Impact Assessment of Scottish Independence on the Space Sector

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by

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Cover Image: ESA
Title: Phytoplankton bloom off the coast of Scotland
Released: 16/05/2008 11:11 am – ID: 234528
Description: This Envisat image captures the green swirls of a phytoplankton bloom in the North Sea off the coast of eastern Scotland. The chlorophyll phytoplankton collectively contain colour the ocean's waters, which provides a means of detecting these tiny organisms from space with dedicated ocean colour sensors, like Envisat's Medium Resolution Imaging Spectrometer (MERIS) instrument. MERIS acquired this image on 7 May 2008, working in Full Resolution mode to provide a spatial resolution of 300 m.

Executive Summary

This politically neutral work explores the impact of independence on Scotland's emerging, innovative and world leading civilian space sector.

The ecosystem is explained and quantified, clarifying the distinction between the European Space Agency (ESA) and the European Union, which the White Paper, *Scotland's Future*, has blurred.

Aspects of the White Paper relating to the sector are highlighted and discussed. The proposed relationship between an independent Scotland (iScotland) and the UK Space Agency (UKSA) is unclear within the White Paper. As the spirit adopted in the White Paper is wherever possible to continue co-operation with existing UK bodies this scenario is considered, with membership of ESA via UKSA, alongside direct membership of ESA.

Scottish independence could be said to be worth £15 – 20 million per year to the sector in the medium-term, and the long-term size and scale of the sector may be of order £100 million; almost triple the current size. However, this is dependent on the relationship established between iScotland and the rest-of-the-UK (rUK), and appears to require a contravention of the spirit of the White Paper.

How iScotland chooses to maintain a formal relationship with UKSA is thus of vital importance, having both economic and legal implications. Seeking a continuing relationship would require agreement about delegation of ministerial power, sovereign funds and indemnity provisions in response to any government liability for damage.

As regards membership of ESA and EUMETSAT in particular, the existing member states are required to agree to accession by iScotland and to set the conditions; any disruption or lack of access to international organisations, including the EU, could be a potentially significant problem. Post-independence, the scope of UK nationality, as opposed to citizenship, would also require clarification in the context of space and any on-going relationship with UKSA.

The relationship with EUMETSAT via co-funding contributions to the Met Office requires further thought but does appear in principle to be a viable option. The same judgement of 'viable' can be reached when considering the Scottish government's proposals around the Research Councils. However, whilst an approach may be viable, no assessment or judgement is offered as to its desirability from either an iScottish or rUK perspective.

Image: ESA/VITO
Title: Springtime in Europe
Released: 04/06/2014 4:49 pm – ID: 312289
Description: This image of Europe is a composite of Proba-V images from 1–10 May 2014. Launched just over a year ago, the washing machine-sized satellite carries the Vegetation imager designed after the French Spot-Vegetation mission, flown on the Spot-4 and Spot-5 satellites. Spot-Vegetation marked 16 years of service in May, and has now passed the torch to its European counterpart. Proba-V maps land cover and vegetation growth across the entire planet every two days. The data can also be used for day-by-day tracking of extreme weather, alerting authorities to crop failures, monitoring inland water resources and tracing the steady spread of deserts and deforestation.

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In September, Scotland will decide whether to become again a nation state, or whether to continue with the Treaty of Union. Such a decision must be about the type of nation we are, that we aspire to be, and how that is best to achieved. The scale of the decision is immense and so it must be an informed one, based not on any single issue but rather on the balance of the evidence. As a contribution to this balance of evidence, this politically neutral work explores the impact of independence on Scotland's emerging, innovative and world leading civilian space sector.

Humanity has dreamt of travel beyond our cradle and into space since, at least, the time of the Roman conquest of Greece. From then, through Jules Verne's inspirational novel *De la Terre à la Lune*[i] and onto the modern-day, humanity's travels beyond our Earth have been told in many a fanciful tale.

To this day space technology maintains a mystique that most other forms of engineering struggle to emulate, and that none have managed to maintain quite so well. But, do not be blinded by the glamour, this is no witchcraft. Space technology offers unique opportunities in science, technology and commerce. In 2006/07, UK space revenues were £6.6 billion. By 2010/11, these revenues had grown to £9.1 billion, sustaining a decade-long growth trend with a near 9% per annum growth in real-terms over that period.[ii]

1. Definition of 'the Space Sector'

The Organisation for Economic Co-operation and Development (OECD) define the space sector as including "*all public and private actors involved in the provision of space-enabled products and services*."[iii] This definition is widely accepted and used within Europe, with the sector sub-divided into the *upstream* and *downstream*. Broadly speaking, upstream categorises the research, engineering and technology providers of spacecraft and their operations, whilst downstream categorises the exploitation

[i] *Published in English as From Earth to the Moon.*

[ii] *2010/11 is the base year for the UK's national, industry-led 2014 Space Innovation and Growth Action Plan (1) using figures from the UK space 'Size and Health' survey (2), a biennial activity; the 2014 'Size and Health' survey launched on 6 May 2014.*

[iii] *See http://www.oecd.org/futures/space/thecommercialisationofspaceandthedevelopmentofspaceinfrastructure.htm, cited 17 June 2014.*

of this technology such as a satellite broadcast service or a Global Navigation Satellite System (GNSS) service provider, including the technology required to do so.

Categorisation as upstream, downstream or out-of-scope can appear based on imprecise boundaries that are best explained by means of an example: the development of instruments for use in space-based astronomy such as the MIRI (Mid InfraRed Instrument) developed by the UK Astronomy Technology Centre (UK-ATC) in Edinburgh for the James Webb Space Telescope is upstream. Meanwhile, the exploitation of the data from MIRI is downstream, and ground-based astronomy such as the work of UK-ATC on the European Extremely Large Telescope is out-of-scope.

2. Assumptions

In order to make any assessment of the impact of independence, a number of assumptions are required.

- In the 2011 census, the UK's population was 63 181 775 while Scotland's was 5 313 600, or 8.41% of the UK total. Hence, when discussing population *pro rata* share, a population split of 8.41% shall be used.
- The current maritime border, established following the median line principles of delimitation of territorial sea between adjacent states and the further criteria used within the United Nations Convention on the Law of the Sea (UNCLOS) is assumed;[iv] giving a Scottish GDP in 2011-12 of £150.8 billion,[v] or 9.6% of the UK's GDP. Hence, when discussing GDP *pro rata* share, a GDP split of 9.6% shall be used.
- It will be assumed that an independent Scotland (iScotland) is a member of the European Union and the European Space Agency, and that contribution levels to each will be in line with current, or planned *pro rata* levels. Sensitivity to this assumption is addressed in Section 5.9.

3. The Space Sector Today

The space sector ecosystem can appear complicated, even to those within the sector, however UK-wide the largest customer group is the commercial sector, accounting for 85% of total turnover (23 % business-to-business; 62% business-to-consumer), while the military, space agencies and civil government represent 7%, 5% and 3% respectively (2). The dominance of business-to-

[iv] *See UNCLOS, Part II, Article 15, http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm, cited 04 July 2014*

[v] *See http://www.bbc.co.uk/news/uk-scotland-22134809, cited 11 June 2014*

consumer in total sector turnover distorts analysis of both the research and development (R&D) spend within the sector and customer location analysis. However, both are critical, as the sector is export and R&D intensive. Total upstream R&D activity equated to 5.2% of turnover in 2010/11; by comparison the 'Aerospace and Defence' sector invested 3.5% of turnover in R&D, making the upstream sector 50% more R&D intensive (2).

With a multiplier impact of 1.99 the space sector made a value-added contribution to UK GDP of £8.2 billion in 2010/11,[vi] and with an employment multiplier of 3.50 supported the employment of over one-hundred thousand people (2). The industry is dominated by the downstream sector, accounting for almost £8.2 billion (89%) of total revenues, and 88% of the value-added contribution (2).

3.1. International

The space sector, perhaps more than any other sector of the economy, is international. Indeed international co-operation is often a pre-requisite. The most significant example of this for the UK space sector is the European Space Agency (ESA),[vii] established in 1975 and headquartered in Paris, it is a twenty member-state intergovernmental organisation dedicated to the exploration of space.[viii] ESA was founded by, and is operated through intergovernmental treaties. Based on its governing Convention this includes cooperation with third states, notably Canada, which also sit on its Council. Four other states participate in the *Plan for European Cooperating States* (PECS),[ix] while other countries are in negotiation with ESA about joining this initiative. As an international organisation, entirely separate to the European Union, its operations benefits from international immunity. Note however that the links between ESA and the EU are complex, with various agreements in place that enable EU funded programmes to be administrated by ESA.

ESA is funded by subscriptions to the mandatory and optional programmes. Funding to the mandatory programme is defined as a function of each member state's GDP. ESA then encourages members to subscribe to optional programmes in proportion to their GDP. Hence, if a member's contribution to the mandatory programme based on GDP is 15%, ESA encourages them to subscribe to any optional programmes at around 15% of that programme; however, unless all member states subscribe to the programme it is clear the level must be varied. In 2012-13, the UK's

[vi] Value-added is defined as turnover less all input costs.
[vii] see http://www.esa.int/

[viii] ESA member states are Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom.
[ix] Hungary, Estonia, Latvia and Slovenia.

contribution to ESA was reported by ESA as €240 million.[x] Within this paper, the UK's 2012-13 contribution to ESA shall be assumed as £190 million,[xi] however it should be noted that in November 2012 the UK government committed to an average contribution of £240 million for the next five years. Scotland's contribution was thus £18.2 million in 2012/13 (based on a GDP *pro rata* of 9.6%), rising to an average of £23 million each year post-2012/13.

Another significant intergovernmental organisation that is separate from the European Union is EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites),[xii] created through an international convention agreed by thirty European member states.[xiii] EUMETSAT commissions, maintains and exploits Europe's meteorological satellites and is funded as a fixed percentage of member states gross national income. The UK is the second largest contributor to EUMETSAT, contributing 15.6% of the approximately €90 million 2013 budget, equating to a contribution of around £11 million through the Met Office. Scotland's contribution, on a population *pro rata*, is thus £0.94 million. However, noting that the White Paper *Scotland's Future* asserts that Scotland's gross national income per head is approximately 8 % higher than the UK's as a whole(4), the level due from iScotland would be around £1.02 million.

The European Commission also fund R&D within the space sector; this funding is part of the €70 billion Horizon 2020 programme, of which €119.5 million was allocated to space in 2014. This funding comes from member state contributions to the overall EU budget.

Much of the legal framework that governs actions in space was developed, and is maintained by, the United Nations.[xiv] This framework defines the roles and responsibilities of nation states. Signatories to these conventions typically reflect obligations within national legislation. Various states, including the UK and Sweden, introduced national space legislation in the nineteen-eighties. More recently, in the first decade of this millennium, an increasing number of states, including France, as Europe's prime launching

[x] *Note that the UK Space Agency accounts recorded an international expenditure of £190.5 million that it noted as "mainly ESA" (3).*
[xi] *This gives a conversion rate of £1 = € 1.26 that will be used throughout this paper.*
[xii] *see http://www.eumetsat.int/*
[xiii] *EUMETSAT member states are Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom.*

[xiv] *Including the 1967 Outer Space Treaty, the 1968 Rescue Agreement, the 1972 Liability Convention and the 1975 Registration Convention; discussed further in Section 5.4.*

state with capabilities in the French département, Guyane, South America, as well as Austria, have joined this effort with their national space statutes. An increasing number of states, including those in the European Union are moving towards introducing national space legislation, notably with a view to regulating the growing nano-spacecraft sector, including CubeSats,[xv] which has emerged from the academic research community (5).[xvi]

3.2. UK

Within the UK, the Outer Space Act 1986 (OSA) is the legal basis for regulating activities in outer space, including the launch and operation of space objects. Sections 3 and 4 of the Act confer licensing and other powers on the Secretary of State acting through the UK Space Agency. The role of the Secretary of State therefore ranges from controlling the activities of space operators under a UK license to carrying out inspection of licensee's facilities, and to the provision of any information the Secretary of State considers fit (Section 5).

The OSA prescribes that operators insure against liability incurred in respect of damage or loss suffered by third parties (Section 5 (2)f). Currently the level of insurance required is €60 million for a standard launch/payload, which is consistent with the level required under French and other European legislation, along with the practise of many other regulatory authorities (6 Ch. 23). The OSA also passes on unlimited liability to the licensee against any claims brought against the government (Section 10). However, the government has begun the process required to give the Secretary of State the power to set or vary this liability limit with a cap of €60 million envisaged for the majority of missions, with further concessions under consideration for certain classes of nano- and micro-spacecraft (7). The government would therefore meet any losses beyond the liability cap.

A multifaceted research and development funding ecosystem is employed. Broadly speaking the Research Councils are responsible for fundamental research (Technology Readiness Levels 1 – 4), and the Technology Strategy Board (TSB) and Satellite Applications Catapult (SAC) are responsible for applied research and pre-commercial development (Technology Readiness Levels 4 – 6).[xvii]

The UK Space Agency (UKSA) is an executive agency of the Department for Business, Innovation & Skills (BIS)

[xv] CubeSats are a standardised spacecraft form, with base unit of a 10 cm cube, which exploit simplicity, standardisation and conformity to drive down cost; see (5).

[xvi] See http://www.oosa.unvienna.org/oosa/en/SpaceLaw/national/state-index.html, cited 8 June 2014

[xvii] Technology Readiness Levels are used to assess and define the maturity of a technology concept, ranging from a low readiness level of one to a mature 'actual' system with a readiness of nine; see page 33 of Ref. 6 for more information.

with responsibility for government policy; it also represents the UK in all international negotiations on space matters.

The Natural Environment Research Council (NERC) and the Science & Technology Facilities Council (STFC) operate a "dual key" partnership with UKSA whereby they work with UKSA to develop and agree science priorities. The dual key mechanism can generally be understood as UKSA fund the upstream and flight activities, including ESA subscriptions, while the research councils fund the down-stream, exploitation activities, studentships/fellowships, and non-mission specific fundamental R&D.

It must be noted that, in apparent contradiction to their official remit, the Engineering and Physical Sciences Research Council (EPSRC) do not, in effect, fund any research within the space sector.

The TSB is the UK's innovation agency, operating at arm's length from the government as a public body reporting to BIS. The TSB's aim is "*to accelerate economic growth by stimulating and supporting business-led innovation.*"[xviii] One of the TSBs priority areas is "*Space: Supporting innovative developments using satellite data and space-based satellite systems.*"[xix] The TSB have a service level agreement with UKSA whereby they are the main delivery partner for telecommunications and navigation programmes, including those run by ESA. This includes sending national delegates to steering boards of both these programmes.[xx] The TSB also directly fund R&D activities through their own funding mechanisms and have funded, in collaboration with UKSA and the SAC, the development of the technology demonstration platform TechDemoSat-1, due for launch in July 2014.

The SAC is one of seven catapult centres, independent innovation and technology not-for-profit companies establish by the TSB and tasked with helping to drive future economic growth. The SAC is focused on the application and exploitation of space derived data and services, and is hence predominantly in the downstream sector. However, the SAC may also act in the upstream sector where it will lead to new, exploitable space derived data and/or services. The SAC funds three centres of excellence, one of which is located in Scotland, at the University of Strathclyde, and focuses on launching commercial opportunities in energy, future cities and other key growth sectors.

The Ministry of Defence (MOD), along with the security services, are active in the space sector; using space-based

[xviii] *From https://www.innovateuk.org/about-us, cited 20 May 2014*
[xix] *From https://www.innovateuk.org/our-priorities, cited 20 May 2014*

[xx] *See http://www.bis.gov.uk/assets/ukspaceagency/docs/service-level-agreement/technologystrategyboardsla2011march.pdf, cited 27 June 2014*

assets for communication and surveillance. Largely, the MOD procures suitable communication capabilities from the private sector. The UK does not publically acknowledge having domestic operational access to military surveillance spacecraft; instead accessing such data through international alliances.

A final important aspect of any sector is the collective of organisations that assist the government in policy formation and business case development through documents such as the Space Innovation Growth Strategy action plan (1), and by providing evidence to parliamentary enquiries. Within the UK there exists a highly active network of such organisations, include trade associations, such as UKspace, ADS (Aerospace, Defence, Security and Space), and tech^{UK}, and professional bodies such as the Royal Aeronautical Society, the Royal Astronomical Society and the Institute of Physics, amongst others. There are also organisations such as the Satellite Finance Network, which provide advice and support to industry, and the Parliamentary Space Committee, a cross-party group in the UK parliament providing a conduit between politicians and space professionals.

3.3. The Scottish Space Sector

Official public reports do not provide a detailed breakdown of the size, health and funding profiles of the UK space sector below the national level, hence accurate and referenceable quantification of the size of the Scottish space sector has not been possible within the scope of this analysis. However, in 2013 Scottish Enterprise commissioned an assessment of the size and health of the Scottish space sector with a view to informing internal strategy towards supporting the sector. The detailed methodology and findings of this survey are not publically available and hence it is not known whether, for example, the standard space sector definition was used. However, some headline results are known. The Scottish Space sector was found to comprise 32 companies including established suppliers, early phase start-up's and firms diversifying from core aerospace and defence activities, with combined company sales for 2012 of £12.5 million. Combined industrial and academic space activity contributed over £35 million to the Scottish economy in 2012.

The Scottish space sector has thus, by any measure, a significantly smaller commercial value than that of the UK. However, the level of importance placed on the growing Scottish sector by the UK is evident in the recently launched Satellite Applications Catapult Scottish Centre of Excellence at the University of Strathclyde, together with the UK Astronomy Technology Centre in Edinburgh. A further example is UKube-1, built by Clyde Space in Glasgow and due for launch in July 2014 as UKSA's first spacecraft. The ability of the SAC Scottish Centre of Excellence to connect with other key sectors of the Scottish economy, such as the energy sector and the future cities demonstrator in Glasgow,

are seen by some as critical to the realisation of the Space Innovation Growth Strategy action plan as they offer significant new growth potential to the space sector.

Furthermore, analysis of research papers in space science between January 1999 and June 2009 by the Times Higher Education found that Scotland ranked top of the global league table for impact, ahead of Israel in second and Canada in third; USA were fifth and England was eighth.[xxi]

4. The White Paper: *Scotland's Future*

The White Paper acknowledges a number of options exist for the funding of R&D but states a desire to "*maintain a common research area with the rest of the UK including existing shared Research Councils.*"(4) It also states an intention to negotiate "*a fair funding formula for Scotland's contribution based on population share*", and that this formula should also reflect the amount of funding received in iScotland may be higher or lower than a simple population share. The Scottish Government has also provided a "*guarantee that current levels of government investment in university research (through SFC and the Research Councils) will be at least maintained and that there will be no adverse funding impact from Scotland's transition to independence*" (8).

Also relevant to the space sector is question 449, which addresses the Met Office and states that the "*Scottish Government will seek agreement with Westminster to maintain the provision of these services on independence. The Scottish Government will make an appropriate financial contribution for the use of these services.*" Implied within this answer is thus a commitment to fund EUMETSAT via contributions to the Met Office. However, since EUMETSAT is an international satellite organisation with the UK as one of its member states, the exact form of collaboration with iScotland would require more detailed attention.

The 'Regulation of Outer Space' is addressed within the White Paper in questions 105 and 106.

> *105. Will Scotland continue to participate in international space agencies?*
> *Yes. Scotland will continue to work with the UK Space Agency and the European Space Agency.*
>
> *106. Will Scottish businesses be able to compete for contracts to the UK Space Agency?*
> *Yes. An independent Scotland will continue to be part of the European Union. In line with EU Public Procurement Law companies in Scotland will be able to compete for contracts to the UK Space Agency and the European Space Agency.*

[xxi] *See http://www.timeshighereducation.co.uk/408577.article, cited 20 May 2014*

Question 105 commits iScotland to continued participation in the space sector but states nothing of the nature of the relationship envisaged with either UKSA or ESA. However, the essence of the White Paper is to continue co-operation with existing UK-wide bodies wherever possible. Hence, it could be deduced that, following the spirit of the White Paper, the intention may be that iScotland should 'seek a fair funding relationship' or 'make appropriate financial contributions' to UKSA and hence maintain membership of ESA via UKSA. This option will be considered in Section 5, together with the option of an independent and direct relationship with the international community.

Question 106 is completely accurate with regard to UKSA, and indeed of other national agencies such as CNES and DLR,[xxii] but does appear to misunderstand the relationship between the EU and ESA, and the fact that ESA is not subject to EU Public Procurement Law as it is a wholly separate entity managed by its own international treaties. While ESA is currently managing the development and contracting for the EU's two major space programmes, Galileo GNSS and Copernicus (formerly Global Monitoring for Environment and Security, GMES), it operates under EU procurement law in terms of the EU/ESA Framework Agreement between both institutions that came into force in May 2004.[xxiii] Other than within this special context, ESA contracts are not subject to EU law and its operations take place under its aegis as an international organisation that benefits from immunity. As a result, whereas space programmes subject to EU procurement are open to judicial review, the same does not apply to programmes and contract awards under ESA procurement rules.

5. Impact of Scottish Independence

It is always unwise to claim knowledge of the future: Consider that in 1876 Sir William Preece (1834 – 1913), Chief Engineer of the General Post Office, the forerunner to BT, is attributed to have said "*The Americans have need of the telephone, but we do not. We have plenty of messenger boys*."

Within this section, the possible impact of Scottish independence will be considered and the primary issues that will need to be considered highlighted.

5.1. European Commission

Funding is awarded on a competitive basis. Hence, Scottish independence is unlikely to have any net, direct impact on the ability of organisations within iScotland to win such funding. Indeed,

[xxii] *CNES (Centre national d'études spatiales) is the French National Centre of Space Research and DLR (Deutsches Zentrum für Luft- und Raumfahrt) is the German Aerospace Centre.*

[xxiii] *OJ L 261, 6.8.2004, p.64. Discussions are currently underway about the options for continued collaboration in the future, see Commission Progress report on establishing appropriate relations between the European Union and the European Space Agency (ESA), COM (2014) 56 final.*

the requirement within most of the Commission's programmes for proposals to have organisations from three different member states may make it easier for Scottish and rest-of-UK (rUK) organisations to win funding, as they would now represent two different member states. In a similar vein, the presence of dedicated Scottish representation in the discussions that inform the Commission's programmes would enable iScotland's priorities to be directly considered. However, this will be as a smaller member state, requiring the development of more alliances and trades with other members than as part of the UK, where such trades happen before these negotiations; that is, at the national level. On balance, it is likely that independence will have little direct, net impact on European Commission funding as related to the Scottish space sector.

5.2. EUMETSAT

As stated in Section 4, implied within the answer to question 449 of the White Paper *Scotland's Future*, is a commitment to fund EUMETSAT via contributions to the Met Office. In practice, a Scottish contribution to the UK funding presupposes that the EUMETSAT Council accepts the co-funding model proposed by what is effectively a separate, albeit small, state, and that issues around Scottish representation at the EUMETSAT ruling council could be resolved in such a scenario. In principle, it is open for iScotland to notify its decision to join EUMETSAT under Article 16(3) Convention, which would require a Council decision on its admission. The same considerations apply as to any new independent state joining an international organisation; there must be full agreement by existing member states and the criteria for admission must be met. It is less the criteria of statehood that are in question here, rather the issue of co-funding. Although a discussion is underway about the exact legal basis to ensure iScotland's continuing membership of the EU after independence, the EUMETSAT Convention does not contain provisions equivalent to Articles 48 and 49 in the Treaty on the European Union; which claims a specific form of supranational character that distinguishes it from other international organisations. Be that as it may, Article 5(2)(a) EUMETSAT enables the Council to set the terms and conditions of state membership, so that where agreement with rUK is reached, then the unanimity requirement of Council members could be met.

5.3. European Space Agency

As previously noted ESA is entirely separate to the European Union and as such is not subject to EU Public Procurement Law. Indeed, a fundamental cornerstone of ESA is the concept of 'fair return' or 'geo-return'; termed *juste retour* by the EU. The main rule adopted by ESA since March 1997 is that "*the ratio between the share of a country in the weighted value of contracts, and its share in the*

contribution paid to the Agency, must be of X per cent (e.g 0.98%) by the end of a given period."[xxiv] If a member state is under-returned special measures can be taken to rectify this situation, however it should be noted that awarded contracts must be judged of sufficient quality at the assessment stage to ensure quality and economy. Hence, member states without a sufficiently sized or skilled space sector can suffer from prolonged periods of under-return while such structural issues are resolved.

Member states subscribe to the optional programmes that align with their national interests. For example, the UK is the largest contributor to the Telecommunications & Integrated Applications programme as this aligns very well with the UKs stated strategic priorities. Being a large contributor to a programme gives a member a considerable influence within that programme. Although in reality iScotland may choose to subscribe to separate activities, for the purpose of this analysis it will be assumed that iScotland would contribute at the same *pro rata* level as the UK currently does, and that a geo-return of 85 – 95% is achieved.

Considering the figures from 2012/13 to enable comparison with the defined Scottish space sector in Section 3.3, the 'Scottish ESA subscription' was £18.2 million (see Section 3.1), giving a geo-return of £15.5 – 17.3 million. Neither ESA nor UKSA track geo-return at the level below member state, hence this due level of geo-return to Scotland cannot be readily compared against the actual level achieved.

Employment in the space sector predominantly breaks down as 55% in Greater London, 24% in the South East, and 12% in the Eastern region, with the South West and East Midlands together taking 8% of the employment (2). Therefore, Scotland, Wales, Northern Ireland and all other regions of England account for around 1% of the sectors employment. Assuming all of these jobs are in Scotland and that Scottish organisations perform as well as rUK companies in attaining ESA contracts it can be surmised that ESA contracts in 2012 were of the order £2 – 3 million, and were highly likely less than £5 million. Thus, it is likely that iScotland would have been under-returned by the order of £10 – 15 million.[xxv]

Noting that the Scottish 'ESA subscription' will increase to an average of £23 million each year, as previously detailed in Section 3.1, it could therefore be suggested that independence would be worth £15 – 20 million per year to the Scottish space sector in ESA contracts alone.

[xxiv] *See http://www.esa.int/About_Us/Industry/Industry_how_to_do_business/Industrial_policy_and_geographical_distribution, cited 20 May 2014*

[xxv] *An informal, unscientific survey of the Scottish space sector suggests ESA contracts in Scotland 2012 were likely below the lower bound of the estimated range, and hence the level of under-return is likely underestimated.*

Any net gain in ESA contracts resulting from the policy of geo-return must be considered in light of iScotland being a significantly smaller and hence less influential member of ESA. In addition, small nations in ESA often subscribe to optional programmes well below GDP proportion, although some countries like Belgium are exceptions to this, with many focused on as direct as possible an industrial return. In some small member states, funding can appear focused on rapid returns with little interest for novel research, which can include the science programme. Such members can also have a strong focus on direct industrial return and in spinning off results of ESA contracts to other areas. Meaning once a company has developed a proven capability, often the member state can be unhappy to reuse them, as it will not develop new capacity.

iScotland would need to make an assessment as to the value of ESA membership and to which optional programmes it would most benefit, ensure it learned appropriate lessons from other small member states and fully exploit all of the mechanism that exist within ESA to help new and emerging nations.

5.4. The Legal Framework

The White Paper commits iScotland to the international treaties to which the UK is already a signatory. Therefore, iScotland would become a signatory to all five relevant UN space treaties, and, as a Member of the United Nations, subscribe to the 'post-Cold War treaties alongside the subsequent generation of so-called 'soft law', non-binding legal rules that also contribute to the governance of space activities. These rules, some being General Assembly Resolutions, others Guidelines, are all designed to clarify and further the longer-term sustainability of space activities.[xxvi] The UN space treaties lay down the principles and specific duties alongside the responsibilities on 'space-faring nations' in relation to their governmental and non-governmental, or commercial, space activities. This international level of regulation is important for the control of activities as spacecraft can be launched in a foreign commercial market. Scotland is involved in developing nano-spacecraft, launched out of foreign states, as well as other satellite-based technologies. Scotland may even have potential as a commercial launch site, all of which requires the government to ensure licensing, and consideration of risk allocation, normally towards the private sector, as well as indemnity insurance requirements to avoid automatically or unwittingly accepting these vicariously.

The main principles governing the peaceful use of outer space are laid down in the 1967 Outer Space Treaty, thereafter expanded in the 1968 Rescue Agreement, the 1972 Liability Convention

[xxvi] *See e.g. unedited transcript, UN COPUOS, Legal Subcommittee, March 2011, http://www.unoosa.org/pdf/transcripts/legal/LEGAL_T827E.pdf, cited 24 June 2014*

and the 1975 Registration Convention. The 1979 Moon Agreement, to which the UK and only a minority of the international state community have subscribed, reiterates the tenor of the original four treaties, but leaves scope for the elaboration of a future regime for extracting the Moon's natural substances. Because of the low level of ratifications, the status of the Moon Agreement remains disputed.

Currently, there appears no justification to depart from Scotland's current position in relation to the above international treaty and the accompanying 'soft law' obligations. Article VI of the Outer Space Treaty provides for governmental authorisation and 'continuing supervision' of all types of national space activities, be these scientific, governmental or commercial. Licensing mechanisms are provided for at the national level. The definition of space activities includes operations involving space data, an important aspect of all space activities because of the impact on downstream markets, which are a key and emerging part of the Scottish space sector.

As previously mentioned, there is a noticeable increase in the number of dedicated national space laws appearing on the statute books of various 'new' small space jurisdictions; these are countries that are witnessing a growth in the nano-spacecraft sector, much of which stems from work coming out of research institutes and universities. Note that UKube-1, UKSA's first spacecraft, is a CubeSat built by Clyde Space in Glasgow, and that UKube-1 emerged from a Knowledge Transfer Partnership between Clyde Space and the University of Strathclyde. As such, iScotland could find itself very much at the forefront of these 'new' small space jurisdictions.

Dedicated space legislation is not essential for licensing regimes, some states that are active in outer space, that is who build and operate spacecraft but that are not launching states, such as Germany who procure the launch service from another nation, do not have dedicated legislation. In such cases, these states may prefer to focus on regulating access to and the use of high-resolution data.[xxvii] However, some important considerations are worth highlighting; firstly, a national space statute provides legal certainty in the case of international state-to-state liability for commercial space activities where there is clear physical, tangible, economic damage. More importantly, it provides a legal basis for governments to claim indemnification from the commercial sector when their launching state liability is called on. This point is further expanded below in relation to the OSA.

Whether by Order in Council or through a delegation agreement equivalent to that bridging the competence gap between the EU and ESA, the respective competences between a rUK and an independent Scottish government's

[xxvii] *See the Satellitendatensicherheitsgesetz, SatDSiG (Satellite Data Security Act); http://www.gesetze-im-internet.de/satdsig/ cited 24 June 2014*

regulatory authority should be clearly delineated.

UK space licenses are awarded by the Secretary of State on the basis of the OSA (see Section 3.2, above). This extends to compliance with the international debris mitigation guidelines that have become an important standard over the past decade. The OSA 1986 currently includes Scotland as well as the Isle of Man and Channel Islands within its scope. The Isle of Man in particular has developed into a commercial space jurisdiction, with the backing of the UK government in the case of any international liability claims. iScotland would require to negotiate the terms of any continued relationship with rUK, not only in relation to licensing by the rUK Secretary of State but also in relation to the issue of United Kingdom nationality (section 2(1) OSA).

The OSA regulates space activities undertaken by United Kingdom nationals. Nationality currently falls within the reserved powers under the Scotland Act 1998.[xxviii] Post-independence, the scope of UK nationality, as opposed to citizenship, would require clarification in the context of space and the on-going relationship with UKSA. There are further implications for the UK Register of Space Objects, and not least, space companies incorporated in iScotland.

Article VII of the OST and the Liability Convention addresses a further aspect of space activities in Scotland, beyond its capabilities in the development and procurement of spacecraft and their components. As part of the UK governments response to the Space Innovation Growth Strategy action plan (1), they set up a cross departmental 'National Space Flight Coordination Group' to develop the necessary legal framework to permit a spaceport to be established in the UK and to aid the selection of its site (9). UKSA, through its Space Collaborative Innovation Team Initiative (Space CITI) pilot programme, is also funding the UKLaunch consortium to study the technical and economic feasibility of a UK-based small satellite launcher. Whilst a number of possible launch sites can be considered, and none have yet been shortlisted, many of the most promising ones are in Scotland. This is due to issues of population density, existing infrastructure and the ability to integrate with existing air-traffic without significant disruption. The UK government acknowledged "*that this is an important area of work which has the potential to provide a valuable addition to the UK space ecosystem, in the longer term potentially leading to more reliable, affordable launch services and new local and regional growth opportunities for space business*" (9). It would therefore seem logical to presume that the space sector in iScotland may wish to continue to pursue this opportunity. The government of iScotland should therefore seek to ensure that no impediment to the development of a domestic launch facility existed, or that could hold back export or launch of

[xxviii] *Scotland Act 1998, c. Schedule 5, B6*

Scottish designed, manufactured or integrated technology.

Article VII of the OST and the Liability Convention impose international state liability of a launching state for third party damage caused by a space object to the property and nationals of other states. The growth of nano-spacecraft procurement paves the way for 'small' space jurisdictions in particular to constitute launching states. This in turn may result in government liability for public and private commercial space activities, as was mentioned previously. The four categories of launching state in the Liability Convention, as repeated in the Registration Convention, are designed to ensure that any damage caused by a space object can be met by at least one liable launching state, whether or not on the basis of joint and several liability. The outer space liability regime is structured on the concept of solvent states, with reliable budgets presumed, to ensure a victim-orientated approach to secure compensation (10).

The driver for national space legislation is therefore primarily to impose a duty on commercial operators (generally insured up to a ceiling) to indemnify the government of the launching state for third party damage, as well as to regulate licensing and appropriate in-orbit insurance coverage. This is all the more important since the launch of nano-spacecraft is generally brokered through a foreign state. A state other than that of the 'home' nationality is often involved in the launch and with this, jointly and severally liable with the procuring state for launching activities. iScotland would be required to manage the fine distinction between the requirements of Article VI of the Outer Space Treaty and the requirements of Article V of the Liability Convention through appropriate bilateral agreements (10,11).

In determining launching state liability, criteria for determining liability being procuring, financing, or launching from own territory or platform, another can be the entry of a satellite or space object on a state's Register of Space Objects, held at national level and by the UN. Various launching states conveniently include the nationality of a foreign spacecraft on their national register in order to help clarify that the satellites are not nationally procured. iScotland would be required to consider whether any continued collaboration with UKSA should be more formalised, with the key bi-lateral markers for assumption of liability mapped out.

Independent of the launching state liability, foreign commercial launching states (such as India or Russia) acquire shared responsibilities in their role as 'appropriate state' under Article VI of the OST. Their status as launching state for foreign spacecraft is clear. The joint and several nature of international liability for spacecraft, under the Liability Convention make it all the more essential to ensure national legislation and international agreements between iScotland and, if so be, then rUK on apportionment.

One further technology, the status of which has not been finally determined within international space law, at least in relation to liability, is the so-called GNSS signal in space. Despite the absence of a clear definition of a signal in space, the current initiative to introduce a convention regulating third party liability from GNSS signals should be monitored.[xxix]

Of the two regulatory regimes that exist for space activities at international level, the first is, as discussed, compliance with the international UN treaty law governing outer space. The second is adherence and compliance with the Radio and Frequency Spectrum management regime governed by the International Telecommunications Union (ITU), a specialised agency of the UN. The ITU orbit allocation and frequency assignment system confers a right on its signatory states to use the spectrum on the basis of international allocations, leaving it to national regulatory authorities to award licenses for the diverse uses of the spectrum that exist. Here too, iScotland would require clarification of the competent regulatory agency and agreement as to whether OFCOM should act – as with UKSA – within a bilateral delegation agreement. iScotland would need to ensure that the administrative requirements for frequency notifications be made at national and international level. Note that the White Paper, in Question 101, states that these powers will "*transfer to the Scottish Parliament as a result of independence*"; hence licensing and ITU registration will be an obligation of the iScotland government.

As indicated, although not all states have a national space law, Article VI of the OST nevertheless requires states to authorise and supervise space activities undertaken by their private entities on a case-by-case basis. Many countries, including those of similar size to iScotland such as Belgium, Estonia and Austria, have developed national space law in response to this international obligation. France is the only European country currently to have integrated its technical requirements relating to sustainability and debris mitigation into substantive national law.

5.5. UK Space Agency, the Research Councils, and R&D Investment

As discussed in Section 4, the envisaged relationship with UKSA in the White Paper is unclear. If the intention is for iScotland to 'seek a fair funding relationship' or 'make appropriate financial contributions' to UKSA, and hence to maintain membership of ESA via UKSA, then many of the previously identified benefits of independence are negated and the discussed legal issues become prominent. However, this would also mean that iScotland would in effect be subsidising the rUK space sector to the value of £15 – 20 million per year in ESA subscriptions alone.

[xxix] *UNIDROIT, LXXIX Third Party Liability for GNSS, http://www.unidroit.org/work-in-progress-studies/studies/civil-liability/393-study-lxxix-third-party-liability-for-global-navigation-satellite-system-gnss-services, cited 23 June 2014*

The answer to question 106 of the White Paper states that "*companies in Scotland will be able to compete for contracts to the UK Space Agency*". As stated in Section 4, this is completely accurate. However, the UK Space Agency typically does not issue contracts, rather issuing grants, which are not subject to VAT or to European Union rules on public procurement. The UK Space Agency 'Annual Report and Accounts 2012-13' show that they issued just over £40 million of grants in the reporting period (3). Should iScotland 'seek a fair funding relationship' or 'make appropriate financial contributions' to UKSA then there is no reason why such grants could not be issued to Scottish organisations as well as those in rUK. However, if no formal arrangement were in place then Scottish organisations would lose access to these grants and a Scottish equivalent would be required.

In a similar nature to the relationship with UKSA, the research councils would need to be formalised. Assuming a funding relationship was achieved that both sides deemed fair then the approach outlined in the White Paper is likely to be viable; however, no assessment or judgement is offered as to its desirability from either an independent Scottish or rUK perspective. Furthermore, issues such as the 'dual key' mechanisms, operated by NERC & STFC with UKSA, would require careful consideration as it is possible Scottish and rUK priorities may differ. In addition, iScotland may decide not to have a formal relationship with UKSA due to the above noted issues on ESA membership, which would further complicate such a relationship.

The issue of research funding has become contentious within the campaign; however, it has rather narrowly focused on the higher education sector. As the upstream space sector is R&D intensive, some of the facts will be briefly considered. Within the White Paper the Scottish Government acknowledge the quality of the Scottish higher education institutions by noting that in 2012/13 these institutions secured 13.1% of UK research council funding awarded on a competitive basis (8). The Scottish Government also say, "*over the three years, 2010/11 to 2012/13, Scotland secured 10.6% of total Research Council spend while contributing 9.4% of UK tax receipts*" and hence that "*there is limited difference*" between Scotland's current contribution and what it gets back (8). Countering this, the *Better Together* campaign contend that "*no fair Scottish science budget*" could maintain current levels of investment,[xxx] and that to do so would require an increase in research spend equivalent to 0.23% of Scotland's 2012 GDP (12).[xxxi]

Research funding and R&D spend go to the core of a nation's level of technical innovation and its international

[xxx] *See http://bettertogether.net/blog/entry/perhaps-the-best-place-on-earth-to-carry-out-scientific-research, cited 01 June 2014.*

[xxxi] *Based on an analysis of Office for National Statistics (ONS) number (see xxxv) this GDP percentage is taken as a population pro rata; a GDP pro rata would be 0.19%.*

competitiveness, something both the UK and Scottish government are already committed to improving in the pursuit of a 'more balanced economy', and hence should be viewed within the European and international context.

Within Europe, a goal of each member spending 3% of GDP on R&D by 2020 has been agreed.[xxxii] The UK government's *Office for National Statistics* (ONS) show that the UK spent 1.72% of GDP on R&D in 2012, of which 63% (1.1% of GDP) was from business. The UK's level of Growth Expenditure on R&D (GERD) has oscillated around this value since 1997 when a decade long downward trend from a high of 2.14% in 1986 concluded.[xxxiii] The UK-wide level of GERD is below the 2004 target set by the UK government for 2014 of 2.5% GDP,[xxxiv] and below the estimated 2.06% EU-average in 2012.[xxxiii]

The ONS show that GERD in Scotland was 1.3% of GDP in 2012,[xxxv] of which 37% (0.47% of GDP) was from business; in Israel, this figure is closer to 80%. A level of business R&D expenditure below 1% of GDP is a cause for significant concern within the European context (13).

It is evident that discussion of research spending should be more than simply government funding and that the total UK research spend is lower than many other similar Western European economies, with that total still lower in Scotland. UK GERD has remained low for the last 15 years and the low level of GERD in Scotland, along with an overreliance on government funding for this R&D is a cause for significant concern. This highlights a structural issue within the Scottish economy that should be addressed no matter the outcome of the referendum in September. With regard to this, it has even be argued that a cut in government funded R&D could be a positive step for Scotland as it would better encourage domestic private venture capital to engage with early-stage start-ups (12). In relation to the space sector, however, it could also be argued that this is perhaps more applicable to the downstream data-exploitation sector than the upstream due to the return on investment timescales and level of risk involved in upstream.

5.6. The Technology Strategy Board

The White paper does not address the relationship with the TSB or the catapult centres beyond the generic comments around seeking "*a common research area with the rest of the UK*". As the TSB operates at arm's length from the

[xxxii] *The target measures investment by business, higher education, government and private non-profits (i.e. charities), and is collectively known as growth expenditure on R&D (GERD); see http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm, cited 01 June 2014.*

[xxxiii] *See http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html, cited 01 June 2014.*

[xxxiv] *See http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/dius/science/science-funding/framework/page9306.html, cited 01 June 2014.*

[xxxv] *See http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/rft-gerd-regional-2012.xls, cited 03 June2014.*

government as a public body, reporting to BIS, it would appear feasible that iScotland could develop a similar relationship should it, and rUK, desire, and agree. However, as with other similar scenarios the value of such an approach would need to be carefully traded against a dedicated Scottish body.

5.7. Satellite Applications Catapult

Considerations of issues around the SAC are slightly different as the catapult centres are independent not-for-profit companies; as such, they are not a grant awarding body, instead placing contracts. Thus, it could be argued that iScotland may expect to gain a *pro rata* share in the ownership of these companies whilst taking on a similar share of any outstanding funding commitments; the *pro rata* adopted would be a matter of negotiation. However, it is also possible that a barter agreement is sought over facilities, whereby for example certain facilities in iScotland are traded against other facilities in rUK rather than simply dividing ownership of everything on the agreed *pro rata* basis. This is an important consideration as it may influence the level of access that researchers based in iScotland would have to facilities in rUK, whilst also likely setting a precedent for any future investments.

5.8. Impact on the Rest of the UK

The consequences of Scottish independence for the rUK space sector would likely be rather minimal; however, whilst much of the impact is dependent on the post-independence relationship between the two parties it would most likely not pass without consequence.

For example, if iScotland were to become a separate member state of ESA rather than, for example, through a delegation agreement with UKSA then the loss of iScotland's 9.6% contribution towards GDP would be disproportionately felt by the rUK space sector. Currently very little of the space investment returns to Scotland, hence, for a flat-funding profile rUK would need to increase spending on space as a percentage of GDP. It is likely that the business case for this increase could be made, and recent actions suggest the rUK government would be responsive to this business case.

The noted potential of a domestic spaceport "*to provide a valuable addition to the UK space ecosystem*" could also be impacted by Scottish independence. However, as potential launch sites exist outside Scotland these areas could gain from Scottish independence if iScotland did not pursue the opportunity with the same vigour as rUK.

5.9. Impact of Delayed Membership

The white paper asserts that Scotland, following a Yes vote, would be independent by 24 March 2016 (4). It is not the role of this analysis to appraise to validity of that statement; however, a core assumption has been that iScotland is a member of international organisations such as the EU and ESA. Given the discussion in the preceding

sections, this is recognised as a considerable assumption to which the impact of independence on the space sector would have a sizable sensitivity.

To quantify the effect of not becoming a member, or a delay in membership of international organisations such as the EU and ESA in monetary terms is immensely difficult. However, the effects can be summarised: a reduction in research funding to industry and academia, a disruption in research and other networks, and a reduction in commercial contracts for industry. Lack of ESA and EUMETSAT membership would also result in a loss of access to some space-derived data products. Any disruption or lack of access to international organisations, including the EU, could therefore be a potentially significant problem.

The Scottish governments "*guarantee*" over university research funding suggests that a delay, or absence of a continuing relationship with the Research Councils should not have a significant financial impact on university research (8). However, it is notable that this guarantee does not extend to, for example, the TSB; who predominantly fund industrial R&D.

6. Transition to Independence

As previously stated, ESA is operated through intergovernmental treaties that commit member states to a defined level of funding. The UK therefore has existing funding commitments to ESA that run well beyond 24 March 2016, the envisaged date of Scottish independence. Two options exist as to how these may be divided. The rUK may decide to take on the full funding commitment to all international bodies and refuse any discussion of a delegation agreement between iScotland and UKSA. In this case, the Scottish space sector would become independent on the proposed date of 24 March 2016 and iScotland will be required to ensure continuity of membership to avoid any adverse effects of discontinuity. Alternatively, the two governments may agree a short-term delegation agreement or similar to allow iScotland to contribute to these existing multi-year international funding commitments. Such an agreement could even form the basis for a longer-term relationship. In such a case, and given the accepted principle of 'fair return' or 'geo-return' within ESA, iScotland could argue that it will contribute on the basis of contracts placed in iScotland by ESA, whilst the rUK would likely desire iScotland to contribute on a GDP *pro rata* basis at 9.6%.

The financial arrangement accompanying iScotland's transition depends on the successor arrangements to the Scotland Act 1998, as amended in 2012. Space has a dual nature of civil and defence, certain issues are currently reserved to Westminster under the devolved legislation. A transition period is required, for not only acceptance by the international governmental and satellite organisations, notably ESA and EUMETSAT, but also the ITU. Any disruption

or lack of access to international organisations, including the EU, could be a significant problem; hence, during the period between a Yes vote and 24 March 2016 the Scottish government would need to ensure contingency plans to address any possible discontinuity in membership. In a similar vein, the Scottish government would need to develop a clear approach to ensuring continuity of R&D funding currently distributed from bodies such as the Research Councils and the TSB in the event that, for example, the timescale outlined were to prove problematic in reaching a sufficient conclusion.

Funding contributions to international organisations is crucial. While trades between the rUK, iScotland and the international community should be approached pragmatically, post-independence Scotland will require considering issues such as definitions of nationality *vis-á-vis* the rUK, and the concept of national for the purposes of licensing space activities. Discrimination on the basis of nationality is not permitted under EU law, which is why France grants equal treatment to liability for all EU launches. The space community has grown in numbers and scope, but there have been little changes to the rules. These include international liability, government indemnification in the event of third party liability, and the capability to continue in space-related R&D.

7. The Case for Investment

Advanced technological nations – and collectives of nations – largely invest in space in order to gain access to data, such as weather and climate data, or to provide services that are of benefit to citizens and their government. Investment is also undertaken in support of commercial enterprises and to stimulate technical innovation more broadly. Whilst national pride and geopolitics have historically been a contributor to the case for space funding, within Western Europe it is now very much the exception, beyond perhaps the Human Spaceflight Programme.

Space investment is today largely based on pragmatism and business cases to meet specific national needs. For a nation such as iScotland, these include the requirements for communications at sea and resource mapping, along with services for many government departments; a recent report by the Norwegian government gives details of how they have achieved this through participation in ESA and EU programmes as well as bilateral programmes with other countries (14).

The multiplier value of space investment was specifically identified in a 2012 report undertaken by PWC, which concluded that investment in ESA programmes generated additional sales of around 4 times the amount invested (15). Of note, for a UK investment in ESA of £190 million in 2012-13, the UK

upstream sector had a turnover of order £980 million, a multiplier of five.

8. Discussion

iScotland would be required to consider two levels of interaction in continuing its current commitment to civil space. The first level is how it transitions its membership of international government organisations, such as ESA, to that of an independent member state, and what, if any, formal relationship it wished to have with UKSA.

Predicting the potential size and scale of a future Scottish space sector, as part of the UK or as an independent nation is as perilous as predicting any aspect of the future. That Scottish independence could be said to be worth £15 – 20 million per year to the Scottish space sector in the near- to mid-term is notable. And that the long-term size and scale of that Scottish space sector may be of order £100 million, or almost triple the current size based on a multiplier of four times ESA subscription (15), even more so. However, this is completely dependent on the relationship established between iScotland and rUK, and would appear to require a contravention of the spirit of the White Paper. Additionally, the ability of the Scottish space sector to secure this massively increased level of ESA funding in the near-term must be cautioned, while also noting that mechanisms do exist within ESA to help new and emerging nations in this regard. Indeed, given the strength and scale of the academic sector this, together with the existing experienced space operators who have previously secured funding from ESA for the development of cutting-edge technologies and technology delivery contracts, could be encouraged to act as a catalyst to future commercial sector growth.

The longer-term growth potential is also completely predicated on the ability of the Scottish space sector to gear ESA and national investment and to assist the Scottish government in correctly nurturing the sector to enable this growth. Currently within Scotland only a limited network of organisations exists that could assist the government in space policy formation and business case development; a new academic / industry forum would therefore likely be required. Of course, no magic formula exists to ensure this growth other than hard work and a highly skilled, motivated and innovative workforce. Whether this level of growth is possible within the current constitutional settlement is unclear, direct membership of ESA would be a significant aid but perhaps it is easier to note that independence would not bring an automatic boost to the sector.

How iScotland would choose to maintain a formal relationship with UKSA is thus of vital importance as it has both economic and significant legal implications.

While a formal link to the existing Outer Space Act 1986 under the notion of continuing validity of non-conflicting legislation sounds attractive at first sight, on a closer examination, it may only be feasible where the international state liability for space activities is clarified

between the Scottish and rUK governments. Scotland's post-independence treaty obligations cannot be passed onto a Minister of State of the rUK without a formal agreement on how each state's respective liabilities are to be borne in principle. Specifically, respective functions of the Secretary of State for the rUK and iScotland would require further agreement about delegation of ministerial power, sovereign funds and rules on indemnity designed to cater for damage arising out of space activities. As regards membership of ESA and EUMETSAT, in particular, the existing member states are required to agree to accession by iScotland and to set the conditions; any disruption or lack of access to international organisations, including the EU, could be a potentially significant problem. Post-independence, the scope of UK nationality, as opposed to citizenship, would also require clarification in the context of space and the on-going relationship with UKSA.

In addition, the relationship with EUMETSAT, and representation on its ruling Council, via co-funding contributions to the Met Office requires further thought but does appear in principle to be a viable option as, if agreement with the rUK is reached, then the unanimity requirement of Council members could also be met. The same judgement of 'viable' can be reached when considering the Scottish governments desire to "*maintain a common research area with the rest of the UK*". However, whilst an approach may be viable, no assessment or judgement is offered as to its desirability from either a iScottish or rUK perspective.

9. Acknowledgements

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11. Acronyms

Acronym	Meaning
BIS	Department for Business, Innovation & Skills
CNES	Centre national d'études spatiales; the French National Centre of Space Research
DLR	Deutsches Zentrum für Luft- und Raumfahrt; the German Aerospace Centre
EPSRC	Engineering and Physical Sciences Research Council
ESA	European Space Agency
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GMES	Global Monitoring for Environment and Security
GNP	Gross National Product
GDP	Gross Domestic Product
GERD	Growth expenditure on R&D
GNSS	Global Navigation Satellite System
iScotland	Independent Scotland
ITU	International Telecommunications Union
MOD	Ministry of Defence
NERC	Natural Environment Research Council
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
OSA	Outer Space Act
PECS	Plan for European Cooperating States
SAC	Satellite Applications Catapult
SFC	Scottish Funding Council
STFC	Science & Technology Facilities Council
TSB	Technology Strategy Board
R&D	Research & Development: defined in the UNESCO Statistical Yearbook 1980 as including fundamental and applied research, as well as experimental development.
rUK	Rest-of-UK
UK	United Kingdom of Great Britain and Northern Ireland
UK-ATC	UK Astronomy Technology Centre
UKSA	UK Space Agency
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
VAT	Value Added Tax

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