

Market analysis

Market study

Australian space sector

APRIL 2021

Canberra

Red Building
Benjamin Offices
Chan Street
Belconnen ACT

PO Box 78
Belconnen ACT 2616

T +61 2 6219 5555
F +61 2 6219 5353

Melbourne

Level 32
Melbourne Central Tower
360 Elizabeth Street
Melbourne VIC

PO Box 13112
Law Courts
Melbourne VIC 8010

T +61 3 9963 6800
F +61 3 9963 6899

Sydney

Level 5
The Bay Centre
65 Pirrama Road
Pyrmont NSW

PO Box Q500
Queen Victoria Building
NSW 1230

T +61 2 9334 7700
F +61 2 9334 7799

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Written enquiries may be sent to:

Manager, Editorial Services
PO Box 13112
Law Courts
Melbourne VIC 8010
Email: info@acma.gov.au

Contents

Executive summary	1
Analysis of space sector businesses	3
About this study	5
Background	6
Investment environment	7
Launches	8
Payloads	9
Satellites	10
Australian space industry	12
Australian Government initiatives	13
Space sector businesses	15
Established space businesses	15
Start-up space businesses	15
Government sector	16
Other space sector businesses	16
Spectrum implications	17
The ACMA's approach	17
Updating regulatory arrangements	18
Satellite filing activity	18
Earth station protection zones	19
Infrared (optical) communication	20
Attachment A - Space sector value chain	21
Attachment B - Space sector businesses	24
Attachment C - Infrared (optical) communication: Legislative background	40
Glossary	41

Executive summary

The Australian Communications and Media Authority (ACMA) regulates communications and media to maximise the economic and social benefits for Australia.

This market study provides a snapshot of the domestic and international space sectors to help us stay informed of developments.

The market study highlights recent growth in the space sector with implications for the ACMA:

- > an increase in satellite filing work
- > an increase in licence application requests
- > a need to provide guidance and information on spectrum requirements – to assist entrants such as start-ups and research organisations that are considering developing experimental satellite systems with short-duration missions
- > a need to monitor developments in emerging space-based technologies and applications, and trends in the spectrum needs of space-based communications systems, with a view to informing future spectrum priorities.

The Australian Space Agency (ASA) defines the space sector as ‘the provision of space related goods, services and applications to broader industries, [excluding] non-space (value adding) activities’.¹ The space sector supports the delivery of a diverse range of services including:

- > voice and internet
- > the Internet of Things (IoT)
- > navigation
- > radio astronomy
- > communications links to support backhaul networks
- > weather monitoring.

The Organisation for Economic Cooperation and Development (OECD) estimates the global space sector was worth US\$277 billion in revenues in 2018, predominantly attributed to satellite services and equipment.²

This report identifies several developments shaping the global space sector, including:

- > **Investment environment:** investment through venture capital firms has been increasing in the space sector over the past 10 years. Start-up investment and the proportion of start-up launches has increased in recent years. The increase in the number of launches has been further fuelled by reduced costs associated with CubeSats and nanosats.

¹ Department of Industry, Science, Energy and Resources, [Defining the Australian space sector](#), accessed 10 August 2020.

² OECD, [The impacts of COVID-19 on the space industry](#), accessed 11 August 2020, p. 2.

- > **Launches:** the cost of launching payloads into space has been falling since 2001, coupled with an increase in launch numbers. Ridesharing and specialised small satellite (SmallSat, comprising mini, micro and nano satellites) launch providers have reduced barriers to entry for satellite operators by reducing launch costs.
- > **Payloads:** satellites remain the most common payload launched into space. The number of satellite payloads has doubled in the past 20 years. SmallSat satellite deployments are an area of growth. One estimate is that average number of SmallSats launched per year will increase from 181 in 2019 to 1,011 by 2029.

The Australian space sector has received a renewed focus with the establishment of the ASA on 1 July 2018. The ASA aims to grow the Australian space sector to be worth A\$12 billion per annum by 2030 – supporting a further 20,000 space industry jobs.

The ASA has identified 6 focus areas in its Communications Technologies and Services Roadmap as areas of greatest opportunity for Australia. This is linked with other government initiatives, such as the Space Infrastructure Fund and International Space Investment – Expand Capability Grants which are seeking to grow Australia's space sector.

IBIS World, an industry research firm, estimates the Australian space sector generated A\$5.7 billion in 2020, with 829 businesses supporting 15,234 jobs. Key factors or trends relevant to the Australian space market include:

- > Australia's geographic position providing a strategic advantage for space observation
- > flow-on benefits to regional Australia through industry growth
- > innovation and multinational space projects, as highlighted by the investment trends above, lead to increased opportunities.

Analysis of space sector businesses



We examined 31 entities operating within the space sector.



Due to the high capital expenditures associated with manufacturing, launching and operating of satellites, it was common to observe:

- > government investment or ownership of space sector companies
- > businesses relying on large amounts of debt (leading to restructuring of finances via mechanisms such as Chapter 11 bankruptcy)
- > EBITDA and revenue figures to be healthy, while net income or profits to be low, due to high depreciation and interest costs.



Businesses which have relied on revenues from communications in the transportation sector have faced negative impacts from the COVID-19 pandemic.



Business revenues associated with communication services (such as telecommunications and IoT) have increased or remained stable during the COVID-19 pandemic.



Revenues from government contracts have been mixed, depending on each country's response to the COVID-19 pandemic.



The more diversified space sector businesses have been able to offset losses experienced from the COVID-19 pandemic with gains in other parts of their businesses.



With the exception of established Australian operators, revenues from the Australian market appear to form a small proportion of revenues for most space sector businesses.



Australia is important as its geographic location allows space sector businesses to monitor their services and to offer global coverage.



Several start-up ventures are in the process of obtaining regulatory approvals to operate on a global scale.

- > A majority of these providers are seeking to provide high-speed internet to parts of the world where traditional broadband is too costly to provide.
- > These businesses are largely being led by either consortia or technology companies.

Australian universities are working with private industry and the government to increase Australia's space capability and its competitive position internationally.

The ACMA encourages industry participants and new entrants to contact satellite.coordination@acma.gov.au early to discuss their business plans and spectrum requirements.

The ACMA is seeking advice from the space sector on infrared communication systems to determine the most appropriate regime to support such systems.

About this study

The ACMA conducts market analysis which contributes to our understanding of communications and media markets.

As part of the market analysis workstream, this market study was conducted to inform our understanding of developments in the space sector. The study was developed based on desktop research that considered both domestic and international developments.

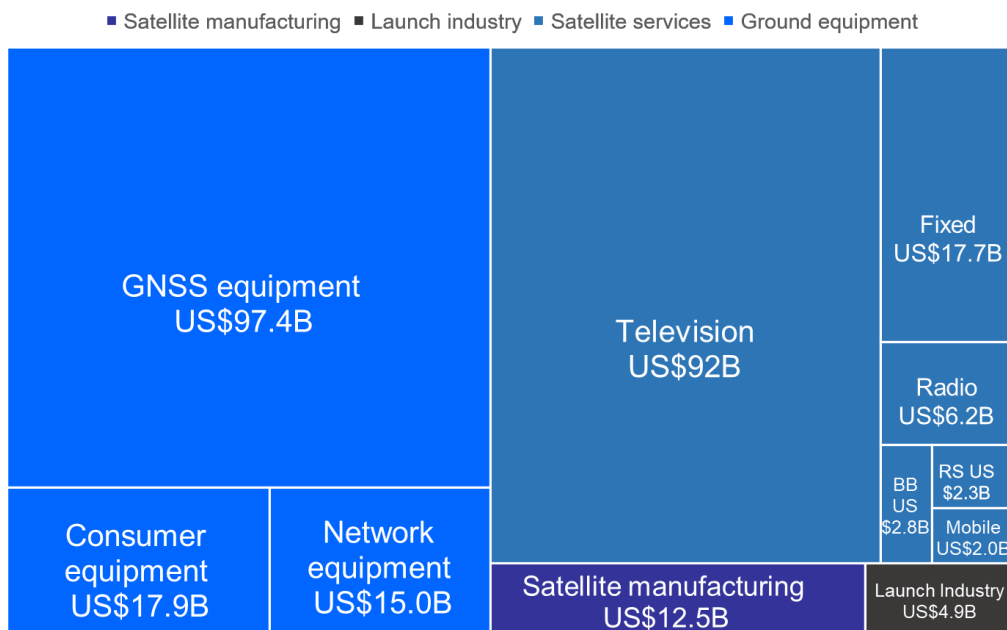
The study includes a summary of space sector businesses at Attachment B. This is based on an illustrative sample selected to identify general industry trends and is not intended to be an exhaustive list.

The ACMA would like to thank the Australian Space Agency (ASA) who provided feedback and input into the development of this market study.

Space sector overview

Estimates of the value of the global space sector range from US\$271 billion to US\$350 billion.³ Figure 1 summarises industry revenue estimates for each of the various areas of the global space industry. This shows that ground equipment (US\$130 billion) and satellite services (US\$123 billion) are the largest sectors in terms of revenue. One estimate is the value of the space industry will grow to US\$1 trillion or more in 2040.⁴

Figure 1: Global satellite industry revenues – 2019



Note: BB is short for broadband, RS is short for remote sensing, and GNSS stands for Global Navigation Satellite System. Fixed comprises transponder agreements and managed network services (including spaceflight management services).

Source: Bryce Space and Technology, *State of the satellite industry report: 2019 top-level global satellite industry findings*, accessed 11 August 2020, p. 2.

³ Bryce Space and Technology, *State of the satellite industry report: 2019 top-level global satellite industry findings*, Accessed 11 August 2020, p. 2; and Morgan Stanley, '[Space: Investing in the Final Frontier](#)', accessed 12 August 2020.

⁴ Morgan Stanley, '[Space: Investing in the Final Frontierspace](#)', accessed 12 August 2020., Accessed 12 August 2020.

The space sector is evolving rapidly in several ways:

Worldwide, governments are the main investors in space activities, via procurement and grants mechanisms to public agencies, research institutes, universities and the private sector. But in only 5 years the global landscape for space activities has evolved, with new countries investing in space research and development, and getting involved in global value chains. Private funding of commercial projects has also grown, with unprecedented private capital flows in the space sector from angel and venture capital investments.

OECD, [The Space Economy in Figures](#), 5 July 2019.

While reusable rockets will help drive those costs down, so too will the mass-production of satellites and the maturation of satellite technology. Currently, the cost to launch a satellite has declined to about \$60 million, from \$200 million, via reusable rockets, with a potential drop to as low as \$5 million. And satellite mass production could decrease that cost from \$500 million per satellite to \$500,000.

Morgan Stanley, '[Space: Investing in the Final Frontier](#)', 24 July 2020.

Investment environment

There has been increased investment by governments into space programs – increasing from US\$52 billion in 2008 to US\$75 billion in 2017.⁵ There are also record investments from angel and venture capital funds, although the amounts are lower compared to public funding.

The mix of funding has changed significantly over the past 20 years, with venture capital being the largest source of funding in recent years (overtaking private debt financing which peaked in 2010).⁶ Private sector investment is geographically dispersed, with the greater number of private investors located in the United Kingdom (UK), the United States (US), Japan and China.⁷

Key observations about the funding of the space sector include^{8, 9}:

- > space venture funds include Boeing's HorizonX Ventures, Lockheed Martin Ventures, Airbus Ventures, Thales Corporate Ventures, and the Dassault System Venture Fund
- > start-up equity investments were US\$3 billion to US\$5.7 billion in 2019
- > investment transactions grew globally, from 200 investment deals in 2011 to over 1,400 in 2017

⁵ OECD, [The Space Economy in Figures: How Space Contributes to the Global Economy, Chapter 1](#), accessed 13 August 2020.

⁶ Bryce Space and Technology, [Start up space: Update on investment in commercial space ventures 2020](#), accessed 13 August 2020, p. 12.

⁷ Bryce Space and Technology, [Start up space: Update on investment in commercial space ventures 2020](#), accessed 13 August 2020, p. 26.

⁸ OECD, [The Space Economy in Figures: How Space Contributes to the Global Economy, Chapter 1](#), accessed 13 August 2020; and Bryce Space and Technology, [Start up space: Update on investment in commercial space ventures 2020](#), accessed 13 August, p. iii.

⁹ Sarah Barry James & Stefan Joshua Rasay, '[3 satellite bankruptcies in 3 months: What happened and who could be next](#)', S&P Market Intelligence, 2 June 2020.

- > most of the recent space companies are privately funded (for example, SpaceX, Blue Origin) and not publicly traded
- > access to capital has tightened with the COVID-19 pandemic disrupting key revenue streams and investors realising the market's demand for new high-speed satellite connectivity may not match supply
- > key factors for investors include increased competition between incumbents and new technological solutions
- > a greater majority of the funding from the private sector has been focused on SpaceX and OneWeb.¹⁰

Despite positive trends, sustained access to finance will remain a challenge for a majority of established and new players in the space sector.

Launches

The cost of launching objects (payloads) into space has been falling since 2001 coupled with an increase in launch numbers.¹¹

There were 102 launches for 2019, comprising 86 public and 16 private launches.¹² Reasons for the increasing market for commercial launches are¹³:

- > Since 2014, US-based providers are gaining in share of commercial launches relative to Russian providers through:
 - > the entrance of SpaceX and its Falcon 9 vehicle, at comparatively lower prices (in part achieved through the ability to reuse its vehicles)
 - > during the past several years, launch failures, quality control problems and supply chain issues have continued to affect the Russian space industry
 - > during this time Europe's Arianespace has remained as another option
- > Sea Launch (once a key player but not dominant) ceased operations
- > Japan's Mitsubishi Heavy Industries (MHI) Launch Services and India's Antrix have become more aggressive at marketing their H-IIA/B and Polar Satellite Launch Vehicle (PSLV), respectively.

China Aerospace (9) and SpaceX (10) had the most launches in the December 2020 quarter.¹⁴ In the previous quarter, China Aerospace had the most launches followed by SpaceX.¹⁵

Locations of the launch sites are spread across the world with the number of launches predominantly originating from China (39) and the US (31) in 2018.¹⁶ There were no active launch sites in Australia, with the last launch occurring in Woomera in 1967. However, Australia has been relatively active when it comes to investing in space ventures and is in the process of building launch sites in Whalers Way (Southern

¹⁰ Bryce Space and Technology, [Start up space: Update on investment in commercial space ventures 2020](#), accessed 13 August 2020, p. 24.

¹¹ *The Economist*, "[The space race is dominated by new contenders](#)", 18 October 2018.

¹² Bryce Space and Technology, [2019 Orbital launches year in review](#), accessed 14 August 2020, p. 2.

¹³ Bryce Space and Technology, [Annual Compendium of Commercial Space Transportation: 2018](#), accessed 14 August 2020, p. 1.

¹⁴ Bryce Space and Technology, [Global Orbital Space Launches Q4 2020](#), 22 January 2021.

¹⁵ Bryce Space and Technology, [Global Orbital Space Launches Q3 2020](#), 31 October 2020.

¹⁶ Bryce Communications, [2018 Orbital launches year in review](#), accessed 14 August 2020, p. 2.

Launch in South Australia)¹⁷, Nhulunbuy (Equatorial Launch Australia in Northern Territory) and Woomera (RAAF in South Australia).

Other recent developments have been ridesharing and small vehicle launch providers.

Ridesharing involves satellite operators entering an arrangement to have their satellites included as part of a payload. This reduces a significant barrier to entry (that is, launch costs) into the satellite market. For example, Arianespace enables smaller operators to launch their satellites via its Small Spacecraft Mission Service (SSMS).¹⁸ Arianespace says the SSMS provides flexibility for accommodating market requirements and minimises cost by reducing overheads for small satellite operators. This is achieved through reducing legal costs (using simplified contracts) and operational costs (applying a lean integration chain). The first commercial Arianespace launch occurred in September 2020, with regular follow-on SSMS flights planned once the 'next-generation' Vega C launcher begins operations.¹⁹

Small vehicle launch providers specialise in launching SmallSats into space. Their approach focuses on minimising launch costs by using smaller rockets, as the payloads associated with SmallSats are significantly smaller than larger satellites. Examples include [Electron \(Rocketlab\)](#), [Virgin Orbit \(LauncherOne\)](#), [Firefly Aerospace \(Alpha\)](#) and other providers.

Payloads

Payloads traditionally refer to the cargo on a vessel. With respect to space, payloads can comprise satellite(s) on a rocket or elements of the spacecraft specifically dedicated to producing mission data and then relaying that data back to Earth. Until the mid-1990s, the launching of objects into space was largely the government's domain (defence and civil), with communications and imaging satellites being launched at low Earth orbit (LEO).²⁰ From the late 1990s to early 2000s there was an increasing trend of commercial payloads, with technology and science objects being launched at LEO.

For geostationary Earth orbit (GEO) satellites, commercial payloads have been a feature since the 1970s, carrying both commercial and civil payloads. Communications appear to be the most common application.²¹ During the 2000s, the proliferation of devices using global positioning technologies was reflected in the increase of navigation payloads.

In the third and fourth quarters of 2020, SpaceX launched the most upmass (that is, payload mass carried) into space.^{22, 23}

¹⁷ It was recently announced that a successful [launch](#) was conducted from this site.

¹⁸ Arianespace, ['Arianespace gives a lift to the small-sat market with Vega's SSMS debut'](#), 3 September 2020.

¹⁹ Arianespace, ['Arianespace gives a lift to the small-sat market with Vega's SSMS debut'](#), 3 September 2020.

²⁰ ESA, ['ESA's Annual Space Environment Report 2019'](#), accessed 19 August 2020, p. 20.

²¹ ESA, ['ESA's Annual Space Environment Report 2019'](#), accessed 19 August 2020, p. 22.

²² Bryce Space and Technology, ['Global Orbital Space Launches Q3 2020'](#), 31 October 2020.

²³ Bryce Space and Technology, ['Global Orbital Space Launches Q4 2020'](#), 22 January 2021.

Satellites

Satellites are one of the most common payloads launched into space. The number of satellite payloads has doubled in the past 20 years.²⁴

Satellites range in sizes from large to nano (see Table 1).

Table 1: Satellite sizes

Satellite type	Example	Weight
Large satellite	RADARSAT-2	>1000 kg
Medium satellite	CASSIOPE	500–1000 kg
Mini satellite	SCISAT	100–350 kg
Micro satellite	M3MSat	10–100 kg
Nano satellite (including CubeSat)	Ex-Alta 1	1–10 kg (1 kg per unit)

Source: Canadian Space Agency, [What is a CubeSat](#), Accessed 4 November 2020.

Note: SmallSats comprise mini, micro and nano satellites (see glossary for definition).

There were 2,666 operating satellites in March 2020.²⁵ This comprises 1,918 LEO, 135 medium Earth orbit (MEO), 59 elliptical and 554 GEO satellites.

SmallSat deployments, comprising mini, micro and nano satellites, are an area of growth, particularly at LEO. One estimate is the average number of SmallSats launched per year will increase from 181 in 2019 to 1,011 by 2029.²⁶

For the SmallSat market²⁷:

- > Mega-constellations (for example, Starlink and Kuiper) will account for half the quantity of SmallSats to be launched between 2020 and 2029, yet only account for 20% of the SmallSat market value due to newer satellites being cheaper to manufacture and launch.
- > An annual average of 1,000 SmallSats are expected to be launched during the 2020s.
- > 2019 had the highest number of SmallSats to date, with 385 SmallSats launched.
 - > These spacecraft generated US\$2.8 billion of market value in 2019, of which 70% was for manufacturing and 30% for launch.
- > From 2020 to 2029, the Asian market will account for 1,600 SmallSats over the next decade, competing with US companies.
 - > 72% of the Asian market is government-driven and predominantly involves, but is not limited to, China.
- > In the coming decade, SmallSat market growth will be dominated by communication satellites, with nearly 5,700 units forecast for launch.

²⁴ OECD, [The Space Economy in Figures: How Space Contributes to the Global Economy, Chapter 1](#), accessed 11 August 2020, Figure 1.1.

²⁵ UCS, [UCS satellite database](#), accessed 25 August 2020.

²⁶ Euroconsult, [Prospects for the small satellite market: Forecasts to 2029](#), accessed 19 August 2020, p. 2.

²⁷ Euroconsult, [Prospects for the small satellite market: Forecasts to 2029](#), accessed 19 August 2020, p. 2.

- > High levels of uncertainty remain as the SmallSat market is, by definition, very volatile. The failure (or market entry) of a single constellation may represent a variation in the forecast in the hundreds.

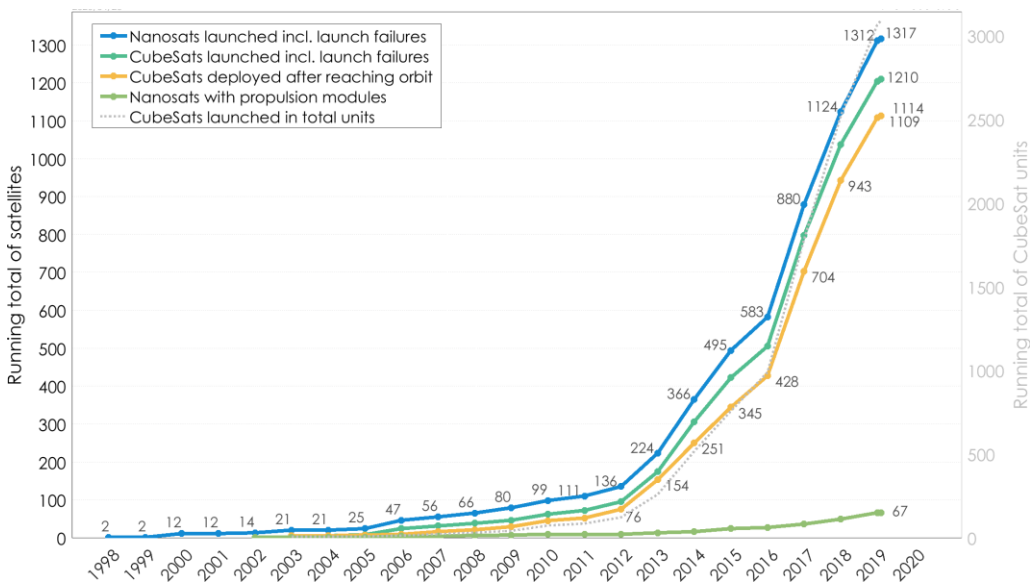
The applications offered by LEO sats are likely to replicate the offerings of LTE and 5G in a number of areas – and likely at much lower cost. Today, railway operators are installing private LTE networks for signalling – LEO satellites could provide this without requiring a single new base station to be built. It’s a similar story for data on the trains themselves.

In fact, many internet of things (IoT) applications being touted as dependent on 5G may well be more economically served by LEO sats, such as transport and logistics, autonomous vehicles, and other in-vehicle data applications. Why would Mercedes, when seeking coverage for autonomous cars, sign up 172 agreements with local mobile operators around the world, for patchy, incomplete coverage when they could have one contract with a worldwide provider?

Michael Ackland, General Manager Government and Strategic Projects, Vocus²⁸

Figure 2 shows the launch trends of CubeSats, nanosatellites, picosatellites and various other small satellites.²⁹

Figure 2: Total nanosatellites and CubeSats launched



Source: Erik Kulu, Nanosats Database, www.nanosats.eu (Figures), Accessed 25 August 2020.

²⁸ Vocus, 'Comms Day Summit 2020: Michael Ackland's presentation', 27 October 2020.

²⁹ See Nanosats database, 'What is a CubeSat & other picosatellites', accessed 25 August 2020, for a detailed explanation of the various satellite types.

One estimate is there will be over 6,500 nanosats launches in 6 years from 2020.^{30, 31}

In the third and fourth quarters of 2020, SpaceX has launched 184 and 247 spacecraft (for example, satellites) respectively.³²

Australian space industry

The Australian space sector has received a renewed focus with the establishment of the ASA on 1 July 2018. The ASA aims to grow the Australian space sector to be worth A\$12 billion per annum by 2030 – supporting another 20,000 space industry jobs.³³ Table 2 shows key information about the Australian space industry.

Table 2: Key statistics and indicators for Australian industry (2020)

Statistic/indicator	
Revenue	A\$5.7 billion
Profit margin	6.1%
Businesses	829 businesses
Employment	15,234 jobs
Life cycle	Growing
Barriers to entry	High but decreasing due to cheaper launch options
Competition	Medium but increasing due to investment and lower barriers

Source: IBIS World, *Satellite communications and astronautics market, January 2020*, p. 6.

IBIS World highlights that the key factors and/or trends for the Australian space market include³⁴:

- > Australia's geographic position providing a strategic advantage for space observation
- > challenges in retaining staff due to higher industry wages found overseas
- > increased government support through the recent creation of the ASA
- > the development of reusable launch vehicles is likely to reduce satellite costs
- > flow-on benefits to regional Australia through industry growth
- > innovation and multinational space projects, as highlighted by investment trends above, lead to increased opportunities.

Attachment A provides an overview of the space sector value chain.

³⁰ Erik Kulu, Nanosats Database, www.nanosats.eu ([Figures](#)), accessed 25 August 2020.

³¹ Bryce Space and Technology, '[Global Orbital Space Launches Q4 2020](#)', 22 January 2021.

³² Bryce Space and Technology, '[Global Orbital Space Launches Q3 2020](#)', 31 October 2020.

³³ Australian Space Agency, [State of space report: A report by the Australian Government Space Coordination Committee \(1 January 2018 – 30 June 2019\)](#), accessed 20 August 2020, p. 6.

³⁴ IBIS World, *Satellite communications and astronautics in Australia*, January 2020, p. 6.

Australia's technical expertise is highly regarded internationally, and Australia is involved in several multilateral space projects. For example, the Canberra Deep Space Communication Complex, Tracking Data Relay Satellite System in Western Australia, and the United States National Aeronautics and Space Administration (NASA) ballooning facilities in the Northern Territory.³⁵

Australia is not involved in all parts of the supply chain. For example, businesses such as Optus and Foxtel tend to have satellite services but outsource multiple aspects such as design, manufacturing and testing to foreign firms. Based on reviewing the financial results of different operators in the space sector (see space businesses discussion and Attachment B), the COVID-19 pandemic has had adverse impacts in terms of revenues and provisions for bad debts. Companies which provide communications services to the travel industry (such as airlines, maritime and cruise ships - all of which are customers for satellite-based communications services) have experienced the most significant impacts.

Australian Government initiatives

The Australian Government recently invested in the space industry through the [Space Infrastructure Fund](#) and [International Space Investment – Expand Capability Grants](#).

The Space Infrastructure Fund is a A\$19.5 million investment into the growth of the Australian space sector. It covers 7 projects:

1. Space manufacturing facilities (A\$2 million) to support delivery of future space manufacturing capability and to develop high-tech skills and new space objects.
2. Mission control centre (A\$6 million) for small and medium enterprises (SMEs) and researchers to control small satellite missions.
3. Tracking facilities upgrade (A\$1.2 million) to support precision tracking of satellites and spacecraft.
4. Robotics, automation and artificial intelligence command and control (A\$4.5 million) to allow SMEs and researchers control over autonomous space operations, build capability in space technologies, and support development and operation of robotic and remote asset management activities in space.
5. Space data analysis facilities (A\$1.5 million), providing SMEs and researchers with space data analysis capability for agriculture, mining, emergency services and maritime surveillance.
6. Space payload qualification facilities (A\$2.5 million), providing capability for SMEs and researchers to test space equipment that is mission-ready including new facilities to support manufacturing, streamline testing of space equipment in Australia, and speed up the delivery of new space-based products and services.
7. Pathway to launch (A\$0.9 million), including projects to start addressing the active interest and growing readiness in industry for launch in Australia, and ensuring safety on Earth and in space.

The focus of the Expand Capability Grants scheme was to:

- > provide international space opportunities for the Australian space sector
- > expand the capability and capacity of the Australian space sector and support job creation
- > demonstrate the Australian space sector's ability to successfully deliver space-related products and services internationally.

³⁵ IBIS World, *Satellite communications and astronautics in Australia*, January 2020, p. 12.

Grants ranging between A\$0.2 million and A\$1.5 million were awarded to 10 entities. The Australian Government has also invested in government-based programs and joint programs with other governments, for example, the [Moon to Mars Initiative](#) (A\$150 million). Further details around funding, grants and cooperation can be found in the [ASA's submission](#) to the parliamentary inquiry into developing Australia's space industry.

The Australian Government [announced](#) the opening of the ASA's [Space Discovery Centre](#) on 31 March 2021. The Space Discovery centre (located in Adelaide, South Australia) will include a Mission Control Centre to enable pre-flight testing, launch support, and communications during flight.

Focus areas

The ASA released its [Communications Technologies and Services Roadmap](#), which identifies Australia's geographic location, regulatory regime and clear skies as areas of competitive advantage.³⁶ The ASA identifies 6 areas of greatest opportunity for the Australian space sector³⁷:

1. **LEO satellite services:** specifically focusing on IoT applications.
2. **Optical ground stations:** providing infrastructure via the Australasian Optical Ground Station Network (AOGSN) extensible to international use and regional growth.
3. **Hybrid radiofrequency optical terminals:** developing this capability could create a new market for high data rate user terminals.
4. **Reconfigurable networks, radios, modems and waveforms:** contributing to cognitive radio global supply chains and hosting ground segment support to international space missions.
5. **Satellite communication network management tools:** supporting operators' planning and operations to cope with the increasing demand and complexities of communication sub-systems through software-enabled network planning tools, underpinned by artificial intelligence.
6. **Quantum-enabled communications:** security advances from quantum-enabled communications are expected to transform data security in sectors such as finance and defence, and position Australia at the forefront of the international supply chain for satellite quantum communication.

In addition, the ASA enters into [statements of strategic intent and cooperation](#) with businesses to allow them to highlight their commitment to growing Australia's space sector. The agency has entered into 16 statements as of December 2020.

³⁶ Australian Space Agency, [Advancing space – Communications technologies and services – Roadmap 2021 – 2030](#), p. 4.

³⁷ Australian Space Agency, [Advancing space – Communications technologies and services – Roadmap 2021 – 2030](#), pp. 13-20.

Space sector businesses

To inform its understanding of the space sector, the ACMA monitors developments regularly. The following is a representative sample of space sector operators in the Australian market. The discussion which follows provides observations about several broad groupings. Further details on these operators are provided in Attachment B.

Established space businesses

Established space sector businesses are those that have been operating internationally for more than 15 years or have an established presence in Australia, or both. General trends for these operators include:

- > due to the high capital expenditures associated with manufacturing, launching and operating of satellites, it is common to observe:
 - > government investment or ownership of space sector companies
 - > businesses relying on large amounts of debt to finance operations (leading to restructuring of finances via such mechanisms as Chapter 11 bankruptcy)
 - > EBITDA and revenue figures to be healthy while figures such as net income or profits to be low due to high depreciation and interest costs
- > businesses which have relied on communications around the transportation sector have faced negative impacts from the COVID-19 pandemic due to reduced travel
- > businesses have seen increased revenues associated with their communication services during the COVID-19 pandemic
- > revenues from government contracts have been mixed depending on each country's response to the COVID-19 pandemic
- > the more diversified space sector businesses have been able to offset losses experienced from the COVID-19 pandemic with gains in other parts of their businesses
- > with the exception of established Australian operators, revenues from the Australian market appear to form a small proportion of revenues
 - > Australia appears to be of importance due to its geographic location, which allows space sector businesses to monitor their services and to offer global coverage. This suggests companies view supply-side benefits from Australia. Most businesses marketing themselves as Australian operators tend to leverage services from established international satellite services (for example Pivotal using Iridium, Intelsat, Optus).³⁸

Start-up space businesses

Start-up space businesses are in the early stages of commercialisation.

The ACMA observes proposed LEO constellations have been generally growing in number, with several start-up ventures in the process of obtaining regulatory approvals to operate on a global scale (for example, Starlink via its parent Space Exploration Technologies (SpaceX)). Most of these providers are seeking to provide high-speed internet to parts of the world where traditional broadband is too costly to provide.

³⁸ Another example of Australian satellite business is [AST Australia](#), which includes Iridium, VSAT, Inmarsat, Sat TV, Optus, Globalstar, Thuraya, Hatteland displays, BGAN satellite broadband, satellite phones, satellite phone hire, and Stratos, as well as smart card operated payphones.

These businesses are largely being led by either consortia or technology companies. It is too early at this stage to tell which provider will emerge as successful, with announcements being released on a weekly, or in some cases daily, basis. Due to the COVID-19 pandemic and the significant capital costs involved in launching satellites, some of these businesses have had to restructure their finances or have been taken over by investment consortia. The more successful start-up businesses to date are supported by either government entities, multi-billion-dollar parent companies or billions of dollars in venture capital.

Government sector

The Australian government sector comprises a mix of entities, these include:

- > **Department of Defence:** providing communications for the Defence Force and taking a proactive role in Australia's security requirements (for example, ensuring security of critical infrastructure such as communications satellites)
- > **Bureau of Meteorology (BoM):** providing weather and scientific services
- > **Commonwealth Scientific and Industrial Research Organisation (CSIRO):** contributing to scientific research and supporting the development of emerging technologies (for example, the development of cheaper SmallSats)
- > **NBN Co:** who offer and provide commercial satellite services to regional and remote Australia through its Sky Muster satellites.

Most government entities form partnerships with international government agencies and businesses to deliver their services. Such partnerships range from commercial arrangements to design and manufacture satellites to formal agreements to provide communications in space (given Australia's geographic location).

Other space sector businesses

There are a number of other businesses which are in the process of increasing their presence in Australia or intending to launch services in the near future. These companies tend to form partnerships with satellite operators and other major companies, and they focus on their core strengths to carve out a niche in the market. This includes Australian universities, who are receiving government funding to advance Australia's standing in the international space industry (for example, [SpiRIT](#) and [CUAVA](#)).

Spectrum implications

As reflected in the analysis of this market study and observing global trends, the space industry is growing. A number of service providers are currently in the trial phase and developing their plans to deliver commercial services in Australia. The ACMA's expectation is that growth in the space industry will result in:

- > an increase in the ACMA's satellite filing work
- > an increase in licence application requests
- > a need to provide guidance and information on spectrum requirements to assist new entrants, such as start-ups and research organisations, considering developing experimental satellite systems with short-duration missions
- > a need to monitor developments in emerging space-based technologies and applications, and trends in the spectrum needs of space-based communications systems, with a view to informing the ACMA's future spectrum priorities.

The ACMA encourages entrants to contact satellite.coordination@acma.gov.au early to discuss their business plans and spectrum requirements.

The rest of this section discusses our approach to the space sector and the known growth areas and challenges – linking together issues identified in this market study and the ACMA's approach.

The ACMA's approach

Each year, the ACMA publishes a spectrum work program called the five-year spectrum outlook (FYSO). The FYSO provides an overview of the technology, market and policy drivers likely to shape the demand for spectrum over the next 5 years, as well as our spectrum management priorities for the next 5 years and our detailed work plan for the coming year.

The FYSO is developed in consultation with industry. Consultation on the draft FYSO forms a key part of the ACMA's engagement and transparency with industry and the community on our spectrum management priorities. Spectrum management priorities in the FYSO are intended to support growth in the space sector and can be summarised as:

- > providing ongoing operational support for Australian-filed satellite networks
- > updating regulatory (including pricing) arrangements to support satellite providers in the Australian market
- > implementing outcomes of replanning activities to provide new spectrum arrangements for satellite services
- > providing guidance and information on spectrum management requirements to assist new entrants
- > monitoring developments in emerging space-based technologies and applications, and trends in the spectrum needs of space-based communications systems, with a view to informing the ACMA's future spectrum priorities
- > developing coordination arrangements between earth stations and terrestrial services as appropriate
- > providing support and information to assist the growing interest from organisations that are considering developing experimental satellite systems with short duration missions.

In addition, the work identified in the FYSO has implications for the ACMA business as usual activities such as:

- > increases in the number and complexity of licence applications
- > increases in satellite filing activity arising from:
 - > requests for new Australian satellite filings
 - > satellite filing coordination activity
- > requests to update the Australian Space Objects and Foreign Space Objects Determinations.

This increase in activities is reflected in recent trends relating to the ACMA's regulatory activities outlined below. The ACMA is considering ways of more actively coordinating spectrum access and managing competing spectrum demand.

Updating regulatory arrangements

Under the *Radiocommunications Act 1992*, a foreign satellite operator must first be included in the Radiocommunications (Foreign Space Objects) Determination 2014 (Foreign Space Objects Determination) before its satellite network can be licensed to operate in specific shared satellite radiofrequency bands listed in the Radiocommunications (Communication with Space Object) Class Licence 2015.

Inclusion in the determination does not confer a right on that entity to obtain a licence, rather it is a prerequisite before a space apparatus licence can be issued. With recent interest from new satellite companies looking to provide services in Australia, the ACMA has updated the determination in:

- > 2017 to include Network Access Associates Ltd (incorporated in the UK) (OneWeb)
- > 2018 to include SpaceQuest, Ltd. (incorporated in the US)
- > 2020 to include Kepler Communications Inc. (incorporated in Canada), SpaceX Services, Inc. (incorporated in the US) and Swarm Technologies, Inc. (incorporated in the US).

From December 2020 to February 2021, the ACMA consulted on another update, to consider the possible inclusion of Astrocast SA (incorporated in Switzerland), Fleet Space Technologies Pty Ltd (incorporated in Australia), Hiber B.V. (incorporated in The Netherlands), Kinéis SAS (incorporated in France), O3b Limited (incorporated in Jersey), Viasat, Inc. (incorporated in the US).

Satellite filing activity

Before operating a satellite network in Australia, along with radiocommunications licensing requirements outlined below, the technical details of the network must be filed with the International Telecommunication Union (ITU).³⁹

The ITU only deals with administrations of ITU member states in the satellite filing process, not with satellite operators. As part of its spectrum management function, the ACMA acts as the Australian administration responsible for the ITU's international process for management of frequencies for satellite communications.

The way the ACMA manages its role in the filing and coordination of Australian satellite systems with the ITU is set out in Australian procedures for the coordination and notification of satellite systems. The ACMA's role includes:

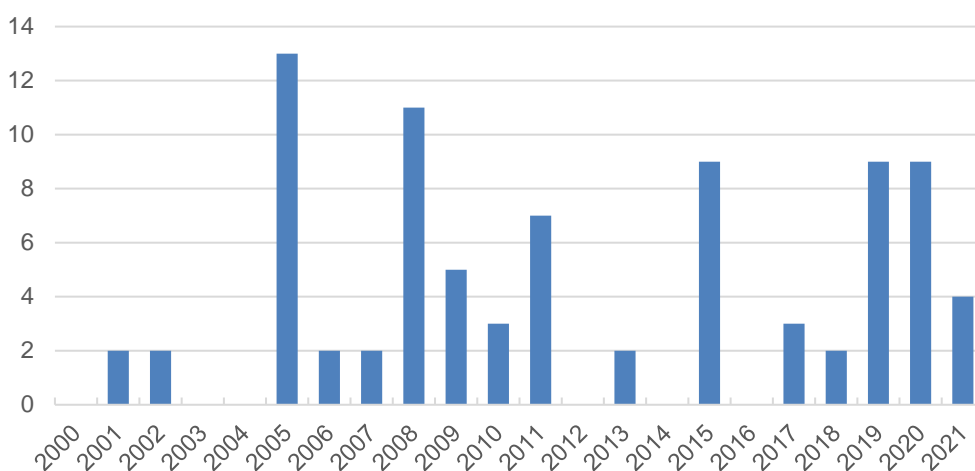
- > assisting Australian satellite operators with ongoing satellite coordination negotiations with other administrations

³⁹ Combination of the requirements of ITU Radio Regulations, the Radiocommunications Act and ACMA policy as outlined in Australian procedures for the coordination and notification of satellite systems.

- > assessing new notices related to progress of existing Australian satellite networks
- > filing of new Australian satellite networks
- > supporting international administration-level satellite coordination meetings with other administrations.

While satellite filing activity can be an irregular activity (as illustrated in Figure 3), after a lull, there has been an increase in the number of satellite filing requests considered by the ACMA.

Figure 3: Request to file satellite networks with the ITU



Source: ACMA analysis

Of note is that in the last 2 years, there have been 6 requests for NGSO networks, compared to the previous 20 years where there have been 3 requests. In part, the increase in NGSO filing is due to interest from start-ups and research organisations as discussed above.

Since 1 July 2020, on behalf of Australian satellite operators, the ACMA has filed 5 new satellite systems with the ITU and submitted modifications to 2.

Earth station protection zones

The ACMA acknowledges coexistence of earth stations with other spectrum uses can, at times, be challenging, as well as the desirability for satellite earth station operators to plan with a degree of predictability, in bands shared with other services. Therefore, the ACMA encourages for earth stations to operate, where possible, in locations (typically regional and remote areas) that help manage coexistence with other services.

Where possible, the ACMA also encourages these earth stations to locate in the same area(s) in order to minimise the impact on spectrum availability for other services. As an incentive to promote such developments, the ACMA has established several earth station protection zones.

In 2009, the ACMA introduced an earth station protection zone in Mingenew, Western Australia ([spectrum embargo 49](#)). As of 1 January 2021, there were 16 earth station sites located within the protection zone, with 179 assignments (116 earth station receive and 63 earth station transmit).

In July 2018, the ACMA identified 3 potential areas for additional earth station protection zones on the east coast of Australia ([Roma, Moree and Quirindi](#)), refer [Frequency coordination procedures for the earth station protection zones](#). As of 1 January 2021, there was only one earth station site in east coast protection zones (Roma).

In the protection zones, arrangements are in place to facilitate long-term use and planning for future space communications facilities. These arrangements, to an extent, quarantine these areas from terrestrial services to encourage the deployment of space communications facilities at these locations.

The ACMA encourages industry use of these earth station protection zones and feedback on the associated arrangements (such as the frequency bands and associated protection requirements).

Infrared (optical) communication

As noted earlier in this market study, the ASA identified optical ground stations as one of 6 focus segments.

Under current regulatory arrangements, infrared optical communications systems would be subject to the Radiocommunications Act (See Attachment C for legislative background). While supportive of the innovations that infrared communications systems bring, the current spectrum management framework is not designed explicitly to support optical/infrared-based satellite communications systems.

The ACMA is currently seeking advice from the space sector on infrared communication systems to determine the most appropriate regime to support such systems, for example, through 'light touch' regulation where possible.

Attachment A – Space sector value chain

The ASA defines the space sector as ‘the provision of space related goods, services and applications to broader industries, [excluding] non-space (value adding) activities’.⁴⁰

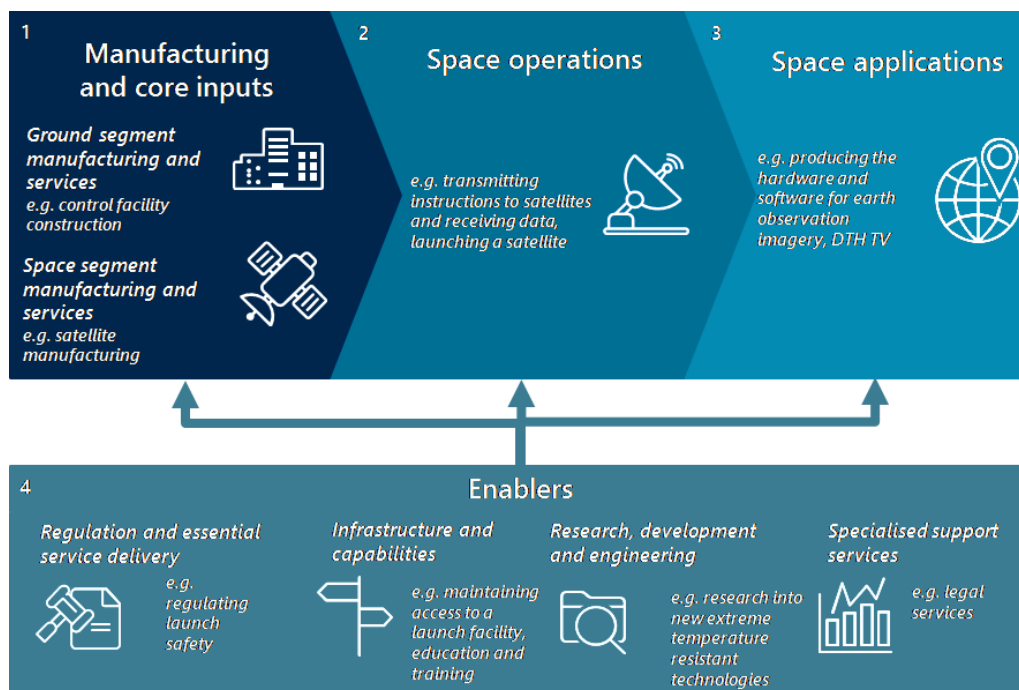
The key components need to operate a service include:

- > having satellites and satellite dishes
- > having facilities to launch and build rockets which carry satellites to space
- > being able to communicate with the satellites in order to reduce the likelihood of collisions, to de-orbit satellites and to provide services on earth through either ground stations or antennae.

In addition to these components there are enablers, which usually involve overheads and support (for the smooth running of businesses), and research and development for the continual improvement of technology (for example, developments in satellites, reusable rocketry components).

Figure A1 identifies the segments in the space value chain.

Figure A1: Value chain of the space sector



Source: Australian Space Agency, [Activities included in the space sector](#), Accessed 19 August 2020,

⁴⁰ Department of Industry, Science, Energy and Resources, [‘Defining the Australian space sector’](#), accessed 10 August 2020.

Manufacturing and core inputs

Manufacturing and core inputs comprise of the building of facilities and services relating to:

- > ground-based facilities, such as
 - > building and integration of facilities and equipment on Earth for satellite and space craft operations (for example, control centres, telemetry and antennae)
 - > building and integration of launch vehicles and subsystems, scientific instruments, ground segment systems and equipment
 - > services associated with ground segments (for example, day-to-day professional and technical operations of ground segment systems)
- > space segment manufacturing and services
 - > building and integration of spacecraft, and any components thereof including propulsion systems, rockets, space craft and satellites
 - > building and integration of payloads and their components, including but not limited to satellites, subsystems, and scientific instruments
 - > manufacturing of products for use in-space (for example, space and flight suits)
 - > services associated with space segment manufacturing (for example, day-to-day professional and technical operations of space segment systems).

Space operations

Involves activities associated with ensuring that satellites are able to be safely put into orbit and function. The ASA provides examples of space operations:⁴¹

- > launch activities and launch services
- > space object tracking and mission planning, including day-to-day management of satellites and spacecraft once they are in space (for example, telemetry, tracking and control, satellite passes), and space situational awareness (for example, monitoring, recovery operations and collision avoidance)
- > lease or sale of satellite capacity
- > uplinks and downlinks for signal processing to reception facility
- > operations and remote operations in space, for example, robotics in orbit and on the surface of the Moon or other celestial bodies, experiments conducted in space relating to biology, effects of microgravity on the human body, microgravity manufacturing in space.

Space applications

Satellites are largely an input as part of delivering a service or ensuring that a product operates the way it is intended to operate (for example, a product which uses satellites to tell the user its position). In turn, commercial and public benefits are derived from these goods and services. The ASA provides examples of space applications:⁴²

- > satellite communications and broadband products and services (for example, mobile satellite communications, satellite internet systems, satellite data, satellite imaging and all other non-television satellite broadcasting, Fixed-Satellite Service (FSS) transponder leasing, FSS managed services, direct to node communications)

⁴¹ Department of Industry, Science, Energy and Resources, '[Activities included in the space sector](#)', accessed, 10 August 2020.

⁴² Department of Industry, Science, Energy and Resources, '[Activities included in the space sector](#)', accessed 10 August 2020.

- > direct to home television products and services
- > earth observation and associated communication and data products and services, for example, weather, surveillance, agriculture, transportation and mining
- > global positioning, navigation, and timing products and services
- > manufacturing and/or development of equipment/software to enable services on the ground, for example, antennae and satellite dishes
- > IoT services that use satellites
- > atlases and maps that are informed by spaced-based data.

Attachment B – Space sector businesses

Attachment B provides a non-exhaustive snapshot of key activities being undertaken by businesses operating in the space sector as at March 2021. It was developed based upon information in the public domain and subscription services.

Established space businesses

Table B1 outlines operators who have been operating internationally for around more than 15 years or have an established presence in Australia or both.

Table B1: Established businesses in the space sector

Company	Segment(s)	Businesses/locations
Al Yahsat Company (revenue not publicly reported)	Space applications	<ul style="list-style-type: none"> > United Arab Emirates government parent owner (established in 2007), which owns 5 satellites offering fixed and mobile satellite services (broadband, video broadcasting, backhauling and mobile voice and data services).^{43, 44} > Provides services to 150 countries across Europe, the Middle East, Africa, South America, Asia and Australasia. > Acquired Thuraya in 2018 which recently has a focus on IoT and machine-to-machine (M2M) communications via satellite.⁴⁵
AsiaSat (Dec 18 revenue A\$0.3 billion) ⁴⁶	Earth stations and space applications	<ul style="list-style-type: none"> > AsiaSat is owned by Asia Satellite Telecommunications Holdings Limited (AST), an investment holding company.⁴⁷ AsiaSat is headquartered in Wanchai, Hong Kong. Established in 1988.⁴⁸ > Was sold to private equity firms on 3 September 2019 (becoming a privately listed company).⁴⁹

⁴³ GlobalData, Asia Satellite Telecommunications Holdings Limited Profile, accessed 9 November 2020.

⁴⁴ S&P Market Intelligence Platform, Al Yah Satellite Communication Company PJSC | Corporate structure, accessed 12 October 2020.

⁴⁵ GlobalData, Al Yah Satellite Communication (YAHSAT) Acquires Stake in Thuraya Telecommunications from Etisalat, accessed 12 October 2020.

⁴⁶ S&P Market Intelligence Platform, Asia Satellite Telecommunications Holdings Limited - 亞洲衛星控股有限公司 | Financial highlights, accessed 23 March 2021.

⁴⁷ GlobalData, Asia Satellite Telecommunications Holdings Limited | Overview, accessed 6 November 2020.

⁴⁸ AsiaSat, 'About Us', accessed 9 November 2020.

⁴⁹ S&P Market Intelligence Platform, Asia Satellite Telecommunications Holdings Limited - 亞洲衛星控股有限公司 | Financial highlights, accessed 9 November 2020.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > It operates 7 satellites and provides satellite services for 100 public and private television and radio broadcasters worldwide.⁵⁰ > Its footprint is largely focused around the Asia-Pacific and Middle East.
BAI Communications (revenue not publicly reported)	Earth stations	<ul style="list-style-type: none"> > Predominantly involved with communications relating to transit systems globally and broadcast transmission in Australia.⁵¹ > Provides project management and engineering for the design and construction of Earth stations necessary for Australia to connect into the Wideband Global SATCOM (WGS) network.
Boeing (Dec 20 Defence & Satellites revenue A\$38.1 billion) ⁵²	Manufacturer	<ul style="list-style-type: none"> > Boeing's satellite activities fall within the Defence, Space & Security segment.⁵³ > This segment engages in the research, development, production and modification of satellite systems. > Space & Security customers include the NASA and customers in international defence, civil and commercial satellite markets.
Echostar (Dec 20 revenue A\$2.7 billion) ⁵⁴	Manufacturer and space operations	<ul style="list-style-type: none"> > Hughes satellites (designs, builds and operates satellites and assists in ground station coordination and design).⁵⁵ > Operates predominantly in the US, the UK and Mexico but has recently expanded into Brazil, India, Africa, the US and Europe. > EchoStar Systems (ESS) provides satellite services on a full-time and/or occasional-use basis to the US Government service providers, internet service providers, broadcast news organisations, content providers and private enterprise customers. > Operates in the US.

⁵⁰ GlobalData, Asia Satellite Telecommunications Holdings Limited Profile, accessed 9 November 2020.

⁵¹ BAI Communications, [About Us](#), accessed 9 October 2020.

⁵² S&P Market Intelligence Platform, 'Boeing Company | Segment analysis, accessed 23 March 2021.

⁵³ S&P Market Intelligence Platform, Boeing Company | Company Description, accessed 8 October 2020.

⁵⁴ S&P Market Intelligence, Echostar | Financial Highlights, accessed 23 March 2021.

⁵⁵ GlobalData, EchoStar Corp | Overview, accessed 28 August 2020.

Company	Segment(s)	Businesses/locations
Global Eagle (Jun 20 revenue A\$0.8 billion) ⁵⁶	Space applications	<ul style="list-style-type: none"> > Global Eagle provides media, content, connectivity and data analytics to markets across air, sea and land.⁵⁷ > Global Eagle was founded in 2011 and is located in Los Angeles, California, US. > It provides connectivity via Hughes satellites. > The company's reliance on the travel industry meant it was affected by the COVID-19 pandemic and filed for bankruptcy in July 2020.⁵⁸ > It has been able to reduce its debt by US\$475 million by selling its assets to its investor group.
Globalstar (Dec 20 revenue A\$0.2 billion) ⁵⁹	Earth stations and space applications	<ul style="list-style-type: none"> > Globalstar operates satellites and ground stations worldwide. Globalstar is headquartered in Covington, Louisiana, US and incorporated in 2003.⁶⁰ > It operates 48 LEO satellites and has 24 Earth stations.⁶¹ > Its revenues are predominantly from the US market, however it does resell wholesale services to operators worldwide, such as Pivotal in Australia. > Another key service for its business centres around IoT and location tracking.
Inmarsat Holdings (Dec 19 revenue A\$2.0 billion) ⁶²	Earth stations, space operations and applications	<ul style="list-style-type: none"> > Inmarsat designs, launches and operates satellite-based networks. Inmarsat is headquartered in London, UK, and was founded in 1979.⁶³ > Inmarsat owns and operates 13 satellites. It has operations in more than 60 countries across Europe, North America and Asia-Pacific.⁶⁴

⁵⁶ S&P Market Intelligence Platform, Global Eagle Entertainment Inc. | Company Screener, accessed 20 January 2021.

⁵⁷ S&P Market Intelligence Platform, Global Eagle Entertainment Inc. | Company description, accessed 20 January 2021.

⁵⁸ Global Eagle, '[Global Eagle Receives Court Approval for Sale](#)', 15 October 2020.

⁵⁹ S&P Market Intelligence Platform, Globalstar, Inc. | Company Screener, accessed 23 March 2021.

⁶⁰ S&P Market Intelligence Platform, Globalstar, Inc. | Long business description, accessed 10 November 2020.

⁶¹ NY20.com, '[Globalstar satellites](#)', accessed 10 November 2020.

⁶² S&P Market Intelligence Platform, Inmarsat Group Holdings Limited | Screener, accessed 20 November 2020.

⁶³ S&P Market Intelligence Platform, Inmarsat Group Holdings Limited | Long Business Description, accessed 29 October 2020.

⁶⁴ GlobalData, Inmarsat Group Holdings Ltd | Profile, accessed 5 November 2020.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > Revenues and earnings before interest, taxes, and depreciation and amortisation (EBITDA) remained relatively stable over the past year, with a steep decline in net profit attributed to a revaluation of a debt instrument. > The company has announced several strategic partnerships recently, including with Farmbot, a leading provider of IoT solutions to the agricultural industry and Pivotel, Australia's leading provider of mobile satellite services.⁶⁵ > Inmarsat has announced that the Australian Defence Force has extended its arrangement with the company into 2027. The agreement was initially signed in 2017 and has a contact value of A\$221 million.
Intelsat (Sep 20 revenue A\$2.9 billion) ⁶⁶	Earth stations, space operations and applications	<ul style="list-style-type: none"> > Intelsat provides commercial satellite communication services to media companies, telcos and networking companies, the US Government and other select military organisations and their contractors.⁶⁷ > The company was founded in 1964 and is headquartered in Luxembourg. > Intelsat filed for Chapter 11 bankruptcy on 14 May 2020 to free up funding to participate in FCC processes and to reorganise its operations.⁶⁸ > Intelsat provides satellite communications services across 200 countries and territories. The company operates through a network of 54 satellites.⁶⁹ > The company focuses on business-to-business services and offers more than 4 different service types: transponder services, managed services, channel services, mobile satellite services and other services.
Iridium (Dec 20 revenue A\$0.9 billion) ⁷⁰	Earth stations, space operations	<ul style="list-style-type: none"> > Iridium offers voice and data communications services and products to businesses, government agencies and other customers

⁶⁵ Inmarsat, 'Farmbot Monitoring Solutions enters into agreement with Inmarsat and Pivotel to bring IoT-enabled water management solutions to farmers across Australia', accessed 5 November 2020.

⁶⁶ S&P Market Intelligence Platform, Intelsat S.A. | Financial highlights, accessed 23 March 2021.

⁶⁷ S&P Market Intelligence Platform, Intelsat S.A. | Long Business Description, accessed 27 October 2020.

⁶⁸ Intelsat S.A., '[Intelsat's Restructuring will help Transform Satellite for a New Age of Connectivity A Q&A with CEO Stephen Spengler](#)', 26 May 2020.

⁶⁹ GlobalData, Intelsat SA | Profile, accessed 28 October 2020.

⁷⁰ S&P Market Intelligence Platform, Iridium Communications Inc. | Financial highlights, accessed 23 March 2021.

Company	Segment(s)	Businesses/locations
	and applications.	<p>worldwide through a constellation of LEO satellites.⁷¹</p> <ul style="list-style-type: none"> > Iridium was founded in 2000. The company was incorporated in 2007 and is headquartered in McLean, Virginia, US. > Compared to several of the other major satellite providers (which have faced either declining revenues or reduced liquidity), Iridium has improved its financial position and exceeded expectations. > It operates through forming partnerships with various providers (including Speedcast and Pivotel in Australia). > A key part of its business relates to IoT services.
Optus (Mar 20 revenue A\$9.0 billion) ⁷²	Earth stations and space applications	<ul style="list-style-type: none"> > Optus positions itself as Australia and New Zealand's largest satellite operator with 5 GEO satellites and 10 Earth stations operating. It commenced operations in 1992.⁷³ > With its network and through its parent, it provides coverage across Antarctica, Asia, Pacific region, Europe, Africa, India and the West Coast of the US.⁷⁴ > It has a long-standing agreement with Foxtel which has been extended to 2031. > It has contracted Airbus Defence and Space for a brand new, OneSat software-defined satellite, Optus 11, to be deployed for Australia and New Zealand in 2023. > It operates in an advisory capacity for Australian SmallSat operators.⁷⁵
Pivotel (revenue not publicly reported)	Space applications	<ul style="list-style-type: none"> > Positions itself as having the fourth largest mobile network in Australia. It was founded in 2002 and is based in Southport, Queensland, Australia.⁷⁶ > Like Omnispace⁷⁷, it markets to its customers the ability to use mobile and satellite services

⁷¹ GlobalData, Iridium Communications Inc | Overview, accessed 10 November 2020.

⁷² Singtel Optus Pty Ltd, '[Optus year-end results reflect challenging fourth quarter](#)', 28 May 2020.

⁷³ Singtel Optus Pty Ltd, '[Satellite Network](#)', accessed 20 October 2020.

⁷⁴ Singtel Optus Pty Ltd, 'Submission in response to ACMA's draft spectrum management work programme', June 2020, p. 18.

⁷⁵ Singtel Optus Pty Ltd, 'Submission in response to ACMA's draft spectrum management work programme', June 2020, p. 18.

⁷⁶ Pivotel Satellite Pty Limited, '[Company Profile](#)', accessed 16 October 2020.

⁷⁷ Omnispace is positioning itself as a business which combines the global footprint of an NGSO satellite constellation with the mobile wireless networks, as a reseller of services. It recently [announced](#) that it raised US\$60 million from venture capital businesses.

Company	Segment(s)	Businesses/locations
		<p>as part of their service offering; reselling services of major satellite providers and mobile network owners.⁷⁸</p> <ul style="list-style-type: none"> > It provides voice, data, tracking, and satellite services for individuals, small businesses, industry and government, and large corporations in Australia and internationally. > The company provides carriers with direct connection service to mobile satellite networks including Iridium, Inmarsat, Thuraya and Globalstar.
Speedcast (Dec 19 revenue A\$1.0 billion) ⁷⁹	Space applications	<ul style="list-style-type: none"> > Speedcast provides remote communications and IT services. The company was founded in 1999 and is headquartered in Botany, Australia.⁸⁰ > It uses a multi-band and multi-orbit network of satellites and an interconnecting global terrestrial network. > It filed for Chapter 11 bankruptcy in the US in April 2020 but has recently reached a deal to reorganise its finances with one its largest debt investors, Centerbridge Partners (paying US\$500 million in return for cancelling out US\$634 million in debt).⁸¹ > Speedcast completed its reorganisation under the ownership of Centerbridge Partners, L.P.⁸²
Telesat Canada (Dec 20 revenue A\$0.9 billion) ⁸³	Space operations	<ul style="list-style-type: none"> > Canada-based, operates globally (including Australia), broadcast distribution and communications, government services.⁸⁴ > Profitability is sensitive to exchange rates and has been affected by the COVID-19 pandemic through lower revenues and increased provisions for bad debts.⁸⁵ > Currently conducting trials using its LEO satellites for commercial and non-commercial

⁷⁸ Pivotel, 'Five-year spectrum outlook 2020-24 Draft Consultation: response by Pivotel', June 2020, p. 2.

⁷⁹ S&P Market Intelligence platform, Speedcast International Limited | Financial highlights, accessed 23 March 2021.

⁸⁰ S&P Market Intelligence platform, Speedcast International Limited | Company description, accessed 16 October 2020.

⁸¹ Zimmerman, A., 'Speedcast files reorganization plan backed by \$500M Centerbridge investment', *S&P Market Intelligence: Leveraged commentary and data*, 13 October 2020.

⁸² Speedcast, '[Speedcast Announces Successful Completion of Restructuring and Emergence Under New Ownership by Centerbridge](#)', 11 March 2021.

⁸³ Telesat Canada, '[Performance results](#)', accessed 5 October 2020.

⁸⁴ S&P Market Intelligence platform, Telesat Canada | Company Description, accessed 6 October 2020.

⁸⁵ Telesat, '[Telesat reports results for the quarter and six months ended June 30](#)', 30 July 2020.

Company	Segment(s)	Businesses/locations
		<p>applications (including public safety mobile broadband and in-flight connectivity).⁸⁶</p> <ul style="list-style-type: none"> > It intends to launch a constellation of 298 LEO satellites.
Telstra (Dec 20 revenue A\$22.5 billion) ⁸⁷	Earth stations and applications	<ul style="list-style-type: none"> > Telstra's satellite business is a relatively small part of its business with it owning 3 Earth stations.⁸⁸ > Telstra's satellite presence is linked with its Earth stations and extensive global telecommunications network. It partners with satellite operators (such as NBN Co, Optus and Intelsat).⁸⁹ > It provides connectivity to its enterprise customers through a range of products.
Thaicom (Dec 20 revenue A\$0.2 billion) ⁹⁰	Earth stations and space applications	<ul style="list-style-type: none"> > Thaicom provides satellite transponder leasing and related services, internet-related services, telephone-related services (overseas), and telephone directories and distribution. Thaicom is headquartered in Nonthaburi, Thailand.⁹¹ > It has operations in Cambodia, Mauritius, the British Virgin Islands, Myanmar, Philippines, Singapore, Thailand, India, Japan, New Zealand and Australia (IPSTAR, a Thaicom subsidiary). IPSTAR was founded in 2003 and is based in North Ryde, Australia. > IPSTAR claims to support over 100,000 regional customers and uses the NBN to connect customers. It also owns Orion Satellite Systems which also operates in Australia. > NBN Co used to lease IPSTAR's satellites to provide satellite coverage in Australia (that is, prior to the 2 Sky Muster satellites NBN Co now operates).⁹²
Viasat (Dec 20 revenue A\$3.3 billion) ⁹³	Earth stations and space applications	<ul style="list-style-type: none"> > Viasat is a global communications company that offers fixed and mobile broadband services, secure networking systems, and advanced satellite communication systems.

⁸⁶ Telesat Canada, '[Performance results](#)', accessed 5 October 2020.

⁸⁷ S&P Capital IQ platform, Telstra Corporation Limited | Financial highlights, accessed 23 March 2021.

⁸⁸ GlobalData, Telstra Corp Ltd | Overview, accessed 20 October 2020.

⁸⁹ Telstra Corporation Ltd, '[Telstra Satellite Services](#)', accessed 20 October 2020, p. 5.

⁹⁰ S&P Market Intelligence platform, Thaicom Public Company Limited | Financial highlights, accessed 23 March 2021.

⁹¹ GlobalData, Thaicom Public Company Limited Overview, accessed 17 October 2020.

⁹² IPSTAR Australia Pty Ltd, '[Internet](#)', accessed 17 October 2020.

⁹³ S&P Market Intelligence Platform, Viasat Inc | Financial highlights, accessed 23 March 2021.

Company	Segment(s)	Businesses/locations
		<p>ViaSat is headquartered in Carlsbad, California, US and was founded in 1986.⁹⁴</p> <ul style="list-style-type: none"> > Approximately 90% of its revenues are from the US market. It has 3 satellites and is building a LEO service. > It has 10 Earth stations including one in Alice Springs.⁹⁵ > It has a business presence across the Americas, Europe, Asia-Pacific, the Middle East and Africa. It has previously delivered satellite services for NBN Co and has contracts with the Australian Defence Force to contribute to the Five Eyes partnership.⁹⁶ > The company announced it entered into a definitive agreement to acquire RigNet, Inc. in an all-stock transaction that values RigNet at an enterprise value of approximately US\$222 million. The acquisition diversifies Viasat's offerings into the IoT space, providing asset tracking and communications services across the globe.

Note: Reported revenues relate to the most recent financial reporting period (year-on-year) for entire business (including revenues attributed to space activities).

Start-up space businesses

Table B2 provides a summary of some of the key start-up businesses.

Table B2: Start-up LEO businesses

Company	Segment(s)	Businesses/locations
Amazon (via Amazon Web Services (AWS)) (Dec 20 revenue A\$65.9 billion) ⁹⁷	Earth stations and space applications	<ul style="list-style-type: none"> > AWS provides cloud computing services to organisations internationally and was founded in Seattle, Washington.⁹⁸ > It has locations in US (Oregon, California, and Virginia), Brazil (Sao Paulo), Ireland (Dublin), Germany (Frankfurt), South Korea (Seoul), Singapore, Australia (Sydney), Japan (Tokyo), Sweden (Stockholm), South Africa (Johannesburg), Sweden (Copenhagen), Norway (Oslo), and India (Bengaluru). > AWS's project Kuiper (LEO venture) plans to invest more than US\$10 billion for the

⁹⁴ GlobalData, ViaSat Inc | Overview, accessed 13 November 2020.

⁹⁵ Henry, C., '[Viasat expanding into crowded ground-as-a-service business](#)', *Space News*, 8 August 2019; and GlobalData, '[Viasat announces launch of RTE facility in Alice Springs](#)', Australia, 30 June 2020.

⁹⁶ S&P Market Intelligence Platform, [Viasat Inc | Long Business Description](#), accessed 18 November 2020.

⁹⁷ S&P Market Intelligence Platform, Amazon.com, Inc. | Segment analysis, accessed 23 March 2021.

⁹⁸ S&P Market Intelligence Platform, Amazon | Long business description, accessed 13 October 2020.

Company	Segment(s)	Businesses/locations
		<p>development of the LEO satellite constellation as a potential rival to Starlink.⁹⁹</p> <ul style="list-style-type: none"> > It is intending to have a constellation of 3,236 satellites operating at 3 orbits within the Ka-band, covering 95% of the world's population.
Facebook (Dec 20 revenue A\$124.9 billion – A\$28.8 billion in Asia-Pacific) ¹⁰⁰	Space applications	<ul style="list-style-type: none"> > Facebook has been involved in various ventures to provide connectivity with its most recent venture being Project Athena via a subsidiary PointView LLC in 2018.^{101, 102} > In October 2020 it was reported that Facebook launched an 'experimental' vehicle with an Arianespace launch on 2 September 2020. > In response to media requests, Facebook has not announced any intentions to launch a broadband satellite service.¹⁰³ > It recently collaborated with Hughes to provide wi-fi connectivity in Mexico.
Kepler (revenue n/a – start-up phase)	Manufacturer and space applications	<ul style="list-style-type: none"> > Kepler designs, develops, and operates satellites and infrastructure for space-based connectivity that connects space stations, habitats, machines, and devices with satellites on orbit.¹⁰⁴ > To date Kepler has raised A\$27.5 million, funded largely by venture capital.¹⁰⁵ > It has built and launched several test satellites and has commenced launching commercial satellites as of September 2020 (operating in the Ku Band).¹⁰⁶ > It intends to offer satellite services and IoT connectivity.
Kinéis (revenue n/a – start-up phase)	Earth stations and space applications	<ul style="list-style-type: none"> > The Centre National d'études Spatiales (CNES – French Space Agency) and Collecte, Localisation, Satellites (CLS) created Kinéis in 2019.¹⁰⁷

⁹⁹ GlobalData, 'Amazon plans to invest more than \$10bn on LEO satellite constellation', 30 July 2020.

¹⁰⁰ S&P Market Intelligence Platform, Facebook Inc. | Financial Highlights and Segment analysis, accessed 23 March 2021.

¹⁰¹ GlobalData, Facebook Inc | Overview, accessed 14 October 2020.

¹⁰² S&P Market Intelligence, Facebook Inc | Long Business Description, accessed 14 October 2020.

¹⁰³ Dano, M., '[Facebook goes to space](#)', Light Reading, 10 September 2020.

¹⁰⁴ S&P Market Intelligence Platform, Kepler Communications Inc. | Company Description, accessed 18 January 2021.

¹⁰⁵ S&P Market Intelligence Platform, Kepler Communications Inc. | Corporate Profile, accessed 18 January 2021.

¹⁰⁶ Kepler, '[A Network to Connect the Globe](#)', accessed 18 January 2021.

¹⁰⁷ S&P Market Intelligence Platform, [Myriota Pty. Ltd. | Corporate Profile](#), accessed 19 November 2020.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > To date Kinéis has raised A\$165.3 million in funding. > Kinéis has 9 satellites in orbit onboarding ARGOS payloads and a network of more than 20 ground stations.¹⁰⁸ > It is intending to launch a constellation of 22 LEO satellites by 2022 and to enter the Australian market. > The company serves various industries with its selling points being its radio chipset to provide satellite network connectivity to any mobile device.¹⁰⁹
Omnispace (revenue n/a – start-up phase)	Space applications	<ul style="list-style-type: none"> > Omnispace was founded in 2012 and is based in the US. It has raised over A\$178.5 million to date.¹¹⁰ > It is intending to offer a service with a 5G network that uses both satellite and mobile technologies – moving away from viewing satellites as providing backhaul services but rather a complement or alternative to terrestrial networks.¹¹¹ <ul style="list-style-type: none"> > The company entered into a strategic interest agreement with Lockheed Martin to explore jointly developing 5G capability from space (using spectrum in the 2 GHz band).¹¹² > Intention of having mobile phones being able to access terrestrial and satellite networks without requiring multiple handsets.¹¹³ > Has links with Intelsat and Verizon. > It focuses on IoT and mobile satellite services.¹¹⁴ > It has deals with Thales and Exolaunch to manufacture and launch its satellites.
OneWeb (revenue n/a – start-up phase)	Space operations and applications	<ul style="list-style-type: none"> > Start-up UK business took over WorldVu in 2015. It has raised over A\$4 billion to date.¹¹⁵ > Declared bankruptcy in March 2020 but has been acquired by a joint venture involving the

¹⁰⁸ Kinéis, 'ACMA 5-year spectrum plan: Kinéis contribution', 24 June 2020.

¹⁰⁹ Kinéis, '[Your Industry](#)', accessed 21 January 2021.

¹¹⁰ S&P Market Intelligence Platform, Omnispace LLC | Private company, accessed 23 March 2021.

¹¹¹ Hill, J., '[Omnispace CEO Determined to Defy Convention with 5G Satellite Constellation](#)', *Via Satellite*, 5 February 2021.

¹¹² Omnispace, '[Lockheed Martin and Omnispace Explore Space-Based 5G Global Network](#)',

¹¹³ Other examples of this proposed approach include [AST](#) and [Lynk](#).

¹¹⁴ Omnispace, '[Redefining connectivity for the 21st century](#)', accessed 8 February 2021.

¹¹⁵ S&P Market Intelligence Platform, OneWeb LLC | Company overview, accessed 8 October 2020.

Company	Segment(s)	Businesses/locations
		<p>UK Government and Bharti Global for US\$1 billion.¹¹⁶</p> <ul style="list-style-type: none"> > It intends to have 110 LEO satellites in orbit by December 2020 and intends to provide in-flight connectivity, backhaul for mobile networks, and connectivity in remote locations (for example, Alaska).¹¹⁷
SpaceX (revenue n/a – start-up phase)	Manufacture, space operations and applications	<ul style="list-style-type: none"> > SpaceX was founded in 2002 and is based in Hawthorne, California, US. Approximately A\$7.5 billion raised to date.¹¹⁸ > It manufactures and launches rockets and spacecraft. > Products and services include rockets, spacecraft, cryogenic tank structure, guidance and control software, launch vehicles, crew and cargo transportation (for example, rideshare), and launch services. > The company launched the GPS III SV04 satellite, modernising and improving the speed and accuracy of positioning systems.¹¹⁹ > Starlink is a satellite internet constellation being constructed by SpaceX. <ul style="list-style-type: none"> > SpaceX has launched almost 1,000 satellites with the intention of offering broadband services initially to Northern US and Canada. > It has plans to expand to the rest of the world, with approval to have a constellation of 12,000 satellites.¹²⁰ > Starlink is currently in a trial phase. Early reporting of tests suggests download speeds topping 100 Mbps, upload speeds above 40 Mbps and roundtrip latency under 40ms.¹²¹ > SpaceX holds apparatus licences in Australia to operate its Starlink service¹²² which has been highlighted in media reports.¹²³

¹¹⁶ OneWeb, '[OneWeb Files for Chapter 11 Restructuring to Execute Sale Process](#)', 27 March 2020.

¹¹⁷ OneWeb, '[OneWeb and Arianespace to restart launches in December 2020](#)', 21 September 2020.

¹¹⁸ GlobalData, Space Exploration Technologies Corp | Overview, accessed 23 March 2020.

¹¹⁹ Lockheed Martin, '[Fourth Lockheed Martin-Built GPS III satellite's on board engine now propelling it to orbit](#)', 5 November 2020.

¹²⁰ Thompson, A., '[SpaceX launches 60 Starlink satellites and lands rocket at sea](#)', Space.com, 6 October 2020.

¹²¹ Thompson, A., '[SpaceX launches 60 Starlink satellites and lands rocket at sea](#)', Space.com, 6 October 2020.

¹²² ACMA, '[Low density and remote areas](#)', accessed 21 January 2021.

¹²³ See for example, Duckett, C., '[SpaceX Starlink picks up Australian 5G mmWave spectrum](#)', ZD Net, 21 December 2020; and Chan, T., 'Starlink gets ACMA greenlight to operate antennas, paving the way for service launch', Communications Day, 28 January 2021.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > It is taking orders for a mid to late 2021 launch in Australia, quoting an installation cost of A\$809 and A\$139 per month.¹²⁴ > It is offering unlimited data, with speeds varying between 50 to 150 Mbps and a latency of 20 milliseconds.¹²⁵

Note: Reported revenues relate to the most recent financial reporting period (year-on-year) for entire business (including revenues attributed to space activities).

Government sector

Table B3 provides a summary of Australian Government entities conducting space activity.

Table B3: Government sector

Company	Segment(s)	Businesses/locations
Bureau of Meteorology (BoM) (Jun 20 revenue A\$0.3 billion) ¹²⁶	Earth stations and space applications	<ul style="list-style-type: none"> > The BoM provides one of the most widely used services through regular forecasts, warnings, monitoring and advice spanning the Australian region and Antarctic territory.¹²⁷ > The agency does not own or operate satellites. > The BoM uses 5 Earth stations, of which it owns 4, to receive data from various weather satellites.¹²⁸ > It leverages satellite technologies (for example, GPS) to aid in providing weather information.
Commonwealth Scientific and Industrial Research Organisation (CSIRO) (revenue not available)	Earth stations and space applications	<ul style="list-style-type: none"> > CSIRO is Australia's national science research agency.¹²⁹ > CSIRO has a long and successful history in the space sector from radio astronomy research, managing complex facilities and observing Earth from above to supporting data and manufacturing supply chains. > It has partnerships with the ASA, ESA and NASA. > It operates the Square Kilometre Array, which is used for astronomy and space research.¹³⁰

¹²⁴ Starlink, '[Starlink](#)', accessed 10 February 2021.

¹²⁵ Starlink, '[Starlink Beta FAQs](#)', accessed 10 February 2021.

¹²⁶ Bureau of Meteorology, '[Annual Report 2019-20](#)', accessed 21 October 2020, p. 18.

¹²⁷ Bureau of Meteorology, '[About us](#)', accessed 21 October 2020.

¹²⁸ Bureau of Meteorology, '[About environmental satellites](#)', accessed 21 October 2020.

¹²⁹ CSIRO, '[About us](#)', accessed 19 January 2021.

¹³⁰ CSIRO, '[Astronomy and space](#)', accessed 19 January 2021.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > It has had a 30-year partnership with Boeing, including a 5-year, A\$35 million research agreement with Boeing with the focus on space technologies.¹³¹ > In 2018, CSIRO's investment fund and Boeing HorizonX Ventures, the company's venture capital fund, invested in Australian nanosatellite communications start-up Myriota (see below).
Department of Defence (Defence) (revenue not applicable)	Earth stations and space applications	<ul style="list-style-type: none"> > Air Force operates Defence's space functions.¹³² > Defence works with the ASA, international partners and commercial providers to deliver a space capability. > The Australian Government recently announced a A\$7 billion investment as part of the 2020 Force Structure Plan.¹³³ > It is upgrading ground stations, working with commercial satellite imagery providers and testing CubeSats as a means to upgrade its capability in space.
NBN Co Limited (NBN Co) (Dec 20 revenue A\$4.3 billion) ¹³⁴	Space applications	<ul style="list-style-type: none"> > NBN Co provides wholesale broadband communications services to residential and business customers. The company was founded in 2009 and is headquartered in Sydney.¹³⁵ > It has a constellation of 2 satellites operating the Sky Muster services, covering regional and remote customers in mainland Australia and Tasmania, and remote islands such as Norfolk Island, Christmas Island, Lord Howe Island and the Cocos (Keeling) Islands.¹³⁶ > The company connected its 100,000th customer to its satellite service around June 2020.¹³⁷ > The company announced that it will expand its satellite beams for retail service provider's business customers to cover 100% of mainland Australia and surrounding large islands on 29 July 2021.

¹³¹ CSIRO, '[Astronomy and space](#)', accessed 19 January 2021.

¹³² Defence, '[Who we are and what we do](#)', accessed 22 October 2020.

¹³³ Defence, '[Annual Report 2019-20](#)', accessed 22 October 2020, p. 96.

¹³⁴ S&P Market Intelligence Platform, NBN Co Limited | Financial highlights, accessed 23 March 2021.

¹³⁵ NBN Co, '[About NBN Co](#)', accessed 18 December 2020.

¹³⁶ NBN Co, '[nbn™ technology 101: What is Sky Muster™?](#)', 16 June 2017.

¹³⁷ NBN Co, '[100,000 reasons to love nbn™ Sky Muster™ satellite service](#)', 10 June 2020.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > Sky Muster's satellite speeds peak at 50/13 Mbps for businesses. > It has reduced the wholesale price on the service by 40%.

Note: Reported revenues relate to the most recent financial reporting period (year-on-year) for entire business (including revenues attributed to space activities).

Other space sector businesses

Table B4 outlines other businesses which are in the process of increasing their presence in Australia or intending to launch services in near future.

Table B4: Other space sector businesses

Company	Segment(s)	Businesses/locations
Astrocast (revenue n/a – start-up phase)	Space operations	<ul style="list-style-type: none"> > Start-up Swiss business (established in 2014) which has funding entities including the ESA and Airbus. A\$23.8 million raised to date.¹³⁸ > Largely focused on building and operating nanosats at LEO to support IoT applications. > Recently announced a partnership with Vertical M2M, who provides a multi-technology IoT Application Enablement Platform, the CommonSense IoT Platform, focusing on oil & gas, farming, and transport & logistics. > Does not launch its own satellites, has agreements with providers to launch (for example, Spaceflight, a rideshare provider to space).
Curtin University (revenue n/a – academic research)	Space applications	<ul style="list-style-type: none"> > Curtin University is developing CubeSats to improve Australia's position in the space industry. > A Japanese start-up, Space BD is intending to launch 2 of its CubeSats (Binar-1 and Binar-2) from the Japanese Experiment Module Kibo on the International Space Station.
Gilmour Space (revenue n/a – start-up phase)	Rocket manufacturer and launch services	<ul style="list-style-type: none"> > Gilmour Space develops low-cost hybrid rockets for the small satellite market. A key technology it leverages for its business is 3D printing. > It is a venture backed company, having partnerships with government, private and academic entities.¹³⁹ > The company was founded in 2012 and is based in Pimpama, Australia.

¹³⁸ S&P Market Intelligence Platform, Astrocast | Company profile, accessed 6 October 2020.

¹³⁹ Gilmour Space, '[About](#)', accessed 20 January 2021.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> > To date Gilmour has raised A\$26 million in funding from venture capital and has been awarded \$3.25 million in grants to work on composite components. > Investors include private venture capital and the CSIRO's venture capital investment fund. > It intends to commence commercial launches in 2022.¹⁴⁰ > The company announced that it is partnering with South Australian business, Fleet Space, to launch 6 Centauri nanosatellites using its Eris rockets in 2023.
Goonhilly Earth Station Ltd (revenue not publicly reported)	Earth station	<ul style="list-style-type: none"> > Teleport¹⁴¹, located in the UK, is forming partnerships with commercial and academic agencies to offer a range of services across the globe.¹⁴² > Raised an estimated A\$50.1 million to date.¹⁴³ > The ASA and Goonhilly Earth Station Ltd signed a statement of intent to collaborate and create new opportunities in the space economy in Australia, the UK and beyond.
Myriota (revenue n/a – start-up phase)	Space applications	<ul style="list-style-type: none"> > Myriota focuses on developing terminals, infrastructure, and applications for the satellite IoT global market. The company serves agriculture, oil and gas, mining, environmental monitoring, and defence sectors. Myriota was incorporated in 2015 and is based in Adelaide, Australia.¹⁴⁴ > To date Myriota has raised A\$50.2 million in funding and is a new business.¹⁴⁵ > Myriota announced its involvement in the SASAT1 Space Services Mission to deliver space services to South Australia; a A\$6.5 million project. > Myriota's IoT connectivity will support the collection of data about multiple weather events, including rainfall and bushfires.

¹⁴⁰ Gilmour Space, '[Gilmour Space](#)', accessed 20 January 2021.

¹⁴¹ Another teleport, which is recently established is [Capricorn Space](#), which is looking to offer connections for businesses looking to link their services through Australia.

¹⁴² Goonhilly Earth Station Limited, '[About GES Ltd](#)', accessed 12 October 2020.

¹⁴³ S&P Market Intelligence Platform, Goonhilly Earth Station Ltd | Funding overview, accessed 23 March 2020.

¹⁴⁴ S&P Market Intelligence Platform, Myriota Pty. Ltd. | Corporate Profile, accessed 19 November 2020.

¹⁴⁵ S&P Market Intelligence Platform, Myriota Pty. Ltd. | Corporate Profile, accessed 19 November 2020.

Company	Segment(s)	Businesses/locations
		<ul style="list-style-type: none"> <li data-bbox="574 324 1173 459">> The company announced that it has expanded access to the Myriota satellite into Canada and the United States; using Rocketlab to launch its satellites.

Attachment C – Infrared (optical) communication: Legislative background

Under the *Radiocommunications Act 1992* (the Radiocommunications Act), radio emissions are considered to be any emission of electromagnetic energy of frequencies below 420 THz. In comparison, in the International Telecommunication Union's Radio Regulations, the frequency limit is 3 THz. Laser (optical) communications systems operate both using visible and infrared light. Laser systems using visible light operating at frequencies above 420 THz are outside the scope of the Radiocommunications Act and hence are not subject to regulation administered by the ACMA.

The infrared portion of the spectrum is approximately between 300 GHz to 430 THz (1 millimetre to 700 nanometres). Accordingly, infrared lasers operating within this range such as those used for earth to satellite communications are within scope of the Radiocommunications Act.

Under the current regulatory framework, all earth stations require licensing. Hence any earth station operating on frequencies below 420 THz requires some form of authorisation under the ACMA's radiocommunications licensing scheme. There are class licensing arrangements support devices such as infrared remote controls and some terrestrial short range (building to building) optical links. However, these arrangements have not been developed with infrared satellite communications specifically in mind.

In the longer term supporting infrared communications might require consideration of the frequency limits of the Radiocommunications Act. This is a matter for the Department of Infrastructure, Transport, Regional Development and Communications.

Glossary

Term	Definition
A\$	Australian dollars
ACMA	Australian Communications and Media Authority
Apogee	Highest point of the orbit (farthest to the Earth)
ADF	Australian Defence Force
ASA	Australian Space Agency
AOGSN	Australasian Optical Ground Station Network
AWS	Amazon Web Services
BoM	Bureau of Meteorology
COVID-19	Coronavirus disease; refers to pandemic caused by a new form of coronavirus. It was first reported in December 2019 in Wuhan, China.
CubeSat	A type of small satellite comprised of modular units (or cubes) each measuring 10x10x10 cm with a combined weight under 10 kilograms (see also What are SmallSats and CubeSats?).
FYSO	Five-year spectrum outlook
GEO	Geostationary Earth Orbit – operates at an altitude of approximately 36,000 km
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAPS	High-altitude platform station or High-Altitude Pseudo-Satellite – operates at an altitude of 20-50 kilometres and at a specified, nominal, fixed point relative to the Earth.
IoT	Internet of Things
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
LEO	Low Earth Orbit – operates between 160 km and 2,000 km
M2M	Machine-to-machine
MEO	Medium Earth Orbit – altitudes between around 2,000 km to below the geosynchronous orbit (approximately 36,000 km)
Microsatellite	A satellite which weighs between 10 and 100 kilograms, with a maximum bus power of 150 Watts, costing between US\$ 10 to 150 million, and maximum dimensions of 1 to 5 metres. They have a mission duration of 2 to 6 years (see ITU definitions for further info).

Term	Definition
Minisatellite	A satellite which weighs between 100 and 500 kilograms, with a maximum bus power of 1 000 Watts, costing between US\$30 to 200 million, and maximum dimensions of 3 to 10 metres. They have a mission duration of 5 to 10 years (see ITU definitions for further info).
MHI	Mitsubishi Heavy Industries
MSS	Mobile Satellite Service
NASA	National Aeronautics and Space Agency, a United States government agency
Nanosatellite	A satellite which weighs between 1 and 10 kilograms, with a maximum bus power of 20 Watts, costing between US\$100 thousand to 10 million, and maximum dimensions of 0.1 to 1 metre. They have a mission duration of 1 to 3 years (see ITU definitions for further info). Also known as a nanosat.
NGSO	Non-geostationary orbit
OECD	Organisation for Economic Cooperation and Development
Payload	Part of a vehicle's load from which revenue is derived, for example, a satellite on a rocket
Picosatellite	A satellite which weighs between 100 grams and 1 kilogram, with a maximum bus power of 5 Watts, costing between US\$50 thousand to 2 million, and maximum dimensions of 0.05 to 0.1 metre. They have a mission duration of 1 to 3 years (see ITU definitions for further info).
Perigee	Lowest point of the orbit (closest to the Earth)
PSLV	Polar Satellite Launch Vehicle
RAAF	Royal Australian Air Force
RMI	Regulatory Futures, Markets and International
SETI	Search for extra-terrestrial intelligence, a non-profit corporation that serves as an institutional home for research and educational projects related to the study of life in the universe
SmallSat	A satellite that weighs less than 500 kilograms, also known as a small satellite
SpaceX	Space Exploration Technologies
SMEs	Small and medium enterprises
SSMS	Small Spacecraft Mission Service
Sub-orbital	The intentional flight of a vehicle expected to reach the upper atmosphere with a portion of its flight path that may occur in space without completing a full orbit around the Earth before returning back to the surface of the Earth (see ITU-R definition).
UK	United Kingdom

Term	Definition
US	United States
US\$	United States dollars
VSAT	Very small aperture terminal is a two-way satellite ground station. VSAT systems provide high speed, broadband satellite communications for internet or private network communications
WGS	Wideband Global SATCOM is a high-capacity satellite communications system planned for use in partnership by the United States Department of Defense, Canadian Department of National Defence and the Australian Department of Defence