Assessing Australia's Use of Space Products and Services: A Comparative Benchmarking Analysis

Special Report for
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1. EXECUTIVE SUMMARY

In the first quarter (1Q) of 2011, the Space Policy Unit (SPU) of the Australian Department of Innovation, Industry, Science and Research commissioned a study by Futron Corporation (Futron) to assess the relative sophistication, development, and efficacy of the Commonwealth of Australia as a user of space products and services.

Several previous studies organised by the SPU explored themes framed in the landmark 2008 Australian Senate report entitled *Lost in Space? Setting a New Direction for Australia's Space Science and Industry Sector*. These themes included an audit of Australian space activities and an assessment of the Australian space industry. This study examines another theme proposed in the Australian Senate report: key space applications. It differs from prior studies, however, in that it focuses not on how Australia produces space resources, ***but on how it uses them***.

This study explores two overarching questions:

- **How effective is Australia currently as a *user* of space?** And
- **How can Australia improve as a space user, relative to its peers?**

To address these questions, Futron, working with the SPU, developed a mathematical model to evaluate Australia's effectiveness as a space user in five distinct application areas relevant to Australian government, enterprise, and society. It then compared Australia's performance in using these space applications against seven comparator nations, selected due to their similarities with Australia in economic development, geopolitical heritage, or space investment. By comparing the space usage scores achieved by Australia against those of these seven comparator nations, this study benchmarked where Australia is a relative leader as a user of space products and services, where it can improve, and what lessons it may draw from the space usage performance of its peers.

1.1. STUDY METHODOLOGY

The Australian SPU, in consultation with Australian government, commercial, and civil society stakeholders, pre-selected the following application areas and comparator nations for this analysis.

Exhibit 1: Australian Space Usage Benchmarking Study Parameters

Five (5) Pre-Selected Space Application Areas	Seven (7) Pre-Selected Comparator Nations
Earth Observation and Resource Management	Canada
Natural Disaster Management	India
Global Positioning System (GPS) Navigation	Indonesia
Satellite Communications	Malaysia
Weather and Meteorology	Singapore
	South Africa
	Thailand

Using these parameters, Futron developed an original National Space Usage Benchmarking Model. A full explanation of the model is found in Exhibit 14 on page 24. The model was composed of 30 individual metrics, each describing a specific indicator of national space usage sophistication, development, or efficacy. These 30 metrics were divided among the five space application areas shown in Exhibit 1, plus one additional cross-cutting category, Coordination and Integration. Each metric was assigned a numeric weight within the model, with the overall model adding up to 100 points. Aggregating relative scores created a framework to compare countries, allowing for a quantitative evaluation of how well Australia uses space products and services relative to its peers.

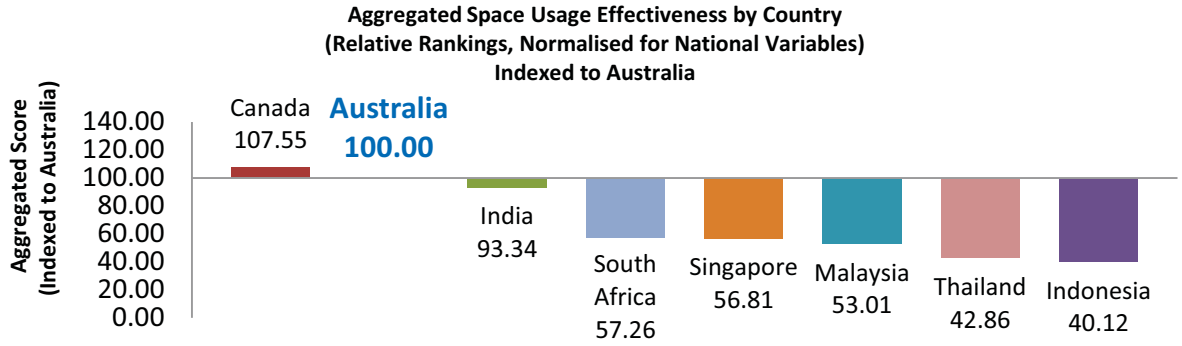
1.2. STUDY RESULTS

The National Space Utilisation Comparison Model results show that on a normalised basis relative to seven peer nations, Australia, as a user of space products and services, places:

- **First** in one space application area (Global Navigation Satellite Systems)
- **Second** in four space application areas (Natural Disaster Management; Earth Observation and Resources Management; Satellite Communications; Weather and Meteorology); and
- **Third** in one space application area (Coordination and Integration)

These individual application area results aggregate upwards into an overall result: **Australia is second in overall space usage effectiveness relative to its seven peers**. Australia's second-place positioning is reflected in the following exhibit, which indexes normalised results to Australia.

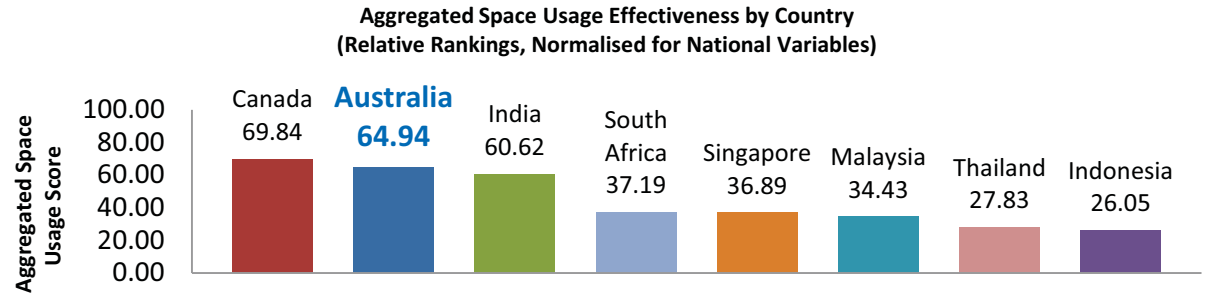
Exhibit 2: National Space Usage Benchmarking Aggregated Results: Indexed to Australia



Note: Australia = 100; all other countries shown in relation to Australia.

In order to concentrate on core national space usage distinctions, scoring results were normalised to control for national variances in population, geographic area, Gross Domestic Product (GDP), Purchasing Power Parity (PPP), and other secondary statistical factors. On this normalised basis, Australia scored 64.94 out of 100 possible basis points. Only Canada, with an overall space usage score of 69.84, edged out Australia. India, with a score of 60.62, trailed Australia, placing third.

Exhibit 3: National Space Usage Benchmarking Aggregated Results



Note: Aggregated score is out of 100 possible basis points.

The following analysis breaks down these results by individual space application area.

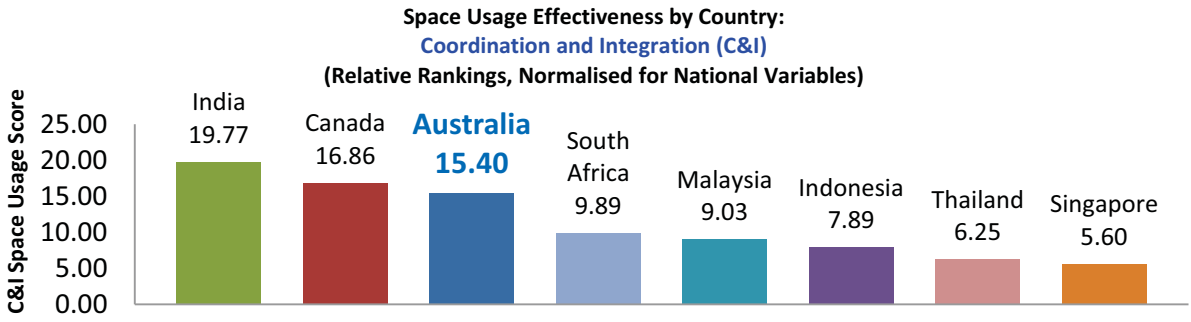
1.2.1. COORDINATION AND INTEGRATION (C&I) RESULTS

No matter how effectively a country uses a particular space application, its benefits are either magnified or diminished depending on the degree to which that country integrates that application

into its government and enterprise activities, coordinates usage among multiple stakeholders, and disseminates the resulting space products and services across society. The Coordination and Integration (C&I) category compares nations along these lines.

Of the eight countries evaluated, Australia was the third-most effective country in space usage coordination and integration, trailing India and Canada, but still placing solidly within the top tier. Space-relevant education is a clear Australian strength. Normalised for population, Australia was the leader in the number of space-related university programs indicator, with the highest per capita count of degree programs in areas such as aeronautical and aerospace engineering, astronomy and space sciences, astrophysics, meteorology, and telecommunications engineering. Australia also placed well in space-related internet activity: normalised by national number of internet users, its score for space-related search queries and social networking presence on sites such as Facebook and LinkedIn trailed the leader in this metric, Canada, by only about 20%. By contrast, Australia's performance in the more government-focused metrics within the C&I category was average to low compared to the other nations assessed. Australia scored in the middle-of-the-pack in the space policy articulation and space-enabling attributes metrics. Meanwhile, its civil space budget was dwarfed by that of India, the leader by a large margin. India spends about four times more on civil space than Australia as a percentage of its overall national budget.

Exhibit 4: National Space Usage: Coordination and Integration (C&I) Results



Note: *C&I score is out of 25 possible basis points.*

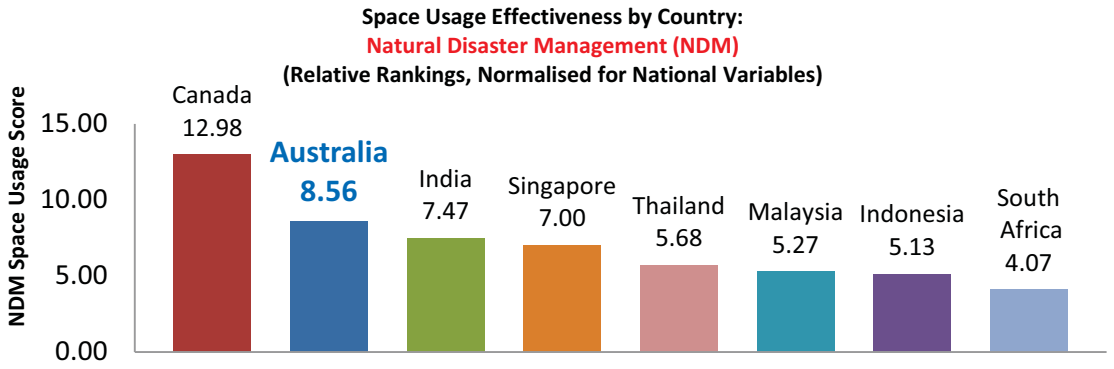
Taken together, these results suggest that Australia is currently stronger in the civil society aspect of its space usage coordination than in the deep integration of space considerations into its government policymaking structures. Given that Australia has only recently begun to re-assess its national space direction following several years of inactivity, sustained policy attention has the potential to increase Australia's future space usage coordination effectiveness relative to its peers.

1.2.2. Natural Disaster Management (NDM) Results

Space assets offer a powerful tool for monitoring natural disasters and assisting relief efforts in their aftermath. Australia ranked second among the eight countries assessed in space usage effectiveness for natural disaster management. Australia was about two-thirds as effective as the leader, Canada, in this category, while outperforming its nearest competitors, India and Singapore, on a normalised basis. Australia rated well in its number of organisations engaged in space-related natural disaster management. Another area of strength was in the space-related elements of the Hyogo framework, a United Nations (UN) protocol that scores nations based on their disaster preparedness. Australia achieved 80% of its maximum potential score in this UN indicator, a positive result shared by India, Indonesia, and Malaysia, positioning the country in a four-way tie for second-place in this metric. Australia also placed second to Canada in its number of natural disaster-monitoring components registered with the Global Earth Observation System of Systems (GEOSS), an international network

of sensors and instruments designed to maximise the utility of space assets and data for environmental monitoring. One area where Australia can enhance its space-related natural disaster management is in its invocation of the International Charter on Space and Major Disaster, which brings together the space resources of several major space actors, along with the UN, to provide space-derived data and imagery to map the natural disaster damage.

Exhibit 5: National Space Usage: Natural Disaster Management (NDM) Results



Note: NDM score is out of 15 possible basis points.

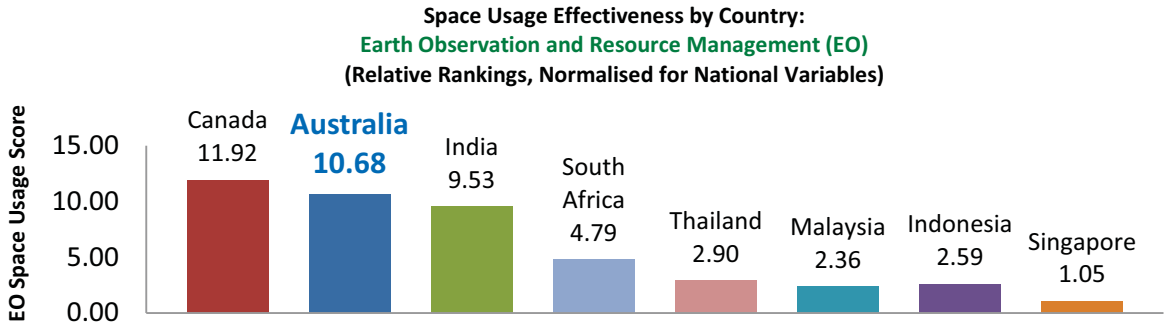
1.2.3. Earth Observation and Resource Management (EO) Results

The vast Australian continent is increasingly dependent on space data to optimise its land management. Several of its comparator nations, most notably Canada, have similarly large and lightly populated territories—and all countries, regardless of size, have an interest in monitoring their topography, vegetation coverage, water balance, and natural resources via satellite.

Australia placed second in its usage of space for Earth observation and resource management. Australia's foremost strengths derive from its comparatively strong contributions to the Earth observation field itself. Australia has more components registered with GEOSS than any of its peers within designated social benefit areas linked to Earth observation and resource management, including agriculture, biodiversity, ecosystems, and water management. From the Australian Soil Resource Information System to the IMOS Ocean Portal, Australia maintains a network of sensors, instruments, and tools that enhance both its own Earth observation capabilities and those of other nations. As a result, Australia led in the GEOSS metric.

While Australia is a robust participant in and contributor to Earth observation systems and coordinating bodies, it has room to grow in pioneering new technologies to translate Earth observation data into end-user applications. For instance, Canadian innovators filed more than twice as many Earth observation-related patents with the World Intellectual Property Organization (WIPO) as Australians over the past decade. By encouraging greater innovation and patent activity in this area, Australian stakeholders can not only deepen their usage of space for Earth observation and resource management, but potentially foster new economic segments in the process.

Exhibit 6: National Space Usage: Earth Observation (EO) Results



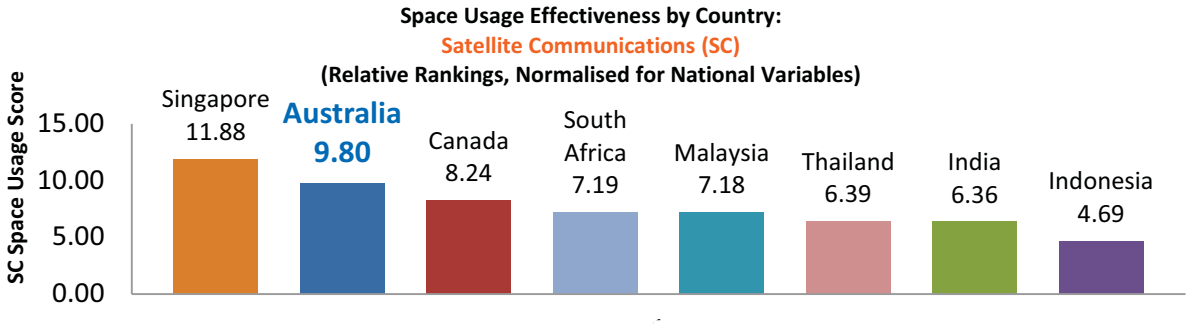
Note: *EO score is out of 15 possible basis points.*

1.2.4. SATELLITE COMMUNICATIONS (SC) RESULTS

From satellite television broadcasts to satellite internet access, to backhaul for cellular phone networks, orbiting spacecraft enable communications services that facilitate commerce and tie countries together. Australia placed second, about 20% behind Singapore, in the satellite communications application area, while leading Canada by roughly the same proportion. The key to Australia's position was its strong performance in the patent applications metric. With 10 independent satellite communications-related patents registered with WIPO over the past decade, Australia has been 40% more prolific in this innovation area than its nearest rival, Canada. Moreover, although the published patent category is normalised by population, it is noteworthy that Australia's lead in satellite communications-related patents filed was not relative, but absolute. This shows that even compared with much larger yet still technologically astute countries such as India, Australia has an underlying innovative capacity that can add value for end-users across multiple dimensions of space usage. Greater leveraging of Australia's innovation sector in other applications besides satellite communication will be an important element in optimising the benefits of space usage for Australia as a whole, as well as realising its economic value.

Australian satellite communications patents—focused on technologies such as data transmission enhancers for low Earth orbit spacecraft and improved antenna receivers to amplify weak signals—reflect the need to connect Australian end users across large distances. In this effort, Australia also benefits from its base of satellite ground stations—a metric in which it placed second to Canada. With 22 teleports and 11,000 very small aperture terminals (VSATs) in service, Australia compares favourably with its peers when normalised for population. Australia also benefits from its considerable number of firms active in the satellite communications sector.

Exhibit 7: National Space Usage: Satellite Communications (SC) Results



Note: *SC score is out of 15 possible basis points.*

1.2.5. Global Navigation Satellite Systems (GNSS) Results

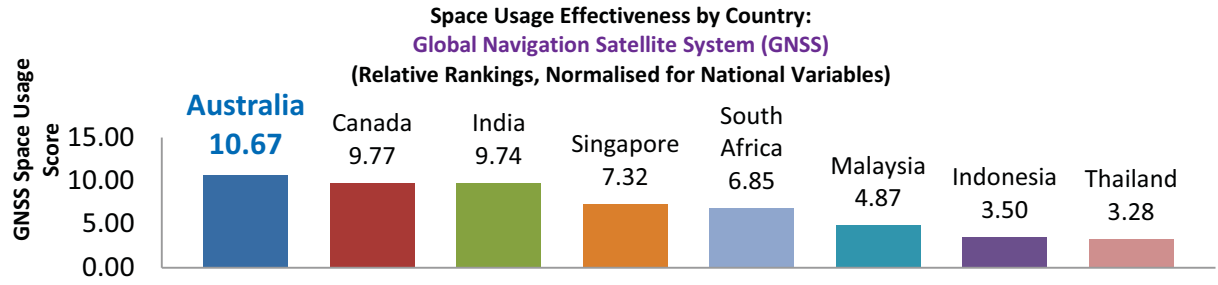
In the most developed countries, satellite navigation services are now so ubiquitous that they go almost unnoticed. Global Navigation Satellite System (GNSS) and Global Positioning System (GPS) devices and chipsets are now embedded into smartphone handsets, automobiles, ships, and aircraft, greatly simplifying both personal and commercial transportation logistics. Accessible mobile navigation services save people and businesses time and effort, producing conveniences and efficiencies that benefit national economies.

Satellite navigation usage was the only application category in which Australia led all other countries, propelled by strong, if not top, scores in a number of metrics, combined with a national presence in all metrics assessed. From an infrastructure standpoint, Australia placed fourth in its number of Geodetic/GNSS ground stations, behind Canada, Singapore, and South Africa. However, while these other nations have more ground stations relative to their size, Australia's GNSS infrastructure is still adequate to meet the needs of most Australians.

Building on its effective, if localised, satellite navigation infrastructure base, Australia performed well in its private-sector activity related to satellite navigation. Over the past decade, Australians filed 41 independent patents with WIPO pertaining to GNSS services. From GNSS vehicle guidance systems to tracking mechanisms for livestock to ocean vessel locator beacons, Australia was second only to Canada in its number of satellite navigation-related patent filings. This innovative activity was enabled largely by Australia's numerous companies and organisations working in the satellite navigation sector.

Against this backdrop, the metric that allowed Australia to take the overall lead in the GNSS application area was participation in the European Satellite Navigation Competition (ESNC). This contest, also known as the Galileo Masters Competition, solicits satellite navigation-related business proposals from companies, entrepreneurs, institutes, universities, and private individuals, with the most feasible ideas receiving a 20,000-euro grant to fund a six-month project incubation period. Australians originated four such ideas for the 2010 competition—an important indicator that gave Australia an edge in the civil society participation aspect of satellite navigation usage.

Exhibit 8: National Space Usage: Global Navigation Satellite System (GNSS) Results



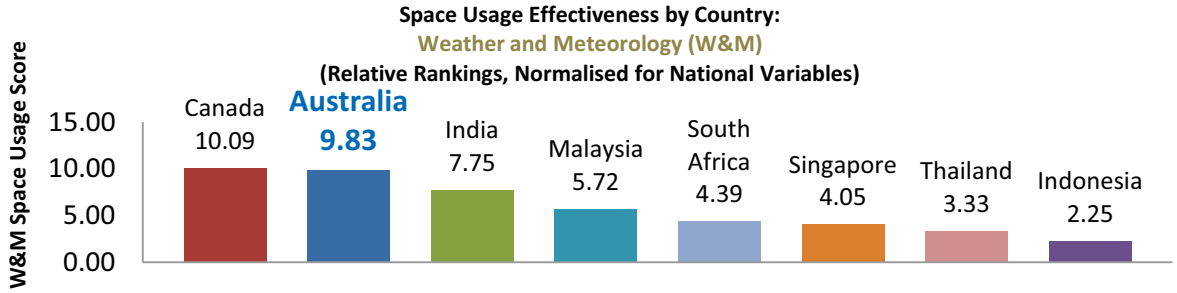
Note: GNSS score is out of 15 possible basis points.

1.2.6. Weather and Meteorology (W&M) Results

No space service is more widely used than satellite-enabled weather and meteorology. Weather forecasts shape not only daily and weekly routines, but also farming and land management decisions, as well as emergency preparations in the event of storms or other extreme phenomena. Weather is also a cornerstone of climate science: monitoring climate change requires tracking minute changes to meteorological patterns over time. In this regard, space-enabled weather services are integral to both everyday life and broader agricultural and economic activity.

Australia placed second in the weather and meteorology space application area, scoring narrowly behind Canada, while leading India. Australia's strongest scores came from its weather and meteorology infrastructure. It had the highest number of GEOSS-registered components for climate and weather. Australian instruments or tools, such as the Land Surface Datasets for the Australian Continent or the Hydrological Sensor Web in the South Esk river catchment of Tasmania, contribute not only to Australian meteorology, but also to worldwide weather networks. Similarly, Australia had the highest number of satellite weather data reception stations, with 295 terminals throughout the continent. By contrast, the runner-up, Canada, had only 178 such stations. Australia also scored moderately well in its satellite weather products. The Australian Bureau of Meteorology offers about a dozen fairly sophisticated satellite-derived weather products via its website, ranging from sea surface temperatures and vegetation index readings to volcanic ash and Antarctic sea ice imagery.

Exhibit 9: National Space Usage: Weather and Meteorology (W&M) Results



Note: W&M score is out of 15 possible basis points.

1.3. INTERPRETING THESE RESULTS

Collectively, what do these individual space application usage scores mean? The results of this study help address key questions about how well Australia currently uses space, in what space usage areas it could improve relative to its peers, and what steps it may consider to become a more effective user of space products and services. These questions are presented below, with brief responses, as a way of translating the numeric model results into policy-relevant findings.

- **In what application areas is Australia a leading user of space products and services?**

  Australia, in relative terms, is the leading user of Global Navigation Satellite Systems, based on an effective, if localised, navigation infrastructure base, numerous navigation-related organisations and firms, and extensive patent filing activity, indicating active development of value added satellite navigation products.

  Australia also placed second in four application areas (Natural Disaster Management; Earth Observation and Resources Management; Satellite Communication; Weather and Meteorology) and third in one cross-cutting application area (Coordination and Integration).

- **In what areas is Australia *not* optimising its usage of space products and services?**

  - Natural Disaster Management: Australia can optimise performance by more frequently accessing the global network of space resources provided under the International Charter on Space and Major Disaster.

- Earth Observation and Resources Management: Increased patent activity can help Australia complement its infrastructure with value-added innovations for the end user.

- Satellite Communication: Integration of satellites into the planned National Broadband Network can augment current usage and bring policy into alignment with usage trends.

- Weather and Meteorology: Australia can consider adding new geo-informatic data layers on top of already-strong existing satellite weather product offerings to improve their depth and utility for end users.

- **Which peers use space products and services more effectively than Australia, and how?**

  While various countries placed ahead of Australia in individual metrics and application categories, Canada offered the most consistent example of a standard against which Australia can aspire to improve in space utilisation. Canada's space usage advantages tended to be ones of volume: larger budgets; greater numbers of instruments or sensors; more organisations devoted to a particular application area; or higher patent application rates. These advantages are largely due to a longer history of space utilisation and investment. However, another key Canadian advantage is robust policy definition and articulation, which fosters an environment conducive to the creation of new space-related organisations across all space application areas. As Australia frames its evolving space policy, focusing on maximising the benefits of space usage for all Australians, it can examine Canada's framework as a guide.

- **What lessons can other nations offer Australia in maximising space benefits for citizens?**

  Each comparator nation varied from Australia in its relative space usage performance. The most relevant lessons for Australia were best identified by examining application areas or implementation strategies that yielded particular space usage effectiveness for each country assessed. These takeaways are succinctly summarised below.

  - Canada: Develop clear policies in conjunction with stakeholders; frequently refresh.

  - India: Focusing on space usage to maximise social welfare increases both the political popularity of space investments and their degree of awareness throughout society.

  - Indonesia: Increased involvement in international organisations offers a constructive path to improve usage performance in space application areas that lack stakeholder traction.

  - Malaysia: Developing civil society enthusiasm for space in a high-profile area (such as human spaceflight) increases space application utilisation uptake downstream.

  - South Africa: Investments in ground station infrastructure help space application utilisation; once citizens are accustomed to a service being available nationwide, they significantly increase their usage levels.

  - Singapore: A flexible, purely market-based approach to space usage—spearheaded by private companies rather than government investment—can build equitable space application usage and access results.

  - Thailand: Activation of the International Charter on Space and Major Disaster offers rapid access to world-class space data and imagery that can substantially improve disaster response times, save government money and resources, and save lives.

- **What strategic gaps exist between Australia's current and optimal usage of space?**

Australia's greatest area for optimisation and improvement is in its national space usage coordination and integration. Australia has an effective combination of international space data sharing partnerships, infrastructure to utilise space services, and a marketplace of space applications users encompassing the government, institutions, private sector firms, and individuals. However, whereas several peer nations have detailed space policies, frequent policy refresh mechanisms, and regular consultation with a broad cross-section of space stakeholders, Australian space usage remains somewhat hindered by the comparative scarcity or newness of its coordination vehicles. Established coordination structures, such as government working groups on specific segments of space policy, industry roundtables, public-private-partnership steering committees, best practices workshops, and websites and social networking forums, play an important role. They routinise space policy review at all levels of government and prompt continual stakeholder engagement and dialogue. This regular and ongoing communication allows for more responsive identification across stakeholder groups of where space applications usage is being optimised, and where it is not: where access to space-derived data or imagery is uneven, untimely, or inequitable; where markets exist for space-derived products or services, but are not being served; or where value-added industries based on innovative new space applications uses have the potential to be born, but only if certain economic actors are aligned.

While Australian civil society has demonstrated a high degree of space usage participation, the government can still play a larger role in defining strategies for national space usage optimisation. The September 2011 release of Principles for a National Space Industry Policy marked a step in this direction. Further policy documents could provide a similar level of detail for all five space application areas examined in this study: plans, goals, and guidelines for each space application area, with clear milestones, benchmarks, and timetables to measure progress along the way.