Project Name: QLD Space Industry
Date of Issue: 23 Oct 2018

Boeing Defence Australia

Response to the:

Inquiry to examine the opportunities for Queensland arising out of the establishment of an Australian space industry

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1. Executive Summary

Boeing would like to congratulate the committee on taking a forward-looking approach to the space industry with this Inquiry.

This report aims to inform the Queensland (QLD) government about existing capabilities in the State's aerospace industry that could be leveraged to increase involvement with the Australian Space Agency, and opportunities arising from a broader space industry.

2. Boeing's Existing Expertise.

Boeing is a worldwide leader in space capability, having directly or collaboratively been involved in the construction and placement of more objects in space than any other organisation. Boeing's Chairman of the Board, Dennis Muilenburg stated in October 2017 that he wants Boeing to "lead the world in space exploration".

Boeing's worldwide capabilities and experience include:

- Collaboration and investment in United Launch Alliance with Lockheed Martin;
- Pioneering work with the Experimental Space Plane (X-37B);
- Development of Phantom Express, a reusable launch vehicle;
- Management and operations of the International Space Station;
- Development of the world's largest rocket - the Space Launch System;
- Development of the next generation of human rated spacecraft with the CST-100;
- Competing on the development of NASA Cislunar Gateway;
- Providing global satellite services, and
- Manufacturing satellite systems from large geostationary to smaller low Earth orbit spacecraft.

Boeing in Australia is the largest Boeing footprint outside of the United States – with its operations in Queensland the largest grouping of Boeing employees in Australia. Boeing entities represented in Queensland include:

- Boeing Defence Australia, with its head office located in Brisbane;
- Boeing's largest R&D facility outside of the US, Boeing Research & Technology Australia, located at the University of Queensland;
- Phantom Works International, with its head office located in Brisbane;
- Insitu Pacific, located in Newmarket; and,
- Boeing Training and Professional Services, located at Brisbane Airport.

Some of the capabilities of those business units that have immediate application or are currently used in the space supply chain include:

- The largest Boeing autonomous vehicle program outside of the United States;
- Virtual Reality and Augmented Reality training and engineering design data for the CST-100, International Space Station, and Cislunar Gateway, as well as part of Boeing's Commercial Aircraft engineering virtual design capability;
- Secure communications infrastructure developed at BR&T-Australia to enable remote access to launch sites, like Baikonur in Kazakhstan, from anywhere in the world, to assist in the facilitation of launch;
- Anti-viral medical technology through collaboration between UQ and BR&T-Australia for use on the International Space Station, which also has application on Earth; and,
- Remote sensing data analysis for monitoring gas pipelines from any source of earth observation data, which can also be applied to multiple other industries.

Many of Boeing's other projects and centers of expertise also provide services and capabilities that can contribute to the space supply chain. Much of the technology developed through defence projects, collaboration with Australian universities, and established partnerships with research organisations like the CSIRO provide technology that can be easily adapted or applied to the space supply chain. This allows Boeing to either support other organisations directly or contribute to the development of capability within the space supply chain.

3. Committee Considerations

Boeing addresses the specific considerations of the inquiry below. Much of the supply chain may be able to be addressed by Boeing and other Queensland organisations which currently operate in parallel or analogous industries or projects.

a. The Australian Government's establishment of an Australian Space Agency on 1 July 2018

The Australian Space Agency's stated goals, and Boeing's relevant capabilities, are shown in the table below. As a large Australian aerospace organisation, Boeing has experience in-country to address some of the goals of the Australian Space Agency (ASA). With such a large footprint in Queensland, Boeing is well placed to contribute to or support any activity in the Australian space industry within the State.

Table 1 - Australian Space Agency Goals and Boeing Capabilities

Agency Goals	Boeing's Capability
Setting national policy and strategy for the civil space sector	Boeing can help inform and guide space industry strategies - leveraging decades of experience working with NASA and DARPA.
Coordinating Australia's domestic space sector activities (including regulatory activities under the Space Activities Act 1998)	Boeing works every day within the CASR and DASR regulatory frameworks and would be able to provide the expertise to support SAA regulations. With reach over to the US Boeing Launch Division, BDA will be able to assist with the design and certification of space assets, in-house and/or supporting startup space companies in QLD.
Leading international space engagement	Boeing has close ties with NASA and has a proven track record of running projects across multiple national and international sites.
Supporting the growth of Australia's space industry	With an established Space Business Development team in the USA, Boeing is well placed to bring this expertise to QLD to service the Asia Pacific region.
Sharing our expanding role in space and importance to the national economy	BDA already has the largest Boeing presence outside of the USA, supporting more than 2000 jobs in SEQ alone. Space opportunities could allow BDA to grow further, bringing more high tech jobs to the region.
Inspiring the Australian community and the next generation of space entrepreneurs	Boeing already participates in STEM projects to inspire the next generation of engineers, adding Space into the mix would undoubtedly increase interest.

b. The space supply chain, which has been broadly categorised as, Space systems (including communication satellites), Ground systems, Applications and ancillary services, and End use (e.g. improved telecommunications, mapping and emergency management)

Boeing has considerable experience across the globe in many of the identified areas of the supply chain and in some instances Boeing Research & Technology Australia (BR&T-Australia) has current space contracts. This includes a highly developed capability in Augmented Reality (AR) and Virtual Reality (VR) that was highlighted within the Australian Government's review of the Supply Chain as being in a start-up state. Further details are documented in Table 2 that addresses each of those areas individually.

Table 2 - Australian Space Supply Chain

Capability Area	Existing Capabilities
Manufacturing	Access to advanced manufacturing capability within Australia could support QLD industry in the design and fabrication of structures including spacecraft and launch vehicles. Relationships with Australian universities and research facilities (including CSIRO) could support payload development, including in communications, on-board data processing, and Earth Observation. Access to US for support on spacecraft design and manufacturing; assist in the development of QLD industry including key suppliers and manufacturing capability

Space Operations	Boeing's relationship with key research institutions, CSIRO, and SMEs in the US places it in a unique position to support both above-the-line and below-the-line work. Boeing already has experience with Space Situational Awareness, Ground Station Operations, and Guidance and Tracking Systems to support establishing a capability in QLD. Boeing is also in a unique position to support space operations, as its capability extends to multiple areas identified by the Australian government including: the provision of launch; spacecraft satellite calibration, validation, and certification; satellite communications; and telemetry, tracking and control.
Application	Mining industry support through remote sensing applications and data processing. Can be applied across agriculture, logistics, environmental conservation, and reef monitoring, and potentially as-yet unidentified applications. Experience in development and operation of autonomous systems BR&T-Australia in QLD has developed a mature capability in VR/AR. It currently provides training for astronauts on Boeing's spacecraft CST-100, the ISS, and Gateway. Boeing has developed a secure communications network to enable remote access to launch sites overseas. This was utilised to reduce the number of people required to travel from the US to locations such as Baikonur in Kazakhstan to facilitate launches. Medical R&D that resulted in development of technology to target viruses in a closed environment such as the ISS. This can be adapted and applied to other diseases enabling long duration and long distance space operations. Boeing operates a world class complex modelling and simulation capability that can support individual satellite and constellation design and optimisation. This is currently used by a range of customers to assist with capability and system level design decisions. Boeing is known as a provider of program management services, engineering services, and complex supply chain. These are all key elements required to execute any program with the complexity of operating in or with the space environment. Boeing has experience with Space Situational Awareness, Ground Station Operations, and Guidance and Tracking Systems to support establishing a capability in QLD.
Ancillary Services	Boeing's relationships and networks place it in a unique position to support both above-the-line and below-the-line work. Can support through an advisory role drawing on world-wide SMEs from industry and within Boeing

c. The review of space supply chain capability released by the Australian Government prior to the Agency being announced

Boeing's capability and ability to contribute to both the Australian and Queensland space industry have been address in both Table 1 and Table 2, a summary is shown below in Figure 1.

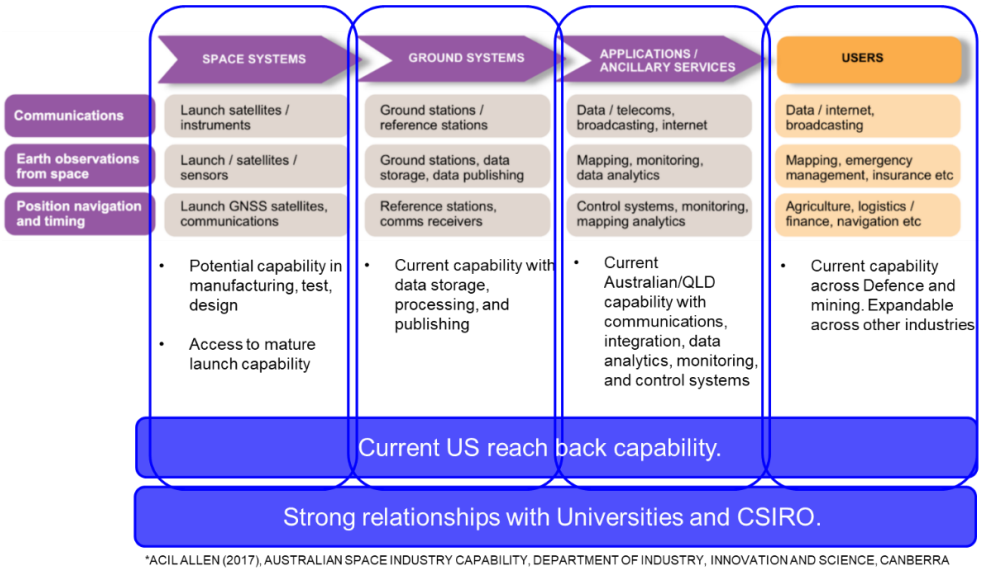

Figure 1 - Australian Space Supply Chain by Priority

d. Queensland's areas of competitive advantage in relation to identified capability which, at a high level, have been identified as communications, earth observations, position, navigation and timing

There are several areas of competitive advantage for Queensland listed below. While these are high-level considerations, the Committee should also consider that certain aspects of Queensland are unique. Queensland is a consumer of earth observation data for things such as disaster management, land management, mining, agriculture and the Great Barrier Reef, as well as the need for position, navigation, and timing capability for many industries and communities. Our needs as a consumer may offer Queensland businesses and industries an opportunity to expand into new and various parts of the supply chain and become leaders in these areas. Some of the identified areas of competitive advantage for Queensland are:

Table 3 – Areas of Competitive Advantage

Capability Area	Existing Capabilities
Geography	Multiple potential launch sites, e.g. Cairns, Cape York or Townsville. Locations for launch and Queensland's natural environment ensure the State is an excellent candidate for space tourism through organisations such as Blue Origin or Virgin Galactic.
Existing infrastructure –	Well established industrial ports, rail and road that can support the logistics requirements of any new industry. Many Queensland industries already utilise specialised materials, including hazardous chemicals and explosives, resulting in a logistics chain that can support unique or specialised needs. Several key sites, such as RAAF Base Townsville, RAAF Base Amberley, and RAAF Base Scherger, could support both launch and recovery of horizontal launch vehicles. This could include recovery of Sierra Nevada's Dream Chaser or launch, and recovery of Virgin Orbital space tourism or Virgin Galactic satellite launch.
High Tech work force:	QLD has centers of excellence for communications, rocket engines, command and control systems and automation. Queensland has access to world class academic institutions already supporting space supply chain through activities such as launch and earth observation. Key areas of the Australian Space Agencies focus include robotics and autonomous capability, both of which are found widely in mining and defence. Boeing and the Queensland branch of the CSIRO both have experience in these areas.

Capability Area	Existing Capabilities
Geographically Diverse Population	QLDs large regional population centers will allow projects to be run from the most suitable locations, resulting in new technology hubs.
Boeing	With the largest Boeing presence outside of the USA and strong ties back to subject matter experts, Boeing is well placed to help further space projects in QLD.

e. Areas of regional Queensland where supply chain capability exists, particularly in areas of competitive advantage.

The table below includes the regional areas that Boeing has identified as possible locations to support the space industry:

Table 4 – Regional Queensland

Capability Area	Existing Capabilities
Townsville	Well established infrastructure and RAAF Base Townsville. Large skilled population.
Ipswich/Amberley	Existing manufacturing capabilities. Expanding Defence company hub.
Sunshine Coast	Growing Technology Startup center With appropriate investment, the New Maroochydore city center is a possible opportunity to create a Space Engineering Hub
Gold Coast	Momentum building in rocket engine design.

4. Industry Collaboration

Boeing is open and enthusiastic about collaborating, supporting, and growing a high tech industry in Queensland. The success in growing an industry for the space supply chain can support many other parts of the State and create future opportunities to benefit many organisations in Queensland. The future of innovation and industry will require a collaborative effort across multiple organisations and, as a global organisation, Boeing has long since recognised the importance of collaboration for success.

Along with the global network, Boeing has a long history of supporting supplier organisations, and providing mentoring and formal training. Each year Boeing celebrates its suppliers through awards and recognition as today's complex project environment requires the best from many people and many organisations.

5. Government Collaboration

The 2017 State of Space Report, published by the Australian Government's Space Coordination Committee, identifies space as part of Australia's National Interests "addressing space-related issues that ensure Australia's national security, economic, and social objectives are appropriately achieved". The services provided by an active indigenous space program apply to all key Government stakeholders residing at local, state, and federal levels of government. Boeing sees the space supply chain as a key enabler across a broad group of departments at each level and encourages collaboration through this network. As the Australian Space Agency will not own a future project workforce they will rely on the existing capability within organisations such as Geoscience Australia, Defence Science and Technology Group the CSIRO or the Bureau of Meteorology. There may be scope for Boeing to engage with the Government in the development of a future space supply chain in Queensland, and the planning and strategy to support this.

Boeing is aware of moves by other states and territories to investigate opportunities provided by the formation of the Australian Space Agency and moves to establish the industry in Australia. Without trying to influence the Committee's deliberations either way, we believe there could be advantages in interstate collaboration rather than full-scale competition.

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6. Conclusion

Boeing has been a major contributor to the exploration of space and the development of the global space industry since the earliest days of the quest to conquer this new and challenging domain. With such a significant presence, established business units and supply chains in Queensland, Boeing is well placed to work with the Government as it further explores the potential for exploiting the State's natural advantages in the nascent space industry. Boeing believes there is still some way to go before the current plans form a sustainable business case, however the possibility exists that this will develop over time. We look forward to working with the Queensland Government if it decides to further pursue concrete steps to foster space endeavours.

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