

Transformation of the global space industry in the 21st century and the NSW rôle in space

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There are three phases of space development: exploration, experimentation, and exploitation.¹

The *exploration* phase is characterised by a journey into the unknown. It's usually high risk and inevitably high cost. And because of that, it's usually driven by government agendas, hence it's generally funded almost exclusively by governments. This was the case for the start of the space race and entry into space. From a commercial perspective the business paradigm is pretty much that industry has a role as an equipment or service provider to meet those government agendas. When you go to the next phase, the experimentation phase, not a lot has changed.

The *experimentation* phase builds on the successes and applications identified in the exploration phase. Again, it's usually high cost but it's lower risk because you do know something about this new environment and how to operate there. You've been there, you've learned from those experiences. This phase is usually focused on the understanding of the new environment and developing a means of operating. Again, it's usually driven by government agendas. Often these are military. They can be economic and, in some cases, prestige. Again, as a result of that, it is usually funded directly by govern-

ments. And the industry paradigm is similar to the first exploration phase: industry is mainly a supplier to the government to meet the government agendas. But it begins to selectively invest or explore commercial opportunities.

The third phase, the *exploitation* phase, however, sees a rapid change, almost an inversion of what has happened in the earlier phases. This phase is characterised by the technology and the science of the new medium being fairly well understood. There is usually a demonstrated value of operating in the new medium and often unique services are possible. The cost might still be high but substantial commercial returns become a possibility. Risk can be mitigated in different ways, managed in slightly different ways. First, you know the medium a little bit better. But, second, insurance can sometimes become available to insure commercial missions. In this environment industry begins to leverage off the government infrastructure or selectively look to build its own where it can return a profit. The business paradigm here flips dramatically. Industry begins to actively invest, in addition to government. Market forces then begin to drive investment and commercial activities start to outpace policy and the legal and the regulatory issues, which can lead to concerns that we should think about. But for this discussion at the moment I'm

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

going to focus on what has been happening in space to this date.

What happened to the space environment, the space regime, when space entered the exploitation phase? What happened to global space revenue from 1973 to 2017? In my view, the end of the exploration phase was pretty much the end of the Apollo missions, roughly around 1973. The total size of the space economy was US\$15 billion at that point. \$12 billion of that was the government payment to companies to build stuff for them to go into space. And there was a nascent emerging telecommunications industry that was generating about \$3 billion. 1998 marked a real watershed in the space industry because that's the year that government expenditure on space — what was generated by governments paying companies to build stuff for them — was matched by what was earned by the commercial sector in its own right. The total pie at that stage was \$68.8 billion, split half and half between commercially generated returns from space and the government programs that were actually buying services from companies in space.

What has happened since the turn of the 21st century? Commercial space has skyrocketed, as it were. The total pie in 2017 was US\$383 billion. Government expenditure has continued to rise: in fact, government expenditure over the entire period, from '73 to 2017, had a compound annual growth rate (CAGR) of around 3.5 to 3.8%, nothing to sneeze at. But CAGR for the commercial sector alone since the turn of the century has been 11.6%. Such a rate of return over a sustained period of 20 years is incredibly significant. In that timeframe, very few other endeavours have achieved this — the Chinese economy grew at about 13% CAGR over that same period. This is why the venture

capitalists, the companies and countries are saying, "We need to get into commercial space. There's money to be made there." The CAGR through 1998 of the entire space economy was 6.3%.

Commercial activities now comprise 80% of the space economy. The biggest transformation that has generated that is the move to the consumer market. Many of the many revenue streams did not really exist 20 years ago. Satellite direct-to-home television comprised the largest chunk of the commercial revenue then (25%). It was only just starting to come in place in the late '80s, early '90s, but has skyrocketed since. The global navigation satellite system (GNSS) and services derived from that make up the next biggest chunk of that, nearly 36% of the industry, including: the equipment used to receive, sat nav implements in the cars, the things that you have in your cell phone that are doing the tracking. All of that is part of the GNSS industry and the services derived from that. And there are others — satellite broadband (8%) has now increased and we now have that here in Australia. And satellite radio (1%), which is still largely based in the United States.

So when you look at what's been taking place in the last 20 years globally, how has Australia performed? Well, it turns out that in space Australia is mirroring what is going on elsewhere. Many people don't realise that Australia has had an extremely strong heritage in space. But we haven't been really good at publicising it: it's usually been people in the know who understand it. One of the things that we in the Space Industry Association have been trying to do is to raise that profile with people like yourselves and others in the community, that actually Australia does have skin in the game and we

do have capabilities and we can move forward. Some of our reports show that there are over 600 organisations in Australia that are involved in some way in space activities. The Australian space sector actually generates annual revenues of around \$4 billion per annum from space products and services. (The ERG report² did a more fine-tuned look at that and came up with \$3.94 billion.) So we're in that range and this is what the government intends to grow over the next ten years, up until 2030, to triple that \$12 billion per annum.

The Australian space industry has around 10,000 staff who are employed in an activity which, at some point, requires them to deal with space in some way. Not everybody is full-time in space of those 10,000 but it's an important part of what they have to do. They are spread across all six states and the two territories in Australia. One of the really interesting findings is this: we looked at every industry sector that the Australian Bureau of Statistics (ABS) uses to categorise Australian industry, to identify which sectors use space services in some way in the normal day-to-day running of their businesses. We expected to find a lot of that, but we did not expect to see that every single sector was included. If you look at the way that is spread around the industry — we chose to use nine ABS categories to describe the activity — it's the satellite systems, it's the things that go into space. It's the launch system, what takes them there. It's the ground networks, which control space activities or communicate with space activities. It's the space-enabled services which are the downstream products of space, including your satellite communica-

tion, your position navigation and timing, your earth observation. Then it's the support services, which include legal, regulatory, as well as specific engineering support. It's space-related R and D. It's space-related learning, education and training. It's the other categories of media, museums etc, public outreach. So you can see that, like the rest of the world, Australia has most of that in the space-enabled services side. We're very strong in ground stations. And we have very strong in R and D and space education and training.

Looking at the ABS statistics of which industries use space: the Federal Government, Defence, the science community. But agriculture, fisheries, forestry and mining are also big users of space. And every state and territory has space staff. New South Wales is the engine of space growth in this country. More staff are here, more revenue here, and that's largely due to the satellite telecommunications industry.

Australia has a very vibrant innovation and start-up scene in space. There are over 50 start-up space companies in Australia, and the majority of those are in New South Wales. It makes Australia probably the second-largest nation or location for space start-ups around the world, outside the United States. Australian venture capital is growing and it is starting to invest in space. There are Australian space start-up companies that are actually drawing venture capital from other places: Australian companies have secured money from Boeing Ventures, from Singtel, from the European Space Agency. There's a wide range of them, covering the gamut of new ideas: propulsion, launch vehicles, launch services, ground networks, space situational awareness (SSA), communication systems, the internet of

² Clark (2018).

things (IoT), robotics, earth observation, small-sat manufacture, and agriculture information from space. The thing about new space is that the lower barriers to entry make a wide range of new businesses possible.

So Australia has world-class space capabilities. We have strong capabilities in world-renowned ground stations³. We have strong capabilities in scramjet and hypersonic research. We're among the world leaders in satellite communications, including the NBN satellites, and in particular the way they are integrated into a domestic network. We are world leader in laser-based orbital space debris tracking⁴. And we are one of the world leaders in R and D in position navigation and timing⁵.

³ We operate deep-space tracking stations for NASA and ESA, and stations for JAXA (Japan) and China.

⁴ The Space Environment Research Centre is developing a network of laser ranging orbital debris tracking stations in Australia.

⁵ Australia is one of few countries with access to all 6 current GNSS systems: 4 global systems (GPS, USA; Glonass, Russia; Galileo, Europe; Beidou, China) and 2 regional systems (QZSS, Japan; IRNSS, India).

We also are seeing an emerging space ecosystem. Many things are happening in low-Earth orbit. The economy is moving there, we are on the cusp of a near-earth space economy and Australian businesses are working into that right now. Finally, the space industry in Australia globally has been growing significantly over 20 years. This growth is attracting private wealth and venture capital. It is one of the hot areas for people to invest in. Australia has leading capabilities in that area and a thriving start-up sector in its own right. And New South Wales is actually leading the nation in a lot of that work. Thank you.

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