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Committee Secretary
State Development, Natural Resources and Agricultural Industry Development Committee
Parliament House
George St
Brisbane Qld 4000

Dear Committee,

SUBJECT: *Submission to the inquiry into job creation opportunities in Queensland arising from the establishment of an Australian space industry.*

Thankyou for the invitation to provide a submission to the inquiry. It is an opportune time to hold the inquiry, as the space industry worldwide is growing at 10% per annum, faster than almost any other sector of the world economy. There is also a significant disruption occurring around the use of small satellites; the so-called "Space 2.0" revolution. New players that can adapt quickly have advantages going forward over established players with legacy infrastructure to maintain. The establishment of the Australian Space Agency, with its focus on economic development, will lead to jobs growth in Australia, and Queensland has the potential to make a strong contribution.

My submission is attached. For clarity, I have included my key recommendation here:

Recommendation

The economic opportunity of developing a launch capability for small satellites in Queensland is significant. Given Queensland's competitive advantage in scramjet technology, as well as for strong commercial reasons, reusable launch should be prioritised. The most effective means to instigate this development is through strategic seed funding.

It is conservatively estimated that 300 direct high-tech jobs would be involved in the design, manufacture and operation of a small satellite launch system. These would be supported by an estimated 100 jobs in business, finance and administration. All these jobs could be in Queensland, building upon the existing strong aerospace sector. Once established, this capability would act as a catalyst for companies involved in all levels of the space supply chain.

A low-cost, reusable space launch system could operate from a number of launch sites in Australia. The positioning of a launch site in regional Queensland would have significant economic flow-on effects on the surrounding community. The coastal region near Gympie would be an ideal place.

Yours sincerely,

Professor Michael K. Smart

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&
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An Opportunity for Queensland in the Global Space Sector

Both Queensland and Australian governments have invested over $70M in hypersonic research over the last 30 years at The University of Queensland (UQ). This has led to UQ's world leading position in scramjet technology. UQ beat NASA to the first flight test of a scramjet with a fraction of the research budget. Hypersonix Pty Ltd was founded in 2017 to commercialise this technology, which has the potential to revolutionise the satellite launch industry by "flying to space" and returning to the launch-pad like a plane.

The opportunity now exists to use this competitive advantage in hypersonic technology to:

- earn significant foreign exchange through the supply of low-cost small satellite launch services to Australian and International customers;
- supply responsive space launch for defence and disaster management, without reliance on other countries;
- and to act as a centre-of-mass and catalyst for the emergence of Queensland and Australian Space 2.0 companies.

The quickest way to commercialise this capability in Queensland is through the application of strategic seed funding. A strategic investment of $10M could result in an industry worth $2.5B over 20 years.

Small Satellite Launch Market

The rapid pace of technological advancement is changing the requirements of current and future satellite launch systems. Due to the rapid development of micro-scale, low power electronics, satellites that were many thousands of kilograms, now weigh just hundreds of kilograms. There is also a movement to even smaller satellites (< 100 kg) that have operational lives shorter than 2 years.[1]

The market for small satellites is growing. A 2017 survey by Euroconsult[2] predicts 6200 small satellites to be launched in the 2017-26 period with an estimated launch cost of US$13.6 Billion. This growth is driven by the needs of customers like Oneweb, which has FAA approval to operate a constellation of 648 small satellites to supply high speed broadband anywhere on the globe.[3]

At present almost all small satellites are launched using a ride-share service that sells spare capacity on upcoming large launches. In these instances the orbit altitude, orbit inclination and launch date are all set by the main customer. The small satellite operator has no control over the launch; a situation that is not satisfactory for commercial, defence or scientific activities. Hence there is a significant commercial opportunity for the development of dedicated launchers, which are designed to launch payloads as small as 100 kg to individual orbits.

Small Satellite Launch Systems

In response to this commercial opportunity, numerous small satellite launch systems are now under development around the world. The most mature are by Virgin Orbit (USA) and Rocket Lab (New Zealand/USA). Both these launch systems involve fully expendable rocket technology (the entire rocket system is thrown away after each launch). The commercial viability of these companies going forward will be dependent on the ability to manufacture cheap rockets that can be launched with high reliability. These two requirements compete against each other at a fundamental technological level. Reusability can break this paradigm.

Throwing away a significant portion of a space launch system each time it flies will always be inherently expensive. SpaceX has pioneered a reusable 1st stage booster for their large scale Falcon 9 rocket,[4] recognising that a partially reusable system will decrease costs if the technology is right. The UQ developed SPARTAN[5] system takes this idea further to include reusable 1st and 2nd stages using UQ's world leading scramjet technology. Scramjets have an advantage over rocket propulsion in terms of a significantly higher specific impulse (fuel efficiency). Recent scramjet flights, such as NASA's Hyper-X, the US Air Force X-51 and the Joint Australian/USA HIFiRE Program (partly funded by the

Queensland Government), have shown that the benefits of scramjets can be realised in hypersonic flight.

SPARTAN is designed to supply dedicated launch of satellites up to 150 kg to Sun Synchronous Orbit (SSO). It will be in direct competition with throw-away systems by Virgin Orbit (200kg to SSO) and Rocket Lab (100kg to SSO). The comparative advantage of SPARTAN is that it is 80% reusable (see the mission profile in Appendix A). A detailed business case indicates that with 5% of the expected satellite launch market (25 launches per year), SPARTAN would be able to supply launch at half the price of throw-away systems of the same size. Scale-up (increased flight numbers) is also much simpler with an aircraft-like system such as SPARTAN, as opposed to expendable systems that require new rockets for each launch.

A further important advantage of SPARTAN is that it will not dump rocket motors or other hardware into the ocean. This is an important advantage for mission planning and can allow significant launch activity that does not hurt the environment. Reusable systems like SPARTAN are the future of the space industry.

Responsive Space Launch

An Australian small satellite launch system would also be of great interest to Defence. A reusable system such as SPARTAN has the potential to be significantly more responsive than expendable launch systems. The ability to launch small satellites with as short as a week's notice is only possible with a system that has operational characteristics more like aircraft than rockets. On the civil side, responsive launch could also perform an important function during natural disasters, where timely satellite imagery may be critical. In Australia, there is currently no such capability.

Benefits of an Australian Small Satellite Launch Capability

Development of a commercial small satellite launch capability, based on locally designed and manufactured vehicles, would deliver a multitude of benefits to Queensland. It would also raise the profile of Australia internationally to be a genuine player in the space launch sector.

Economic Benefits

The economic benefits of developing and operating a small satellite launch system in Queensland include direct high-tech jobs, support jobs in business and administration, and indirect jobs in the wider community. These jobs would all paid for by the capture of Australian and international revenue from small satellite operators (a percentage of the $13.6B launch cost estimated for the 2017-26 period).

A good model for the benefits that would accrue to Queensland is RocketlLab in New Zealand. A detailed economic analysis was conducted by Sapere Research Group of Rocket Lab's contribution to the New Zealand economy[6]. Benefits include jobs at Rocket Lab and its suppliers, jobs associated with the operation of the launch site, and induced impacts like space tourism, cluster effects and increased prestige. In 2017 Rocket Lab had 200 direct employees, with a planned expansion to approximately 300 employees when fully operational. Over a 20 year period, a value of between $360M and $1.05B was estimated for Rocket Lab's contribution to the New Zealand economy.

Cluster effects are very important. A small satellite launch capability would create a centre-of-mass around which Australian Space 2.0 companies could operate and grow. Having a close connection between launch services, satellite component manufacturers and end-users of satellite data, can create synergies that promote commercial competitiveness in all areas of the space supply chain.[7] New advanced aerospace/composites/avionics manufacturing capability would also be needed. This manufacturing capability has significant cross-over with defence programs, and can be quickly built upon the strong aerospace sector that already exists in south east Queensland. This can also leverage and grow existing expertise at Australian academic institutions.

Cultural Benefits

Cultural benefits would include a sense of ownership and pride in space science and engineering by the community at large, as well as creation of a constant stream of space and aerospace related research needs for Australian universities. It would also increase general awareness and recognition of Australia around the world as a high technology nation.

There is also a clear aspirational effect from a high profile space launch system. Achievements in aerospace have been shown to have a significant impact in motivating prospective students and researchers into high technology industries.[6] Australians will see that there is a growing space industry in their home country and that it is an exciting and worthwhile dream to pursue this as a career, where previously they have had to move overseas.

Queensland Launch Site

Modern constellations require satellites in Low Earth Orbit (LEO) at a number of different inclination angles ranging between equatorial and polar. Whilst launch sites close to the equator suit low inclination orbits, and launch sites far from the equator suit high inclination orbits, a general purpose launch site can benefit from being "in between". Such is the case with Florida in the US.

At present there are two commercial companies developing launch sites suitable for small satellites in Australia; (1) Equatorial Launch Australia (Gove, Northern Territory) which is close to the earth's equator, and (2) Southern Launch (Coastal South Australia).

A launch site situated in regional Queensland would provide significant economic benefits to the surrounding community. These flow-on economic effects have been shown to have a large multiplication factor.[6] For this reason, if a launch site were constructed, it should be based in an area with an established population base. A coastal position would be ideal, however launch over the Great Barrier Reef may be problematic. The coastal area in the Gympie region (launching easterly over the ocean) would be an ideal place for the following reasons:

1. Suitable for a wide variety of orbital inclination launches due to latitude similar to Florida
2. Clear and safe flight path over open ocean
3. Airspace over the adjacent ocean is under defence jurisdiction and easily controlled
4. South of the Great Barrier Reef
5. A great place for launch site staff and families to live
6. It will bring more tourists to the Sunshine Coast.

Commercialisation

Hypersonix Pty Ltd was founded in 2017 to commercialise the world leading hypersonic technology developed at UQ over the past 30 years. The SPARTAN launch system is being developed by Hypersonix to launch small satellites to orbit once per week from Australia for Australian and International customers. Development of this capability over a 5-year period would be a game-changing high-tech project for Australia. Once established, revenue of $125M per year would accrue from a minimum of 25 launches per year. Over a 20-year period this amounts to a $2.5B industry.

The recent successful launches by Rocket Lab in New Zealand shows that new players can enter the satellite launch industry with relatively small investment (US$150M). While Rocket Lab is yet to perform a commercial launch (the first is planned for late in 2018), it is valued as a billion dollar company.[8] It also has pre-signed commitments for over 30 launches,[6] showing the high demand in the small satellite sector.

Despite the fact that Rocket Lab's Electron rocket was conceived and designed in New Zealand, it is now a US owned company. It's launch site is in New Zealand (taking advantage of the relatively clear sky's of the southern hemisphere), but it has moved its company registration to the USA, along with the majority of its profits.[8]

How do we keep the profits from of a system like SPARTAN in Queensland?

Hypersonix seeks to remain an Australian company. It is currently pursuing Phase A funding, where the most pressure is applied by venture capitalists to control ownership and structure. Seed funding of as little as $10M would enable Hypersonix to mature SPARTAN without giving away equity or control. Local control of the company will enable it to remain in Queensland. Total funding of $150M is needed to get to commercial launch. With the firm technological basis gained through seed funding, the remainder of these funds will be obtained from the investment community.

This would be a very highly leveraged use of seed funding, where a $10 million allocation could result in a $2.5B industry for Queensland.

Hypersonix has emerged from the UQ's Centre for Hypersonics, where a strong culture of rigorous engineering has combined with Australian tenacity and ingenuity to maximise the use of funding dollars. For example, in 2002 we were the first team in the world to successfully flight test a scramjet (Hyshot 2); beating NASA with a fraction of the funding. Since that time we have continued to punch above our weight in projects like HIFiRE (partly funded by the Queensland government), advancing our knowledge and developing the world leading technology which is the basis for SPARTAN.

Hypersonix will continue with this agile culture, demonstrating the ability to maximise value from funding and investment, while maintaining the highest standards of engineering and innovation. It could become the SpaceX of the southern hemisphere.

References

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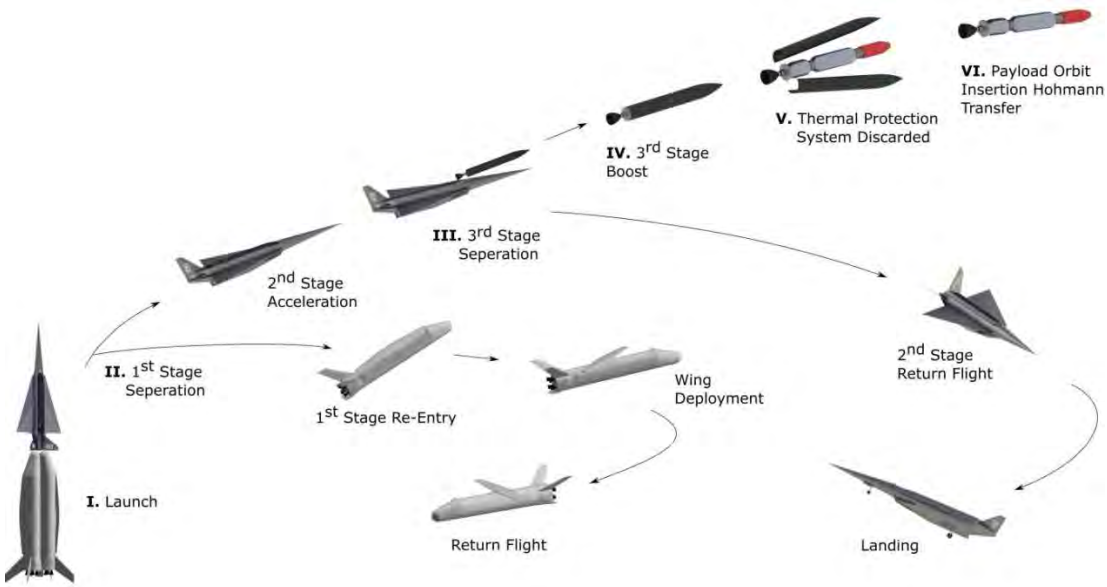
Appendix A: SPARTAN Small Satellite Launch System

The mission profile for SPARTAN is shown in the figure below. Both 1st and 2nd stages are fully reusable (80% of the launch mass), and it involves:

- A first stage rocket booster that flies back to base by deploying wings and a propeller motor (50 flights) (https://www.uq.edu.au/news/article/2015/12/uq-system-set-launch-australia-space).
- A hypersonic second stage powered by UQ's world leading scramjet technology (50 flights) (http://www.bbc.com/future/story/20161117-australias-hypersonic-spaceplane-for-a-new-space-race)
- An expendable 3rd stage that takes the satellite into its desired orbit.



SPARTAN Mission Profile

The SPARTAN system can supply flexible, dedicated launch of satellites up to 150 kg. It has three important advantages over competitors planning to use traditional expendable rockets:

1. It is 80% reusable. A detailed business case indicates that SPARTAN could deliver satellites to Sun Synchronous Orbit at $25,000/kg; i.e. less than half the price quoted for expendable systems of the same scale.
2. It can provide flexible orbit inclination and timing through aircraft-like operation of the scramjet powered 2nd stage.
3. It does not dump debris or expended rocket motors into the ocean. It is therefore environment friendly and allows simplified mission planning.