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SECURING AUSTRALIA'S FUTURE IN SPACE

A pragmatic approach for an optimistic future.

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Introduction

Space is by nature a complex geopolitical and technological challenge, upon which civilian and military infrastructure are heavily reliant.[1] Australia continues to rely on partners for space capabilities, however, domestic development has gained momentum in recent years. This has included the establishment of space-related government entities, such as the Australian Space Agency and the South Australian Space Industry Centre (SASIC).

The exponential growth of space debris - coupled with the increasing menace of counter-space activities - poses an inalienable threat to Australian access and utilisation of space. Additionally, the emergence of a burgeoning commercial space sector has demonstrated the necessity for Australia to establish itself as a leader in the global space community.[2]

This White Paper provides recommendations which target these challenges, and are directed to SASIC, the Australian Space Agency, the Australian Government, and further stakeholders within the Australian Space Industry ('Industry'). This paper addresses the following key topics: Space Situational Awareness (SSA), Space Traffic Management (STM), space debris mitigation and remediation, Industry information resources, and the Australian Space Agency as a statutory authority.

Methodology

Preliminary recommendations were devised by first assigning positions and roles of key stakeholders to each contributor. Theoretical scenarios were then undertaken from the perspective of these stakeholders. This aided in enriching the quality and coherence of the recommendations. Prior to presenting initial recommendations to a panel of specialists, research was conducted alongside engagement with Subject Matter experts. The assessment and feedback from this panel was then used to aid the refinement of the final recommendations presented in this White Paper.

The following assumptions are made to ensure the recommendations are feasible:

(i) Sufficient technological advancements occur in the areas specified by the recommendations;
(ii) stakeholders are prepared to cooperate; and
(iii) the recommendations can practically be implemented within appropriate timeframes.

It is acknowledged that although this White Paper has been formulated by passionate, dedicated individuals, the team has limited professional experience within the industry. Moreover, it is recognised that at the time of writing there are technological and financial constraints on relevant governing bodies. Given the relatively restricted time frame of consultation, we recognise there are several significant aspects that are unable to be engaged comprehensively.

Recommendation 1: Strengthen domestic Space Situational Awareness capability to ensure the security of civilian and defence assets.

The Department of Foreign Affairs and Trade defines SSA as the 'monitoring and tracking of orbiting space-based objects such as satellites and debris using ground-based radar and optical stations'.[3] SSA provides the data required by decision-makers to manage risks to the security of Australia's assets. Amongst other things, it enables the prediction of collisions, evaluations of collision avoidance manoeuvres, and attribution of actions by other spacefaring states. As space becomes increasingly congested, contested and competitive, Australia's current SSA capability will be insufficient in ensuring the safety of its space-based assets.[4] Accurate and timely SSA data is also instrumental to the development and operation of a space traffic management (STM) framework.[5]

The three key avenues identified as opportunities for improving domestic SSA capability are:

(i) extension of sensor networks;

(ii) SSA data interoperability and data sharing architectures; and

(iii) development of improved collision avoidance technologies.

Extension of sensor networks

Australia has established radar and optical sensing capability in the commercial and public sectors.[6] The next step is expansion, with a goal of improving accuracy and coverage of SSA data. This could be achieved through the establishment of a space sensing technologies research centre, which can be modelled off the SmartSat Cooperative Research Centre.[7] As this aligns with the objectives of the Department of Defence ('Defence') in the space domain, we

recommend that Defence, in collaboration with the broader Australian government, incentivise the development of new sensors.

Further, they should support research into novel sensing technologies, including passive and event-based sensors. This can be achieved through the provision of contracts to relevant industry partners or research organisations. As a well-connected industry-focussed body, SASIC could assist in connecting Defence with suitable industry partners to fulfil these contracts. Contracts should also extend into the development of related software capability, with a goal of optimising sensor data using autonomous systems.[8]

SSA data interoperability and data sharing architecture

SSA data coverage should be improved by optimising integration of data from diverse sensor types, for instance radar and optical, and enabling effective sharing of data between SSA providers.[9] Furthermore, SASIC should invite Industry participants to develop an API-based architecture to enable the sharing of diverse SSA data from multiple operators in a user-friendly manner.[10] This could be utilised to support development of STM systems as detailed in Recommendation 2.

Collision avoidance technologies

SASIC should support the development of collision avoidance technologies that expand conjunction prediction services to include decision support for avoidance manoeuvres.[11] This could include further funding of initiatives such as Industrial Sciences Group/Stamen Engineering's Decision Support Service. Another possibility is the extension of existing tools, such as the Space Environment Research Centre's (SERC) Conjunction Assessment Service, to include manoeuvre assessment tools.[12]

Recommendation 2: Develop a Space Traffic Management framework to ensure continued access to space and complement national strategic objectives.

The increasing number of objects in space requires the implementation of new STM systems. The development of an STM framework supports national strategic objectives from the detection and tracking of objects in space, to strengthening the international regime that applies to it.[13] The policies of the Australian government also cite assured access to space[14] and space control[15] as critical to national strategic abilities, such as situational awareness and delivery of real-time communications.[16]

STM is an area which Australia needs to prioritise domestically and participate in developing internationally.[17] Noting the past efficacy of Australian domestic regulation,[18] Australia should focus on development at a domestic level in order to motivate action at a global level.[19]

To accomplish this, Australia should develop an STM framework. The focus should be communication and knowledge sharing that creates data sets which space operators can rely on to coordinate their activities.[20] This will allow movements and actions to be predicted to prevent collisions and other interference with space assets. The framework should also consider the facilitation of data access and protection, along with the establishment of an audit process to ensure data integrity. Additionally, the framework should also look to outline requirements and obligations for participation, such as participants' collision avoidance strategies and end-of-life provisions.[21]

In order to achieve this recommendation, more engagement and coordination across government is required on the issues relating to space.[22] A potential solution for this is addressed in Recommendation 6. Although an international framework is required for an effective global STM system, Australia should prioritise the development of a domestic STM framework. Doing so will promote its interests when multilateral action is taken and ensure the protection of Australia's access to space in the interim.

Recommendation 3: Support research and development of active debris removal and preventive debris mitigation technologies.

Simulation of Low Earth Orbit (LEO) space debris growth indicates a 75% increase in object count over 200 years if no active debris removal (ADR) is conducted.[23] Debris proliferation imposes an inherent security risk due to increased likelihoods of collision events - and the associated consequences of collisions - where satellites can be rendered inoperable.

Australia relies on satellites for civilian and military communications, natural disaster planning and Earth observation.[24] Currently, even with an idealistic full adherence to the Inter-Agency Space Debris Coordination Committee's (IADC) mitigation guidelines - and cessation of all launch activities - long-term debris proliferation is still projected.[25] Therefore, the exponential growth of space debris and its implied threats should be reduced with a combined approach of mitigation and remediation.

We recommend that SASIC and the Australian Space Agency support the research and development of ADR technologies. By removing 5-10 of the largest critical pieces of debris over a period of 12 months, such as defunct rockets, long-term debris proliferation could be slowed.[26] However, targeting only larger debris does not address near-term collision risks posed by smaller debris (1-10cm).[27] For this reason, we recommend that research addresses technologies targeting both smaller and larger debris, with an initial focus on the heavily congested LEO environment.[28]

We recognise that ADR will not alone be an all-encompassing solution to address the space debris issue, and we acknowledge the overall infancy of current ADR technologies.[29] Therefore, we also recommend that SASIC and the Australian Space Agency conduct further research into

preventative debris mitigation technologies, which has also been proposed by the United Nations Committee on the Peaceful Uses of Outer Space.[30] Once developed, these technologies could be applied to the design of future space objects. Examples include designing elements that prevent system failures, the on-orbit breakup of space objects,[31] or developing technologies which enable a space object to safely remove itself from its orbital region following its end of life.[32] Regulation of debris removal is addressed in Recommendation 4.

We also recommend that SASIC and the Australian Space Agency engage with Industry to evaluate and explore proposals and concepts for ADR and preventative debris mitigation technologies. Promising concepts could be awarded contracts for longer term development. A potential business model for Industry - particularly concerning ADR - could also be produced. This should focus on the achievement of space sustainability alongside profits.[33] Additionally, SASIC and the Australian Space Agency could further support Industry growth and innovation by facilitating access to academic, industrial, governmental, and international partners and connections.

We suggest implementing space debris mitigation technologies within five years, with the view to implement ADR technologies within 10 years. This recognises the technical and operational challenges of development, use, and associated costs. It must be noted, however, that with dedicated research and financial support, this timeframe could be accelerated.

Recommendation 4: Develop regulation which permits the adoption of unclaimed space debris and its removal from space.

Currently, Article VIII of the Outer Space Treaty (OST)[34] mandates that a State retains jurisdiction and control over items launched. This complicates debris removal if there is no identifiable owner, operator, or launching State. Additionally, the Liability Convention of 1972,[35] establishes 'a liability regime according to which "launching States" are liable for damage caused by debris generated by private entities for which such States are responsible'.[36] In order for the Liability Convention to be effective, claimants must be able to identify the space object in question and establish the launching and controlling State.[37]

We recommend that the Australian Space Agency cooperate with government agencies and external stakeholders to establish a regulation that will operate alongside the OST. This regulation should allow space debris removal entities to take ownership of debris by 'adoption' and remove them.[38] This will enable effective ADR as put forward in Recommendation 3.

Evidence of rigorous investigation would be required to demonstrate that the original owner could not be found - mitigating the potential for the process to be perceived as aggressive or politically motivated. This recommendation could be actioned via an amendment to the *Space (Launches and Returns) Act 2018 (Cth)* ('the Launches Act') and related policies. Amendments to

existing legislation and associated policy should include a clear outline of what constitutes sufficient evidence that the debris is ownerless, and the launching State could not be identified. Having clear outlines and objectives can help Australia coordinate efficiently and effectively with other countries to remove debris. The Australian Space Agency could also contract with Industry participants to facilitate and finance their involvement in the proposed debris adoption scheme.

Regarding space debris with identifiable owners, we recommend that launching States be encouraged to 'relinquish jurisdiction and control over objects that have reached the end of life'.[39] As the current regulation was established by United Nations Office for Outer Space Affairs (UNOOSA), this recommendation is similarly directed to UNOOSA, and Australian representatives at this platform. This would permit other actors in the global space community to remove objects with ADR technology. To incentivise the participation of Industry in ADR, while acknowledging the additional regulations associated with this recommendation, we suggest authorising Industry participating in ADR to re-use and recycle the materials they remove. The re-use and recycling of space debris materials in space is an area of research projected to be of increasing importance.

Recommendation 5: Establish a centralised resource portal for Australian stakeholders to learn about the space environment and its regulation.

In order for Industry participants ('participants') to understand the Industry and their domestic and international responsibilities, they currently have to undertake research across multiple sources. This process heightens the risk of misinformation, confusion, and duplicative efforts. Further, the lack of a cohesive resource increases the likelihood of participants failing to understand their responsibilities and the consequences of not adhering to legal and regulatory requirements.

We recommend that SASIC, SIAA or the Australian Space Agency resolve this issue through the establishment of a centralised resource portal ('portal'). On this portal information, standards, legislation and norms can be monitored for interoperability, appropriateness and relevance. Each of these organisations have the brand and the industrial and academic networking that could be leveraged to ensure such a resource is effective and aligned with Industry goals. Inspired by the Secure World Foundation's Handbook for New Actors in Space[40] and ANGELS' Australian Navigational Guide Explaining Laws for Space, Figure 1 presents a future vision of Australia's portal for all things Space.[41]

The portal will act as the Industry's primary source of information, with its own URL landing page so that it is easy to find and share. Additionally, it would decrease the time needed to search for information, ensure that a higher percentage of participants obtain and retain the information required, and ensure that participants understand the Industry and their obligations - both domestic and international. The establishment of an open-source portal will democratise key

legislative and regulatory information for those without experience in policy or governance, lowering the barrier for entry into the Industry. To ensure its accuracy, currency and integrity, the portal will require regular updates under a fit-for-purpose governance model. This task would be suited to being part of an internship or high-school work experience opportunity, which would be cost-effective. This would also lead to further exposure of the Industry within the education sector. Once established and in use, the portal will facilitate access to information, as well as safe and informed participation in the Industry.

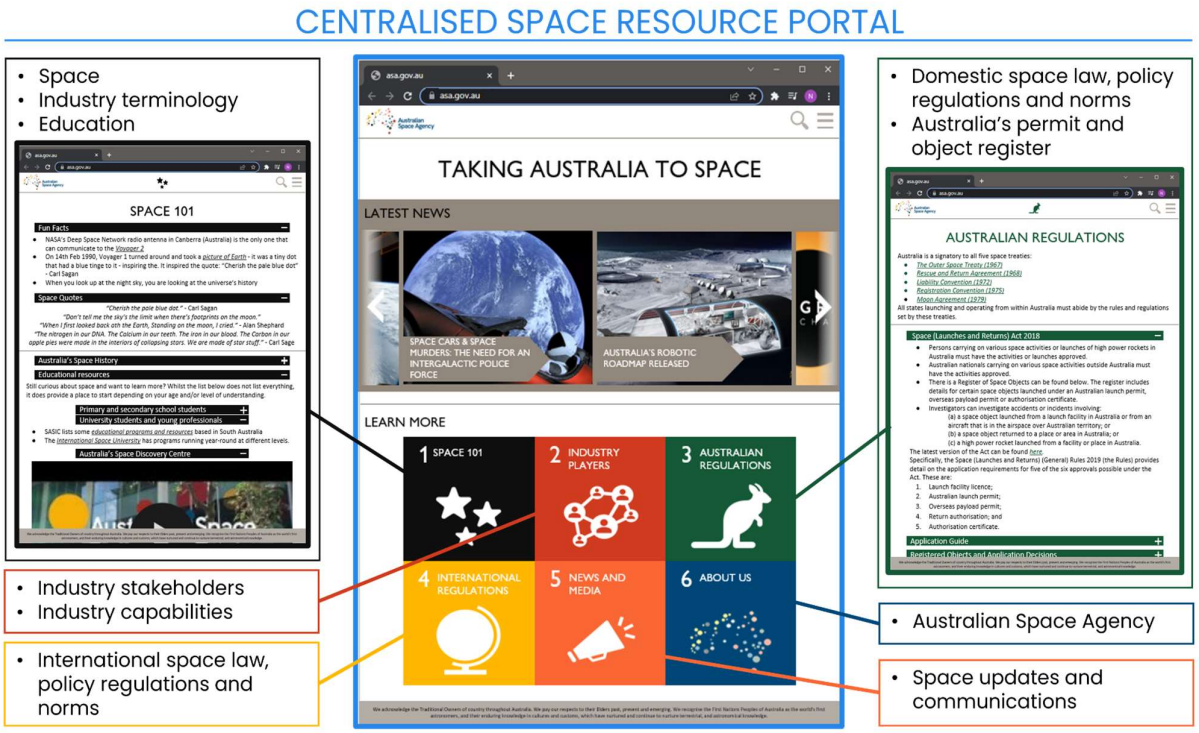

Figure 1: Example of the centralised resource portal for Industry participants

Recommendation 6: Establish the Australian Space Agency as a statutory authority.

We recommend that the Australian Space Agency be established as a statutory authority under domestic legislation. The concept of Australia creating a statutory authority for the Industry is not a novel idea. It was previously posited in 1985,[42] 2008[43] and 2021.[44]

Hesitancy surrounding the establishment of the Australian Space Agency as a statutory authority is partly due to the associated financial implications. Currently, there are multiple Australian Government entities which receive funding for activities involved in the Industry, for example the Australian Communications and Media Authority, and the Commonwealth Scientific and Industrial Research Organisation.[45] This recommendation seeks to cement the future of the

Industry and support Australia's long-term objectives for space, while facilitating better coordination on space matters across government and civilian sectors.

There would be further benefits in including the civil sector in the development of the statutory authority, such as providing greater transparency into the future regulatory body. While it is acknowledged that there may be political and administrative barriers in establishing the statutory authority, this recommendation has widespread Industry and bipartisan support.[46]

Recommendation 7: Amend the *Space (Launches and Returns) Act 2018 (Cth)* to include a Space Situational Awareness tracking strategy as an application requirement.

As LEO becomes more congested, orbital transparency will become crucial to the mitigation of collisions and the security of Australia's space assets.[47] Article IX of the Outer Space Treaty mandates that States 'avoid the harmful contamination' of outer space.'[48] However, the provision fails to obligate that signatories actively mitigate debris creation and track space objects. In Australia, this regulatory void is somewhat diminished by Section 34(2) of the Launches Act.[49] This provides that each application for an Australian launch permit contain a 'debris mitigation strategy,' which includes amongst other things the disclosure of accidental collision probabilities and measures to reduce long-term orbital presence.[50] The Act, however, does not ensure that licensees track their space objects after launch.

To address this legislative gap, we recommend that the Launches Act be amended to include an 'SSA tracking strategy' as a mandatory application requirement. Complementing section 34(2), this amendment would oblige licensees to actively track their space objects and share this data with the Australian Space Agency.

A shortcoming of this recommendation is that the requirement may disincentivise corporations from registering for launch in Australia. With minimum insurance requirements of $100 million and harsh penalties for contraventions,[51] additional regulatory hurdles could prove too onerous for potential launch licensees, damaging the Industry in the long-term.[52]

As a solution, we recommend the Australian government establish a reciprocal incentive framework to compel future licensees to conform to tracking strategy requirements. That is, in exchange for ongoing blanket visibility over all commercially launched payloads, the government could grant complying licensees with exclusive access to extended SSA information based on both tracking data provided by other licensees, as well as Australian owned sensing networks. This incentive will encourage emerging space actors, such as members of the recently inaugurated 'Australian Defence Industry Space Capability Alliance' to advance SSA technologies, comply with tracking requirements, and continue to develop launching capabilities on Australian soil.

Recommendations

Recommendation 1: Strengthen domestic Space Situational Awareness capability to ensure the security of civilian and defence assets. This recommendation is directed to SASIC, the Australian Government and the Department of Defence.

Recommendation 2: Develop a Space Traffic Management framework to ensure continued access to space and complement national strategic objectives. This recommendation is directed to SASIC and the Australian Government.

Recommendation 3: Support research and development of active debris removal and preventive debris mitigation technologies. This recommendation is directed to SASIC and the Australian Space Agency.

Recommendation 4: Develop regulation which permits the adoption of unclaimed space debris and its removal from space. This recommendation is directed to the Australian Space Agency, as well as the Australian Government and legislative officials.

Recommendation 5: Establish a centralised resource portal for Australian stakeholders to learn about the space environment and its regulation. This recommendation is directed to SASIC, SIAA, and the Australian Space Agency.

Recommendation 6: Establish the Australian Space Agency as a statutory authority. This recommendation is directed to the Australian Government and legislative officials.

Recommendation 7: Amend the *Space (Launches and Returns) Act 2018 (Cth)* to include a Space Situational Awareness tracking strategy as an application requirement. This recommendation is directed to the Australian Government and legislative officials.

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