Please note: the substantive content of the 2026 NRI Roadmap Survey begins at Question 20 (with prior questions dealing with administrative and other information).

As such all submissions that are published include the responses submitted from Question 20 onwards only.

Q20.

Part 2: Research themes

2.1 NRI comprises the assets, facilities and associated expertise to support leading-edge research and innovation in Australia and is accessible to publicly and privately funded users across Australia and internationally. We are seeking your input on possible directions for future national-level investment - i.e., where the requirements are of such scale and importance that national-level collaboration and coordination are essential.

The 2021 Roadmap used a challenge framework to support NRI planning and investment. With this in mind, consider likely future research trends in the next 5 - 10 years, and with respect to one or more of the 8 challenge areas identified in the 2021 Roadmap as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or not at sufficient scale and
- describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities.

Q21.

Resources Technology and Critical Minerals Processing

Q22.

Food and Beverage

Q23.
Medical Products

Q24.
Defence

Q25.
Recycling and Clean Energy

Q26.
Space

Q27.
Environment and Climate

Q28.
Frontier Technologies and Modern Manufacturing

Q29.

2.2 The 2024 statement of National Science and Research Priorities (NSRPs) includes outcomes linked to each priority to assist in identifying critical research needed in the next 5 to 10 years.
Consider the priority statements and, with respect to one or more of the 5 priority areas as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or
- not at sufficient scale and describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities, and where relevant, refer to the underpinning outcomes and research identified in the NSRPs document.

Q30.

Transitioning to a net zero future

Q31.

Supporting healthy and thriving communities

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

Q33.

Protecting and restoring Australia’s environment

Q34.

Building a secure and resilient nation

Advanced Mathematical Sciences: Foundation for National Security Advanced Mathematical sciences form the bedrock of national security in the modern world. Sovereign capability in this field is crucial for addressing complex security challenges at their fundamental level. Advanced cryptography and data encryption, powered by abstract mathematics, safeguard sensitive information vital to national interests. More recently, AI has also become an urgent focus in national security – see for example the material from the United Kingdom's Government Communications Headquarters (GCHQ) in that regard: https://www.gchq.gov.uk/artificial-intelligence/index.html AI raises many foundational questions and security issues that need high level mathematical expertise to address, and – at the same time – itself could provide tools (in qualified hands) to address mathematical issues of deep importance to modern society. Advanced Mathematical Sciences: National Resilience Advanced Mathematical sciences equally strengthen national resilience through optimization and predictive modelling that support critical infrastructure. An example is the collaborative project launched by Germany's Fraunhofer Institute for Wind Energy Systems: https://www.iwes.fraunhofer.de/en/press-media/assessing-the-stability-of-power-grids-with-high-levels-of-renew.html. The relevance of modelling in the context of a changing energy infrastructure exposed to extreme climate events in Australia is clear. In environmental and health sectors, mathematical modelling enables effective disaster response and epidemic management. South Korea's response to COVID-19 incorporated sophisticated mathematical models that accurately predicted infection patterns and guided intervention strategies – see https://pubmed.ncbi.nlm.nih.gov/36579373/. Similarly, Japan's earthquake and tsunami warning systems rely on complex mathematical algorithms that process seismic data in real-time. Returning to the theme of AI in the context of resilience, it is notable that France committed EUR1.5bn to a national AI strategy in 2018 (https://www.inria.fr/en/french-national-artificial-intelligence-research-program), expanding their commitment in 2021. A part of this effort called “PERP” is “…Priority Research Programmes and Equipment) piloted by CEA, CNRS and Inria, dedicated to embedded AI and frugal AI, decentralised AI and trusted AI, as well as the mathematical foundations of AI” (my emphasis). Investment for Sovereign Security and Resilience Despite these critical applications, Australia lacks the necessary investment in residential mathematical sciences infrastructure. Overseas examples include Germany's Max Planck Institutes or France's Institut des Hautes Études Scientifiques (IHÉS). In a geopolitical context where sharing of deep expertise – especially in issues of national security and resilience – can no longer be taken for granted, this represents a serious gap in Australia’s critical infrastructure.

Q35.

2.3 The case for a new NRI capability, or enhancements to existing capabilities, typically emerges through advocacy from research communities clustering around rigorously identified needs and goals. Such a concept could respond to a requirement for novel or expanded capacity within a domain, or across domains, and must be such that it could only be made available with national-level investment.

If you have identified such a requirement, briefly describe the need, the proposed infrastructure capability, the medium-term goals, impacted research communities, and the timeframe over which you advocate its establishment. Your response can include links to relevant existing reports.

Identified need: A National Priority - The Urgent Need for Investment in Mathematical Sciences Infrastructure In my response to q2.2 I outlined ways in which advanced mathematical sciences benefit national security and resilience. Australia constantly faces the challenge of having to 'punch above its weight' in many areas of importance. Having identified investment in advanced mathematical sciences as critical in the medium to long term, the question is how to invest in research infrastructure in a highly effective way. My response is based on the observation that Mathematics – in particular advanced mathematics – is an activity that absolutely requires a physical and mental environment that allows deep individual concentration, as well as fruitful collaboration. While everyone is familiar with the possibilities of online engagement, even in the general workplace the limits of virtual interaction have become clearer and are particularly acute in Mathematics. Collaboration in advanced mathematics require dedicated research time in an amenable environment – one that simultaneously allows for solitude and sustained personal and professional interaction. This 'amenable environment' is the 'lab' for mathematics – unlike experimental or other sciences very little other equipment is required, but an appropriate residential facility fulfils the key need. To date national investment in a residential advanced mathematics research centre has effectively been absent. This contrasts starkly with developed countries which established significant national infrastructure for mathematical sciences through the 20th century, with strong government backing: 1. The Isaac Newton Institute for Mathematical Sciences in Cambridge, UK, serves as a prime example of a world-class mathematical sciences research institute. Additionally in 2020, the UK announced a GBP60 million annual boost for mathematical sciences infrastructure, significantly enhancing the activities of three leading mathematical institutes. 2. In the US, the Simons Laufer Mathematical Sciences Institute and the Institute for Pure and Applied Mathematics are renowned for their contributions to advancing mathematical sciences. Similar to the UK, the US established the Institute for Mathematical and Statistical Innovation in 2020 under the National Science Foundation to innovation across the mathematical disciplines. 3. In early 2024 China launched the Shanghai Institute for Mathematics and Interdisciplinary Sciences, complementing the Beijing Institute of Mathematical Sciences and Applications founded in 2021. Proposed Infrastructure – A Residential National Research Institute for Mathematical Sciences It is proposed that long-term national support be provided for MATRIX (https://www.matrix-inst.org.au), as it is uniquely positioned to address the infrastructure need for a national residential mathematical research institute. Operating on a lean budget for nearly ten years, MATRIX has been supported by five leading Australian universities (The University of Melbourne, Monash University, The University of Queensland, Australian National University and UNSW Sydney) and the US-based Simons Foundation. However, it has yet to receive sustained national infrastructure funding, with the exception of a single ARC LIEF grant. Despite this, MATRIX has achieved impressive results. As of the end of 2024, it has delivered 88 programs, bringing together 1,900 scientists from 47 countries, advancing knowledge across a broad spectrum of mathematical disciplines, from pure mathematics to applied research across scientific disciplines. Impacted Research Communities - Extensive Benefits for the Broader Scientific Landscape Fields that could benefit directly or indirectly from investment in a national residential mathematical institute include: Mathematical research centres across Australia: • MATRIX support brings leading mathematical researchers from around the globe to Australia. Once in Australia, they often visit and collaborate with Australian researchers at various university departments and SMRI in Sydney alongside MATRIX workshops, benefitting the entire Australian research community. Healthcare and Medicine • Genomic data analysis • Epidemiological forecasting Computer Science • Artificial intelligence and machine learning • Quantum computing • Algorithm design and analysis • Cryptography and cybersecurity Economics and Finance • Financial modelling • Risk assessment Emerging Technologies • Renewable energy systems integration Engineering • Aerospace engineering (flight dynamics, structural analysis) • Electrical engineering (signal processing, control theory) • Mechanical engineering (stress analysis, thermodynamics) • Civil engineering (structural mechanics, earthquake engineering) • Chemical engineering (reaction kinetics, transport phenomena) Physical Sciences • Theoretical physics (quantum mechanics, string theory, general relativity) • Astrophysics and cosmology • Materials science and solid-state physics • Fluid dynamics and plasma physics • Optics and photonics Biological Sciences • Computational biology • Bioinformatics Earth Sciences • Climate modelling • Geophysics • Oceanography • Meteorology • Seismology Chemistry • Quantum chemistry • Computational chemistry Timeframe – A step change Investment over 5 years MATRIX is proposing a phased approach that would require investment through 2030. This funding will provide MATRIX with the opportunity to significantly expand its operations, increase the number of research programs, and strengthen international collaborations with leading institutes. A significant portion of the funding will be dedicated to large-scale research initiatives that directly and indirectly support Australia's long-term national security and resilience.

Q36.

Part 3: Industry perspectives

This section is seeking input specifically from industry-based respondents. Other respondents can skip this section.

Recommendation 6 of the 2021 Roadmap related to improvements in industry engagement with NRI. To complement work on this topic that has occurred since then, we are seeking additional advice on NRI requirements as perceived by current or potential industry-based users.

Q37.

3.1 Have you (or your organisation) interreacted with or used Australia's NRI?

- ○ Yes
- ◉ No

Q38.

3.2 If so, please briefly outline the NRI capabilities you (or your organisation) have interacted with or used. Do not limit your response to NCRIS capabilities.

This question was not displayed to the respondent.

Q39.

3.3 Please indicate your (one or more) primary reasons for interacting with NRI:

This question was not displayed to the respondent.

Q40.

3.4 If you answered no, please indicate your (one or more) primary reasons:

- [ ] I did not know about it
- [ ] Other facilities suit my needs better
- [ ] I would like to, but cannot get access due to geographical location
- [ ] I would like to, but believed that access was only available to academic researchers
- [x] I am not aware of any capability that meets my needs
- [ ] Other (please specify)

Q41.

Part 4: Other comments

4.1 Please elaborate on any of your above responses or add any other comments relevant to the development of the 2026 Roadmap. Your response can include reference or links to existing reports that you recommend be considered during the 2026 Roadmap development process.

The following reports highlight the national need for investment in mathematical sciences and expose the current funding gap in this critical field in Australia: - Decadal Plan for the Mathematical Sciences (2016–2025) – Australian Academy of Science and the Australian Mathematical Sciences Institute: https://www.science.org.au/support/analysis/decadal- plans-science/decadal-plan-mathematical-sciences-australia-2016-2025 - ATSE 2025-26 Pre-budget Submission (Jan 2025): https://www.atse.org.au/media/ipioffw0/atse-sub-250129-pre-budget-submission-v3.pdf - AMSI-MATRIX Report on Research Investment and Expenditure (May 2024): https://amsi.org.au/wp-content/uploads/2024/05/amsi-matrix-research-funding-report-may-2024.pdf - Call to Action Based on AMSI-MATRIX Findings (August 2024): https://www.matrix-inst.org.au/call-to-action/