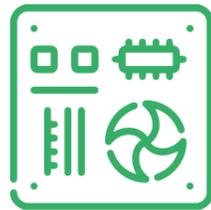




# Advanced Radiofrequency Communications



Devices and systems that use radio waves to transfer information over free space (i.e. air or the vacuum of space) and use novel modulation techniques, advanced antenna designs and beamforming technologies to transfer information faster, more reliably, more efficiently and/or using less energy.

## Key Sectors

Influences all sectors of the economy, including:

- Agriculture
- Banking & Finance
- Communications
- Defence & Defence Industry
- Energy & Environment
- Health
- Transport & Logistics
- Education & Research
- Mining & Resources
- Manufacturing
- Space

Estimated impact on national interest	Low	Med	High
Economic Prosperity			X
National Security			X

Key Australian Government Actions	Example Outcomes	Underpinning Science	Example Applications
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- Initiatives**
- 5G - Enabling the Future
  - 5G Test Beds
  - 5G Innovation Initiative
  - Digital Economy Strategy
  - Telecommunications Security Review
  - National Earth Observations from Space Infrastructure Plan (NEOS-IP)
  - Advancing Space: Australian Civil Space Strategy 2019-2028
  - SmartSat CRC

- Regulations**
- Radiocommunications Act 1992
  - Telecommunications Act 1997
  - Defence and Strategic Goods List 2021

- Example Outcomes**
- Greater capacity and lower latency, with a greater number of active devices
  - Greater wireless connectivity drives growth of the digital economy
  - Increased productivity through IoT and connected systems
  - More resilient emergency management and enhanced rapid response capabilities
  - Improved access to health and medical interventions through enhanced telehealth capability
  - Smart Cities and enhanced infrastructure and regional development through improved connectivity
  - Improved access to banking and financial services, especially for remote communities
  - Improved access to online education through faster and more widely available broadband internet services and the emergence of tactile internet

- Underpinning Science**
- ANZ Standard Research Classification Category
- Communications engineering
  - Atomic, molecular and optical physics
  - Electronics, sensors and digital hardware
  - Distributed computing and systems software
  - Classical physics
  - Aerospace engineering
  - Electrical engineering

- Example Applications**
- Readiness Level – Now**
- High speed broadband internet connectivity (4G and 5G)
  - Wi-Fi and Bluetooth connectivity
  - IoT connectivity
  - Remote-piloted vehicle control and monitoring
  - Machine connectivity for industry automation
  - Satellite uplinks and downlinks
  - Space communications
  - Television and radio broadcasting services
  - Dedicated government radio communications
  - High bandwidth, low latency satellite communications for defence

- Readiness Level – 2–5 years**
- Ultra-low latency augmented reality and advanced simulations and models
  - Improved industrial automation using 5G ultra reliable low latency communication enabled networks
  - Consumer-ready and affordable low earth orbit (LEO) satellite constellations that offer high bandwidth and low-latency internet access
  - Faster and more reliable Wi-Fi in dense environments, like apartment buildings

- Readiness Level – Beyond 5 years**
- Very-low-power, high efficiency IoT devices
  - Real-time, mobile augmented and virtual reality
  - Wireless body area networks through on-skin, under-skin and clothing to monitor patients, athletes, soldiers
  - 6G ultra reliable low latency communication enabled smart traffic systems and autonomous vehicle communications

### Australia's place in the world

Australia ranks 11<sup>th</sup> for research impact, led by the University of Technology Sydney, which ranks 27<sup>th</sup> internationally. While the United States has the highest overall research impact, China has 3 universities in the top 5 international institutions. The French National Centre for Scientific Research (CNRS) ranks highly for research impact across the advanced communications technologies—advanced radiofrequency and optical communication technologies.

The United States dominates venture capital investment in this area, ahead of second placed China. The number of patents is increasing by around 5% p.a., with China having the greatest number of patent families, slightly more than the USA.

Radiofrequency technologies, including 5G and communication satellites, are vital for Australian connectivity, and will underpin the digital economy and enable a more innovative and agile Australia. New South Wales, Queensland, Victoria, and Western Australia all have private-sector operated 5G innovation centres.

### Opportunities and Risks

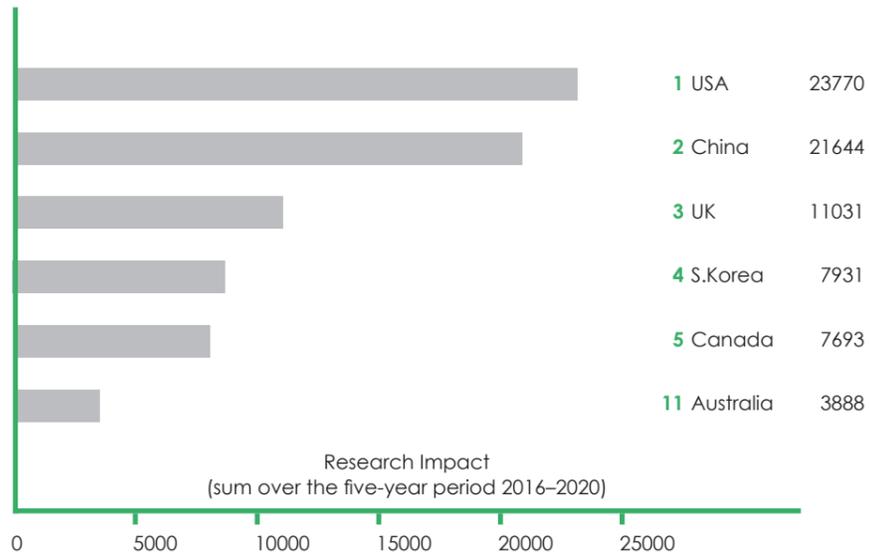
Australians depend on advanced radiofrequency communications and digital connectivity for economic, education and social activity. Devices and everyday objects are also increasingly dependent on advanced radiofrequency communications technologies for home and industry automation. While increased connectivity has benefits across all of society and the economy, there are increased risks associated with cyber security, data collection, protection, and privacy that are being actively addressed by government.

A significant risk for advanced communication technologies in Australia (including advanced radiofrequency and advanced optical communications) is related to access and supply chain security. Specifically, Australia is almost entirely dependent on overseas manufacturing and suppliers of advanced communications material and equipment. This is compounded by high supplier concentration with a small number of vendors dominating the market, some of which may not be from trusted international partners. As Australia's national security has significant reliance on high-bandwidth, secure market diversity and security will be important. Internationally, advanced communications technologies are highly dependent on a reliable supply of semiconductors. To address these risks the Australian government has established the Office of Supply Chain Resilience and the Supply Chain Resilience Initiative to develop tangible measures to mitigate these risks. Australia is also working with QUAD partners and other like-minds to identify trustworthy vendors, encourage vendor diversity and improve diversity and competitiveness in the market.

Ensuring adequate infrastructure and support of these technologies has the potential to improve productivity across all sectors, ensure we remain competitive in traditional areas, such as agriculture and health care, and improve competitiveness in emerging areas. However, if Australia has insufficient domestic expertise or capability in advanced radiofrequency communications technology we risk higher costs and delays for commercial and civilian applications, which could limit Australia's capacity to use other technologies that require faster and more reliable connectivity and communication.

## Research Impact (RI)

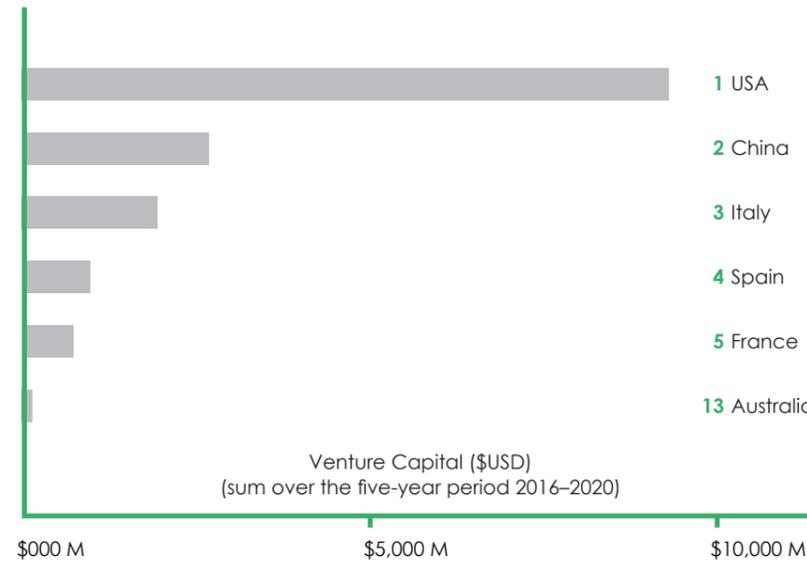
Australia ranks 11<sup>th</sup> for research impact in a field led by the United States and China. Total volume of published research has increased at around 7% p.a. over the 5 year period 2016–2020, with 7% of research involving international collaboration.



The research impact provides an indication of the productivity of a country or institution. Here, productivity was assumed to be represented by the volume of publications (i.e. scholarly output) as an indicator of the resources & facilities, and the level of interest in the publications as an indicator of quality.

## VC Investment

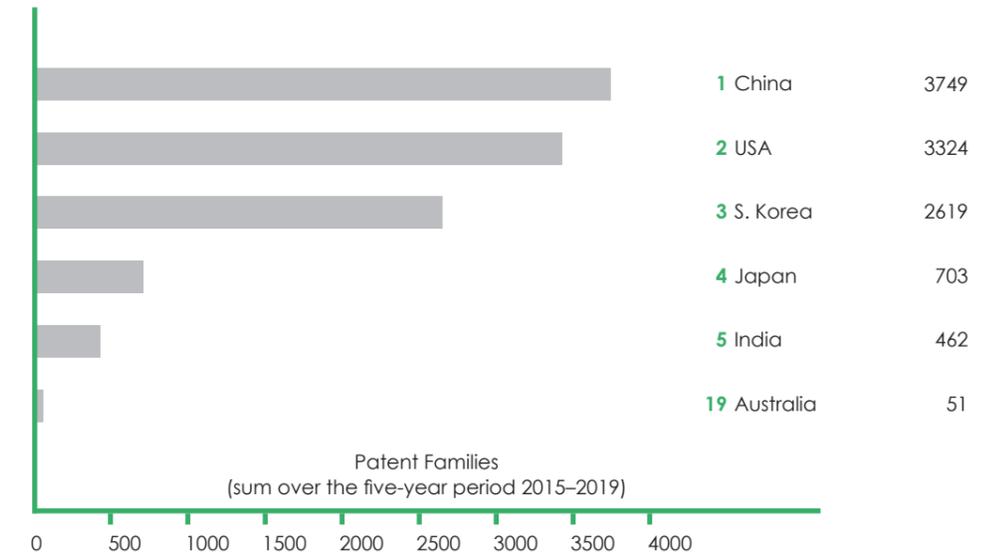
The United States dominates venture capital (VC) investment in this area with approximately 3 times the amount invested in China; Australia is ranked 13<sup>th</sup>. Investment globally in this area has been growing at around 44% p.a. since 2016.



Data from Crunchbase. The Crunchbase database provides a partial view of the global VC landscape. However the quantity, quality and richness of the data are considered to be statistically significant, and indicative of global trends.

## Patents – International

For this technology, most patents were filed by Chinese applicants or inventors, followed closely by the United States. Australia ranks 19<sup>th</sup>. Overall patent applications have been increasing at around 5% annually since 2015.



## Research Institutions – International

China (3) and South Korea (2) make up the top 5 international institutions, led by Tsinghua University, for research impact.

Rank	Top International Institution	Research Impact
1	Tsinghua University   China	2583
2	University of Electronic Science and Technology of China   China	2261
3	Samsung   South Korea	2132
4	Sungkyunkwan University   South Korea	2084
5	Southeast University, Nanjing   China	1858
6	Nanyang Technological University   Singapore	1667
7	University of Southampton   United Kingdom	1630
8	French National Centre for Scientific Research (CNRS)   France	1556
9	University of Edinburgh   United Kingdom	1550
10	Lucent   United States	1476

## Research Institutions – Australia

Within Australia, the University of Technology Sydney has the highest research impact, ranking 27<sup>th</sup> internationally. The University of Sydney and the University of New South Wales are ranked 40<sup>th</sup> and 45<sup>th</sup>, respectively, internationally.

Rank	Top Australian Institution	Research Impact
1	University of Technology Sydney	833
2	University of Sydney	689
3	University of New South Wales	652
4	Royal Melbourne Institute of Technology University	592
5	University of Melbourne	288
6	Australian National University	265
7	Monash University	256
8	University of Wollongong	135
9	Macquarie University	97
10	CSIRO	72

## Patents – Australia

Top 4 Australian Patent Applicants	Patent Families
Myriota (low Earth orbit nanosatellite provider)	2
Fleet Space Technologies (nanosatellite provider)	1
Nova Professional Services	1
Speedcast International (satellite provider)	1

Patents filed by Australian businesses, 2015-2019.