Submission to the 2016 National Research Infrastructure Roadmap Capability Issues Paper

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Question 1: Are there other capability areas that should be considered?

The current draft roadmap identifies some important key areas which align well with the Science Party's support of biomedical research (particularly life extension); combating and adapting to climate change through environmental monitoring and management, and investigation of non-fossil fuel energy sources; and involvement in the space industry.

Another area which we believe needs investment is fostering a culture for research across the whole of Australian society—teaching of critical analysis within education systems to foster the ability on a population level to recognise robust research, and the provision of incentives for conducting research.

Education is a critical part of Australia's future research infrastructure and a roadmap must include a plan for the people who will be undertaking this critical research. To that end, the Science party supports the reform of funding to public schools, improving staffing at disadvantaged schools and a commitment to the work force that our students will enter. This includes mandatory computer programming and STEM classes in schools. The Science Party also supports fully publicly-funded education at all levels, including university.

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Ideally, Australian researchers would have affordable access to international infrastructure due to participation in international collaborations and organisations. Where this is not the case, allowances should be made for Australian researchers to access the best infrastructure to answer their research questions.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

Access to international facilities should be prioritised when the need for the research is pressing, where the capability doesn't exist here, and when replication of the capability would be unnecessary or prohibitively costly.

Examples include research collaborations focussed on harnessing nuclear fusion energy, such as the International Thermonuclear Experimental Reactor (ITER), to which individual Australian researchers are contributing, but of which Australia is not a participant. Australians are also involved in particle physics research at CERN, under the auspices of a co-operation agreement, while membership comes at a greater cost but also brings advantages. Australia has also declined three invitations of associate membership from the European Space Agency, despite the benefits of membership.

While these and other projects present ready collaborations, it is important to note that an excessive focus on English-speaking and European collaborations might mean we are missing opportunities with our neighbours in the Asia-Pacific region. For example, the Japanese Space Exploration Agency (JAXA) may represent excellent collaboration opportunities for Australian scientists in a number of fields (see questions 21 and 22 for further discussion of the wide range of capabilities that can apply to space research).

Question 5: Should research workforce skills be considered a research infrastructure issue?

Question 6: How can national research infrastructure assist in training and skills development?

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

It is in the best interests of research institutions to support the development of researchers who are capable in the use of high-end infrastructure. This presents an opportunity for the bodies that administer infrastructure to partner with universities to take on Higher Degree by Research students who can gain training in the relevant techniques throughout their studies.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

The Science Party supports public investment in large infrastructure projects for which the cost is prohibitive and/or the return on investment is either indirect or too long-term to encourage private investment. Transparency is a core principle of the Science Party which we believe should apply to all aspects of the public service and public operations.

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

Care should be taken when defunding and decommissioning infrastructure. In particular, the uniqueness of national research infrastructure when compared to international infrastructure should be a contributing factor when determining to decommission infrastructure. Research fields sometimes decline in relevance or importance as fields advance, but this does not necessarily herald the extinction of the field in question. As a field becomes less relevant or important, it may be safe to decommission some of the infrastructure associated in with the field if there are multiple efforts in Australia or elsewhere. However, removing the last remaining or only piece of infrastructure in a field becomes a less straightforward choice, as it is difficult to regain lost capabilities and expertise. In such an event, the relative utility of the field as a whole should be considered relative to the utility of other spending options of the government.

Ways to safely decommission infrastructure without threatening the value of the research performed may include investing in more cost effective infrastructure, or forming international collaborations to reduce duplication of similar efforts.

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

The Science Party supports a mixed approach to scientific funding prioritisation. Scientific research ranges from incremental to revolutionary. Incremental research, which makes consistent but small advances on recent existing research, should typically be prioritised based on immediate net effect on utility (utility is used here in the moral philosophical sense). Trying to solve the biggest problems that affect the most people that are the easiest to solve should be the highest priority. For example, solving problems that we a priori believe are easy to solve should be attacked with small amounts of money. Problems that are harder, but that affect a large number of people, should receive larger amounts of money.

It is possible that rare diseases get too much funding using this model. An investigation into the cost-effectiveness of research into rare diseases should be carried out to determine if the funding culture of the governments of the past reflect the true priority of those disease in terms of funding received.

The other category of science, revolutionary science, is harder to price in a rational way. What is the economic and utility contribution of Einstein's work on the photoelectric effect, quantum mechanics, special relativity and general relativity? It is not difficult to make an argument that the contribution is in

the order of trillions of dollars already, and over the existence of the human species may be many orders of magnitude greater than that. The hard part is to determine what to put into higher-risk fields such as mathematics, physics and other cutting edge fields. Will putting ten times as much money into mathematics and physics result in ten times as many Einsteins? How does one judge the performance of people in fields who may spend decades in a field before making a groundbreaking discovery?

As such, the government should maintain committed to a mixed approach. Some funding should be directed to research with short-term goals, determined on a competitive basis with regular review, but we should also fund some research with long time horizons and higher risk. Doing so will give the community comfort that hard questions are being worked on while incremental (but important) advances are being made.

Question 11: When should capabilities be expected to address standard and accreditation requirements?

Accreditation processes—and government submissions in general (including this one)—are often vague. Success in accreditation can sometimes be more a reflection on the researcher's skill in terms of shoehorning their research capabilities into government documents than the importance of the research or the quality of the work being performed. This is not an easy problem to solve, and we don't believe we have the magic wand. However, it should be noted that added bureaucracy has a tendency to exclude smaller players. When forming standards, compliance and accreditation requirements, the government should take into consideration the relative cost of fulfilling the requirements of the bureaucracy. Research grant applications should have a recommended compliance budget line on every application where compliance is necessary, and if additional compliance requirements are added by the government, the government should consider adding additional budget to existing projects.

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

The identified emerging directions and research infrastructure capabilities identified are aligned with the current health research environment both in Australia and globally, however there are a number of additional considerations that should be included in the Roadmap:

Diseases of aging

Industry currently focuses on diseases that affect younger people with long-term expense schedule. Diseases that currently affect older people are considered to be end-of-life diseases, however this is only the case because these diseases coincide with that stage of life currently. Diseases that occur in older people stand to be cured, extending the life of these patients.

Health delivery systems

Investing not only in pharmaceutical innovation but also health care provision and health care delivery is vital. There is a significant focus in this document on novel therapies and on translating research into

these areas into clinical practice (5.2.1, 5.2.2, 5.2.3, 5.3.4). However, cost of treatment remains a formidable barrier to the availability of these therapies to the population, and has special relevance for the Australian funding model for medications. The Roadmap currently does not address health economics research as an important component to understanding these cost implications, and to find feasible mechanisms of paying for the translation of these novel therapies into clinical practice, to maximise access while relieving pressure on the current funding systems.

Research QMS

The recognition of a gap in the form of a system-wide research quality management (5.1.5) system is an excellent step and critically needed to standardise quality oversight of research across Australia, in line with the most advanced academic and industry-based research environments around the world, to make us truly competitive. However, there is no further mention in the Roadmap document of how this gap will be addressed through desirable new capabilities (5.3).

Big data

As indicated in the Roadmap (5.3.5), collection of population-level data is not new. However, unified platforms that allow for standardised collection of this data, especially in the health sector, in a way that it can be linked seamlessly and cleanly, are needed critically and urgently to make these data useful. The quality of data being collected is also very important to increase its utility for research. Investments into data landscaping exercises with clear communication to researchers about what data is available, how it can be linked, what the access rules and conditions are around the use of this data, and the costs and processes involved in accessing the data is essential to allow researchers to plan their projects.

The health sector also needs more and better registries. The Swedish model is a good one to consider, with registries that not only collect data passively, but also provide quality metrics to clinicians to help them improve performance/outcomes. With well-trained staff, these registries can be an invaluable resource not just for data, but they can also be linked directly to clinical trials to allow access to wider pools of patients.

The suggestion to link health data to non-health data is very positive and has the potential to deeply enrich health outcomes research while creating significant cost efficiencies and ensuring higher quality results.

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Australia should be participating in both private and public international research collaborations. The government should be acting as a facilitator to make sure that the right contacts are being made between research scientists.

Precision medicine/genomics (5.2.4, 5.3.3) is an important current trend in health and medical research. Cost considerations are important here, and research around payment models is crucial to understand how these tests can be scaled up to reach the entire population where their benefits can be fully realised. This is also a crucial area for Australia to collaborate with international biobanks and genomics databases where the infrastructure has already been developed and implemented, and integration of data from Australian populations would allow for a much richer information output than isolated efforts.

Google Calico and Human Longevity Inc. are examples of private companies tackling age-related diseases, and 23andMe is a firm focussed on providing low-cost genetic sequencing services. Using some of the services of these companies may result in low cost advances for public health care. Wholly relying on private partnerships for any field has significant risks associated with it, however private partnerships should make up part of the mixed approach for future research and health care capabilities.

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

Areas that we believe are important are:

- Research involving wearables and mobile devices—both to validate the use of these devices for data collection, especially in a research setting, and in the context of treatment delivery/support.
- Health systems research: telemedicine, robots for assisting the elderly, remote robotic surgery, improvement in management of chronic diseases from a systems perspective, optimisation of patient flows in hospitals to reduce waiting times and improve outcomes.
- 3-D printing of organs and organ-on-a-chip technologies for increasing the efficiency and reducing costs of clinical trials.
- Human/technology interface: biomechanical devices (e.g. spinal cord stimulators). Australia has already realised significant impact in this area with the cochlear implant and bionic eye, but this is still a major emerging trend which needs a more capability and infrastructure development.

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

Energy

Australia's energy security into the future is an area of major concern. Australia relies heavily on fossil fuels both to power itself and as exports. Given the ample conditions for solar and wind generation, and the plentiful supply of nuclear fuel, Australia should focus on alternate methods of power generation.

Although we have plentiful resources for ourselves without nuclear, we are responsible for 9.3% of global uranium production and have 29% of global reserves[1]. Being a major supplier of fissile material means that we have a responsibility to determine methods that generate nuclear power with greater long-term cleanliness. Australia, with plentiful resources and reasonable wealth, should be at the forefront of nuclear research.

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Advanced chemistry and physics discoveries will advance our understanding of, and capability in, areas from materials science to biomedicine. Without the initial investment in chemistry and physics the designing of materials (such as polymers), processes (such as those used in batteries) or states (such as the Bose–Einstein condensate) would not be possible. These fundamental science fields are often looked over for those that are closer to market.

[1] http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx

Physics

Quantum computing is an area in which Australia should remain a world leader. We must also support our synchrotron and cyclotron capabilities, as these provide our research scientists with the ability to perform advanced materials analysis without the need for international travel.

Space

The Science Party is a strong advocate for an Australian space industry and believes that there should be a greater focus on space science. We agree some consideration should go into establishing launch capabilities again and believe research should be conducted to discover the viability with a focus to be placed on land requirements, air space restrictions and environmental impact. However, research priorities should be placed on materials science for fabrication as this is an important sector in the space industry that is for ripe for specialisation. Key examples of advanced materials that promote the growth of the space industry include aerogels, metal foams and nanomaterials.

Another emerging direction in the field of materials is the additive manufacturing sector. 3D printing and similar technologies will be a huge commercial industry in the future. Allocating funding towards advancing these processes will put Australia in a prime position to capitalise as an industry leader, and these technologies will also be instrumental in effective space colonisation.

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Australia should accept the European Space Agency's invitation for membership as this would increase Australia's market for the space sciences and allow us to specialise in key areas such as materials science (fabrication), aeronautics and propulsion. To facilitate this, an Australian Government Space Agency should be established to handle all space related collaborations in research and development. As an associate member of ESA, Australia would benefit economically (Canada receives an equal return or greater for every dollar they contribute to ESA). This is in addition to contracts and projects from other space agencies like NASA, and those in our region. The Japanese Space Exploration Agency (JAXA) in particular, presents outstanding growth and innovation opportunities for Australia.

As discussed in the capability issues paper, Australia has played an important role in modern astronomy and astrophysics. The Australian Research Council's support of the Laser Interferometer Gravitational-Wave Observatory (LIGO) was explicitly noted during the announcement earlier this year that gravitational waves had been directly measured; what many people have declared the beginning of gravitational wave astronomy. Western Australia was proposed as a detector site, however in 2011 the Australian government would not commit to funding. Given that we are now seeing a whole new field of gravitational wave astronomy emerging, this should be seen now as a sizable missed opportunity. Given our history of strength in astronomy Australia should aim to play a large role in the future of gravitational wave astronomy.

On 8 September 2016, the Australian Research Council released the successful funding grants for the Centre of Excellence projects[2]. Amongst the successful grants were the astronomy project CAASTRO-3D and a new gravitational wave project. This shows a clear indication from the ARC of the direction it believes Australian expertise in Space and Astronomy should take.

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Nuclear Fusion

[2] https://rms.arc.gov.au/RMS/Report/Download/Report/a3f6be6e-33f7-4fb5-98a6-7526aaa184cf/66

Australia should assist with international efforts or play host to research of self-sustaining nuclear fusion. The attainment of nuclear fusion would give us near limitless clean, nuclear energy. To achieve this, worldwide cooperation will be necessary, as the cost of establishing such technology is beyond most countries' budgets, Australia included. Australia should increase its involvement in nuclear fusion research, and encourage other nations to follow suit. Research into nuclear fusion is part of the diversified, long-term strategy of the Science Party regarding energy.

Mathematics

While this section heading contains the word 'mathematics', there is essentially no mention of mathematics in the content. In recent years Australia has put a large emphasis on research that is low risk, with short-term goals in mind. This leaves mathematics—as a field of research—underfunded, along with all other fields of purely theoretical work. In addition to focussed research priorities, it is important that we return support to so-called blue sky research; research for the sake of curiosity. This is often orders of magnitude cheaper to fund and where the majority of paradigm-shifting science happens.

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

In the interests of creating liveable cities, the Science Party is in favour of collecting data relating to the behaviour of people in urban areas (8.2.1) to improve urban planning.

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

To the best of our knowledge, Australia has only three BSL-4 laboratories: two in Victoria and one in Queensland. The continued emergence of new pathogens indicates a need for more such facilities, particularly in other parts of the country.

The focus on cyber security at the expense of academic freedom is a concern for the Science Party. We believe that the Defence Trade Controls Act (which controls many items deemed to be "dual-use", including strong encryption) was formulated with very little regard for the impact on scientific development or the impact on the economy as a whole. An urgent review of this legislation is needed.

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

Notably absent is mention of access to published research. The world is moving from the paywalled model of traditional journal publishers towards free or low-cost sharing of information, including of academic publications through open-access journals (although these sometimes demand fees of the authors) or via services such as ArXiv. This move will not only benefit established research institutions which currently pay high fees for journal access, but will allow participation in scientific research by citizen scientists who would otherwise not have access to the latest published findings.

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33: Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

High-speed internet—for both uploads and downloads—on a national scale is of the utmost importance for any cloud infrastructure to be a consideration in future research capabilities. Increasing the speed at which data can be communicated to no less than 100/25 Mbps is important for the distribution of data between researchers nationwide and vital to Australia's participation in data-intensive research.

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.