable full service satellite communications.

Around $2Bn of financing was arranged, mainly as debt from the capital markets which was secured by the quality of the UK government commitment to overall revenues and to an EADS commitment to Paradigm's project cost and delivery risks, for both the satellites and the ongoing operational services. The greater part of the financing arrangement was developed under full competitive pressure, as was the service contract itself.

3.5.2 Galileo

Galileo has been deliberately designed to offer a range of civilian services including integrity and liability and seeks to achieve market revenues. Originally mandated by European governments to attract private investment to set up the infrastructure, Galileo presented the European Union (EU) with its largest-ever collaborative project and the first significant PPP at the European level. But after over five years of seeking a PPP solution, the decision was taken last year to rely instead on public financing.

From its early days the Galileo PPP faced several management challenges:

- The EU's executive institution the European Commission (EC) and the European Space Agency (ESA) were working together for the first time, with different financial and operating procedures and cultures.
- The project required agreement between the EU's Member States, and getting multinational cooperation to agree upon Galileo's outputs was not always simple.
- There was a parallel procurement with the EU in control of the PPP and ESA managing the technology development programme, making it difficult to set up efficient lines of customer authority.
- Many in the European public sector were facing for the first time up-front private investment rather than public asset delivery, when government traditionally would have created the initial service and then phased in private management for operations and private capital for future development.

- There was a long lasting and confusing political association between market revenues and the PPP concept, and a political expectancy that the acquisition of private capital was dependent on taking on market risk, which was always going to be unacceptable.
- The competition for the lead supplier was closed under political pressure well before priced outputs could be formally submitted.

Above all, the important PPP requirement for a single effective customer was never met. As the programme developed, it moved further and further away from the UK's view of how a PPP should be done. In the end, a Galileo PPP proved too difficult to deliver and an arrangement has recently been put in place where the EC will fund the procurement by ESA of the satellites and ground infrastructure, but under EC competitive procurement rules.

4. APPLICATION TO THE US-UK LUNAR INITIATIVE

4.1 General

The US-UK lunar initiative provides a number of CDP and PPP opportunities. They require development as commercial ideas at the same time as the enabling technology is brought to operational readiness. Phased Government supported programmes could start with direct investment in a company as in COTS (Commercial Orbital Transportation Services), or with prizes, or with other forms of parallel government and commercial project investment, and leading to the commercial management of design, production, delivery and operational risks.

Demand is key, whether from public or private markets, and if non-space spin-offs are absent or insufficient then exclusive rights may have to be supplied to de-risk prospective revenues to the point where investment decisions can be made. Such exclusivity, from either US or UK public authorities, needs to be competed for.

Prerequisites to success are a lower cost commercial capability, managed regulatory issues, clearly definable deliverables and a clear client commitment to the requirements – from a team from one or other national agencies or a combined management entity.

Below are suggested candidates of potential near term lunar applications or markets for development progress or operation within the next 10 years. These were conceived and categorized into the major categories shown during the Second Next Generation Exploration Conference as detailed in the final version of the meeting proceedings.[vii] They include components of larger commercially delivered products and services; support services that require little capital investment; and non-lunar applications that can be associated with the lunar initiative.

4.2 Transportation

- Terrestrial rover sandboxes, exploration rovers, and tele-operated repair robots
- Small-scale people, cargo movement capability
- Surface topography mapping.
- Development of fuel depot systems
- Orbital hotels in LEO
- Electric car stations, stations for dedicated network of terrestrial rovers.
- Terrestrial launch and landing facilities.

4.3 Habitability

- Human factors designs.
- Food grown in habitat.
- Storage and cargo logistics systems
- Delivery from Earth, distribution, and storage of chemical consumables
- Delivery from Earth, distribution and storage of water infrastructure.
- Ionic membrane, carbon-dioxide control systems, mechanical filtering of dust for air systems.
- Piping, plumbing, external and internal recycling for waste management.
- Breathing air, cooling, navigation systems, umbilical connections, crew survivability equipment for space suits.
- Active and passive thermal control systems.
- Furniture, exercise, and lab equipment. Appliances, tools, supplies, and clothing.

4.4 Power, Communications, and Navigation

- Solar power generation and cryogenic storage.
- Private expansion of the Deep Space Network.
- Lunar navigation via high-resolution images and pattern-recognition advancements.

4.5 Facilities

- Testing facilities (and brokerages) for radiation, thermal, microgravity, vacuum, dust, vibration tests.
- Orbital habitats and ISS centrifuge facilities for space and lunar-based research.
- High strength-to-weight, memory shape, and radiation protection construction materials.
- Lightweight construction tools and equipment, and simple construction rovers.
- Regolith excavation, mass-moving, sampling and drilling, and dry mining equipment and facilities.

4.6 Services

- Space debris tracking and removal
- Vehicle recovery
- Removal and recycling of waste produced on the Moon.
- General services for multi-capability robotics.
- Legal advice for entrepreneurs and legislators.
- Knowledge storage on the Earth and on the Moon for operational support.
- Systems engineering and administrative documents for operational support.
- Development and accreditation of industry standards.
- Communications data and services.
- Communications spectrum management and regulation.
- Insurance.
- Navigational signals for space traffic management.
- Cartographic data.
- Specialist health services treatment of astronauts, including preventative

medicine, telemedicine, and medical equipment supply.

4.7 Lunar Access

- Small lunar landers.
- Multiple landers on an ESPA ring.
- Secondary payload Earth-to-Orbit launch vehicle adapters.
- Unmanned space tug and space ferry demonstration missions.
- Automated rendezvous and docking demonstration on-orbit.
- Commercial orbital test services.
- Demonstration mission of an orbital propellant depot.

4.8 Lunar Environment Utilization

- Lunar map production.
- Ruggedized instrumentation, tools, and equipment.
- Sale of lunar dust.
- Dust mitigation techniques.
- Terrestrial bioremediation techniques.

4.9 Cultural Industries

- Parabolic flight agreements for "super-hero" experiences.
- Remote-controlled rovers in extreme locations on Earth and on the Moon.
- Self-contained battle rooms to control robots.
- Refinement of existing high-definition, sensory media experiential devices.
- Terrestrial, space-themed sports parks with space-themed products, boards, and U-ramps.
- Wedding ceremonies in space.
- Earth-based reality game shows ("Tuff-'Nuff for Space").
- Space lotteries with flights as prizes.
- Guidebook for the Moon.
- Using lunar rocks or dust, meteorites, crystals, etc., for space jewellery.
- Collection of materials for lunar data archiving.
- Space-themed luggage.

5. CONCLUSION

In this paper, NASA ESMD's Commercial Development Policy (ECDP) and the UK's Public-Private Partnership (PPP) concepts are described. They are similar in trying to meet the government's specific needs by leveraging private capital to provide commercial goods and services more efficiently. These goods and services can meet the needs of non-governmental customers as well.

Although private risk investment for lunar exploration is at an early stage, within the context and timescales of the US-UK agreement to collaborate on lunar exploration, several opportunities present themselves and need to be assessed. The list includes both services and products, and can be expected to develop as the Moon programme itself develops.

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[i] Joint Statement of Intent for Cooperation in the Field of Space Exploration, NASA/BNSC, April 19, 2007

[ii] Joint Working Group Report on Lunar Cooperation, NASA/BNSC, February 15, 2008

[iii] The Stevenson-Wydler Technology Innovation Act of 1980.

[iv] NASA Policy Directive (NPD) 7500.2.

[v] Contracts under Federal Acquisition Regulations (FAR) Part 12.

[vi] FAR Part 15 contracts.

[vii] Proceedings of the Next Generation Exploration Conference-2, held at NASA Ames Research Center, Moffett Field, California, 12-15 February 2008.