Submission
2016 National Research Infrastructure Roadmap
Capability Issues Paper

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SECTION 3.1: CAPABILITY AREAS

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

The Government announced National Science and Research Priorities (SRPs) on 26 May 2015. The Department of Industry, Innovation and Science (DIIS) notes that Attachment C to the *National Research Infrastructure Capability Issues Paper (July 2016)* maps the research infrastructure capability focus areas against these priorities. Future investment in national research infrastructure (NRI) should take account of the SRPs.

SECTION 3.2: GOVERNANCE

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

The Australian NRI system is composed of diverse facilities, hosted by universities, private companies, publicly funded research agencies (PFRAs) and Australian Government departments. Funding support is delivered through grants programmes and administered funding and in many cases is supplemented through co-investment and modest user pays arrangements where possible. Governance arrangements across the range of existing NRI vary considerably according to the nature of the NRI in question, the structures and norms of various discipline communities and the requirements of the participants and funders.

The DIIS incorporates the Australian Astronomical Observatory (AAO), the National Measurement Institute (NMI) and Questacon as divisions of the department, each of which host significant infrastructure. It should be noted that extra-departmental PFRAs, as hosts of NRI facilities, are also part of government, have governing Boards, deliver annual reports and are subject to Senate Estimates scrutiny and in some cases, the Parliamentary Standing Committee on Public Works. This also applies to government departments that host NRI. DIIS does not consider it appropriate for a 'one size fits all' governance model to be imposed on individual projects or facilities. DIIS does, however, support an effective and efficient approach to governance and considers that opportunities to streamline governance arrangements across facilities should be explored as appropriate.

It would be worth considering the benefits of being able to garner independent, expert advice to government on NRI priorities from a ministerially appointed board or similar advisory body with ongoing oversight across the NRI system. This could be comprised of a small number of suitable

qualified members, both in terms of expertise and experience, as well as an ability to appreciate new areas of NRI requirement.

Such a body could:

- provide independent, expert advice to government on NRI at particular points in the planning cycle;
- undertake regular roadmapping exercises to identify priorities for collaborative research infrastructure for the following 10 years; and
- oversee development of a comprehensive, national collaborative research infrastructure inventory.

Cognisant of the Smaller Government Agenda, this role could be filled by an existing body such as the Commonwealth Science Council or the Innovation and Science Australia Board (or appropriate sub-committee in either case).

DIIS supports the development of a framework that guides long-term investment in NRI. The framework needs to be flexible enough to accommodate all national collaborative research infrastructure facilities, not just those funded through the National Collaborative Research Infrastructure Strategy (NCRIS) grant programme.

Research infrastructure roadmaps are an appropriate and proven, mechanism for determining Australia's future research infrastructure priorities. DIIS supports roadmaps being undertaken on a regular basis, such as every five years, with oversight by an appropriate governing body. It may be appropriate for the oversighting body to appoint an expert working group to undertake these roadmapping exercises, similar to the current process.

Part of the role of this body, in determining priorities for future investment, should be to prioritise funding for facilities and make assessments of whether existing facilities should be defunded or decommissioned.

To support future investment in NRI, it is proposed that regular evaluations of the economic and social impact of research infrastructure be undertaken. The body should be responsible for commissioning and overseeing such evaluations. This will support the case for ongoing funding for NRI, but may also provide a mechanism for standardised comparisons of the value of diverse facilities, given the level of investment made by the Government.

SECTION 3.3: INTERNATIONAL

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

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

International research facilities are increasingly becoming an important complement to Australia's NRI system and access to such facilities should be funded through NRI investment where appropriate.

Such investments should be considered in light of international opportunities, with an analysis of the benefits of building locally being considered relative to either co-investing or accessing international facilities through user-pays mechanisms. This should apply to NRI facilities, as well as those global research infrastructures, or 'mega science' facilities, where single government investment is untenable or there are few suitable sites for a particular facility.

There are finite resources available for investment in NRI - it is impossible or does not make sense to fund construction and operation of all priority research infrastructure facilities locally. As such, it is often more effective to leverage funding to invest in international facilities, when appropriate. Investment in international facilities should continue to be driven by:

- Willingness of a country or countries to fund and maintain a facility and receptiveness that Australia access the facility through a subscription or other mechanism. For example, investment in a component of infrastructure or an upgrade may be economically viable where construction of a standalone facility in Australia is not. In some circumstances, there can be scope for a portion of this activity to take place in Australia, driving technological development and innovation as well as Science, Technology, Engineering and Mathematics (STEM) employment opportunities within the country.
- Australia not being physically suited to host a facility - there may be certain facilities that are more appropriate to locate overseas due to environmental/physical/climatic conditions. For example, Australia is well suited to radioastronomy, given the large land mass and low population levels in remote areas but due to geographic isolation would not be well suited to hosting a facility like the Conseil Européen pour la Recherche Nucléaire (CERN).
- Costs, specifically if they are prohibitive or construction is not financially viable without external support.
- Opportunities exist to increase expertise/skills of Australian researchers and build capacity and capability for future investment in emerging technologies.

Other reasons that investments in international NRI might be made could include the development and maintenance of strategic international partnerships, or to support economic development under appropriate conditions for example.

Opportunities to leverage existing government funding programs to gain access to international research infrastructure should also be considered. For example research costs such as travel can be supported through grants from the Australian Research Council and the

National Health and Medical Research Council. The DIIS Global Connections Fund (GCF) and the Global Innovation Linkages (GIL) programme could both provide modest support for access to international research infrastructure (noting each grant is capped at $50,000 and $1 million over four years, respectively). While these funds are aimed at supporting collaboration between industry and researchers, they are not fit-for-purpose in terms of facilitating access to research infrastructure and are expected to be highly competitive and oversubscribed.

There may be opportunities to enhance international researcher-researcher and research-industry collaboration through access to international facilities by Australian researchers, where infrastructure is not available in Australia (e.g. could be a specific piece of equipment/beamline at an overseas facility) or where Australia is not already paying a subscription to access international facilities.

For example, the Australian Synchrotron Research Program provided access for Australian researchers to access overseas Synchrotrons. The program allowed researchers to access otherwise unavailable techniques, but also built important expertise and a user community within Australia. It yielded important knowledge and networks necessary for constructing a local facility and established and strengthened international collaboration.

Further, international involvement or partnerships should be encouraged for Australian NRI facilities. This can be achieved by encouraging investment in NRI by international parties. This has proven successful for the Australian Nuclear Science and Technology Organisation (ANSTO). The organisation has a formal collaboration with Taiwan to build and operate a state-of-the-art $8 million triple-axis spectrometer (SIKA) at the Open Pool Australian Lightwater (OPAL) research reactor. SIKA was funded by the National Science Council of Taiwan, with the construction phase of the project managed by the Centre for Neutron Beam Applications at the National Central University (NCU) of Taiwan. Taiwan's National Synchrotron Radiation Research Centre (NSRRC), which involves the ongoing placement of six NSRRC staff at ANSTO, now maintains full responsibility for operation, maintenance, repair and resources for the instrument. In return for its investment in SIKA, Taiwanese researchers gain merit-based access to the Bragg Institute's instrument suite, commensurate with 70 per cent of SIKA's capacity. Taiwan is committed to bringing its researchers to OPAL, in preference to other facilities in the United Stated of America (USA), Japan or elsewhere in Asia.

SECTION 3.4: SKILLS AND TRAINING

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?

Appropriately trained and skilled technicians and researchers are essential for the operation and exploitation of what are typically specialised and complicated facilities. Without a skilled workforce, NRI facilities cannot be operated or used effectively.

Predictable funding for NRI facilities to provide certainty, for both technicians and researchers, is important for retention of talent. For NCRIS facilities, a decade of operating funding is the first step in being able to offer career pathways for technicians and researchers. If not already the case, NCRIS funding agreements could stipulate the proportion of funding to be spent on specialist technical and research staff.

NRI facilities have a number of mechanisms to develop skills and training. Most directly, they are responsible for supporting and developing the technical and research staff that operate and maintain NRI. They should be encouraged, wherever possible, to support opportunities for learning and development for staff. This is demonstrated at the Australian Synchrotron (the Synchrotron), where a component of available beamtime is quarantined for staff-specific research (including for staff development). This means that technicians are able to maintain their own projects and publications, which is important for future career prospects and to keep skills current to support future development.

NRI facilities also have the opportunity to support postdoctoral students and fellows. This could be achieved through facilities preferentially weighting early career researchers (ECRs) in access models.

Attracting international students through access to and training at NRI facilities is also important to support Australia as an education destination. In 2014-15, international students studying and living in Australia contributed approximately $18.2 billion to the Australian economy.[1] The benefits are not quarantined to financial gains; networks are built and maintained at the research group and institution level.

A number of NRI facilities within the Industry, Innovation and Science portfolio run outreach and learning programs for primary, secondary and tertiary students, igniting an interest and passion for science and engineering, developing the next generation of researchers. One example is the CSIRO Astronomy and Space Science (CASS) mentoring program, run in the remote Western Australian community of Pia, where the Australian Square Kilometre Array (SKA) Pathfinder is located. CASS has been visiting the Pia Remote School since 2006 to run educational programs including viewing nights and more recently programs to discuss career options with students. Community engagement is considered essential, given the SKA will be hosted nearby when constructed.

[1] Research Snapshot November 2015

With regard to the role of institutions preparing 'infrastructure ready researchers', there are opportunities to access NRI to train students and ECRs using institutional funding. For example, a number of university foundation investors in the Synchrotron, including Monash, La Trobe, and a consortium of Western Australian Universities, used their 2.7 per cent preferential access to beamtime, secured for five years, in return for a $5 million contribution for student and ECR training.

There is also a need for NRI facilities to train users, particularly those from institutions that are not familiar with a particular facility, or where a facility is in its infancy so a mature user base has not yet been established. By way of example, the Winter School scholarships offered through the Australian Institute of Nuclear Science and Engineering (AINSE) encourage undergraduates to take an interest in nuclear science and engineering and to learn how to apply these techniques in their future research.

SECTION 3.5: ACCESS

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

NRI, by definition, is funded to enable world-class research. It should be available to Australian and international, publicly-funded researchers and industry users.

For Government funded NRI, where the resource is finite and access has to be rationed, access should be primarily merit-based. This is consistent with international experience for comparable facilities and is in line with the Global Research Infrastructure Framework (Group of Senior Officials on Research Infrastructure). The benefits of merit-based access have been recognised in the *European Charter for Access to Research Infrastructure* (2015) – it enables collaborative research and technological development across geographical and disciplinary boundaries. User charging for proprietary access should also be encouraged, but be capped at a percentage of facility use. A primarily merit-based approach would ensure that facilities continue to support high quality outcomes.

The criteria for merit-based access to NRI could include weighting for alignment with the SRPs, as currently used by some NRI facilities. The growth sectors could also be used, as is the case for several funding programmes, including the Australian Research Council's Industrial Transformation Research Programme, Cooperative Research Centres projects and the Global Innovation Linkages programme. Further to this, applications could be considered in light of alignment to the Industry Growth Centres' Industry Knowledge Priorities (IKPs), which are under development, and will set out the industry research needs of, and commercialisation opportunities in, the growth sectors.

Access models that reward co-investment should also be considered. An example of this could be preferential access to facilities, on the basis of co-investment in either operating or capital costs. Such access should expire after an agreed time period, to offer opportunities to other parties. As previously noted, the level of preferential access available at a facility should be capped at a percentage of facility use to ensure the NRI fulfils its primary objective.

It is also important that access models encourage collaboration among local and international researchers and industry. Open access by international researchers to Australian NRI is important for developing ongoing collaborations, exchange of knowledge and staff (in both directions) and also to maintain the general principle of reciprocal access, which allows Australian researchers to access overseas facilities. Open and transparent access processes are considered particularly important to encourage industry use, especially for use by small to medium enterprises. Development of a consolidated guide to all NRI (including but not limited to CSIRO, ANSTO and NCRIS facilities) would be beneficial to assist firms to identify what infrastructure capabilities exist and how to access them.

SECTION 3.6: DEFUNDING AND DECOMMISSIONING

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

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?

NRI assets are generally large-scale, complex and long-lived facilities. DIIS strongly supports whole-of-life planning and funding, when prioritisation occurs in the roadmap context.

Any decision to defund a facility should be undertaken by an independent body with responsibility for NRI. To support this process, lifecycle planning should include facility reviews every four years and again at a set stage of life. Perhaps at the half way point of the effective useful life (as determined at the inception of a facility) a decision on defunding, i.e. whether the Government should continue to support a NRI should be made.

Factors that should be considered include:

- Is the facility or capability collaborative and/or accessed by diverse users?
- Is the facility or capability leading-edge, or are there newer more effective and efficient technologies?
- Is the facility or capability enabling high quality research (in the form of excellence and/or outcomes)?
- Is the level of investment required to continue operating the facility or capability higher than building and operating a new, replacement facility?
- Is the level of investment required to continue operating the facility or capability higher than co-investing or user pays options at international facilities?[2]
- Is the facility delivering the services intended and/or to the expected standards?
- Is the required investment no longer significant, and could/should be met by an individual institution?

Decommissioning has a technical/legislative definition and should be addressed for NRI facilities, as the associated costs can be significant.

[2] Other factors must also be considered including strategic importance and the need to retain a national capability.

SECTION 3.7: FUNDING FOR RESEARCH INFRASTRUCTURE

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

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

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

Wherever possible, whole-of-life costs should be considered for NRI facilities, including those associated with decommissioning facility sites, buildings and equipment, as appropriate. Funding should address operating and capital requirements, including ongoing minor capital and maintenance needs to ensure the NRI remains at the technological leading edge and stays relevant to the research it supports.

The response to questions 5 – 7 deal with support for students and researchers.

Financing models should encourage co-investment by industry, universities, state and territory governments and other countries.

SECTION 3.8: STANDARDS AND ACCREDITATION

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

DIIS recognises that meeting standards or accreditation will incur costs for NRI facilities. Costs of meeting standards or accreditation should be considered to be part of standard operating costs and taken into account when assessing if an NRI facility should be constructed or defunded.

Capabilities should address standard and accreditation requirements where international standards exists and where capabilities are aimed at gaining access to global supply chains. For example, adoption of Industry 4.0 presents an opportunity to develop Australia's future manufacturing capabilities in line with existing international standards.

The Prime Minister's Industry 4.0 Taskforce (the Taskforce) is leading efforts to assist Australian industry to transition to modern production methods that take advantage of data and digital technologies to improve business processes and production systems (commonly termed 'Industry 4.0'). These methods are currently being adopted by industry in most advanced industrial nations. Successful adoption of Industry 4.0 is critical for Australian manufacturing to remain globally competitive.

The German Government, through Platform Industrie 4.0, has identified more than 500 sites where funded Industry 4.0 projects are being carried out in Germany. There are a number of testbeds at universities and research institutions in Germany where complex components and systems are tested and further developed in a realistic, simulated environment. These testbeds are also networked to enable realistic simulation across several test environments.

One of the Taskforce's aims is for Industry 4.0 testbeds, such as those identified in Germany, to be made accessible to Australian businesses.

SECTION 5: 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?

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

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?

Health and Medical Sciences is an important infrastructure capability and aligns with the Health SRP. NRI facilities that support this capability would be expected to address the SRP practical challenges regarding models of health care, local and regional health threats, better health outcomes for indigenous Australians and technologies for self-management of healthcare. Improved data integration and management is considered an area that could provide opportunities for NRI prioritisation and international collaboration is also important and could be achieved through access to or investment in international NRI for example.

DIIS considers that the draft Sector Competitiveness Plan prepared for the Medical Technologies and Pharmaceuticals (MTP) Growth Centre (MTPConnect) is consistent with the issues paper.

Currently, the Australian MTP sector has low rates of local commercialisation with research often moving offshore for further development. Through its draft Sector Competitiveness Plan recently released for stakeholder consultation, MTPConnect sets a 10 year strategy for the sector which seeks to improve the translation of Australia's research into value-added products, through onshore commercialisation, and helping companies to seize global export opportunities.

MTPConnect's vision is for Australia to retain all current and planned levels of research and development investment while achieving greater commercialisation success, creating more products that reach proof-of-concept and early stage commercialisation, increasing the number of medium-sized to large companies with late stage product successes, and maximising the value of any Intellectual Property-monetisation events along the way. The Plan identifies Sector Growth Priorities that will underpin this vision and address elements of the value chain and includes for example:

- Creating a highly productive commercialisation environment from research to early clinical trials and proof-of-concept.
- Strengthening Australia's position as an attractive clinical trial destination.
- Supporting the development of digitally enabled MTP solutions: devices and data analytics which will benefit patients while enhancing Australia's relevance in a fast growing area of the global economy.

DIIS considers that there are international projects with which Australia should engage over the next decade and beyond. Collaborations are continuing to develop and should be focused on innovation priorities. For example, the mandate for the government-funded industry-led MTPConnect includes improving their capability to engage with international markets, in particular in Asia. DIIS and MTPConnect have been developing links with international counterparts.
As flagged in the issues paper (part 5.1.3), the research infrastructure roadmap should emphasise the need for collaboration at the key translation stages of proof-of-concept and early-stage commercialisation, to seize global opportunities.

The paper highlights the role that stem cell science can play in the future of Australia's health and medical science and the importance of collaboration. This complements existing government support. For example, on 18 December 2015 the Australian Trade and Investment Commission (Austrade) signed a Memorandum of Understanding (MOU) with Japan's Forum for Innovative Regenerative Medicine (FIRM). DIIS is working with Austrade to ensure that this collaborative work is fully realised. The objective is to identify effective ways to help Australian and Japanese researchers and companies collaborate to increase commercial outcomes and therapy solutions.

SECTION 6: 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?

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?

NRI facilities that support this capability have potential to contribute to a number of the SRPs and associated practical challenges. For example, the Atlas of Living Australia,
Integrated Marine Observing System and Terrestrial Ecosystem Research Network all contribute to critical information collection that is important for the SRP on Environmental change. They are particularly relevant to the practical challenge of improving accuracy and precision in predicting and measuring the impact of environmental changes.

There is also alignment with government policies. METS Ignited is the not-for-profit company responsible for delivering the activities of the Mining Equipment, Technology and Services Growth Centre. METS Ignited's vision is for the METS industry to have an aligned, efficient and agile industry ecosystem with a high degree of collaborative, global leadership in innovation, and a growing share of the global market.

Through its draft Sector Competitiveness Plan, METS Ignited is working with the sector to identify its industry knowledge priorities. Once developed these priorities will complement the environment and natural resource management capability area.

Regarding emerging directions, the Environment and Natural Resource Management capability could reference that marine science and data collection are considered important in determining risks of seabed mining and developing technologies to protect the marine environment.

Mineral extraction could also be considered as part of the solid earth capability. As the industry moves to poorer quality ores and deeper deposits, more research will be required to extract and process these deposits (testing, modelling, improving extractive processes, three dimensional mapping and processing techniques). Reclaiming and rehabilitating old tailings or low grade ore stockpiles also relevant.

Further, an identified METS sector gap is infrastructure upon which new research and concepts can be tested. Unlike other sectors where developments can be tested at lab or pilot scale, mining innovations often require a living lab (a pilot mine), where concepts can be tested through to commercialisation. Miners can be reluctant to test technology on commercial mines due to the perceived risk. Test mines could also be used for training and skills development. This project has significant pull from METS and miners, who see living labs as an opportunity to bring together METS, miners and research organisations, in order solve real problems.

As is the case for other capabilities, better access to computer processing power and servers, particularly powerful and accessible cloud servers, could assist researchers and data analysts tackling significant Natural Resource Management issues requiring 'big data' processing.

Use of cloud hosting and servers such as Amazon Web Services, and machine learning (finding patterns in data using iterative processing) has been witnessed in resource sector 'hackathon' events – where teams of researchers hack big datasets and run algorithms to simulate model solutions to sector problems. These hackathon events are innovative and quick to find solutions.

SECTION 7: 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?

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

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?

This capability has relevance to several of the SRPs, including Energy and Advanced Manufacturing. The existing facilities, as listed in the issues paper, contribute directly to two of the three practical challenges under Energy, including low emission energy production and cost-effective and reliable clean energy sources and storage technologies. An example of NRI that is contributing to the Advanced Manufacturing SRP is the Australian National Fabrication Facility. This facility is fundamental to the development of high-performance materials, composites, alloys and polymers. The neutron beam instruments and Centre for Accelerator Science, hosted by the ANSTO also support materials research.

Refer to question 20 response under National Resources Management Capability – improved computer processing power to run mathematical and physical models against large datasets could solve resource sector problems.

The imaging and analytics facilities outlined under Advanced Physics, Chemistry, Mathematics and Materials Current Capabilities and Emerging Capability Needs' remain necessary for collaboration.

Looking forward, it is expected that Australia's involvement in astronomy infrastructure projects over the next decade will be international in scope, whether facilities are situated locally or overseas. It should be noted that Australia has already made significant investments in the Giant Magellan Telescope (GMT) and the SKA and should continue to play a leading role in provision of science and technology for these projects. With regard to long-term investments, once ratified, the SKA Convention will commit Australia to construction obligations and ongoing operational costs.

SECTION 8: 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?

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?

This capability will have the potential to support a number of the SRPs and practical challenges. For example, the National Centre for Indigenous Genomics is expected to support better diagnosis and treatment of diseases. This capability also aligns with the Transport SRP. The Australian Urban Research Infrastructure Network can support prediction and planning of tomorrow's urban centres. Expected impacts are likely to be higher productivity of the workforce due to shorter commutes and better health outcomes as a result of access to facilities for example.

SECTION 9: NATIONAL SECURITY

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

The Australian Cyber Security Centre represents an existing capability that has not been included under National Security.

DIIS considers that Food (recognised as one of the SRPs) should be more closely linked with the proposed national security capability area, particularly biosecurity and water security.

Access to research infrastructure enables food and agribusiness firms to develop solutions to technical challenges and to pursue commercialisation opportunities based on innovative product offerings. The vast majority of the 178,517 businesses in this industry are SMEs.[3] SMEs can be deterred from utilising science research infrastructure due to inflexible access and perceived high-transaction cost. Broad, flexible and low-cost access would enable greater innovative SMEs' use of NRI facilities and maximise value of government' investment.

In collaboration with CSIRO, the Food and Agribusiness Growth Centre identified Industry Knowledge Priorities in its Sector Competitiveness Plan. The Industry Knowledge Priorities highlight what the Food and Agribusiness industry requires from the Australian research sector. Four priority areas identified are food security and sustainability, enhanced production and value addition, a global market place and the future consumer.

The Australian food and agribusiness industry has a vital role to play in meeting the growing demand for food, improving global food security and enabling value addition. Therefore, priority research infrastructure will need to assist the food and agribusiness industry:

- Produce food sustainably and adopt innovative practices and technologies to improve productivity and environmental outcomes
- Ensure Australia's infrastructure, biosecurity and food safety systems to support a growing food industry
- Understand the effects of climate change on agricultural production and the development of mitigation strategies
- Develop novel food processing technologies, minimise food wastage and value add to wasted food
- Understand the needs of future consumers and better cater to changing consumer preferences in the context of ageing population and increasing prevalence of lifestyle diseases.

In regards to cyber security, the statement on page 37 of the issues paper that the 'The Centre will have responsibility for coordination of research and innovation activities…' is incorrect. The Growth Centre will work to align the many disparate cyber security research and innovation related activities in the private sector, research community, academia and across governments. It is not the responsibility of the Centre to coordinate, but rather to facilitate communication and provide a network for collaboration between the research and industry sectors.

On water security, there would be benefit in addressing water treatment research and technologies, given the critical part that both will play in ongoing water security.

Regarding opportunities for the capability, linkages could be established between existing cyber-security infrastructure overseas, including the MITRE operated federally funded research and development center (FFRDC) in the USA and the Gav-Yam Negev Advanced Technologies Park (ATP) in Israel. There are a number of examples of international collaboration in the national security space.

[3] Calculations based on ABS Cat. No. 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2011 to Jun 2015

Regarding Cyber Security, DIIS considers that there is a significant opportunity for Australia to capitalise on commercialisation in the Asia Pacific region. Cyber security capability is underdeveloped in a number of countries in the region (with some notable exceptions such as Singapore). There is an opportunity to capitalise on this from a market perspective, and to grow a shared Asia-Pacific cyber security research infrastructure.

SECTION 10: 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?

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?

DIIS recognises that this capability is foundational to the SRPs and associated challenges. For example, high performance computing (HPC) is necessary for fulfilling a number of the challenges and associated practical challenges. In turn, HPC is also essential to support a range of NRI facilities, including those in the astronomy space and the SKA for example. Similarly, activities undertaken at the OPAL research reactor contribute to many SRPs and other NRI capabilities, ranging from Health to National Security.

SECTION 11: 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?

Strategies for collecting and managing data are becoming critical, as the volume and in many cases complexity of information collected across all disciplines increases. Data is all-pervasive and is considered foundational to each of the SRPs. Data related activities also have the potential to drive technological innovation and enhance Australian industry capability.

The National Innovation and Science Agenda highlighted the important role of data as a driver for innovation. The commitment by the government to make non-sensitive data open by default and where possible, ensure non-sensitive publicly funded research data is made open for use, will create opportunities to use public and research data in new ways across and between disciplines. Research infrastructure to support data being findable, accessible, interoperable, and re-usable remains essential if Australian research is to take advantage of these new opportunities.

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.

NRI definition

For clarity, DIIS considers NRI facilities to be those with the following characteristics:

- funded to support a diverse range of users from more than one institution or sector; and
- involve significant collaboration by researchers on at least a national level; and
- may be single sited facilities or nationally distributed networks and enabling capabilities.

NRI includes:

- landmark facilities such as the Research Vessel *Investigator*, the OPAL research reactor, the Synchrotron;
- NCRIS facilities;
- unique collections for which a single or a number of institutions may be custodians;
- e-research investments; and
- Australian investments in international research infrastructure.

One of the key objectives of the Industry Growth Centres Initiative is to increase collaboration between industry and research, and improve commercialisation outcomes. To reflect the Government's focus on commercialisation of research by industry, the roadmap would benefit from discussion on how research infrastructure builds industrial competitiveness and improves linkages with industry. The roadmap could also identify how industry can access and benefit from improved NRI.