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Inquiry into Developing Australian Space Capabilities

House of Representatives Standing Committee on Industry, Innovation, Science & Resources

DMTC Limited [formerly the Defence Materials Technology Centre] welcomes the opportunity to provide a brief submission to the Committee in relation to its inquiry into opportunities to develop Australia's space industry. Our submission focuses on those terms of reference that most closely align to DMTC's experience and expertise.

Key Observations

With relatively modest investment from Government, DMTC has worked with industry and research partners (including Skykraft and a number of other submitters to this inquiry) on advances in a number of space-related technologies. These collaborative efforts have produced some stunning results, including a key contribution to an Australian CubeSat mission scheduled for launch this year.

There are many overlaps and synergies between space technologies and defence-related technologies. DMTC contends that more can be done to develop Australian industrial capabilities in this area, and to support the continuing development and expansion of the nascent space industry sector in Australia.

Specifically, DMTC recommends that the Committee might helpfully focus attention on:

- Gaps in the Australian market in either specific technical expertise or in supply chain and production capacity,
- The extent to which Australian case studies and success stories in space technology advancement to date provide a template for future success,
- Whether the extant and predominantly grant-based industry development funds and other incentives that are available to Australian industry are addressing the point above, or whether more targeted measures are required, and
- The merits of the Department of Defence naming spaceborne technologies as a specific Sovereign Industrial Capability in addition to the initial list announced in early 2018.

Context

DMTC is an independent, not-for-profit company that develops sovereign industrial capability for Australia's defence and national security communities.

Our programs enhance Australian industrial capability through collaborative efforts that are intensively managed and underpinned by Australia's world-renowned research expertise.

Our work relies on bringing together:

- Government agency stakeholders (principally from Defence but increasingly from other parts of government) who have a 'seat at the table' to ensure that technology development efforts led by DMTC remain relevant to the customer's requirements;
- Research organisations (both public and private, including Universities) as a provider of industrially-relevant and often world-leading technical capability and expertise; and
- Industry as the path to commercial opportunities and the integration of enhanced technology to deliver improved capabilities.

DMTC programs and projects operate on a co-investment model, an approach that allows each partner to leverage the expertise, investment, human resources and capabilities of the other partners. Our work spans many of the traditional and emerging 'domains' within the defence sector, and are geared towards rapid technology adoption and transfer, not grants-based or other arms-length forms of investment. DMTC has historically had a strong focus on engaging small to medium enterprises (SMEs) in our activities, harnessing their niche expertise and breaking through fears or misconceptions about engaging in truly collaborative endeavours. This is particularly relevant to Australia's space industry sector.

DMTC's involvement in technologies of interest to the space industry is an example of the flexibility and scalability of our model, taking guidance from government stakeholders on areas of demonstrable capability need beyond 'traditional' Defence domains.

DMTC's High Altitude Sensor Systems Program presents a useful case study for building Australian space capability and developing Australia's space industry. The HASS Program preceded the formation of both the Australian Space Agency and the SmartSat CRC. It was established in 2016-17 with modest seed funding from CSIRO as both a signal of the relevance of space technologies to CSIRO's national mission but also a validation of the DMTC model for collaboration, bringing together stakeholders from across Government to align program scope with targeted areas for investment. In this respect it was very much in line with Defence's acknowledgement that evolving threats and changes in ISREW technologies required attention and investment if Australia was to maintain a capability edge.

To date, DMTC's work in the space sector has been focused on developing technologies to underpin capability of utility in ISR and Geospatial fields and includes ground based, air based and space-based technologies and infrastructure. Enhancements in Australia's capabilities in these areas will be a critical enabler of a significant number of the major equipment projects in Defence's Integrated Investment Program.

DMTC's experience with the space industry sector since 2016 points to a comparatively small but smart, tight-knit and internationally respected community of practitioners. The sector is dominated by startups and small businesses (with an emphasis on the 'S' rather than "M' of the small-medium enterprise continuum). The community has clear ambitions to grow and to mature Australian capability and innovation in space systems, encouraged by opportunities for both further innovation and commercialisation.

Evident areas of capability strength across the Australian space sector include:

- hyperspectral sensors with low size, weight and power;
- passive radar systems,
- compact high-sensitivity receivers,

- advanced alloys and additive manufacturing processes enabling sensors, and
- on-board processing, and compression of large volumes of satellite data.

There is substantial cross-over potential between these capabilities and other sectors including materials, manufacturing, aerospace, and communications. There is also significant relevance to the Defence sector, particularly with regard to space-borne technologies which enable situational awareness of areas of denied access, provision of data in real-time, and a sovereign manufacturing capability for small satellite technology. While there is clearly a growing base of innovative space capabilities in Australia, the sector is still relatively nascent compared to the sectors DMTC traditionally works within[1], and lacks well-established and networked end-to-end supply chains in key areas. Since 2017 there have been many new partnerships between the research sector, Australian space start-ups and SMEs, and multinational aerospace primes, but more can be done.

CASE STUDY 1

A DMTC project team has successfully demonstrated a novel approach to accelerating the production of satellite components using Invar, a low thermal expansion alloy of nickel and iron. The Imaging Payload Assembly (IPA) mounted on the composite Ti-6Al-4V / Invar36 optical mount (pictured right) is scheduled to be launched into orbit as part of the Australian M2 mission in 2021.

The use of Invar seeks to directly address the challenge of significant temperature variations on small spacecraft. The stability of the structure under these conditions is critical to the performance of optical payloads (components that produce and deliver mission-specific data).

DMTC collaborated with UNSW Canberra Space, CSIRO, La Trobe University and industry partner A.W. Bell on a project to research, design, test and additively manufacture a CubeSat chassis and the optical mount. UNSW Canberra and A.W. Bell collaborated on the design of the CubeSat chassis, after which A.W. Bell commenced manufacture, informed by a La Trobe University literature review on the castability of Invar. UNSW conducted a range of metrology and vibration test on the manufactured components to validate the design integrity and simulate the effect of launch conditions. CSIRO manufactured six prototype optical mounts using alternative additive manufacturing techniques (including electron beam melting and cold spray).

This project is a further demonstration of the capacity and expertise of Australian industry and research organisations to meet a growing demand for high-performance small satellite structures and componentry.

[1] such as land vehicles, maritime structures, aerospace machining, high performance materials, biomedical technologies and innovative manufacturing solutions

Specific comments with regards to the Terms of Reference

- *Development of space satellites, technology and equipment*

Australia's space capabilities, while already considerable, need to continue to grow in both maturity and scale, particularly in support of defence and national security outcomes.

Faced with an evolving threat landscape and the space domain increasingly viewed as a contestable area of operations, a key question for Australia is what areas of space capability, technology or equipment are most critical to have in Australia, and/or to have resident manufacturing and supply chain capacity in Australia? And how do we best support the development of those critical capabilities? The bureaucratic response to such a question can often be to spawn new rounds of grant funding, often with either matched funding or onerous reporting requirements for small businesses. As the JSCFADT[2] and Senator David Fawcett[3] and others have identified, more effective, more direct and targeted forms of intervention and investment may be required. The Department of Defence could also have a role through acknowledging space domain awareness and related technologies as a Sovereign Industrial Capability.

One example is in relation to small satellite design and production. Defence has traditionally been an early adopter and/or sponsor of early stage research into new technology and capabilities. A number of recent strategic shifts have provided the impetus for development of a 'homegrown' Australian space sensor capability. The ADF relies on space-based assets to provide critical situational awareness during operations, exercises and training, as well as to provide intelligence on the capabilities and activities of foreign organisations if required to protect our national interests. To date however, the space-borne assets we have accessed have been traditional large satellites that have been built, owned and operated by our allies.

Over the past decade an emerging global capability for disruption of large form factor satellites and availability of open-source and commercial earth observation data (e.g. proprietary products including Google Earth) have eroded the reliability and strategic advantages imparted by our access to satellite data through alliances. More recently a series of large international primes and small start-up companies (e.g. Gilmour Space Technologies and RocketLab) have been established to bring small payload (e.g. CubeSat) and low earth orbit capability to the Oceanic region. Given these developments, and Australia's already established strengths in satellite communications and navigation, a gap remains in our ability to field satellite hardware and sensing capability of appropriately miniaturised size, power and weight specifically tailored for CubeSats. This is an example of an emerging technology area where Australia could not only meet its own sovereign requirements but also become a global leader (refer Case Study 1 above).

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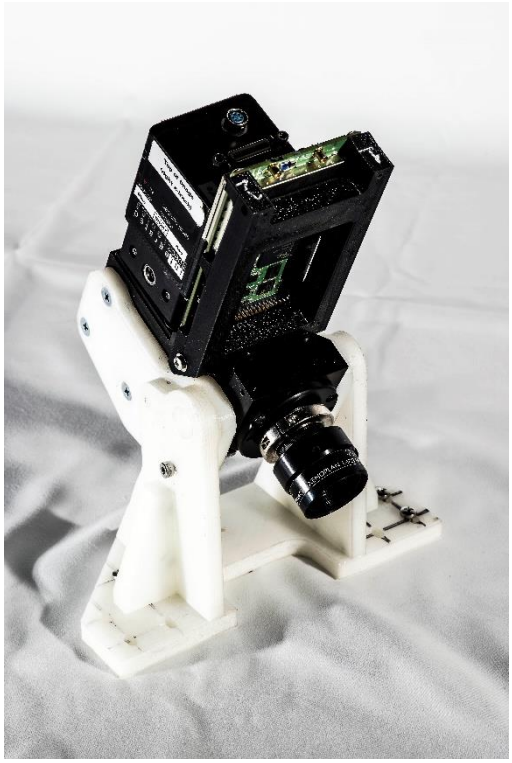
[2] cf. Recommendations 14 & 15 of the **Inquiry into the implications of the COVID-19 pandemic for Australia's foreign affairs, defence and trade**, Report released 8 December 2020 © Commonwealth of Australia 2020

[3] Senator the Hon David Fawcett, Keynote address to Defence Teaming Centre Summit, 24 September 2020

CASE STUDY 2

In conjunction with University of Technology Sydney (UTS) and industry partner HyVista, DMTC's Compact, Spatially Agile Spectral Sensor (C-SASS) project has successfully developed and flown a prototype hyperspectral imaging system (pictured right) that can be pointed off-nadir, and has made other key advances including in the software used to analyse and process the images.



Conventional spectral sensor systems enable images to be collected looking only directly down to the Earth from the unmanned manned aircraft on which the imager is mounted. This restricts the range of operating environments in which the technology can be used.

The ability to tilt the view angle of the sensor and look 'off nadir' enables the image to be acquired at a distance from the target area, such as flying above the open ocean and looking towards a beach or coastal environment.

Advanced image processing and analysis techniques including Artificial Intelligence (AI) and machine-learning methods are needed to rapidly and accurately interpret these images, and to identify objects of interest from within the complex images.

The C-SASS imager can change its look angle, it has a very low signal to noise level and can be mounted on a wide range of aircraft including drones. The project partners are now looking to finalise the development of this system towards operational readiness.

Another example worthy of further consideration are optical device and semiconductor manufacturing. Both optical devices and semiconductors are an increasingly significant enabling capability in manufacturing generally (e.g. underpinning quantum computing), but specifically in a broad range of current and future defence systems across many operating domains (land, sea, air and space). Defence's demand for these products, either through direct investment or the activity of prime contractors, is considerable and so too are the broader benefits for Australian industry and the national economy if Australian-made products can compete with the best from the rest of the world on quality, cost and performance benchmarks.

Despite the importance of optics as an underpinning capability, Australia's sovereign capability and capacity in this area is currently poorly integrated[4] and under-developed. For example, during our own work to establish the High Altitude Sensor Systems program, DMTC found just two Australian-based companies and one research facility with the capability to manufacture optical lenses, and only a handful of companies capable of designing optical

[4] Report prepared for the Office of the NSW Chief Scientist & Engineer, **Australian Semiconductor Sector Study: Capabilities, opportunities and challenges for increasing NSW's participation in the global semiconductor value chain**, December 2020

devices. There is a clear need for better access to innovation testbed facilities, advanced technologies, rapid prototyping and production of high-performance, customised devices. This is a significant sovereign capability issue in the current environment and DMTC strongly supports consideration of growing Australia's industrial capability to fill this gap. With high barriers to entry, the Government has a clear role to play in setting the conditions for sovereign industrial capabilities to be established in these sectors.

- *International collaboration, engagement and missions*

DMTC acknowledges the Space Agency's efforts in this area, including with regard to taking Australian delegations to overseas events and welcoming international interest in Australia. More could be done here, as other submissions have noted, including a more strategic vision from the Space Agency and better alignment of the space sector's efforts with Defence's extant export promotion (including export finance) and *Team Defence Australia* activities.

- *Commercialisation of research and development, including flow on benefits to other industry sectors*

Many of the sensing and earth observation capabilities desired by Defence have a potential corresponding application to civil/commercial challenges. For example, space-borne hyperspectral sensors can be used to derive information significant to amphibious combat but can also be used to remotely monitor the health of food crops and water resources. The ability to extract and classify military targets of interest from a real-time data stream is equally useful when inspecting large pieces of civil infrastructure such as the national power grid.

DMTC contends that the duality of these opportunities should be identified and harnessed as a key advantage for the development of a world-leading, stable and healthy industrial base. The Space Agency's current program funding guidelines, which explicitly prevent Universities and publicly funded research agencies such as CSIRO from leading funding proposals, should be reconsidered if Australia is to take full advantage of the broad range of skills and experience in the space sector across academic, research and industry partners. DMTC's experience with successful multi-partner collaborations, founded on our best practice Intellectual Property model, could be adopted to facilitate greater collaboration amongst all these elements.

The space sector in Australia is rapidly developing, but is currently dominated by startups and small businesses, and there are specific considerations as a result of the fragility and risks to viability of many of these companies. In this context, recent legislative changes in Australia to reform corporate insolvency processes are welcome, to the extent that these changes provide more flexibility for small businesses and lower the barrier to attracting risk capital in a sector where elements of the ecosystem have high barriers to entry. As discussed above in relation to optics and semiconductor production, these changes will assist in creating conditions where investors might salvage elements of value created, should high-risk ventures not proceed.

- *Future research capacity*

DMTC has a strong focus on supporting Masters, PhD and postdoctoral research through its portfolio of project activities. Masters and PhD candidates are utilised to investigate specific areas of research within larger collaborative projects involving Defence, industry and research partners.

This approach provides the student with invaluable experience in, and exposure to, collaborative development programs. Industry partners gain access to new ideas and research expertise, and the sponsoring University is provided with assurance of the industrial relevance and contemporary alignment of their research outputs to current and future defence capability requirements. Due to the often sensitive nature of Defence projects, applicants for DMTC top-up or full scholarships must be either Australian or Permanent Residents and may be required to obtain a Defence Security Clearance. Ongoing professional development opportunities are also provided. Aspects of this best-practice model could be adopted by the Space Agency or more broadly across the sector.