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Defence space situational awareness: opportunities for Australian industry

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I'm going to talk about the part Defence can play in supporting the Australian space industry.[1] I'll focus on space situational awareness, or, more properly, space domain awareness (SDA). Hopefully, some of the things I will say about things that we're looking to do in Defence, working with our industry, about space domain awareness, might strike a chord, especially given the concern with debris in space.

First, what is SDA and why do we need it? It's understanding the totality of space, the space environment, space weather, what is occurring due to natural phenomena to and human activity. It's understanding that satellites are up there, the debris created by man, the space junk, and the myriad of satellites that are there now and into the future. Understanding objects in space and the environment effects of space allows us to predict what might occur. The worst outcome is a conjunction and a collision between two satellites. These have occurred before and they're probably going to occur again, unfortunately. The most notable example is Iridium 33 and the Cosmos 2251, which, on 10th February in 2009, collided at about 42,000 km/h, creating about 2,000 pieces of debris bigger than 10 cm in diameter. Amazingly, when we're talking about SDA, Iridium was a live satellite and it manoeuvred to miss the other satellite but actually manoeuvred to crash into it.

Why is SDA important? Without a reasonable level of SDA your satellites become more vulnerable. In the military context, that vulnerability moves beyond just space weather and the opportunity for a collision, it extends to an adversary possibly blinding, jamming, spoofing or, in the extreme, destroying one of ours or our allies' satellites We're now pretty well versed in how dependent Australian society is on space for banking, mining, agriculture, entertainment and communications, and Defence has critical dependencies as well for positioning, navigation and timing, timing probably being the most important there, communications as well. If we think that Paul's Space 2.0 has legs — and there's no reason to think that it doesn't — there'll be a dramatic increase in the number of satellites up in orbit very soon. It's becoming more congested, contested and operationally challenging than ever before.

The United States is our great ally, and I'd like to talk about the US Air Force capabilities for a moment, because we are linked very closely. The USAF has many of things that contribute to SDA, including telescopes that look all the way out to geostationary orbits, radars that look at low-Earth orbits, passive radar capabilities, electronic warfare capabilities, satellites in orbit for the express purpose of looking at

1 This is an edited version of the transcript of Dr Lind's talk.

other satellites, and debris, as others have discussed. These all contribute to the space surveillance network that the US runs, and result in the space catalogue, which is positional information and prediction, which the USAF make available for all to see and all to use. Unfortunately it doesn't contain full information. Some of the information is not that accurate and some of it is missing, either by design or by omission.

Satellite constellations are also quite expensive. Even though the costs are coming down, you still really don't want to lose one. The debris could be generated from an avoidable collision and affect many other objects in space. The Kessler effect or syndrome, where we might have a cascading effect of debris, would be something really catastrophic. The movie "Gravity" portrayed the cascading effects that might occur. Indeed, only about 90 of the of the 2,000 pieces of debris from the Iridium/Cosmos collision have decayed out orbit. That's over ten years so it's pretty grim. Once things are up there the debris stays there for a very long time.

Satellite operators, and governments seeking to protect their investments, want assurance and are generally fairly willing to pay for it. Companies have started to seize on these opportunities, such as Exo-Analytic and AGI with networks and space telescopes and radars and complex mission systems that can determine what is occurring and predict conjunctions or collisions and allow us to take evasive action.

Where is Australia in all this, what capabilities does Defence have, and what are the opportunities for Australian industry?

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Whilst our US allies are our great friends and we will share these two sensors, the priorities of the US and Australia don't always align, so there is a need for us to have some sovereign capabilities, so that our sovereign priorities can be serviced as we see fit. As noted above, there are telescopes, radars, lasers, satellites in orbit that can provide us with SDA. Australia probably needs a suite of these types of capabilities because one particular asset can't do it all. For example, telescopes are great to look out into space but they work best at night. Radars are fairly expensive and struggle to look past low-Earth orbit. On-orbit capabilities are coming down in price but they're

still expensive and they're very fragile. You certainly can't update them once you put them in orbit.

Defence has been taking the view that Australian industry and Australian innovation is world class in this area and that we should encourage it. So we've been holding a SDA demonstration activity for the last couple of years. Colloquially, it's known as SpaceFest. Companies and universities go there and show their wares. It's in Glendambo in South Australia and what's been coming out of Space Fest has been pretty amazing. The diversity of thinking and the demonstrations of inexpensive and novel solutions for SDA has been pretty impressive. A number of ideas have since been funded by the Defence Innovation Hub and some of them are coming to the end of that funding and are seeking commercialisation for operations. I'd like to describe just a few of these because there are many. This is not an exhaustive list of what our Australian companies have been doing in this sphere.

First, the Western Sydney University neuromorphic sensor. It works a bit like an eye in that it detects changes in movement in a scene and each pixel is independent of each other pixel. It has an extremely fast integration rate, meaning it sees minute changes. And because it just looks at changes, it has a very small bandwidth so it's easy to send that information around — it's easy to pull that information and send it to where it needs to go. It's proving to be fairly revolutionary and it's not just for SDA: there are other applications for it as well.

Second, Silentium Defence have been looking at passive radar, which is a radar that doesn't use a specific source. In this case, they've been using things like FM radio station side lobes and satellite television station transmission signals as well, so they can detect debris in low-Earth orbit. They look at all the sky at once. Whether it's day or night doesn't really matter. It's relatively inexpensive because it doesn't have a transmitter and it's rapidly developing into a really first-class capability.

Third, FireOPAL — Curtin University and Lockheed Martin Australia have developed a system called FireOPAL which is a network of really simple cameras, each with a solar cell. It takes a picture of the sky every ten seconds, and transmits it via the mobile phone network. They plan to roll out hundreds of these cameras across Australia or the world. The cameras just sit there, powered by the solar panel. Someone comes out every year or two to service the camera and it sends that information back to a central processing. It is extremely effective and it really is an innovation because it's taken really simple things inexpensively and provides a really high-quality output.

Fourth, Electro Optic Systems. They've been at this for a while. They've got incredibly accurate laser-ranging systems which can tell you exactly where your particular satellite might be.

All these innovations are sovereign. They offer opportunities not just for Defence but for commercialisation and export, and it's one of the few areas that I deal with where technology is increasing and cost is decreasing. So it's an exciting time for Defence and Australian industry and we just hope to continue our small part in it.