Australian Government

Department of Education, Science and Training

National Research Infrastructure Framework
The Final Report of the National Research Infrastructure Taskforce

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Chair

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1 Introduction

The National Research Infrastructure Taskforce was announced by the Hon Dr Brendan Nelson MP, as part of *Our Universities: Backing Australia's Future*, the Government's response to the Higher Education Review 2002. Dr Nelson asked the Taskforce to develop a National Research Infrastructure Strategic Framework to inform Government investment in research infrastructure for universities and publicly funded research agencies.

1.1 Terms of Reference

The Terms of Reference for the Taskforce are at Appendix A.

1.2 Taskforce Membership

The Taskforce is chaired by Dr Mike Sargent AM. Dr Sargent is Deputy Chancellor of the University of Canberra, a board member of the Australian Research Council, and Chair of the Australian Research and Education Network Advisory Committee.

Taskforce membership comprises representatives of the Australian Research Council (ARC), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Vice-Chancellors' Committee (AVCC), the National Academies Forum, the Federation of Australian Scientific and Technological Societies (FASTS), the Council for the Humanities, Arts and Social Sciences (CHASS), the Department of Education, Science and Training (DEST), the Department of Health and Ageing (DHA), the National Health and Medical Research Council (NHMRC), the Department of Industry, Tourism and Resources (DITR), and the Department of Communications, Information Technology and the Arts (DCITA).

Professor Laureate Adrienne Clarke, School of Botany, University of Melbourne, and Professor Max Bennett, Department of Physiology, University of Sydney, are members of the Taskforce in a personal capacity.

The Taskforce benefited from the assistance of the Defence Science and Technology Organisation (DSTO) and the National Office of the Information Economy (NOIE).

2 Executive Summary

A high quality research sector is an essential component of national competitiveness. Australia has highly effective mechanisms to promote research excellence using competitive peer reviewed processes and larger-scale mission-oriented tasking. Lack of access to research infrastructure of relevance and of global significance will, however, limit the outcomes and quality of Australian research. Therefore, to maximise return from investment in research, Australia must provide researchers with access to modern and relevant research infrastructure. Similar conclusions have been reached by other nations. Globally this has resulted in an increasing consciousness of the challenges to research policy-making and budgeting posed by research infrastructure. Appropriate levels of funding for research infrastructure must form a key component of any national research system.

The consensus across all Australian Governments and research institutions is that, while decisions on research themes or projects might be made through a competitive process, investment in research infrastructure should be made in a strategic, collaborative manner. This will require collaboration between Australian Governments, and a clear requirement that all universities, publicly funded research agencies, and research funding agencies cooperate in this National Research Infrastructure Strategic Framework.

Three broad questions emerged during the Taskforce's work:

- How to plan for, and to prioritise between, different infrastructure requirements.
- How to fund research infrastructure, including capital investment, standing operating and refurbishment.
- How to facilitate collaboration and access to research infrastructure. These are consistent with the results of reviews in other countries.

Submissions and consultations supported the proposition that there needs to be an overall national strategic framework for investment in research infrastructure. The four main foci of the Framework are:

- Establishment of a framework for collaboration between the major stakeholders in provision of research infrastructure – the Australian, State and Territory Governments, research institutions, and research funding agencies - all of which are significant investors in research infrastructure.
- Linking of research infrastructure decisions to national, regional, institutional, and thematic priorities, through a National Research Infrastructure Strategic Framework.

- The establishment of a National Research Infrastructure Council to manage the National Research Infrastructure Strategic Framework, and to assist in priority setting and decision-making on investment proposals for research infrastructure encompassed by the Framework.
- The development of specific ‘strategic road maps’ to integrate research priorities with research infrastructure investments.

Reviews of research infrastructure funding in many countries have come to similar conclusions.

The role of the National Research Infrastructure Council (NRIC) should include:

- To enhance, implement, review and monitor the Framework.
- To develop and implement a national process to identify and prioritise research infrastructure needs.
- To ensure that there are mechanisms through which thematic groups are able to identify and prioritise infrastructure requirements and specialised taskforces are able to identify structural and systemic infrastructure requirements.
- To ensure that, where these groups do not already exist, they are established.
- To consolidate the work of these groups with institutional, regional, national and international strategies and priorities, in order to develop this Framework for research infrastructure investments.
- To foster and actively seek collaborative ventures and collaborative investors.
- To advise Government on funding priorities for new research infrastructure funding programmes that may be introduced.
- To monitor and review the performance and capability of funded infrastructure.

To do this the NRIC should be representative of the research community and should include representatives of universities, publicly funded research agencies, research funding agencies, governments, and industry, and may be advised by international peer review.

In order for the NRIC to link investments in research infrastructure to strategies and priorities for research, the Taskforce recommends that a regular national process, under the auspices of a Strategic Research Council, be established to enhance coordination and to integrate the disparate research strategies and priorities of the Australian Government, regions, institutions, and thematic groups and, where relevant, bilateral and multilateral strategies and priorities, and thereby to develop a national strategic research plan.

The Taskforce considers that investments in research infrastructure should be developed around the following principles, and recommends that these principles be adopted by all universities, publicly funded research agencies and funding agencies:

- Infrastructure investments should support quality research across all innovation platforms from basic to applied research.
- Investment in research infrastructure should be made in a strategic and collaborative manner.
- Funding programmes and processes should recognise the need to support national, regional, institutional and international strategies and priorities as well as the strategies and priorities of thematic groups.
- Funding programmes and processes should foster collaborative investment in infrastructure, rather than competition for infrastructure funds.
- Investment in research infrastructure should be made in a transparent manner that provides effective use of funds and ensures that infrastructure is productive and remains viable.
- Funding of research infrastructure should ensure the ongoing viability of infrastructure by providing for effective operation and staffing, and for refurbishment while it remains relevant to research.
- Access regimes should, if appropriate, permit research infrastructure to be broadly available to researchers to support their research.
- Infrastructure investments should foster collaborative use of research infrastructure.

The National Research Infrastructure Strategic Framework addresses four categories of research infrastructure of importance in underpinning quality research associated with national, regional, institutional and thematic groups. These are:

- *Australian Foundation Facilities* which are systemic or structural facilities such as networks of instruments, advanced computers and data repositories and their associated services. These are almost unanimously recognised as vitally important.
- *Australian Landmark Facilities* which are unique, large-scale, complex facilities which are international in capacity.
- *Australian Major Research Facilities* which are facilities used to support research undertaken to address national and regional strategies and priorities, and generally involve multi-institutional and multi-sectoral collaboration.

- *Australian Research Sector Facilities* which are facilities generally shared by a consortium of institutions to pursue regional and institutional strategies and priorities and to support a number of research programs of international standing.

A fifth category of research infrastructure - Institutional Research Facilities - which typically facilitate institutional research priorities and support research projects undertaken by individuals and small teams, generally involving a single institution, is outside the Framework. Ideally, however, arrangements for this category of infrastructure would be consistent with the Framework.

Overall, the Australian Government makes a significant investment in research infrastructure each year through various research funding agencies and programmes, including higher education block grants and several ad hoc programmes. While the level of funding is significant, the ad hoc nature of some programmes has undermined the research community's capacity to plan for and prioritise research infrastructure needs.

There are statements that, over a period of time, there has been an underinvestment in research infrastructure. To bring funding for research infrastructure into balance with funding for research would require the establishment of ongoing funding programmes to support investment in research infrastructure that the Taskforce has categorised as *Australian Foundation Facilities, Australian Major Research Facilities* and *Australian Research Sector Facilities*, and for the development of business proposals for *Australian Landmark Facilities*. The increase required is relatively small compared to the Australian Government's total investment in research infrastructure. In addition, the Australian Government will need to continue to make capital investments in infrastructure the Taskforce has categorised as *Australian Landmark Facilities.* Such investments are usually considered through Cabinet processes rather than infrastructure funding programmes.

To facilitate collaborative investment and use, the research infrastructure funding programmes, apart from programmes directly supporting institutional infrastructure, should be designed and funded to permit proposals from universities, publicly funded research agencies and medical research institutes. Research infrastructure funding programmes should avoid inflexible leveraging requirements as this diverts funds from the purposes for which they were intended and often inhibits opportunities for participation. Irrespective of how funding for Institutional Research Facilities in universities is provided, universities should have an adequate level of discretionary funding to allow them to pursue regional and institutional strategies and priorities and to adequately support research projects funded by granting bodies.

The importance of understanding and sourcing funding for the capital, standing operating and maintenance costs necessary to maintain the viability of infrastructure has been widely recognised, as well as defining the regimes for access by researchers and charging for access. A number of such regimes are extant in

Australia, and provide the experience and the models for future Australian investment in research infrastructure. The Taskforce considers that the combination of funding research infrastructure for both capital and standing operating costs, and the recommended charging regimes based on marginal costs, provides the best outcome for research.

The Taskforce concludes that:

- To ensure consistency in the acquisition, governance, access and charging arrangements for research infrastructure, all universities, publicly funded research agencies and research funding agencies should follow one of five broad acquisition models defined in the Framework, and all research infrastructure investments with a Government funding component in excess of $5m should be consistent with this Framework and its acquisition, governance, access, and charging models.
- That access to Government funded research infrastructure by researchers in universities, publicly funded research agencies and medical research institutes should be based on a merit based allocation system.
- That the principle should be adopted that charging regimes for researchers in universities and publicly funded research agencies accessing infrastructure funded in accordance with this Framework should be related to marginal operating costs.

Associated with its recommendation that research infrastructure should be funded for both capital and standing operating costs, the Taskforce concludes that the introduction of a more formal and rigorous reporting regime is necessary for significant research infrastructure facilities, in which the host/manager of the facility reports annually on the operations of the facility, including usage, research supported and budget performance, and an assessment of the ongoing relevance of the infrastructure in respect of the research conducted.

2.1 Key Findings and Recommendations

The Key findings and recommendations of this Framework are:

That the Minister note that, to maximise return from investment in research, Australia must provide access to modern and relevant research infrastructure for researchers.

That investments in research infrastructure should be developed around the following principles, and that these principles be adopted by all universities, publicly funded research agencies and research funding agencies:

- That infrastructure investments should support quality research across all innovation platforms from basic to applied research.
- That investment in research infrastructure should be made in a strategic and collaborative manner.
- That funding programmes and processes should recognise the need to support national, regional, institutional, and international strategies and priorities as well as the strategies and priorities of thematic groups.
- That funding programmes and processes should foster collaborative investment in infrastructure, rather than competition for infrastructure funds.
- That investment in research infrastructure should be made in a transparent manner that provides effective use of funds and ensures that infrastructure is productive and remains viable.
- That funding of research infrastructure should ensure the ongoing viability of infrastructure by providing for effective operation and staffing, and for refurbishment, while it remains relevant to research.
- That access regimes should, if appropriate, permit research infrastructure to be broadly available to researchers to support their research.
- That infrastructure investments should foster collaborative use of research infrastructure.

That a National Research Infrastructure Council (NRIC) be established to further develop, implement, review and monitor this Framework and, in particular, to develop and implement a national process to identify and prioritise research infrastructure needs. The NRIC should be representative of the research community and should include representatives of universities, publicly funded research agencies, research funding agencies, governments, and industry, and may be advised by international peer review.

That, in order for the NRIC to link investments in research infrastructure to strategies and priorities for research, a regular national process, under the auspices of a

Strategic Research Council, be established to enhance coordination and to integrate the disparate research strategies and priorities of the Australian Government, regions, institutions, and thematic groups and, where relevant, bilateral and multilateral strategies and priorities, and thereby to develop a national strategic research plan.

That, for major research infrastructure, research infrastructure funding programmes should ensure that both capital costs and standing operating costs are funded to maintain viability of the infrastructure. They should ensure that infrastructure is funded for any specialised staff such as operators and, for very large or complex infrastructure, business managers, for the proposed term of operation of the facility.

That, to ensure consistency in the acquisition, governance, access, and charging arrangements for research infrastructure, all universities, publicly funded research agencies and research funding agencies should follow one of five broad acquisition models defined in this Framework. All research infrastructure investments with a Government funding component in excess of $5m should be consistent with the Framework and its acquisition, governance, access and charging models.

That the host/manager of significant research infrastructure facilities should report annually to the facility's board or governing body on the operation of the facility, including usage, research supported, budget performance and an assessment of the ongoing relevance of the infrastructure in respect of the research conducted.

That the principle be adopted that charging regimes for researchers in universities and publicly funded research agencies accessing infrastructure funded in accordance with this Framework should be related to marginal operating costs.

That access to Government funded research infrastructure facilities by researchers in universities, publicly funded research agencies and medical research institutes should be based on a merit based allocation system.

That, to facilitate collaborative investment and use, research infrastructure funding programmes should be designed and funded to permit proposals from universities, publicly funded research agencies and medical research institutes.

That research infrastructure funding programmes should avoid inflexible leveraging requirements as this diverts funds from the purposes for which they were intended and often inhibits opportunities for participation.

That, irrespective of how funding for Institutional Research Facilities in universities is provided, universities should have an adequate level of discretionary funding to allow them to pursue regional and institutional strategies and priorities and to adequately support research projects funded by granting bodies.

That the Australian Government provide ongoing research infrastructure funding for four categories of infrastructure defined in the Framework. The four categories are

Australian Foundation Facilities, Australian Landmark Facilities, Australian Major Research Facilities, and Australian Research Sector Facilities.

That the Minister note that present support for these four categories is currently in the order of $110m per annum, and that increasing this to $195m per annum would provide improved underpinning of research priorities and allow continued prioritisation of and investment in infrastructure.

That NRIC advise Government on priorities for these funds and any other new research infrastructure funding programmes that may be introduced.

3 Background

3.1 Introduction

Australia has a reputation for excellent research of international standing. Retaining this reputation will be crucial to Australia's future social, economic, geopolitical and environmental wellbeing.

Research of this standing requires that Australia acquire and maintain modern, state-of-art infrastructure, ensure the quality and quantum of underlying basic infrastructure (laboratories, instruments, etc), as well as develop and retain excellent researchers, establish strong frameworks for collaboration nationally and internationally, and provide a supportive research environment. It can be argued that the capability of research infrastructure available to Australian researchers is and will remain a prime determinant of the international standing and the national relevance of Australia's research and researchers.

The role of research infrastructure, and its relationship to the research it supports, is changing. The increasingly interdisciplinary nature of research places new demands on research infrastructure, as do developments in information and communications technologies which make remote collaboration and access to infrastructure a reality, and continuously improve the capacity to gather, manipulate, analyse, make use of and communicate data. The rapidly increasing capability, complexity and expense of research infrastructure, and the associated need for replacement and/or expansion, means that continuous investment or reinvestment in research infrastructure is essential.

Australia's capacity to invest in research and research infrastructure must, however, be considered in the context of its modest resource base. Australia's Gross Domestic Product (GDP) is 3.7% that of the United States and around 1.2% of global GDP. Purely in terms of scale, Australia cannot expect to match the research infrastructure capabilities of larger countries. As a consequence, in the future there will be entire areas of big research that Australia cannot afford, even areas in which Australia may have previously made investments (NICTA, Submission 8). This clearly defines the need for Australia to establish strategies for investment in research infrastructure, or access to research infrastructure, to support its research strategies.

The development of investment and access strategies will be most effective, and truly nationally in scope, only if they bring together the research strategies and plans of national, regional, institutional, and thematic groups. (As research is increasingly inter-disciplinary and multi-disciplinary, the term 'thematic groups' is used in this Framework to describe research groupings that have common research interests, both intra- and inter-disciplinary).

As well as providing research infrastructure to support its own research needs, Australia's natural and unique advantages will make it a suitable location for infrastructure of a global scale. For example, Australia is one of the few places in the world that provides the large, radio quiet spaces needed for low-frequency array (LOFAR) or a square kilometre array (SKA). Added to this, Australia's economic and political stability make it a desirable location. This positions Australia to develop capabilities to participate in these global research initiatives.

3.2 The Importance of Government Funding For Research Infrastructure

The Australian Government has four key roles in Australian research, science and innovation. They are to:

- Invest in research, science and innovation to support the development and use of new knowledge.
- Stimulate and strengthen awareness throughout the community of the need for, and the value of, research, science and innovation.
- Foster domestic and international collaboration.
- Provide leadership in Australia's contribution to the global development of skills and knowledge.

The Australian Government's framework for research, science and innovation is articulated in the Research White Paper, *Knowledge and Innovation*, announced in 1999, and in *Backing Australia's Ability – An Innovation Plan for the Future*, announced by the Prime Minister in 2001. Backing Australia's Ability set out a five year strategy for research and innovation.

The Australian Government's investment in the science, research and innovation system is spread across a number of portfolios and the Government has established a range of mechanisms for whole of government or multi-portfolio decision making and coordination.

3.3 The Need for a National Research Infrastructure Strategic Framework

The increasing importance of research infrastructure, combined with its increasing complexity, cost and global nature, point to the need for this Framework to guide investment in infrastructure and ensure its ongoing viability and availability to researchers.

This is not the first time that Australia has considered the importance of research infrastructure. Over the last 20 years Australia has undertaken a number of reviews and developed priorities for acquiring and managing research infrastructure. Previous reviews are described briefly in Appendix B.

The Australian Government is not alone in wanting to plan for and prioritise research infrastructure needs. At the regional level, State and Territory Governments develop research, science and innovation visions with the aim of improving the social and economic wellbeing of their residents. At a research discipline level, optical astronomers are frequently cited for the strength of their planning and prioritising. At an institutional level, universities and publicly funded research agencies identify priorities and prepare regular research and research infrastructure plans.

The Taskforce drew from work undertaken by the Intellectual Property Research Institute of Australia (IPRIA) that looked at research infrastructure approaches in a range of countries. IPRIA found that in all countries surveyed there is a consistent recognition of the need to identify and prioritise infrastructure needs in the context of research strategies and priorities (IPRIA, 2003).

4 The Approach

4.1 Terms of Reference

The terms of reference of the Taskforce are at Appendix A. In summary, the Taskforce's objectives were to:

- Develop a nationally integrated strategic framework for research infrastructure investments.
- Develop a general overview of the likely need to invest in major research infrastructure projects over the next five to 10 years, including refurbishment of current infrastructure.
- Make recommendations on the best approaches to providing funds for major research infrastructure.
- Make recommendations on arrangements for:
    - Management of national research infrastructure assets, to ensure that they are productive and remain viable.
    - Appropriate regimes for access to research infrastructure.

This document, the National Research Infrastructure Strategic Framework, is the culmination of this work.

4.2 Definition of Research Infrastructure

To ensure that this Framework recognised the important role that research infrastructure has across the innovation cycle – from basic to applied research - the Taskforce adopted a functional definition of research infrastructure:

> Research infrastructure comprises the assets, facilities and services, other than the academic personnel directly responsible for the conduct of research and the direct costs of their research (such as travel and consumables), which support the conduct of organised research undertaken by researchers across the innovation cycle and which maintain capacity of the researchers to undertake organised research.

While recognising the breadth of research infrastructure encompassed by the above definition, the Taskforce placed most emphasis on those categories of research infrastructure for which the cost and complexity of acquisition, provision and operation are such that few Australian universities or publicly funded research agencies could expect to acquire it on their own.

This includes:

- Specific expensive infrastructure items such as X-ray diffraction facilities, electron and atomic force microscopes and NMR machines,
- Specific larger infrastructure such as telescopes, supercomputers, ship and aircraft time, animal houses, biological field stations and synchrotrons.
- Systemic infrastructure such as major data repositories and networks.
- National, experimental and production facilities.

Within this definition is included the concept of acquisition, provision and operation of, and access to, international facilities and private facilities.

4.3 Key Terms

Definitions and acronyms used in this Framework are set out in section 16. Key terms used in this Framework are as follows:

- **Backbone:** The top level of a network; a set of paths to which local distribution points link for long-distance interconnection.
- **Co-investment:** Purchasing a fixed-share in infrastructure such as a fixed share of access.
- **Data:** Generally and in research, a term applied to a gathered body of facts. In IT the term refers to information converted into binary digital form so that it is convenient to move or process by computers and transmission media.
- **Database:** A collection of electronic information organised in such a way that its contents can be easily accessed, managed and updated.
- **Dataset:** A collection of data relating to a particular discipline or theme. Datasets used by researchers are becoming increasingly large scale and distributed through networks, rather than located in one place. Datasets can contain various kinds of electronic material, eg files or images.
- **Data repository:** A place where data and datasets can be stored and maintained.
- **Leveraging:** Requirement that funding programme recipients contribute to infrastructure capital (or other) costs as a condition of grant.
- **Marginal operating costs:** Incremental costs associated with the use of infrastructure by individual researchers or research projects such as the cost of consumables.

- **Programme based:** An individual project that is developed within a portfolio of projects that may be related but not necessarily interconnected.
- **Project based:** An individual project that typically stands alone but may be interconnected to other projects.
- **Region:** State and Territory or combination thereof.
- **Research community:** Research system stakeholders including researchers, universities, publicly funded research agencies, research funding agencies, governments and industry.
- **Research institution:** Research performing body such as a university, publicly funded research agency, medical research institute or museum.
- **Standing operating costs:** Costs associated with maintaining and making incremental changes to infrastructure including salaries of administrative and technical staff.
- **Thematic groups:** Intra- or inter-disciplinary groups with a common research interest.
- **Thematic strategies and priorities:** Strategies and priorities of a thematic group.

4.4 Consultation with the Research Community

The Taskforce established processes to engage the research community early in its work. The Taskforce established a website and public sharespace (available from the website) and issued an *Invitation for Submission* in August 2003.

During mid August the Taskforce undertook initial consultations in each capital city to ensure that the research community was aware of and understood the scope of the Taskforce's work and to encourage submissions. The initial consultations involved meetings in each capital city with members of the research community and with State and Territory Governments.

On 29 August 2003 submissions closed. More than 120 submissions were received, mainly from universities, publicly funded research agencies, thematic groups and researchers. Submissions can be viewed on the Taskforce's website.

In October 2003 the Taskforce undertook a second round of consultations, again in each capital city, to strengthen and shape this Framework. The Taskforce's draft discussion paper, which set out the Taskforce's interim views, was provided to stakeholders who attended the consultations. The Taskforce then released the National Research Infrastructure Taskforce: Discussion Paper. The Discussion Paper is available on the Taskforce's website.

4.5 Other Reviews and Evaluations

The Framework is one of several reviews and evaluations that will inform the Government's research investment over the next five to 10 years. Others include the Evaluation of the 1999 Knowledge and Innovation Reforms, the Review of Closer Collaboration between Universities and Major Publicly Funded Research Agencies, the Mapping of Australia's Science and Innovation System and the Investment Review of Health and Medical Research. These are described below.

The Evaluation of the 1999 Knowledge and Innovation Reforms has focussed on the operation of the Research Training Scheme (RTS), the Institutional Grants Scheme (IGS), the Research Infrastructure Blocks Grants (RIBG) Programme, the Regional Support Package, the Research and Research Training Management Reports, and access of the Institute of Advanced Studies of the Australian National University to RTS, IGS and RIBG.

The Review of Closer Collaboration between Universities and Major Publicly Funded Research Agencies has examined the extent to which collaboration can enhance critical mass of research effort, improve research outcomes, achieve more effective use of resources and strengthen institutional performance.

The Mapping of Australia's Science and Innovation System study took stock of the state of Australian science, technology and innovation. It covered key elements of the innovation process including Australia's ability to generate ideas and undertake science and related research and development, the commercial application and utilisation of research and the frameworks which support it, and the development and retention of relevant skills for science, innovation and enterprise..

The Investment Review of Health and Medical Research is being conducted by the Department of Prime Minister and Cabinet and the Department of Health and Ageing in 2003. The findings of the Review will influence future directions for health and medical research funding in Australia.

4.6 Earlier Reviews and Evaluations

The Taskforce considered a number of reports and reviews about research infrastructure funding and related issues. The earliest report reviewed was the 1984 ASTEC report *Guidelines for the Operation of National Research Facilities*, and the most recent was the 2002 report of the Higher Education Bandwidth Advisory Committee, *A Framework for an Australian Research and Education Network*.

Many of the reports examined the adequacy of current funding arrangements, particularly with regards to flexibility, the appropriateness of existing funding cycles and the provision for hidden infrastructure costs. A number of the reports identified gaps and disparities in current infrastructure provisions. Other major issues identified

included the lack of any national strategy which might help to avoid duplication of and inefficiency in the management of research facilities, the need to identify Australia's research strengths and priorities at a national level, the need for lifetime funding for infrastructure, including the provision of technical and other support staff, the effect on research infrastructure funding of the growth in competitive research grants, and accountability and transparency issues.

Conclusions generally clustered around several main areas: that there should be central strategy at the national level, that competitive and other research grants should fully cover infrastructure costs, and that adequate accounting and costing of research in order to properly identify infrastructure costs and to ensure transparency and public accountability is essential. Many reports suggested that grants needed to be flexible with respect to funding cycles and other institutional needs, and there was some support for the idea that research facilities should be located in order to promote collaboration, linkages and critical mass. Reports also emphasised the need for empirical data to inform proper accounting practice, and the need for a national register or directory of research facilities in order to inform policy making in Australia. Finally, a number of reports argued that it would be beneficial for Australia to produce a directory of major research facilities that described their capabilities and access arrangements.

These reviews are described in more detail in Appendix B.

5 Performance Based Block Funding

5.1 Introduction

Performance based block funds are funds provided to universities to support their research and research training activities. They include:

- The Institutional Grants Scheme (IGS), which supports research and research training activities.
- The Research Infrastructure Block Grants (RIBG) Scheme which aims to support high quality research by meeting project related infrastructure costs associated with project grants, ensuring that areas of recognised research potential have access to the support necessary for their development, enhancing support for areas of existing research strength, and remedying deficiencies in research infrastructure. RIBG is not available to non-university recipients of project grants such as medical research institutes and museums, and these must rely on grants from State and Territory Governments for funding for infrastructure for research funded by Australian competitive grants.

The IGS and RIBG, and other research funding arrangements, are the subject of the Evaluation of the Knowledge and Innovation Reforms, which was undertaken concurrently with the development of this Framework, and are detailed therein.

The IGS and RIBG are important sources of funding for infrastructure the Taskforce has categorised as Institutional Research Facilities (see section 7.9). These are facilities that are of relatively low cost, and that are implemented from the host institution's resources (including performance based funds such as IGS and RIBG).

5.2 The Importance of Performance Based Block Funding

Performance based block funds:

- Support the fabric of basic research infrastructure including facilities the Taskforce has categorised as Institutional Research Facilities (see also section 7.9).
- Allow universities to pursue regional and institutional research strategies and priorities.
- Allow universities to seek State Government co-investment in research and research infrastructure.
- Are a source of funding for universities' co-investment in or subscription to research facilities.

While Institutional Research Facilities are outside this Framework, they are an important part of the overall research infrastructure system and integrally linked to infrastructure that is within the scope of this Framework. As the Taskforce received a number of submissions on this category of infrastructure, this section provides a summary of the issues raised and the Taskforce's recommendations in respect of these issues insofar as they relate to the Framework. The Taskforce therefore has several recommendations regarding this critical source of funds.

5.3 Adequacy of Performance Based Block Funds

Many submissions indicated that performance based block funding for universities is inadequate. A number indicate that performance based block funding has not increased in line with increases in competitive grants and argue that this has exacerbated a gap between research capability and research infrastructure capability. A number indicate that the formulae used to calculate the quantum of these funds do not adequately track research potential and collaborative research activity.

Many submissions cite international comparisons to demonstrate that existing levels of performance based block funding are inadequate. The Taskforce found that an examination of such comparisons indicates that there are so many structural, methodological and definitional differences that comparisons are difficult. The adequacy of funding levels is confused by the leveraging requirements imposed by competitive funding programmes (see also section 5.7), such that a baseline assessment of the adequacy of current funding levels is problematic.

The Taskforce notes that these issues are being considered by the Evaluation of the Knowledge and Innovation Reforms. However, as noted earlier, performance based block funding is an important source of funding for a range of purposes that are integrally related to this Framework. The Taskforce considers this interrelationship so important that any changes to its overall level, or the arrangements by which it is provided, should be subject to a comprehensive review.

5.3.1 Recommendations

That performance based block funding provided to publicly funded universities for provision of Institutional Research Facilities be maintained at least at the present level pending a comprehensive review of the adequacy of the funds. Section 5.3

That, irrespective of how funding for Institutional Research Facilities is provided, universities should have an adequate level of discretionary funding to allow them to pursue regional and institutional strategies and priorities and to adequately support research projects funded by granting bodies. Section 5.3

5.4 Infrastructure Funding for Australian Competitive Grants

Several submissions argue that RIBG funds should be attached to Australian competitive grants and paid to universities by the competitive grant funding agency. Most, however, argue that such a shift would undermine universities' ability to pursue regional and institutional imperatives.

5.4.1 Comment

The Taskforce notes that this issue is being considered by the Evaluation of the Knowledge and Innovation Reforms.

5.5 Inconsistency across Funding Programmes for Institutional Research Facilities

Many submissions argue that funding for project related infrastructure costs associated with Australian competitive grants should be consistent for all recipients of competitive grants. They argue that existing arrangements for medical research institutes and museums are inconsistent and inadequate compared to arrangements for universities. These inconsistencies become especially apparent when medical research institutes or museums conduct collaborative research with universities.

5.5.1 Comment

The Taskforce notes that these issues are being considered by the Evaluation of Knowledge and Innovation Reforms and the Investment Review of Health and Medical Research.

5.6 Funding for Medical Research Institutes

Medical research is undertaken in university-based, hospital-based and independent medical research institutes. The research community is critical of the current system for funding health and medical research infrastructure for hospital-based and independent medical research institutes.

University-based medical research institutes are eligible for performance based block funding associated with Australian competitive grants. Hospital-based and independent medical research institutes are not and must rely on State Government and other sources of funding. These other sources of funding are not consistent across the States and Territories. Nor are they consistent with funding for university-based medical research institutes.

The system is described as complicated, fragmented, and disjunct, leading to inadequate provision for medical research infrastructure and consequent inefficiencies in the conduct of research. Hospital-based and independent medical research institutes report that they will increasingly forgo research grants because they do not have sufficient funds to provide required infrastructure.

The research undertaken in medical research institutes is described as an important element of the national research effort, with strong links to and interdependencies with other research sectors, and there is considerable support for a resolution that is consistent with this Framework.

The Taskforce is concerned that existing arrangements do not promote collaboration and collaborative use of infrastructure, and may undermine the most effective use of infrastructure investments, and considers that there is a need for Australian and State and Territory Government collaboration to identify and implement better mechanisms. The Taskforce notes that these issues are being taken up in the Investment Review of Health and Medical Research.

5.6.1 Recommendations

That the Investment Review of Health and Medical Research seek Australian and State and Territory Government collaboration to identify and implement better mechanisms for funding infrastructure in medical research institutes. Section 5.6

That the proposed mechanisms seek consistency with this Framework. Section 5.6

That the Investment Review of Health and Medical Research is cognisant of university-based, hospital-based and independent medical research institutes. Section 5.6

5.7 Leveraging Requirements

Programme requirements for leveraged contributions towards infrastructure capital costs have been a feature of the research funding system for some time and are intended to encourage collaboration, build critical mass of the research system and foster institutional self-prioritisation of funding applications.

The research community very widely reports that these programme requirements have created a leveraging ‘fatigue’. Universities in particular note that they have little scope to further commit funds to infrastructure if leveraging requirements remain a feature of funding programmes. Where they do make leveraged contributions, they often do so from their performance based block funds, which impacts on their capacity to provide and maintain basic infrastructure and to pursue regional and institutional strategies and priorities.

Leveraging requirements also appear to disadvantage small and regional universities. Small universities face a general diseconomy of scale in terms of their capacity to contribute leveraged funds.

The Taskforce is convinced that there is a level of leveraging fatigue in universities. Universities have used block funds to meet leveraging requirements at the expense of acquiring, developing and maintaining infrastructure for which block funds are intended. This is stated to have contributed to an under investment in universities' research infrastructure.

It is the Taskforce's view that programmes that seek leveraged contributions towards capital costs, as a condition of grant, divert funds provided for other purposes and thereby undermine the general fabric of universities' research infrastructure and undermine their capacity to pursue regional and institutional strategies and priorities. The Taskforce concludes that research infrastructure funding programmes should avoid inflexible leveraging requirements as this often inhibits opportunities for participation.

5.7.1 Recommendation

That research infrastructure programmes should avoid inflexible leveraging requirements as this diverts funds from the purposes for which they were intended and often inhibits opportunities for participation. Section 5.7

6 Strengths, Gaps and Emerging Trends in Australian Research

6.1 Introduction

The Taskforce was asked to identify the availability of, and gaps in, research infrastructure in the context of the National Research Priorities, and domestic and international trends, across all disciplines.

The Taskforce drew from the Mapping of Australia's Science and Innovation System. The preliminary report of Mapping of Australia's Science and Innovation System (the Mapping Report) used the Emerging Sciences and Technologies (S&Ts) identified through the National Research Priorities, CSIRO, ARC and NHMRC programmes, to provide a framework through which to examine Australia's current and future capabilities in the emerging S&Ts.

The Taskforce also specifically invited the research community to comment on Australia's research infrastructure strengths, gaps, and emerging needs in their submissions to the Taskforce. Submissions provided information on the current and future research and research infrastructure strengths, gaps and emerging needs specific to their field of expertise. The CSIRO submission (submission 60) identified examples of national research infrastructure and the areas of research they support, over a broad range of fields, which will be necessary over the next five to 10 years.

This section provides an overview of priorities and comments identified in submissions and the Mapping Report, with respect to the strengths and gaps in Australian research and research infrastructure.

6.2 National, Regional, Institutional and Thematic Priorities

Australia's research effort is a necessary foundation for modern research of international standing. The Australian Government, many State and Territory Governments, institutions, and many thematic groups have identified priorities and developed strategies for research and research infrastructure in basic and emerging disciplines.

Announced by the Prime Minister in December 2002, the National Research Priorities are:

- An environmentally sustainable Australia.
- Promoting and maintaining good health.
- Frontier technologies for building and transforming Australian industries.

- Safeguarding Australia.

These four priority areas provide a vision for research by focusing Australia's research effort on key challenges for today and into the future. They are intended to build on Australia's strengths while seeking new opportunities in emerging areas and to strengthen collaboration between research bodies and with industry, and build critical mass of excellence in the priority areas.

State and Territory Governments have considered the National Research Priorities and have increasingly focussed innovation strategies and investment in research infrastructure along similar lines, to increase their scientific research capability, with the aim of creating economic growth and employment.

With reference to the National Research Priorities, universities have developed strategies to develop areas of research strength and to respond to emerging research, while publicly funded research agencies have developed strategies for their mission-oriented research.

Thematic groups, both disciplinary and inter-disciplinary, have research strategies and infrastructure priorities in place to guide their prospective development. Astronomers and geoscientists are noted within the research community for the strength of their planning and prioritising.

6.3 Emerging Areas and Current Strengths in Australian Research

The Mapping Report summarised that Australia is engaging in inter-disciplinary research, has a significant capability in a number of emerging science and technologies including biotechnology, nanotechnology, quantum technology and photonics and advanced materials and has established a solid presence in many of these fields. The report noted that challenges to be overcome include the sustainment of a critical mass in scientific expertise and research infrastructure, the supply of technical and commercial skills and access to capital.

There is an international trend to increasingly multi-disciplinary and collaborative research, which was reinforced in submissions, and reported in the Mapping Report. For example, multi-sector researchers in the social sciences and physical sciences collaborate to address complex problems in the natural and human environments. Such research and its dissemination more widely demonstrate the linkages that are established between researchers to provide project and broader outcomes, in response to the various research priorities. Integrated funding systems for research and research infrastructure need to recognise and support the formal and informal collaborations that are a standard feature of quality, internationally competitive research.

In order for thematic groups to adopt the various levels of priorities, including the National Research Priorities, submissions noted that Australia needs coordination mechanisms to enable the quality and capacity of research infrastructure which supports fundamental and applied research in diverse areas.

Emerging Areas and Current Strengths - Environmentally Sustainable Australia includes:

- Natural resource management supported by long-term monitoring of atmospheric composition; surface radiation and hydrological measurements; and long-term studies of the responses of river catchments to interventions and disturbances.
- Developments and applications in minerals exploration and geosciences, land and water resource management, agricultural production systems management, climate and weather applications, and research on the atmospheric and natural environment.
- Marine science research to engage in global research and meet international commitments.
- Carbon accounting.
- Monitoring and verification of greenhouse gas mitigation strategies (e.g. terrestrial sequestration, methane emissions from livestock).
- Energy efficiency technologies such as distributed energy, biomass conversion, and transport fuels, to reduce greenhouse gas emissions.

In addition, submissions suggest this should be complemented by a capacity to preserve and use related material, collections, and datasets.

Emerging Areas and Current Strengths - Frontier Technologies includes:

- Nano-science and technology using surface analysis facilities, microscopy, and microtechnology manufacturing facilities, synchrotron, and other materials research instruments.
- Physics and engineering research in areas such as superconductors, fullerenes, colossal magneto resistive materials, microelectronics and quantum technologies.
- Precision antenna measurements for emerging defence and commercial millimetre-wave bands used for surveillance, sensing, communications and tracking.
- Mining and minerals processing.

The Mapping Report provided some analysis of the needs of nanotechnology and photonics. Specialised infrastructure for the analysis and fabrication of nano-materials and devices are critical to the development of nanotechnologies. The establishment of the Nanostructural Analysis Network Organisation (NANO) MNRF, which provides access to sophisticated facilities at five university 'nodes', reflects this requirement. A DITR report on the emerging nanotechnologies industry has noted an increased need for centralised infrastructure that would allow fabrication of prototypes and larger scale nanotechnology manufacturing (DITR, 2002).

The need for infrastructure to support current and future manufacturing requirements of the photonics industry has recently been recognised through the establishment of The Bandwidth Foundry MNRF, a facility for automated manufacturing of photonics components, photonic packaging and photonic chips. The Bandwidth Facility will also serve researchers at the prototyping stage and is seen as a forerunner for a large-scale photonic chip manufacturing capability.

Emerging Areas and Current Strengths - Safeguarding Australia, includes:

- High standard quarantine and containment facilities for the biosecurity of Australia's agricultural and environmental resources, to service the needs in the areas of biosecurity, importation of biological control agents and germ plasm, and risk assessment of GMOs.
- Fire research and testing facilities.

Emerging Areas and Current Strengths - Promoting and Maintaining Australia's Health includes:

- Molecular biology.
- Bioinformatics.
- Biotechnology (genomics, proteomics, medical devices).
- Neuroscience.
- Immunology.

The Mapping Report commented that in the area of biotechnology, Australia will continue to have difficulty competing with some other countries in terms of outright funding and infrastructure. Australia ranks quite highly in terms of support for biotechnology as a percentage of Budget appropriations on research and development—at around 7.5%—fifth behind Belgium, Canada, Finland and the UK.

Similarly, the Mapping Report noted that, for bioinformatics, Australia has a significant research base, an established infrastructure and a developing tertiary education capability in bioinformatics, though industry involvement and commercialisation is limited. Elements of infrastructure have enhanced linkages

between researchers and the services areas. ANGIS (the Australian National Genomic Information Service) and high performance computing clusters were identified as essential infrastructure.

The research community identified opportunities to host significant international astronomical facilities and maintain the international research competitiveness of Australian astronomers. The Research Reactor and the Australian Synchrotron were also cited as international standard facilities that could support and revolutionise the emerging research areas of the diverse fields of drug design, advanced manufacturing, biomedical imaging, materials research, nanotechnology and mineral analysis. Proteomics Centres of Excellence were mentioned as providing an opportunity for international research collaboration.

6.4 Current Needs and Gaps in Australian Research Infrastructure

Submissions commented that in order to conduct internationally competitive, quality research, researchers need access to appropriate leading edge infrastructure that is provided in a systematic and integrated manner.

However, submissions to the Taskforce frequently stated that Australia's infrastructure stock is generally run down due to years of underinvestment, partly as a consequence of funding programme leveraging requirements. In order to maintain Australia's research capability, the research community strongly highlighted the need for significant upgrades to research facilities, and provided particular examples:

Current Needs and Gaps - Environmentally Sustainable Australia:

- The National Tidal Facility of Australia requires investment to provide the fundamental sea-level measurements used to support research on climate change, climate variability, and coastal management.
- The number of Australian blue-water research vessels has actually declined from three in 1998 to just one in 2002. This decline has occurred despite Australia's Marine Science & Technology Plan recommending 'strengthening and broadening Australia's blue water research fleet' to meet the needs of the huge Australian offshore jurisdiction to be claimed under the 1994 United Nations Convention on the Law of the Sea.

Current Needs and Gaps - Frontier Technologies:

- The Nuclear Microprobe (NMP) and Linear Accelerator (LA) Laboratory facilities, as well as a range of other degraded infrastructure such as microscopy, x-ray diffraction and mass spectrometry instruments, require replacement and complementing with leading-edge instruments to support a range of geoscientific and materials science research.

- Mathematicians and physicists stated that the declining research and infrastructure capacity in fundamental and applied mathematics and physics needs to be addressed to meet longer term needs.

Current Needs and Gaps - Safeguarding Australia:

- Facilities such as the Australian Animal Health Laboratories (AAHL), which provides a major research facility for exotic and endemic animal disease, and the Australian National Insect Collection (ANIC) Facility to support research into insects and related invertebrates, are unique internationally.

Current Needs and Gaps - Promoting and Maintaining Australia's Health:

- Comprehensive transgenic animal facilities and experimentation facilities for translational research and researcher training are required to support growth in biological and medical disciplines.

Both the Mapping Report and submissions commented on the challenges Australia must meet to have a nationally strong and internationally competitive research and research infrastructure system.

The Mapping Report commented that the perceived growing cost of keeping up with leading-edge science is one factor that has prompted Australia's participation in the OECD's Global Science/Megascience Forum established to foster cooperation on large, long-term, multi-national projects including centralised large scale facilities e.g. the proposed Square Kilometre Array (SKA) and distributed informatics and collaboration driven projects e.g. the Global Biodiversity Information Facility (GBIF) and the Human Genome Project.

The Mapping Report noted that Australia's major research facilities were found to mirror perceived strengths in research generally, especially in earth sciences and oceanography, but to be out of line with overseas capabilities in the areas of synchrotrons and lasers.

Increasing costs and requirements have also placed the international competitiveness of Australia's research infrastructure system under pressure. Capital intensiveness of science has increased, with an increasing number of fields such as the life sciences requiring advanced experimental equipment. In particular, in areas such as libraries there have been dramatic increases in the cost of scholarly journals.

Skilled researchers and skilled infrastructure support were identified in the Mapping Report and submissions as being key to the effectiveness of Australia's research and research infrastructure. The Mapping Report noted that of the science and engineering occupations examined by the Department of Employment and Workplace Relations' Skilled Vacancies Index (SVI), those needing particular attention were engineering managers; the group of material scientists, metallurgists, meteorologists and physicists; chemists; science technical officers; young life

scientists; the group of mathematicians, statisticians and actuaries; and IT services and operational managers.

Both the Mapping Report and submissions from the research community, across all areas of research, commented on the importance of both national policies for, and the provision of, enabling technology infrastructure. This encompasses information and communications technologies, broadband communications capacity, advanced computational grids, internationally connected networks, and data repositories and services. Enabling technology is needed to underpin quality research, which is becoming increasingly multi-disciplinary and collaborative and requires world class high performance computing facilities. Some of these areas are the humanities and social sciences, climate predictions and climate change, natural resource management, marine science, frontier technologies in materials and drug design, fluid dynamics and lattice-gauge theory, and bio-hazards. The Framework discusses and describes current initiatives for enabling technologies in more detail in section 7.9.

The Mapping Report noted that there are concerns that bandwidth capacity will not be sufficient to meet future growth which is being driven by increased research collaboration, development of research involving large global databases, the rising cost and sophistication of cutting edge research infrastructure and increased requirements for computing capacity and data storage (Higher Education Bandwidth Advisory Committee, 2002).

6.5 Summary

The submissions provide input on existing and growing areas of research that are key to the various levels of strategies and priorities. In many submissions, systematic provision of advanced and appropriate infrastructure was mentioned as being a key requirement for quality and globally competitive research to respond to these strategies and priorities.

While the Mapping of Australia's Science and Innovation System and submissions provide useful information on the gaps in and strengths of Australia's existing infrastructure, they do not provide a complete picture. Nor do they provide a sound basis for prioritising future infrastructure needs. The Taskforce proceeds to systematically categorise infrastructure initiatives in more detail in section 7.9.

While there are research strategies and priorities that have been developed by national, regional, institutional and thematic groups, there is still a need to link and integrate these various research priorities more effectively and collaboratively, to achieve optimal outcomes for research. The Taskforce discusses this concept of a nationally integrated process for research strategies and priorities in section 7.3 and provides recommendations in section 8.3.

There is a need for investment in research infrastructure to support research strategies and capabilities, across the innovation cycle, at national, regional, institutional and thematic group levels. However, the Taskforce considers that the current disconnect between funding for research and funding for research infrastructure needs to be addressed to achieve a nationally integrated system for effective management of research infrastructure investments. In sections 7.6 and 7.7, the concept of a national coordinating system to link research funding and research infrastructure funding is discussed further, with recommendations set out in section 8.3

6.5.1 Recommendation

That the Minister note that, to maximise return from investment in research, Australia must provide access to modern and relevant research infrastructure for researchers. Section 6.5

That NRIC, once established, map Australia's research infrastructure strengths, gaps and needs in the context of national research and research infrastructure strategies and priorities. Section 6.5

7 Strengths, Gaps and Emerging Trends in Australian Research and the Implications for Research Infrastructure

7.1 Introduction

In this section the Taskforce sets out a blueprint for the requisite systemic approach to the strategic development, funding, ongoing monitoring and review of publicly funded research infrastructure to support the national research effort. This section looks at current funding systems led by the Australian, State and Territory Governments, as well as the arrangements in other countries. It analyses the need for different categories of infrastructure facilities and the necessity for the various bodies supporting research infrastructure to work together to achieve a coherent, integrated national approach, particularly in view of the significant costs of infrastructure in Australia and overseas. A brief case study of the Nanostructural Analysis Network Organisation is included to illustrate the benefits of collaboration.

Drawing from submissions and feedback during consultations, the Taskforce defines five broad categories of infrastructure, according to a range of factors including cost, complexity and extent of collaboration required; that is: Australian Foundation Facilities, Australian Landmark Facilities, Australian Major Research Facilities, Australian Research Sector Facilities and Institutional Research Facilities. The Taskforce considers that the first four should be developed within this Framework and that the fifth should be consistent with principles enunciated in the Framework.

Finally, the Taskforce turns to issues relating to the maintenance of viable and productive research infrastructure, such as co-investment, standing operating and maintenance costs, access, upgrading and the option of centralising certain types of facilities.

7.2 Current Research Infrastructure Funding Systems

7.2.1 Australian and State and Territory Government Funding

A snapshot of research infrastructure funding in Australia indicates that the Australian Government and State and Territory Governments contribute significant funding for research infrastructure through funding programmes and arrangements.

Australian Government funding includes funding to universities – through performance based block funding arrangements and programmes for significant

infrastructure – and funding to mission-oriented publicly funded research agencies through annual appropriations and, in some cases, to industry. Australian Government funding is provided to support national, regional, institutional and thematic groups' strategies and priorities, and international strategies and priorities.

State and Territory Governments also provide funding to support research infrastructure in universities, publicly funded research agencies, medical research institutes and consortia of research institutions. State and Territory Government programmes for research infrastructure seek to build innovation and capacity, develop specific research areas and support participation of their agencies and higher education institutions in collaborative research efforts such as the consortia established in Cooperative Research Centres (CRCs).

Not all State Governments provide research infrastructures support through formal funding schemes. Almost all can, however, be seen to provide research infrastructure funding through involvement of their agencies and/or higher education institutions in CRCs. Most have also contributed infrastructure support and/or host a Major National Research Facility (MNRF).

The Taskforce estimates that in 2003, Australian and State and Territory Government funding for research infrastructure was in the order of $750m.

7.2.2 Australian Government Research Infrastructure Programmes

In its August 2003 Invitation for Submissions and consultations, the Taskforce sought input on the strengths and weaknesses of the research infrastructure funding system. Feedback generally focussed on three Australian Government funding programmes: the Strategic Infrastructure Initiative (SII), the Major National Research Facilities Programme (MNRF), and the Linkages Infrastructure Equipment and Facilities (LIEF) Programme. SII, MNRF and LIEF, and other government funding programmes, are described in Appendix D.

Feedback on the outcomes of these programmes was consistently positive. Generally there were concerns that funding for research infrastructure is inadequate. Concerns were expressed about the ad hoc nature of the SII and MNRF which was said to:

- Undermine research institutions capacity to plan and prioritise research infrastructure needs.
- Encourage submissions that do not necessarily reflect overall infrastructure priorities, do not provide the best potential collaboration and co-investment and are not carefully costed.

- Limit infrastructure managers' capacity to sustain skilled staff to operate research infrastructure, leading to a serious impediment to maximising the use of research infrastructure.

Concerns were also expressed about the short lead times allowed for the preparation of business proposals for both the SII and MNRF and about the back end loading of funding for the MNRF.

A frequent comment was that funding for LIEF had not kept pace with Australian competitive grants and there were suggestions that LIEF tended to direct funding to established researchers in larger institutions and away from smaller institutions and evolving areas of research concentration.

A key concern was the tendency for infrastructure programmes to provide only partial funding, often only initial capital costs. Feedback indicated that this imposes on research institutions a need to fund, or recover from access charges, operational, maintenance and refreshment costs, and the costs of providing skilled operators. Where this is difficult or impossible to do, infrastructure that would otherwise be productive and viable risks becoming underutilised or non-operational. There is a very strong feeling in the research community that assumptions that infrastructure can and should be self-supporting are flawed.

There were also concerns that there is no transparent process to identify, prioritise and plan for investments in very large infrastructure such as synchrotrons or research vessels.

The Taskforce considers that these concerns and implications are, for the most part, valid and points to another concern with the infrastructure funding system – that of leveraging requirements. This is discussed in section 5.7.

In sections 7.8 and 7.9 the Taskforce considers the need for ongoing funding for significant infrastructure. Specific recommendations for ongoing funding are set out in section 9.2.

7.2.3 Overseas Approaches to Research Infrastructure funding

IPRIA (2003) describes research infrastructure funding arrangements in the United Kingdom, the United States, Canada, Hong Kong, Japan, Germany, Finland and the European Union. IPRIA found that, historically, funding for the acquisition and construction of infrastructure in these countries has largely been through funding to institutions. Criteria for allocation of funds are typically formula based, using research indicators.

Both Germany and Finland fund research infrastructure through funding “centres of excellence” or specialist research centres, through large multi-year grants which fund expenses such as staffing and some equipment.

By contrast, the US has historically provided most research infrastructure funding through programmes to cover research infrastructure costs. The National Science Foundation is an example of one mechanism for funding through tiered funding programmes. Canada has grant schemes for research infrastructure which also provide funding through three tiered programmes based on different cost structures.

A number of countries have introduced research funding programmes to meet specific funding needs. Funding for high performance computing facilities is a common infrastructure priority to support research across a broad range of countries. For example, Germany has specific funding for library services and information systems. Finland, Canada and the EU have funding programmes for high performance computing and information systems.

The IPRIA report is summarised at Appendix C.

7.3 Infrastructure Needs to Support Many Strategies and Priorities

In section 6.2 the Taskforce notes that, across the research community, there are various research strategies and priorities. To assist its thinking and the development of this Framework, the Taskforce categorised strategies and priorities as follows:

- *National strategies and priorities.* This first category refers to strategies and priorities of the Australian Government, such as the National Research Priorities, and regional, institutional and thematic groups’ strategies and priorities.
- *Regional strategies and priorities*. This second category refers to the strategies and priorities of regions, usually state or Territory Governments, who typically are interested in research as part of an overall innovation framework.
- *Institutional strategies and priorities*. This third category includes the strategies and priorities of an individual institution such as a university or mission-oriented publicly funded research agency.
- *Thematic groups strategies and priorities*. This fourth category includes strategies and priorities of specific fields of research, such as optical astronomy, as well as interdisciplinary areas of research such as bioinfomatics.
- *International strategies and priorities*. This fifth category refers to bilateral and multilateral strategies and priorities including obligations set out in international treaties.

The categories of strategies and priorities are not mutually exclusive and are not meant to imply a funding programme structure. In many cases infrastructure will support the pursuit of more than one category of strategies and priorities.

In its October 2003 consultations and *Discussion Paper* the Taskforce noted that there is no consistent national process to integrate and prioritise national, regional, institutional and thematic strategies and priorities for research and no process to link research strategies and priorities with research infrastructure. Feedback was generally supportive of the need for such a process.

This absence of a consistent national process undermines governments, research funding agencies and research institutions' efforts to maximise the efficiency and effectiveness of investments in research infrastructure. The Taskforce considers that there is a need for a national process to integrate and prioritise these strategies and priorities but notes that there is no existing structure to do this. The Taskforce considers that, in the absence of such a process and structure, it will be more difficult to link research strategies and priorities with research infrastructure strategies and priorities.

7.4 Infrastructure to Support Research across the Innovation Cycle

Australia's stock of knowledge and skills, of which research and research infrastructure play a key part, is critical to Australia's socio-economic, geopolitical and environmental wellbeing. Public and private research infrastructure provides the basis upon which quality research and resulting innovations are possible. Information and communications technologies, such as broadband communications capacity, advanced computing, and data repositories and services, are integral to all areas of research across the innovation cycle.

The Taskforce considers that research infrastructure needs to support quality research across the innovation cycle and in an international research context. The Taskforce's definition of innovation cycle encompasses research from basic to applied research and industrial application research. The Taskforce's definition of quality research is distinct to excellent research. In the context of this Framework, quality research refers to research that is undertaken in universities, publicly funded research agencies, medical research institutes, museums, and other research institutions, the funding of which is subject to some form of merit review such as peer review, conformity to strategic directions, or corporate or customer business objectives.

The implication of this view is that the development of research infrastructure strategies and plans needs to include researchers, research funding agencies, research institutions and industry.

In section 8.3 the Taskforce recommends the establishment of an organisational structure to integrate national, regional and institutional research infrastructure strategies and priorities with the strategies and priorities of thematic groups. Given its view that research infrastructure needs to support research across the innovation cycle, and in an international context, the Taskforce considers that the organisational structure should be representative of the research community and should include representatives of universities, publicly funded research agencies, research funding agencies, governments, and industry. The Taskforce also considers that the structure should, where appropriate, be advised by international peer review.

7.5 The Need for Collaboration

Research collaboration is a fundamental mechanism to enhance critical mass, improve research outcomes, achieve more effective use of resources and strengthen research performance. Collaborative activities and international partnerships provide increasingly important means of keeping abreast of new insights critical to maintaining leadership in key fields.

Over the course of its work the Taskforce developed the view that research infrastructure is a key enabling mechanism for enhancing research collaboration. Research infrastructure provides additional opportunities for collaboration, including collaborative co-investment in infrastructure where, for example, a number of bodies purchase a fixed share in a significant asset and collaborative use of infrastructure, and collaborative use of infrastructure. The cost of significant research infrastructure is, of course, a further incentive to collaborative research, collaborative use of infrastructure and co-investment in infrastructure.

The following case study describes an innovative and successful example of collaboration.

7.5.1 Case Study

The Nanostructural Analysis Network Organisation (NANO) is one of the 15 MNRFs funded by the Australian Government in 2001-02. The NANO-MNRF is the peak Australian facility for nanometric analysis of the structure and chemistry of materials in both physical and biological systems. NANO operates and maintains state-of-the-art facilities for the characterisation and manipulation of matter at the atomic and molecular scale.

With a primary focus on microscopy and microanalysis, this network organisation creates collaborations to explore and define the structure-function relationships which enable innovation in nanotechnology and biotechnology. NANO is developing and will support a commercial-arm so as to provide a vehicle for the rapid commercialisation of results.

The NANO-MNRF functions as an unincorporated joint-venture between the University of Western Australia, The University of Queensland, The University of Melbourne, The University of NSW and The University of Sydney, where the NANO nodes are based. NANO has a future priority to establish new local and international nodes.

Access to NANO is via a uniform protocol that partners share, described at www.nano.org.au. Access is not restricted and the facilities and expertise are available to all university, national laboratory and industry bodies. The NANO Scientific Committee has a Travel and Access Program, which provides a contribution of the travel, accommodation and beam-time costs for users.

NANO has developed tele-presence facilities across the network, which allows operators, remote from a network node, to see and interact with data from a microscope using electronic access through the internet. The telepresence also allows staff at the five nodes to interact and work together, and provides new ways for NANO training and research to reach existing and new users. NANO is closely associated with GrangeNet as a provider of high bandwidth network, to assist in the transmission of data.

NANO has provided research services to some of Australia's largest companies, such as Alcoa World Alumina, as well as supporting the development activities of smaller start-up ventures and small and medium enterprises. It has also established a two year research program with BHP Billiton to develop characterisation methodologies. State Government support has been provided for the Victorian node. NANO has signed MOUs with the National Institute of Materials Science, Japan, and Nankai University in China, to promote collaborative research and international exchanges, and has initiated collaborations with overseas companies.

7.5.2 Australian and State and Territory Government Collaboration

Input from submissions and consultations recognised the need for close collaboration between Australian and State and Territory Governments in the funding of research infrastructure. While the potential benefit of Australian and State and Territory Government collaborative investment is evident, and there are examples of co-investment which have been of considerable benefit to researchers, there are, however, a number of barriers to it.

Firstly, the intermittent nature of some Australian and State and Territory Government infrastructure funding precludes the development of a strategic framework for collaborative investment. Secondly, funding cycles often do not mesh or do not provide sufficient lead times for both to agree to collaborative investments in particular infrastructure or facilities.

The Taskforce considers that there appears to be a recognised need for the Australian government to take a leadership role to establish closer collaboration with State and Territory Governments to facilitate efficient and effective investments in research infrastructure.

7.5.2.1 Conclusion

That the Australian Government should take a leadership role to establish closer collaboration with State and Territory Governments to facilitate efficient and effective investments in research infrastructure.

7.6 The Need to Plan and Prioritise

The Taskforce found positive and negative aspects of current planning and prioritising processes. On the positive side, there is considerable planning by individual researchers, at the levels of thematic groups, institutions, and regions, and by the Australian Government. In New South Wales, for example, universities' Deputy and Pro Vice-Chancellors Research meet annually to examine potential applications for infrastructure funding and to consider integrating bids for similar infrastructure from competing institutions (UNSW, Submission 66). The establishment of the Higher Education Bandwidth Advisory Committee and the Australian Research Information Infrastructure Advisory Committee are also positive examples of approaches to planning and prioritising research infrastructure investments. The work of both committees is discussed in section 7.9.

On the negative side, there is no process by which research infrastructure strategies and plans can be integrated. In its October 2003 Discussion Paper the Taskforce noted that decisions to fund infrastructure need to be made within a strategic collaborative framework, due to the significant cost of infrastructure. In that paper, and during its October 2003 consultations, the Taskforce set out an indicative conclusion regarding the establishment of an organisational structure to develop and implement processes to plan and prioritise research infrastructure investments. Feedback on the proposed structure was almost unanimously positive.

The Taskforce concluded that there is a need for a national process to identify and prioritise research infrastructure needs in a coordinated and strategic way. In section 8.3 the Taskforce recommends the establishment of an organisational structure to integrate national, regional, and institutional research infrastructure strategies and priorities with the strategies and priorities of thematic groups.

There are international precedents for planning and prioritising infrastructure needs. For example the US National Science Foundation coordinates its investments with those of other organisations, agencies and countries to ensure complementarity.

7.7 The Need for an Integrating Structure

In section 7.3 the Taskforce noted that research infrastructure needs to support national, regional, institutional and thematic groups' research strategies and priorities. The Taskforce noted, however, that there is no obvious existing organisational structure to lead such a process, and discussed the problems that arise from this.

The Taskforce considers that there is a need to establish a process and structure to integrate national, regional, institutional and thematic groups' research strategies and plans. In the absence of such a structure it will be more difficult to link research strategies and priorities with research infrastructure strategies and priorities and to give effect to this Framework.

In section 8.4 the Taskforce recommends that a regular national process be established to enhance coordination and to integrate national, regional, institutional and thematic groups' research strategies and priorities. The Taskforce also recommends the establishment of an organisational structure to lead this process.

7.8 The Need for Ongoing Programmes for Investment in Research Infrastructure

Input to the Taskforce was positive about the outcomes of research infrastructure funding programmes but there was a consistent concern regarding the ad hoc nature of programmes for infrastructure that the Taskforce has categorised in section 7.9 as Australian Foundation Facilities, Australian Major Research Facilities, and Australian Research Sector Facilities. Some feedback expressed concern that there is no process to plan for very large infrastructure[1].

There is also a concern that the LIEF Programme, which provides funding for research infrastructure that the Taskforce categorised in section 7.9 as Australian Research Sector Facilities, has not kept pace with increases in funding for research projects.

The cost and complexity of many important elements of infrastructure is such that few research institutions can expect to acquire it on their own. At present the LIEF Programme is the only ongoing Australian Government research infrastructure funding programme for Australian Research Sector Facilities. There are no ongoing Australian Government programmes specifically designed to provide infrastructure categorised as Australian Foundation Facilities or Australian Major Research Facilities.

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[1] such investments are usually considered through Cabinet processes rather than infrastructure funding programmes.

The Taskforce considers that there is a need for ongoing programmes for significant research infrastructure, and that continuity of programmes is vital if Australia is to ensure the viability and continuing relevance of investments in research infrastructure, and ensure the necessary funding flows often required to develop significant research facilities.

The Taskforce also considers that Australian Government funding programmes, where appropriate, should be designed and funded to permit business proposals from universities, publicly funded research agencies, and medical research institutes, rather than specific sectors of the research community.

In section 7.9 the Taskforce discusses research infrastructure funding in more detail and sets out conclusions regarding the importance of ongoing funding for significant research infrastructure. The Taskforce makes a number of specific recommendations for ongoing research infrastructure funding programmes in section 9.

7.9 Categories of Research Infrastructure

The increased importance of research infrastructure, the cost and complexity of both networks of facilities and of the facilities themselves, the extent and approach of collaboration required, and distinct and different investment approaches relevant to different types of research infrastructure, necessitate clear categorisation of research infrastructure. Drawing from submissions and feedback during consultations, the Taskforce defined five broad categories of infrastructure. This categorisation is not meant to imply a funding programme structure; rather it is a categorisation of infrastructure according to a range of factors including cost, complexity, and extent of collaboration required.

These categories are:

- Australian Foundation Facilities
- Australian Landmark Facilities
- Australian Major Research Facilities
- Australian Research Sector Facilities
- Institutional Research Facilities

The Taskforce considers that the importance, cost, complexity and nature of the first four categories are such that business proposals for investment should be considered within this Framework. Ideally, proposals for the fifth category of infrastructure should be consistent with this Framework. Business proposals for investment for the fifth category of infrastructure would, however, be made within the decision making framework of the funding institution.

7.9.1 Australian Foundation Facilities

Australian Foundation Facilities is the first category of infrastructure. Australian Foundation Facilities are typically systemic or structural in nature. They include infrastructure such as advanced computing, broadband communications, and data repositories and data services, and standardised measurement systems. Australian Foundation Facilities are typically linked to global capabilities, and require national collaboration and access. While they are typically implemented as a sequence of linked, smaller projects, the investment in each class of facility will typically be in excess of $A50M.

There are a number of current initiatives aimed at ensuring that Australian Foundation Facilities are well placed to support Australia's research needs. These include:

- *Australian Research and Education Network (AREN)*. AREN is a collaborative venture between the Australian Government and State and Territory Governments, the higher education sector and AARNET, and is collaboratively funded by them. AREN arose from the work of the Higher Education Bandwidth Advisory Committee (HEBAC). HEBAC found that there is considerable disparity in the availability and affordability of bandwidth across the higher education sector, often greater than could be explained by differences in research intensity, which limits Australia's research capacity. AREN will evolve as a network of networks, with special purpose networks such as experimental and special research-focus networks built on a robust underpinning infrastructure. This underpinning infrastructure will comprise backbone infrastructures connecting major research centres, with connections to smaller research centres. Enhanced international connections will be provided to ensure that Australian researchers have opportunities to participate fully in international research collaborations and consortia, and have access to major international research facilities.

- *The Australian Partnership for Advanced Computing (APAC).* APAC is a national partnership for the development of an Australia-wide computing and communications infrastructure supported by coordinated programs in research, education and technology diffusion. Its specific roles includes providing users, particularly in the higher education sector, with peak computing systems beyond the capacity that was previously available. Another is strengthening the expertise and skills necessary for effective use and development of these facilities. The focus for the next stage of APAC is on development of advanced computing and grid infrastructure to serve the Australian research community[2].

[2] A Framework for an Australian Research and Education Network

- *The Australian Research Information Infrastructure Framework*. The Framework was developed by the Information Infrastructure Advisory Committee, a body established by the Minister for Education, Science and Training, to allow key stakeholders to provide advice on the research information infrastructure needs of the higher education sector as well as to identify infrastructure gaps and advise priorities for funding. The Committee identified priorities in the areas of discovery and management of research information, access to research information resources, and creation and dissemination of Australian research information. The Framework will be advanced under the auspices of the recently establish Australian Research Infrastructure Advisory Committee.

- *The Advanced Networks Programme (ANP)* was established by the Minister for Communications, Information Technology and the Arts. It is intended to contribute to the development of advanced network infrastructure in Australia by supporting progress towards the establishment of a national advanced backbone network. In 2001, ANP announced funding of $37.23m to the following three successful projects:

    - *Centre for Networking Technologies for the Information Economy (CeNTIE)*. CeNTIE will establish a nation-wide optical fibre backbone research network (the 'Foundation Network'), consisting of broadband Metropolitan Area Networks (MANs) in Sydney and Perth linked by a dense wave-division multiplexing (DWDM) long-haul optical fibre network. The Sydney and Perth MANs will be based on newly-constructed or leased dark fibre. To this will be added DWDM systems supporting multiple 10Gbits/S (upgradeable) networks to interconnect new and existing research and administrative LANs belonging to consortium members. CeNTIE will establish Testbeds which will be used for projects in the areas of tele-health, media systems, tele-collaboration and information brokering.

    - *mNet.* The mNet project will concentrate on research into wireless data applications intended to establish state-of-the-art wireless LANs and leading-edge pre-commercial 3G mobile networks and to link them with optical fibre to provide services in and around ten public buildings in the city of Adelaide. A regional hub at Whyalla will explore the remote delivery of services and interoperability between separated networks, and test delivery of health services to remote and regional areas. mNet will connect to GrangeNet and CeNTIE.

    - *Grid and Next Generation Network (GrangeNet).* GrangeNet is a three-year program to install, develop and operate a multi-Gbit network supporting grid and advanced communications services. The GrangeNet network will consist of a backbone linking Melbourne, Canberra, Sydney and Brisbane connected to GrangeNet Points-Of-Presence at the AARNET sites in each city. Gbit Ethernet tails will connect clients to the GrangeNet backbone. The backbone

is connected to the AARNet international network at Sydney providing access to the global research and Education networks.

7.9.1.1 GrangeNet Case Studies (GrangeNet, 2003)

GrangeNet provides incentives to explore novel techniques and forge new collaborations which demonstrate capacity of infrastructure in the Australian Foundation Facilities category to reshape the way research is done, to improve collaboration and to create critical mass. Some interesting examples are:

- *Access Grid* – Access Grid is high quality real time video conferencing made possible through a GrangeNet access grid node. The node is a room fitted with cameras and advanced communication facilities. An unlimited number of nodes can participate in collaborative video conferencing sessions.
- *NANO* – NANO's tele-instrumentation resources can be shared across the country through the use of access grids. Tele-instrumentation is the connection of unique and often expensive scientific instrumentation to high performance networks. Users can remotely access and utilise the instrumentation in real time to access complex images and data repositories.
- *Paradisec* – The Paradisec project is a collaborative effort to digitise analogue recordings of languages and music of the Asia-Pacific area. The large size, need for replication and access from various locations high bandwidth, intelligent data transport systems and complex data management systems would be impossible without the high speed and bandwidth of GrangeNet.
- *FilmEd* – The FilmEd project aims to develop and demonstrate technical financial models for providing the tertiary education sector with high speed access to the wealth of high quality and unique film and video content within Australian moving image archives. FilmEd fosters collaboration with industry based film producers, through the provision of access to digital editing and storage tools, as well as linking with film, media studies and journalism students.

7.9.1.2 Data Repositories

The area that raises concern for the Taskforce is that of data repositories. Most areas of research now depend on access to large data repositories and the number of data repositories, and the rate at which they are growing, is staggering. In the areas of bioscience and biotechnology, there are about 25 core databases, totalling <10Tb, that are growing by about 1% each day, and a further 300-500 data bases are increasingly rapidly. Data repositories increasingly provide data models, analytical tools and visualisation tools, all of which require significant storage capacity. Micro array data bases and image data bases will require even greater storage capacity(Ragan, Buchhorn, Burrage, Coppel et al, Submission 3).

Australia has massive holdings of social and economic data in administrative records maintained by governments at local, state and national level (such as Medicare, Centrelink, education agencies and health agencies), that could potentially be available to researchers if data consistency and interoperability problems were resolved and mechanisms and policies to preserve confidentiality were developed and implemented[3]. Similar issues arise with data repositories maintained by hospitals and health research agencies.

There are two issues with the transmission of major datasets. The first is the cost of data transmission, which the research community indicates can cost from thousands to tens of thousands of dollars for a single transaction. The second is the problem of transmission over insecure communications networks, which has potential to constitute publication. The lack of trained staff to support the development, maintenance and use of huge and complex data repositories is also a problem[4].

7.9.1.3 Middleware

Middleware is a critical but unrecognised part of the Australian Foundation Facilities category. Middleware facilitates storage, indexing, retrieval and exploitation of datasets and data repositories within a robust, shareable, interoperable and secure framework. This adds value to research data, facilitates its re-use, instils confidence in data integrity and research results, provides an environment for a user pays financial model and negates the need for the costly development of multiple middleware tools, standards and methodologies. (DSTC, submission 115). Several submissions noted that the development of middleware policies and mechanisms will greatly facilitate research and e-Research.

7.9.1.4 Summary

Australian Foundation Facilities are almost unanimously recognised as a vitally important enabling mechanism for Australia's current and future research and research infrastructure needs. This recognition crosses all research areas and is seen to be of growing importance. The possibility of more easily bringing together, virtually as well as physically, domestic and international academic communities of interest, and the capability to store, access, manipulate and analyse large volumes of data, are especially welcome.

The Taskforce considers that Australian research will be well served by initiatives such as AREN, APAC, ARIIF, ANP but notes that ongoing investments in these initiatives are likely to be required as researchers' needs for increased capability develops. In recent years the Australian Government has funded Australian

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[3] for example see University of Adelaide submission, Submission 77

[4] for example the University of Adelaide (submission 77) identifies the problem in respect of social science data repositories.

Foundation Facilities from the Systemic Infrastructure Initiative (SII). The SII is, however, a terminating programme.

The Taskforce concludes that the Australian Government should establish an ongoing funding programme to support continued work of initiatives such as APAC, AREN and ARIIF.

The Taskforce also considers that fund should be provided within an Australian Foundation Facilities Programme to develop policies on and mechanisms to underpin the growing number of data repositories and systems.

The Taskforce considers that, once established, NRIC should advise government on necessary levels of funding for Australian Foundation Facilities. In the interim, the Taskforce considers that the existing level of funding provided through the SII, which is in the order of $55m per annum, would provide adequate support and allow continued prioritisation of and investment in Australian Foundation Facilities.

The Taskforce's recommendations regarding ongoing programmes for Australian Foundation Facilities, and the development of policies and mechanisms to support the growing number of data repositories and services, are set out in section 9.2.

7.9.2 Australian Landmark Facilities

Australian Landmark Facilities is the second category of infrastructure. Australian Landmark Facilities are typically large-scale, complex facilities that serve large and diverse user communities. Located (a) in Australia or (b) overseas, they include light sources (eg synchrotrons), neutron sources (eg nuclear reactors), research vessels and aircraft, space-based experiments, unique global experiments, and large-scale radio and optical telescopes.

Landmark facilities are generally regarded as part of the global research capability, typically involve an investment in excess of $A100M, and engage national and international collaborators in investment and in access protocols.

For overseas landmark facilities, participation normally involves a subscription or other regular payment, combined with an Australian-based presence to manage access and build expertise. Selection, funding and governance arrangements will be specific to the facility.

The cost of Australian Landmark Facilities is such that they are investment decisions are usually considered through Cabinet processes rather than infrastructure funding programmes. Australia does not have processes to plan for and prioritise development of, or in the case of overseas facilities, contributions towards and access to, Landmark Facilities. There are several reasons why the Taskforce considers this is untenable.

- Firstly, in the absence of a process to prioritise investments in infrastructure of this scale, the Australian Government is not well positioned to make strategic investments. This is because the cost of Landmark Facilities is such that Australia may need to prioritise some facilities over others, and to indicate priorities to the research community as early as possible. To illustrate this point, in the foreseeable future it is likely that Australian Government funding will be sought for some or all of the following an Extremely Large Telescope, the Square Kilometre Array, the Australian Synchrotron, a replacement research vessel, LOFAR (low frequency array) and Australia's subscription to the European Framework Six Programme.

  Should Australia decide to invest in all of these facilities, the total investment required – for the Australian component only - would be likely to require more than $1b.

- Secondly, the lead times for Landmark Facilities can be many years, with several iterations of costly and time consuming business proposals.

- Thirdly, in spite of the long lead times, Landmark Facilities may require early financial commitments [5]. Furthermore, in the case of Landmark Facilities located overseas, if Australia is unable to indicate a financial commitment to a facility at the required time, Australian researchers may lose access to the facility or may pay a higher access.

The Taskforce considers that NRIC should establish a process to plan for Australian Landmark Facilities. The Taskforce also considers that, given the cost of developing business proposals for facilities of this cost and complexity, that Australian Government funding programmes should provide funding for the development of business proposals for Australian Landmark Facilities.

There are international precedents for establishing processes to plan for and prioritise Landmark Facilities such as the UK Large Scale Facilities Roadmap. The Taskforce considers that NRIC, once established should develop similar strategic roadmaps for Australian Landmark Facilities.

7.9.3 Australian Major Research Facilities

Australian Major Research Facilities is the third category of infrastructure. Australian Major Research Facilities pursue regional, institutional and thematic groups' research

[5] For example, CSIRO (submission 60) notes that the construction of the Square Kilometre Array will begin in 2012 and major investments may not become necessary until 2010 but strategic investments are already essential if Australia is to position itself as the preferred host country.

priorities, are implemented in a collaborative and coordinated way, require national and regional collaboration and access, and require funding levels of $A1-100M.

Australian Major Research Facilities are a key mechanism for undertaking leading-edge research and building collaboration and critical mass of the research effort. Major Research Facilities are expensive - the Taskforce estimates their cost in the order of $A1 to 100m – beyond the means of an individual institution and indeed beyond the means of most groups of institutions or consortia.

The Australian Government has provided support for the establishment of Australian Major Research Facilities through two ad hoc Major National Research Facilities (MNRF) Programmes, the first in 1995 and the second in 2001.

At present there are no plans for a further MNRF Programme and there is no ongoing Australian Government programme for Australian Major Research Facilities. This has created considerable uncertainty for the research community. The Taskforce considers that this uncertainty undermines the Australian Government's investment in this category of research infrastructure. The Taskforce considers that the Australian Government should provide ongoing programme funding for Australian Major Research Facilities.

A critical question for the Taskforce is what level of funding is likely to be necessary, especially in the absence of national strategies and priorities for research infrastructure. The Australian Academy of Science (submission 1) suggests that the level of unmet demand from the previous round of the MNRF provides some guidance.

The Taskforce considers that the most accurate answer to this question will flow from the establishment of the processes recommended earlier in this section. In the interim, the Taskforce considers that annual funding of $80m would provide some certainty to the research community and allow continued prioritisation of and investment in Australian Major Research Facilities.

7.9.4 Australian Research Sector Facilities

Australian Research Sector Facilities is the fourth category of infrastructure. Australian Research Sector Facilities typically facilitate regional and institutional strategies and priorities, require regional and institutional collaboration and access, are implemented in a coordinated way within a strategic framework, and require a capital investment of $0.15-1M. Infrastructure in this category typically involves a commitment from the host institution.

The Australian Government currently provides funding for Australian Research Sector Facilities through the LIEF Programme. The Taskforce notes that LIEF funding has not kept pace with increases in funding for research projects. The

Taskforce considers that the LIEF programme should be doubled, from $25m to $50m per annum to keep pace with increases in funding for research projects.

7.9.5 Institutional Research Facilities

Institutional Research Facilities is the fifth category of infrastructure. Institutional Research Facilities typically facilitate institutional research priorities, are of relatively low cost or are site-specific in nature, and are implemented from the host institution's resources. Institutional Research Facilities are not within the scope of this framework. They are, however, an important part of the overall research infrastructure system and integrally linked to infrastructure that is within the scope of this Framework. The Taskforce has several recommendations regarding this critical source of funds. These are set out in sections 5.3 and 5.7.

The relationship between the five categories of infrastructure and the various levels of strategies and priorities is illustrated in diagram 1.

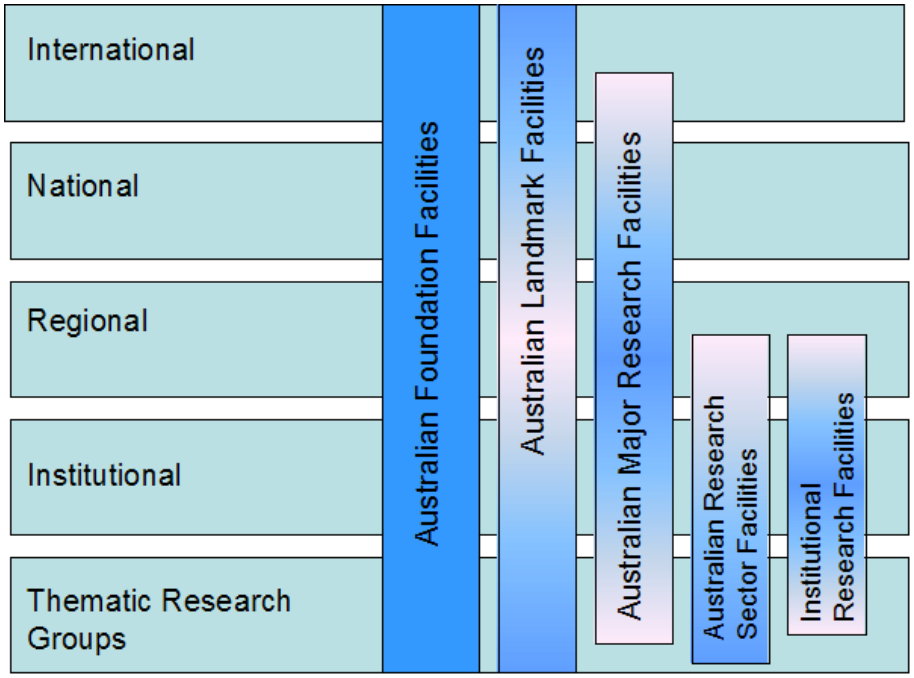

Figure 1 The Relationship between Categories of Infrastructure and Strategies and Priorities

7.10 Leveraging Requirements

Programme requirements for institutional leveraging towards infrastructure capital costs have been a feature of the research funding system for some time. It is Taskforce's view that programmes that seek leveraging to meet capital costs, as a condition of grant, divert funds provided for other purposes and thereby undermine the general fabric of research infrastructure and undermine capacity to pursue regional and institutional strategies and priorities. The Taskforce considers that

Australian Government research infrastructure programmes should not have leveraging requirements to meet capital costs as a condition of grant.

It is not, however, the Taskforce's view that the co-investment in capital or other costs should never occur. The Taskforce envisages arrangements whereby co-investment in capital costs could, for example, purchase a fixed share of infrastructure access. Where they do occur, funding agencies should ensure that these requirements are equitable for small and regional research institutions.

8 A Strategic Approach – Linking Research Strategies and Priorities to Research Infrastructure

8.1 Introduction

In sections 6 and 7 the Taskforce concludes that there is a need to integrate national, regional, institutional and thematic groups' research strategies and priorities and link them to research infrastructure strategies and priorities.

In this section the Taskforce proposes the establishment of a National Research Infrastructure Council as the organisational structure to integrate national, regional and institutional strategies and priorities, taking into account the strategies and priorities of thematic groups. Pointing to the need to link research strategies and priorities with research infrastructure strategies and plans, the Taskforce concludes, with backing from feedback received during consultations with stakeholders, that there is a need for a regular national process for overall research strategy management. The Taskforce also proposes that the Australian Government adopt a set of research infrastructure funding principles, recommends that these principles be applied to existing, as well as new, infrastructure and recommends further work regarding collaboration and co-investment with industry.

8.2 Research Infrastructure Funding Principles

In section 7.2 the Taskforce outlined many of the strengths and weaknesses of the current research infrastructure system and identified emerging trends that must be addressed in this Framework. This information was drawn from submissions, consultations, research infrastructure reports and reviews, and overseas approaches such as those described by IPRIA (2003).

The Taskforce's conclusions in that section informed the development of the research infrastructure funding principles below. The Taskforce considers that these principles should underpin the research infrastructure funding system and that Australian Government investment in research infrastructure that falls within this Framework should be developed around the principles:

8.2.1 Funding Principles

- Investment in research infrastructure should be made in a strategic and collaborative manner.

- Funding programmes and processes should recognise the need to support institutional, regional, national and international strategies and priorities as well as the strategies and priorities of thematic groups.
- Funding programmes and processes should foster collaborative investment in infrastructure, rather than competition for infrastructure funds.
- Investment in research infrastructure should be made in a transparent manner that provides effective use of funds and ensures that infrastructure is productive and remains viable.
- Funding of research infrastructure should ensure the ongoing viability of infrastructure by providing for effective operation and staffing, and for refurbishment while it remains relevant to research.
- Infrastructure investments should support quality research across all innovation platforms from basic to applied research.
- Access regimes should permit research infrastructure to be broadly available to researchers to support their research.
- Infrastructure investments should foster collaborative use of research infrastructure.

8.2.2 Recommendation

That Australian Government investment in research infrastructure should be developed around the Funding Principles set out in this Framework, and that these principles be adopted by all universities, publicly funded research agencies and research funding agencies. Section 8.2

8.3 Linking Research Infrastructure Strategies and Priorities - The National Research Infrastructure Council

In section 7.3 the Taskforce concluded that there is a need for an organisational structure to integrate national, regional, and institutional research infrastructure strategies and priorities with the strategies and priorities of thematic groups. The Taskforce noted, however, that there is no obvious existing organisational structure to lead such a process.

In its *Discussion Paper* released in October 2003, the Taskforce set out its indicative conclusion that many of the weaknesses of the existing research infrastructure funding system arise from the lack of a strategic collaborative framework for infrastructure, and proposed, and sought feedback on, the establishment of a

National Research Infrastructure Council (NRIC). Feedback was almost unanimously in favour of the establishment of such a body.

8.3.1 Recommendation

That a National Research Infrastructure Council (NRIC) be established to further develop, implement, review and monitor this Framework and, in particular, to develop and implement a national process to identify and prioritise research infrastructure needs. Section 8.3

The NRIC should be representative of the research community and should include representatives of universities, publicly funded research agencies, research funding agencies, governments and industry, and may be advised by international peer review. Section 8.3

The role of the National Research Infrastructure Council (NRIC) should include:

- To enhance, implement, review and monitor the Framework.
- To develop and implement a national process to identify and prioritise research infrastructure needs.
- To ensure that there are mechanisms through which thematic groups are able to identify and prioritise infrastructure requirements and specialised taskforces are able to identify structural and systemic infrastructure requirements.
- To ensure that, where these groups do not already exist, they are established.
- To consolidate the work of these groups with institutional, regional, national and international strategies and priorities, in order to develop this Framework for research infrastructure investments.
- To foster and actively seek collaborative ventures and collaborative investors.
- To advise Government on funding priorities for new research infrastructure funding programmes that may be introduced.
- To monitor and review the performance and capability of funded infrastructure.

To do this the NRIC should be representative of the research community and should include representatives of universities, publicly funded research agencies, research funding agencies, governments, and industry, and may be advised by international peer review.

The Taskforce envisages that, to promote funding, acquisition and access decisions that are consistent with this Framework, NRIC should, early in its operation, and in consultation with research institutions and research funding agencies, identify

Australian Government research infrastructure funding programmes that should be consolidated within the Framework, for consideration by government.

Recognising the long lead time involved in many major projects, and the need to respond to changing research needs, priorities, technological developments and international and domestic opportunities, the process should be comprehensively reviewed on a regular basis, at least every three years, with updates on an annual basis.

8.3.2 International Precedents

There are many international precedents for more systematic planning of research and research infrastructure. Increasingly OECD countries are identifying a need for or are actively seeking in some form to ensure that research infrastructure is subject to coordinated planning.

IPRIA (2003) reported on arrangements in the UK, Hong Kong, Germany, Finland, the United States and Canada and found attempts to establish mechanism for such planning to some degree in all of these countries.

Many countries have established high level advisory boards to prioritise research infrastructure funding decisions. Such boards have representation from both government and the research communities to ensure that research infrastructure decisions consider both priorities within research disciplines and across disciplines, in many instances against stated goals.

The European Union is seeking to provide a mechanism to provide for research infrastructure needs common to all member countries through the European Strategy Forum on Research infrastructure, which was established in 2002. Functions of the Forum include providing technical assistance such as scientific advance and cost benefit analyses as well as providing policy advice.

8.4 Linking Research Strategies and Priorities with Research Infrastructure Strategies and Plans

In section 7 the Taskforce concluded that there is a disconnect between funding for research and funding for research infrastructure. The Taskforce also concluded that there is no existing structure to integrate national, regional and institutional research strategies and plans with research strategies and plans of thematic groups. In the absence of such a structure, it will be more difficult to link research strategies and priorities with research infrastructure strategies and priorities.

Given the positive feedback the Taskforce received on the proposed National Research Infrastructure Council (NRIC) (see section 8.3) during its October 2003 consultations, the Taskforce sought feedback during on how best to link research

strategies and priorities with the proposed NRIC. There was strong support for the establishment of a national process to integrate research strategies and priorities.

8.4.1 Recommendation

That a regular national process, under the auspices of a Strategic Research Council, be established to enhance coordination and to integrate the disparate research strategies and priorities of the Australian Government, regions, institutions, and thematic groups and, where relevant bilateral and multilateral strategies and priorities, and thereby to develop a national strategic research plan. Section 8.4

The process would include:

- Work by thematic groups to develop strategic road maps of foresighted views of the likely and potential directions of their research and to analyse Australian capabilities to perform this research at a global standing, feeding into:
- A coordinating body representative of institutional, regional, national, and international interests to develop strategic roadmaps:
- Research funding organisations targeting specific areas of research, developing and implementing research strategies, and monitoring the quality of their outcomes, on a recurring basis, to inform:
- The work of the NRIC.

Recognising the long lead time involved in many major projects, and the need to respond to changing research needs, priorities, technological developments and international and domestic opportunities, the process should be comprehensively reviewed on a regular basis, at least every three years, with more regular updates if appropriate.

8.5 Maintaining Viable and Productive Research Infrastructure

In section 7.2 the Taskforce outlined some of the problems that arise from current research infrastructure funding arrangements. In summary, existing arrangements typically fund infrastructure capital costs but require that infrastructure hosts or managers fund standing operating and maintenance costs and marginal operating costs, or recover these costs from access charges. Where this is difficult or impossible to do, infrastructure that could otherwise be productive and viable risks becoming underutilised or non-operational.

After considering options for ensuring that research infrastructure investments continue to be productive, relevant and viable, the Taskforce concluded that, for infrastructure categorised in section 7.9 as Australian Foundation Facilities, Australian Landmark Facilities, and Australian Major Research Facilities, the best option is to fund not only the capital cost of the infrastructure, but also the standing operating . These costs should be funded at least for an initial period, with ongoing funding subject to a periodic review of performance, relevance and viability.

The Taskforce considers that marginal capital and operating costs should be recovered from access charges. The Taskforce considered that these costs should be met by research funding agencies as part of their commitment to funding research. This is discussed further in section 11.3.

8.5.1 Recommendations

That, for major research infrastructure, research infrastructure funding programmes should ensure that capital costs and standing operating costs are funded to maintain viability of the facility and that infrastructure is funded for any specialised staff such as operators and, for very large or complex infrastructure, business managers, for an initial period, with further funding subject to a review of the ongoing viability and relevance of the infrastructure. Section 8.5

That, to inform effective investment decisions, the research infrastructure business proposal should address the initial capital costs, provision for standing operating costs and (subject to review, continuing relevance and good governance) renewal and upgrade costs. Section 8.5

That where possible and appropriate, marginal operating costs should be recovered from access charges. Section 8.5

8.6 A National Approach to Upgrading Basic Research Infrastructure

In section 6 the Taskforce noted that submissions had broadly made the point that basic research instrumentation is in a stage of rapid evolution in capability, contributing to the obsolescence of many facilities. While the cost of individual instruments may be minor, the cost of re-equipping on a large scale is considerable.

In the *Discussion Paper* in early October, the Taskforce asked whether there should be a national effort to re-equip basic research infrastructure to ensure interoperability of facilities and systems and compatibility of data repositories.

Feedback provided a number of examples where there is a need to bring basic equipment in research laboratories up to modern standards and indicated that a national discussion on appropriate technology and standards would be beneficial.

8.6.1 Recommendation

That the NRIC initiate discussion and a review of the opportunities to upgrade basic infrastructure across the research sector. Section 8.6

8.6.2 Libraries and Museums

The Taskforce notes that libraries and museums are custodians of significant datasets. The Taskforce considers that NRIC, once established, should consider how libraries and museums should be integrated into this Framework and into any national approach to upgrading basic infrastructure

8.6.2.1 Recommendation

That NRIC consider how libraries and museums should be integrated into this Framework and into any national approach to upgrading basic infrastructure. Section 8.6

8.7 Centralised Research Infrastructure Facilities

The Taskforce notes that a number of submissions had suggested that current examples of centralised research infrastructure facilities – especially central animal houses, animal production facilities, and instrument laboratories – offer a possible model for provision and management of research infrastructure, particularly at a regional level such as the University of Tasmania's Centralised Science laboratory and the University of Queensland's Institute of Molecular Biology. The Taskforce also noted that two State Governments have or are moving to centralised research infrastructure facilities.

In the *Discussion Paper* released in mid October, the Taskforce sought feedback on the merits of this model for providing research infrastructure. While the feedback was not extensive, it was generally positive and the Taskforce considers that the concept of centralised research facilities warrants further consideration. The Taskforce also considers that funding programmes should foster centralised facilities, where appropriate.

8.7.1 Recommendation

That the NRIC give further consideration to the merits of this model. Section 8.7

That funding programmes should foster the establishment of centralised facilities, where appropriate. Section 8.7

8.8 Existing Research Infrastructure

In October 2003 the Taskforce undertook a second round of consultations and released a *Discussion Paper* with a number of indicative conclusions, many of which have become recommendations and models in this Framework. One of the most frequently asked questions during the consultations was whether this Framework would apply to existing infrastructure.

The Taskforce considers that, in principle, existing research infrastructures should fall within the scope of this Framework and should, for example, be eligible for funding for standing operating, maintenance and refurbishment costs subject to an assessment of its performance, viability and relevance, and subject to adoption of management, access and charging regimes set out in this Framework. Indeed, the most effective and efficient investment decisions for new research infrastructure would be made within an understanding of the performance, viability and relevance of existing infrastructure.

The Taskforce considers, however, that it will be necessary to develop a process for integrating decisions about investment in existing research infrastructure into the strategies and priorities of this Framework. The Taskforce would envisage that this process would, at least initially, be separate to processes for investment decisions in new infrastructure but considers that process would involve a review of performance, ongoing relevance and viability. The Taskforce considers that this is an area that requires further consideration.

The Taskforce also considers that existing facilities should be eligible for Australian Government infrastructure funding programmes, subject to an assessment of their performance, relevance and viability.

8.8.1 Recommendation

That NRIC, once established, develop a process to integrate existing research infrastructure within this Framework. Section 8.8

That existing infrastructure be eligible for Australian Government research infrastructure funding programmes, for example for standing operating, maintenance and refurbishment costs. Section 8.8

8.9 Collaboration and Co-Investment with Industry

In its October 2003 *Discussion Paper*, and during it second round of consultations, the Taskforce sought feedback on the barriers that inhibit industry investment in and use of infrastructure. The Taskforce considers that this is an area that warrants further consideration.

8.9.1 Recommendation

That Taskforce recommends that NRIC give further consideration to the opportunities for collaboration with and co-investment from industry. The Taskforce also echoes its earlier recommendation that NRIC's membership include industry representation. Section 8.9

8.10 Leveraging and Co-Investment

8.10.1 Definitions

Co-investment: Purchasing a fixed-share in infrastructure such as a fixed share of access.

Leveraging: Requiring that funding programme recipients contribute to infrastructure capital (or other) costs as a condition of grant

8.10.2 Leveraging

In section 7.10 the Taskforce described some of the problems caused by funding programme leveraging requirements and, by contrast, discussed some of the benefits of co-investment arrangements.

In sections 5.7 and 7.10 the Taskforce expresses its concern about leveraging requirements. The Taskforce considers that research infrastructure funding programmes should avoid inflexible leveraging requirements for the reasons outlined in those sections.

8.10.2.1 Recommendation

That research infrastructure funding programmes should avoid inflexible leveraging requirements as this diverts funds from the purposes for which they were intended and often inhibits opportunities for participation. Section 8.10

8.10.3 Co-Investment

In section 7.10 the Taskforce also concluded that funding arrangements that encourage co-investment in research infrastructure, for example to purchase a fixed share in an asset:

- Encourage research collaboration.
- Encourage collaboration in the acquisition, development and use of infrastructure.
- Maximise investments in research infrastructure. Co-investment can do this in two ways. Firstly co-investment can provide infrastructure to groups of

researchers with compatible infrastructure needs that otherwise might not be available at all. Secondly co-investment can also provide scope for investments from researchers whose needs are complementary.

The Taskforce noted, however, that co-investment requirements can create barriers to participation for small and regional research institutions and concluded that they should not be applied inflexibly.

The Taskforce concluded that co-investment requirements should be encouraged where appropriate.

8.10.3.1 Recommendation

That, where co-investment requirements are desirable, they should encourage co-investment or provide other incentives such as a fixed share of infrastructure access, and ensure that requirements are equitable for small and regional research institutions. Section 8.10

9 Research Infrastructure Funding Programmes

9.1 Introduction

In this section the Taskforce outlines the need for commitment to an integrated suite of funding programmes in line with the categories of research infrastructure it proposed in section 7.9. It recommends:

- for Australian Foundation Facilities a funding programme of $55m per annum.
- for Australian Landmark Facilities; a process to plan for and develop business proposals, plus $10m per annum in programme funding for the development of business proposals..
- for Australian Major Research Facilities, $80m pa through an ongoing funding programme;
- for Australian Research Sector Facilities, $50m pa – of which $25m is additional funding - through an ongoing programme which would be the successor to the current LIEF programme.

The Taskforce recommends staged application processes to inform planning and prioritising processes. Through the proposed funding recommendations the current level of Australian Government infrastructure support would rise from $110m to $195m. Finally the Taskforce emphasises the need for adequate lead time to enable well-coordinated and strategic planning.

9.2 Need for a Commitment to New Research Infrastructure Funding Programmes

In sections 7.8 and 7.9 the Taskforce concluded that there is a need for ongoing funding programmes for investment in research infrastructure. The continuity of programmes is vital to ensuring the viability and continuing relevance of investments in research infrastructure and to ensuring the necessary funding flows often required to develop a facility over extended periods.

9.2.1 Australian Foundation Facilities

In section 7.9 the Taskforce noted that Australian Foundation Facilities - such as broadband communications capacity, high performance computing and major data repositories and services - are almost unanimously recognised as a vitally important enabling mechanism for Australia's current and future research and research

infrastructure needs. This recognition crosses all research areas and is seen to be of growing importance.

While a number of initiatives (APAC2, AREN, ARIIF and ANP) have been undertaken to address this need, ongoing investments in these initiatives are likely to be required as the needs of researchers for increased capability develops. The Taskforce concludes that the programme of investment in these Australian Foundation Facilities should be continued as a matter of high priority, given their broad and critical importance to Australian research priorities.

The Taskforce considers that, once established, NRIC should advise government on necessary levels of funding for Australian Foundation Facilities. In the interim, the Taskforce considers that the existing level of funding provided through the SII, which is in the order of $55m per annum, would provide adequate support and allow continued prioritisation of and investment in Australian Foundation Facilities.

9.2.1.1 Recommendation

That the Australian Government note that there is a need to establish ongoing funding programmes for Australian Foundation Facilities to support continued work of initiatives such as APAC, AREN and ARIIF. Section 9.2

The area that raises concern for the Taskforce is that of major data repositories. Most areas of research now depend on access to large data repositories and the number of data repositories, and the rate at which they are growing, is staggering. Considerable research and implementation effort needs to be applied to the issue of effective management and distribution of large data repositories, and to the intellectual property issues associated with managing such data repositories. The development of middleware policies and mechanisms, as discussed in section 7.9, is also an area that requires attention.

9.2.1.2 Recommendation

That funds be provided within the Australian Foundation Facilities programmes to develop policies on and mechanisms to underpin the growing number of data repositories and to develop policies and mechanisms for middleware. Section 9.2

9.2.2 Australian Landmark Facilities

In section 7.9 the Taskforce noted that the cost of Australian Landmark Facilities is such that they are not funded through funding programmes but are subject to decisions in the context of Australia’s Budget, and often State and Territory Governments budgets.

It was also noted that Australia does not have processes to plan for and prioritise development of, or in the case of overseas facilities, access to, Landmark Facilities.

The Taskforce is concerned that, in the absence of a process to plan for and develop business proposals for Landmark Facilities, the Australian Government is not well positioned to make strategic investments in infrastructure of this scale.

The Taskforce concludes that a process to plan for and prioritise Australian Landmark Facilities should be established to ensure that:

- Strategic planning for the major investments involved can occur, and Australian Landmark Facilities priorities can be indicated to the research community as early as possible;
- Progressive development of proposals over what is typically a long time scale can occur in an efficient and structured way;
- Timely and progressive financial commitments can be made in a clear strategic framework.

A key element of this process is the establishment of a funding programme to fund the development of business proposals as part of the process of planning and prioritising research infrastructure needs. This may be a specific programme under the Australian Landmark Facilities category, or an aspect of the Australian Major Research Facilities funding programmes. As the expenditure on these activities will not follow a regular pattern, it is considered that an amount of $10m per annum be added to the Australian Major Research Facilities support programme to cater for these costs.

The UK Large Scale Facilities Roadmap provides an example of such a process. The Taskforce considers that NRIC, once established should develop similar strategic roadmaps for Australian Landmark Facilities.

9.2.2.1 Recommendations

That a process be established, under the auspices of the NRIC, for planning and prioritising Australian Landmark Facilities. Section 9.2

That the Australian Government establish a funding programme to support the development of business propositions that will inform this process, or make provision for funding of business proposals in another related programme. Section 9.2

9.2.3 Australian Major Research Facilities

In section 7.9 the Taskforce noted that Australian Major Research Facilities are a key mechanism for undertaking leading-edge research and building collaboration and critical mass of the research effort. The Taskforce considers that the need for funding for Australian Major Research Facilities is a key priority. As such, the funding of these facilities should be provided as an ongoing programme, rather than an ad hoc activity.

The Taskforce also considers that funding for Australian Major Research Facilities should not be limited to capital costs only. They should include standing operating and maintenance costs and refurbishment costs where necessary and, for very large or complex infrastructure, business managers, for the proposed term of operation of the facility.

A critical question for the Taskforce is what level of investment is likely to be necessary for Australian Major Research Facilities, especially in the absence of a national plan and Framework for research infrastructure. The Australian Academy of Science (submission 1) suggests that the level of unmet demand from the previous round of the MNRF provides some guidance.

The Taskforce considers that the most accurate answer to this question will flow from the establishment of national planning processes recommended above. In the interim, the Taskforce considers that annual funding of $80m would provide some certainty to the research community and allow continued prioritisation of and investment in Major Research Facilities.

9.2.3.1 Recommendation

That the Australian Government note that there is a need to establish ongoing funding programmes for Australian Major Research Facilities. Section 9.2

9.2.4 Australian Research Sector Facilities

The Taskforce concludes that research infrastructure in this category should be subject to the same proposal/decision process as those in the Australian Major Research Facilities category, but as the investment in each facility is smaller, and there will most likely be fewer collaborating institutions, the processes should be simplified.

The Australian Government currently provides funding for Australian Research Sector Facilities through the LIEF Programme. The Taskforce notes that LIEF funding has not kept pace with increases in funding for research projects. The Taskforce considers that annual funding of $50M should be provided for Australian Research Sector Facilities to provide a balance with funding for research projects.

9.3 Staging Research Infrastructure Funding Application Processes

A number of submissions commented on the considerable effort and cost involved in the preparation of applications for infrastructure funding. Part of the cost arises from

the irregular nature of some infrastructure funding programmes [6]. Because of the cost of developing proposals, and especially given the uncertainty of future funding, there is some support for programmes for major and systemic infrastructure to be staged.

The Taskforce favours staged application processes to inform the planning and prioritising process recommended previously and to defray the substantial cost of developing business proposals for Australian Foundation Facilities, Australian Landmark Facilities and Australian Major Research Facilities.

9.3.1 Recommendation

That Australian Government funding programmes for Australian Foundation Facilities, Australian Landmark Facilities and Australian Major Research Facilities include, where appropriate, staged application processes and funding for the development of business proposals. Section 9.3

9.4 Funding and Programme Management

While the Taskforce has categorised research infrastructure into the categories of Australian Foundation Facilities, Australian Landmark Facilities, Australian Major Research Facilities and Australian Research Sector Facilities for discussion purposes, the Taskforce considers that the funding programme for research infrastructure should be an integrated programme to allow for evolving requirements between and across the categories.

9.4.1 Recommendation

That the Australian Government provide ongoing research infrastructure funding for four categories of infrastructure defined in this Framework: Australian Foundation Facilities, Australian Landmark Facilities, Australian Major Research Facilities and Australian Research Sector Facilities as an integrated research infrastructure funding programme. Section 9.4

The Taskforce has indicated the extent of funding requirements for each category in previous sections. In the context of the recommendation for an integrated research infrastructure funding programme, the Taskforce recommends funding as follows:

9.4.2 Recommendation

That the Minister note that present support for these four categories is currently in the order of $110m per annum, and that increasing this to $195m per annum would

[6] in the absence of regular, ongoing programmes, with objectives and criteria that are stable over a period of time

provide improved underpinning of research priorities and allow continued prioritisation of and investment in infrastructure. Section 9.4

The Taskforce has recommended a number of principles upon which research infrastructure investments and funding programmes should be based. The Taskforce has also outlined the need that, as a consequence of the large capital investment involved in providing research infrastructure, the portfolio of investments – on both a portfolio and individual facility basis – should be subject to regular review and evaluation to ensure that the research infrastructure remains relevant and viable.

9.4.3 Recommendation

That the programmes should be consistent with the Funding Principles set out in this Framework, recognise that infrastructure initiatives are likely to have large initial capital costs, and be subject to regular review and evaluation to ensure that they remain relevant and viable. Section 9.4

The importance of integrating research infrastructure investments with national, regional, institutional and thematic research strategies and priorities has been previously identified, and the role proposed for the National Research Infrastructure Council includes recommendations to the Australian Government in relation to research infrastructure investments.

9.4.4 Recommendation

That NRIC advise government on priorities for these funds and any other new research infrastructure funding programmes that may be introduced. Section 9.4

In response to the issues of timeliness of research infrastructure funding programmes and the need to plan adequately before making investment decisions, the Taskforce considers that research infrastructure funding programmes should also have their scope and timetables defined well in advance of investment decisions to ensure that there is ample lead time to develop proposals and engage potential collaborators and co-investors.

9.4.5 Recommendation

That infrastructure funding programmes should also have their scope and timetables defined well in advance of investment decisions to ensure that there is ample lead time to develop proposals and engage potential collaborators and co-investors. Section 9.4

The Taskforce has noted the need for collaboration across the research sector and within the research community in the efficient and effective provision of research infrastructure. Current differences between funding rules and different funding processes are seen to inhibit this collaboration. To ensure these future research

infrastructure funding programmes encourage collaboration and co-investment, the Taskforce considers that research infrastructure funding programmes should be designed and funded to permit proposals from universities, publicly funded research agencies and medical research institutes.

9.4.6 Recommendation

That, to facilitate collaborative investment and use, research infrastructure funding programmes should be designed and funded to permit proposals from universities publicly funded research agencies and medical research institutes. Section 9.3

10 Acquisition and Development of Research Infrastructure

10.1 Introduction

A number of models for acquisition and development of research infrastructure have been used in Australia, and are in use internationally. All inherently follow an asset investment model, with the scope of the business case/model varying depending on the complexity and cost of the infrastructure to be acquired or developed. For all types of research infrastructure investment the presentation of a business proposal is a fundamental requirement and, for larger investment proposals staged funding may be sought to either further develop the proposal, or to stage the acquisition or development process.

After consideration of Australian and international experiences and examples, the Taskforce ultimately developed five broad models for the acquisition and development of research infrastructure. It is the Taskforce's view that, to ensure consistency, the acquisition and development of research infrastructure that falls within this Framework should follow one of these models.

10.2 Models for Acquisition and Development of New Research Infrastructure

Submissions describe a range of research infrastructure acquisition and development models but note that there is no consistent approach for the acquisition and development of research infrastructure.

This Framework sets out models for acquisition and development and an indication of when the various models might be applied.

All models require the development of a business proposal. The depth and breadth of the proposal would depend on the cost and complexity of the proposed infrastructure. At a minimum all business proposals should set out the potential research and social, economic, environmental and geopolitical benefits of the research infrastructure to the proponents and the broader research community, proposals for collaborative investment and use, whole of life costs, proposals for access and charging regimes, and identify the skills that would be required to use and operate the infrastructure.

10.2.1 Model 1

(eg, for Australian Landmark Facilities located in Australia):

- Project based.

- Expert group develops scoping proposal, with preliminary assessment of research supported, usage, benefits, and costs estimates for review by funding agency (involving international peer review of research and research infrastructure standing).
- Stage 1 funds provided to develop business plan for facility, including expanded scoping statement, costs estimates, facilities management and operations proposals, access and charging regime proposals.
- Call for proposals to invest in and/or host facility, or to bid for global facility.
- Funding agency assesses proposals, decides on preferred option.
- Stage 2 funds provided to develop proposal including facility design, revised cost estimates, management and operating regimes, access and charging regimes.
- Funding agency recommends funds for acquisition/development of facility.

10.2.2 Model 2

(eg to fund access to international research infrastructure):

- Project based.
- Opportunity for Australia to participate is identified, either by Australian researchers or by the facility developers overseas.
- Expert group convened to develop scoping proposal, with preliminary assessment of research supported, usage, benefits, and cost estimates for review by funding agency (involving peer review of research and research infrastructure standing).
- Scoping proposal evaluated and, if agreed, proposers invited to develop business plan for Australian participation in the facility, including expanded scoping statement, cost estimates, offshore and onshore facilities management and operations, access and charging regimes, and proposed international agreement.
- Stage 1 funds provided to develop this plan.
- Funding agency considers business plan and makes recommendation regarding (a) negotiation of international agreement and (b) funding of participation in the facility.

10.2.3 Model 3:

(eg, for Australian Foundation facilities):

- Project based

- Expert group develops scoping proposal, with preliminary assessment of research supported, usage, benefits, and costs estimates for review by funding agency (involving international peer review of research and research infrastructure standing).
- Stage 1 funds provided to develop business plan for facility, including expanded scoping statement, timetable and programme for implementation, costs estimates, facilities management and operations proposals, access and charging regime proposals.
- Funding agency recommends programme funds for development of facility.
- Call for proposals to invest in and/or host facility.
- Funding agency assesses proposals, decides on investment programme.
- Programme funds provided to implement investments.

10.2.4 Model 4:

(eg, for Australian Major Research Facilities)

- Programme based.
- Community of interest working groups or institutions develop scoping proposals, with definition of research supported, usage, benefits, and costs estimates and proposed investment partners for review by funding agency (involving international peer review of research and research infrastructure standing).
- Where proposal involves major investment (say more than $25 million) Stage 1 funds provided to develop business plan for facility, including expanded scoping statement, costs estimates, facilities management and operations proposals, access and charging regime proposals.
- Funding agency assesses proposals, decides on preferred proposals.
- Programme funds provided to implement investments.

10.2.5 Model 5.

(eg, for Australian Research Sector Facilities)

- Programme based.
- Community of interest working groups or institutions develop scoping proposals, with definition of research supported through competitive and non-competitive grants, facility usage, benefits, and costs estimates and proposed investment partners for review by funding agency (involving international peer review of research and research infrastructure standing).

- Funding agency assesses proposals, decides on preferred proposals.
- Programme funds provided to implement investments.

10.2.6 Recommendation

That, to ensure consistency in the acquisition, governance, access and charging arrangements for research infrastructure, all universities, publicly funded research agencies and research funding agencies should follow one of five broad acquisition models defined in this Framework. Section 10.2

That all research infrastructure investments with a government funding component in excess of $5m should be consistent with this Framework and is acquisition, governance, access and charging models.

10.2.7 Recommendation

That, where significant investment in research infrastructure is considered in an institution or agency other than the National Research Infrastructure Council, business proposals should confirm that the proposed investment is consistent with this Framework and its acquisition, governance, access and charging models. Section 10.2

10.3 Reinvestment in Infrastructure

In section 8.8 the Taskforce indicates its view that existing facilities should be eligible for Australian Government infrastructure funding programmes, subject to an assessment of their performance, relevance and viability. The Taskforce does not envisage that this assessment would follow one of the acquisition models outlined above, but would be conducted by expert panels who would assess performance, relevance and viability of infrastructure, the proposed forward plan for development of the facility, the consistency of governance and access management with the models set out in this Framework. The Taskforce also envisages that the panel would recommend to NRIC its priority ranking.

10.3.1 Recommendation

That hosts or owners of significant research infrastructure facilities should be eligible to apply to NRIC to have their facilities assessed for incorporation into this Framework. Section 10.3

10.4 Locating Research Infrastructure

Internationally there is a trend, at least for major research infrastructure, to identify the location of planned research infrastructure using parameters such as the location of any necessary supporting infrastructure, the location of potential users, the

whereabouts of the technical skills necessary to operate the facility, and any facility specific requirements such as radio silence.

The Taskforce considers that generally it should be an absolute requirement that the managing agency have active involvement in the relevant field of research and should be a potential major user of the facility. The best outcome is seen to be to locate the facility or other infrastructure where it can have the greatest impact. In many cases this might be where there are active or emerging industry clusters having strong links to the local research infrastructure.

10.5 The Scope of Business Proposals

The Taskforce considers that all proposals for infrastructure should be pursued through a business proposal that outlines the nature and scope of the research infrastructure investment proposed. The depth and breadth of the proposal would depend on the cost and complexity of the proposed infrastructure. For the most complex and/or expensive infrastructure, the proposal would set out:

- The nature and scope of the facility proposed, including all associated research infrastructure (such as broadband connections, computing capacity, data repositories) necessary for its effective functioning.
- The potential research outcomes and socio-economic, environmental and geopolitical benefits of the research infrastructure, both to the proponents and the broader researcher community, (both domestic and overseas).
- The likely useful lifespan of the research infrastructure.
- Indicative estimates of whole of life costs including total development, construction and operating costs and the likely costs of refurbishment in its expected useful life, for the facility and its associated research infrastructure.
- Proposals for collaborative investment and use.
- The availability and quality of necessary supporting infrastructure and human skills that would be required to use and operate the infrastructure.
- Identification of active or emerging industry clusters having strong links to the research infrastructure.
- Degree to which the proposed host is likely to have active involvement in the relevant field of research and be potential major users of the facility.
- Proposed governance and intellectual property arrangements, access and charging regimes, and marketing, training and exit strategies.
- A risk analysis incorporating risks such as the possibility of technological obsolescence prior to the end of the planned life of the infrastructure or the

possibility that user demand might change over its life and the impact this would have on its viability.

11 Charging Regimes for Use of Research Infrastructure

11.1 Introduction

Aside from a few major facilities such as the Australian Partnership for Advanced Computing (APAC) and the Research Reactor, and for international facilities used by Australian researcher, there is no consistent framework for charging for use of research infrastructure. The charging regimes used by APAC and ANSTO are reflective of international practice, and provide a model for the regimes which are broadly accepted by researchers, and which should be more broadly applied as a framework for charging for use of research infrastructure funded predominantly by the Australian Government.

The issues of access to research infrastructure and charging for use of research infrastructure have been canvassed in many of the submissions, and the Taskforce identified a need to ensure transparency of charging and access regimes for all research infrastructure. While the issues of access and charging are related, for clarity in this Framework the issue of access charges are dealt with in this section, while access regimes are considered in the following section 12.

Many submissions were critical of the lack of consistent funding for access to infrastructure and lack of (or reducing) and inconsistent funding arrangements for associated costs such as airfares and accommodation. According to the Australian Academy of Science (submission 1), ‘there is mismatch between the MNRFs business model of providing a state-of-the art service for the Australian (and international) scientific communities and the capacity of potential users to obtain funding in research grant applications to the services offered by the MNRFs’.

This impediment relates mainly to Australian competitive grants in which requests for such funding may not be provided as part of the grant. According to the Australian Academy of Science (submission 1), the solution advocated by the MNRF Directors is to introduce an MNRF use line item in competitive grant applications’. Other submissions make similar points about access to research facilities generally though they vary in their views as to whether funding for access should be linked to funding for research or funding for infrastructure.

11.2 Options for Charging

As a basic principle, funding and charging regimes should allow the infrastructure host to ensure the viability of the infrastructure over its expected life. As noted previously, the prime role of the host is to manage the facility for the benefit of the research sector, and in a way which ensures the viability and relevance of the facility to national, regional, institutional and discipline strategies.

The options for charging range across a spectrum from free to designated users to full cost recovery (of capital and operating costs). While there are many intermediate or mixed models, there are four basic options relevant to the structure of Australia's research sector:

- Full cost recovery of capital and operating costs.
- Full cost recovery of operating costs.
- Free to designated users, except for marginal operating costs.
- Free to designated users.

In the context of a nationally integrated research infrastructure strategic framework, the first two market-driven models place large market and financial risks on the host of the facility, and unless the current arrangements for research funding are changed to a more market-driven, full-funding mode, may place at risk the ongoing viability and relevance of the facilities. These models for charging also introduce additional complexities for management of cash derived from recovery of capital charges by facility hosts, and for the creation of usage models which may be at odds with the national, regional, institutional and thematic groups' strategies and priorities.

The Taskforce considers that costs associated with accessing infrastructure may in some cases be associated with funding for the research infrastructure, especially in the case of Australian Foundation Facilities and Australian Landmark Facilities, and in some cases associated with the funding of research, for example in the case of access to Australian Major Research Facilities.

The Taskforce considers that funding for associated costs, such as travel and accommodation, should be linked to funding for research rather than funding for research infrastructure.

11.3 Preferred Charging Model

For these reasons the Taskforce has concluded in previous sections that the funding of research infrastructure should provide both capital and standing operating costs. In this context, the Taskforce concludes that the facilities should be made available to designated users free of charge except for marginal operating costs. The Taskforce suggests that the marginal operating costs should be considered as a component of the research funding arrangements.

11.3.1 Recommendation

That, as a basic principle, charging for use of research infrastructure funded within this Framework should be on the basis that designated users will be charged only for marginal operating costs. Section 11.3

In respect of determining ‘designated users’ for whom the recommended access regime is available, the Taskforce considers that the key determinant is support of quality research in universities and publicly funded research agencies. This inherently requires a merit-based or mission-oriented process by research funding bodies to determine the researchers who will have access to the facility.

11.3.2 Recommendation

That research funding agencies, in making a decision to fund research, should also fund the access to any research infrastructure facility required to conduct that research. Section 11.3

11.4 Multiple Charging Arrangements

Submissions have noted that it will be necessary to have flexible and multiple charging arrangements for particular facilities, depending on their scale and clientele. For example, major facilities such as the Australian Partnership for Advanced Computing (APAC) have different charging regimes for merit-based publicly funded research, for co-investors and for private research. APAC operates on a ‘resource share’ model whereby organisations can make cash and in-kind contributions that buy a share of the resources of APAC’s National Facility. As part of the partnership arrangements, the APAC partners have committed a minimum cash contribution to the National Facility in return for resource shares.

The Taskforce notes that research facilities should have the flexibility to operate multiple charging regimes pertinent to the facility, encompassing subscription/co-investment models and full cost recovery models.

11.4.1 Recommendation

That, as a principle, access charges for use of publicly-funded research infrastructure facilities, by research organisations outside the publicly funded research sector, should be on a full cost recovery basis but should be flexible. This flexibility should, for example, take into account any co-investment made by the research organisation, or take advantage of emerging research collaboration opportunities. Section 11.4

12 Collaboration and Access to Research Infrastructure

12.1 Introduction

In this section the Taskforce considers the importance of information sharing as an adjunct for successful collaboration and recommends the establishment and maintenance of a uniform catalogue of research infrastructure. The Taskforce also points to the need for improvement in access regimes so that they are based on allocation by merit and encourage use the infrastructure by developing researchers and those working in developing areas. These factors also need to be taken into account for Australian participation in overseas facilities.

12.2 Awareness and Availability of Research Infrastructure

A common message from the research community is that many researchers and potential co-investors do not know what research infrastructure is available. A very large number of submissions called for the establishment of a research infrastructure database that outlines the availability of infrastructure and its access and charging regimes.

The Taskforce recognises the difficulties in maintaining a centralised database of research infrastructure across the complete spectrum of facilities, and concludes that a collaborative approach is preferred, in which each host or institution maintains a catalogue of the facilities hosted or owned by them, and which are available to the research community at large, to a nationally consistent standard.

12.2.1 Recommendation

That a uniform catalogue of research infrastructure be established to promote access to infrastructure across the whole of the research platform, to inform investment decisions, and to provide transparent and accessible information on access and charging regimes. Section 12.2

12.3 Access Regimes

Submissions noted that there is a lack of consistency and transparency in access regimes (as well as in facility charging regimes). This often leads to limitations on access to infrastructure.

In the case of some facilities, and especially those within the category of Australian Landmark Facilities, access regimes are clearly defined for researchers both within

and from outside the managing institution, and represent good models of these regimes. Examples of these are:

- APAC grants its share of the APAC National Facility through a merit allocation scheme. The merit allocation scheme has the primary objective of ensuring that the demands of high quality researchers requiring high performance computing capabilities are satisfied in Australia.
- University of Adelaide, through its centralised facility for microscopy and micro-analysis, Adelaide Microscopy, provides access to high cost instrumentation to all SA researchers as well as interstate and international users, using a web based booking system to ensure that all users are able to easily book instrument time (University of Adelaide, submission 77).
- The Australia Telescope National Facility has an external Time Assignment Committee (for allocating use of the instrument according to peer review of the quality of research proposed) and a User Committee which gives user feedback on faculty operation (ATNF/CSIRO, submission 13).

The Taskforce considers that the basic principle for access regimes is that research facilities should be available to researchers who need them with a focus on ensuring that the best researchers – wherever they may be based – can get access to the best equipment wherever it happens to be. An effective access policy will be simpler where facilities have been funded through national programs to support national research. To the extent that a particular state, host or other parties have also invested in the infrastructure, they may wish to recover that investment either through charges to external researchers or a level of preferential access for their staff (AVCC, submission 107).

The Taskforce recognises that there may be privacy or security issues that would, for some facilities, limit the amount of information which may be made publicly available through this reporting process. The extent of this limitation is considered to be a matter for decision by the board or governing body of the facility host.

The Taskforce also considers that access regimes need to enable and encourage research by developing researchers, including higher degree research students, as well as established and developing researchers conducting novel research in emerging areas. Submissions recognised that developing skilled researchers and developing emerging areas of research are essential for Australia's future research and innovation capability.

12.3.1 Recommendation

That, as a basic principle, access to government funded research infrastructure facilities for researchers in universities, publicly funded research agencies and

medical research institutes should be based on a merit based allocation system. Section 12.3

That access regimes enable and encourage developing researchers and novel research in emerging areas. Section 12.3

That where publicly funded research agencies or universities have subscribed to or co-invested in a research infrastructure facility, that agency or university should manage a merit-based allocation system for their researchers within the arrangements for access to the facility agreed at the time of co-investing or subscribing. Section 12.3

12.3.2 Comment

The Taskforce notes that access arrangements and agreements may be arranged on a bilateral or multilateral basis with overseas institutions, and that the access arrangements to Australian research infrastructure may be defined in those agreements. The Taskforce considers that when those agreements are negotiated, endeavours should be made to ensure that access arrangements are consistent with those set out in this framework.

12.4 Access to International Research Infrastructure

Access to international research infrastructure is a vital component of the Australian research effort. Benefits to accessing international infrastructure include access to infrastructure that might not otherwise be available, access often at greatly reduced cost, and increased international collaboration.

With the increasing importance, complexity and costs of research infrastructure, these international relationships and access arrangements are critical.

Access to major overseas research infrastructure is currently facilitated by a number of agreements brokered by ARC, NHMRC, and various thematic groups. In addition to the existing arrangements, a number of potentially vital opportunities are presenting themselves and a process of assessing, planning and prioritising them is necessary.

12.4.1 Recommendation

That the international access arrangements and opportunities be integrated into this Framework by the National Research Infrastructure Council. Section 12.4

13 Management of Research Infrastructure

While a number of major Australian research facilities have governance and management processes that represent good practice, submissions noted that there is no consistent process whereby the Australian Government (and other investors) can monitor the management, performance, accessibility and ongoing capability of infrastructure they have funded. In the absence of such processes, the Australian Government (and other investors) cannot be sure that the funded infrastructure is used effectively and productively, and that it remains relevant and viable for the research it supports.

The Taskforce considers that the decision to locate a research infrastructure facility funded predominantly by public funds, within an institution, confers on the institution the status of 'host' rather than 'owner'. The typical responsibilities of the host, which underlie any contractual agreement, are to act as custodian (for Australian Research Sector Facilities) or steward (for the Australian Foundation Facilities, Australian Landmark Facilities and Australian Major Research Facilities), to ensure efficient and effective operation to support researchers, and to operate an equitable access and charging regime for researchers.

The stewardship role for the more significant infrastructure facilities, encompasses marketing and development of the facility. Marketing is necessary so that potential users, especially those in the private sector, understand the relevance of the facility to their work and can seek advice on how to use it. Development, within the terms of the contractual agreement, is necessary so that the relevant capability and capacity of the facility is maintained and enhanced.

The contractual agreement for funding of a significant infrastructure facility would include separate and identified appropriations that cover full capital and standing operating costs. Separate accounting can help provide a commitment from the host organisation for the term of the agreement, requiring it to continue managing and providing infrastructure services at a specified level, even if changes in its own priorities make the infrastructure less relevant to its new challenges and directions.

The Taskforce, associated with its conclusion that funding of research infrastructure should include funding of standing operating as well as capital costs, considers that the host/manager of the facility should have responsibilities to report on the operations of the facility to the facility's board or governing body and investors. This reporting should be in a format standardised for each of the infrastructure categories, as part of the introduction of a nationally consistent, transparent and rigorous reporting regime.

While some 'hosts' undertake research in their own right, and may operate a merit-based access regime in their own right, this is not an essential component of their responsibilities as a facility operator. In this context, CSIRO (submission 60)

suggests that the management of infrastructures should be separate from the process of determining access. The Taskforce has identified a need to ensure transparency of access and charging regimes for all publicly funded research infrastructure, and this issue is discussed in sections 11 and 12.

13.1 Recommendation

That the host/manager of significant research infrastructure facilities should report annually to the facility's board or governing body on the operations of the facility, including usage, research supported, budget performance, and an assessment of the ongoing relevance of the infrastructure in respect of the research conducted. Section 13.2

The Taskforce considers that all research infrastructure investments with a government funding component in excess of $5m should be pursued within this governance/management model.

13.2 Recommendation

That all research infrastructure investments with a government funding component in excess of $5m should be pursued within one of the governance/management models set out in the National Research Infrastructure Strategic Framework. Section 13.2

14 Other Issues

14.1 Introduction

The Taskforce encountered a number of important issues that were outside its Terms of Reference. The Taskforce notes that the Minister may want to consider these issues further through other mechanisms or fora.

14.2 Intellectual Property

The Taskforce received comments about intellectual property. The main issue is that intellectual property is a barrier to collaboration and collaborative investment in research and research infrastructure. An example cited on a number of occasions relates to research infrastructure facility managers seeking intellectual property over research conducted at their facility even where the research was conducted without any input (other than the facility itself) from, or collaboration with, the facility's host researchers.

The Taskforce is also aware of a second intellectual property issue that is said to undermine industry collaboration with researchers in universities. The issue arises when universities seek intellectual property rights over the products that arise following industry funded basic research undertaken in a university.

The Taskforce is aware of an interesting approach that would appear to address this second issue. IBM's Centres for Advanced Studies in North America uses an intellectual property agreement in which IBM does not claim ownership of the intellectual property created by academic researchers but instead is granted a non-exclusive, worldwide, irrevocable royalty free licence to the intellectual property, allowing it to be used in products and services its offers without restriction. The faculty and graduate students are free to publish the results of their work, subject only to the restriction that they not disclose any confidential information that they received without written permission from IBM. The entire agreement is less than two pages long.

14.3 Regulation and Insurance

Regulatory arrangements and increasing insurance costs are also said to impact greatly on research. UNSW (submission 66) indicated that in science, medicine and engineering, a significant part of their Research Infrastructure Block Grant is targeted at upgrading research facilities to comply with the Occupational Health & Safety legislation and Office of Gene Technology regulations. During consultations a number of researchers were critical of the gene technology regulations. One suggested that a research impact statement be a requirement of proposals for such legislation.

A number of submissions noted that performance based block funds have not acknowledge increases in research related insurance. Increasing insurance costs are said to undermine capacity to conduct research and provide effective infrastructure (for example Menzies Medical Research Institute, submission 56).

14.4 Depreciation

The Taskforce received many comments on depreciation. Many suggest that research infrastructure hosts should recover capital depreciation costs as part of their access costs. The Taskforce took the view that allowing hosts to recover depreciation costs, by default, allowed them to reinvest in the original infrastructure, or use the recovered funds in other ways. The Taskforce took the view that this would be inconsistent with this Framework as it would bypass the Taskforce's recommended review of infrastructure prior to reinvestment and, in effect, bring forward Australian Government investment. The Taskforce notes, however, that this issue warrants further consideration, even if only to strengthen the Taskforce's recommendation.

14.4.1 Comment

That the Minister note these issues and consider whether they warrant further consideration through other mechanisms or fora.

15 Summary of All Recommendations

This section summarises all recommendations set out in this Framework.

16 Definitions and Acronyms

This section defines key terms and acronyms.

AAREN - Australia's Academic and Research Education Network

AARNet - Australian Academic Research Network

AGPS - Australian Government Publishing Service

AIBLABS - Adelaide Integrated Biosciences Laboratories

AINSE - Australian Institute of Nuclear Science and Engineering

ANP - Advanced Networks Programme

ANSTO - Australian Nuclear Science and Technology Organisation

APAC - Australian Partnership for Advanced Computing

ARC - Australian Research Council

AREN - Australian Research and Education Network

ARIIF - Australian Research Information Infrastructure Framework

ASTEC - Australian Science, Technology and Engineering Council

AVCC - Australian Vice-Chancellors' Committee

Backbone - The top level of a network; a set of paths to which local distribution point’s link for long-distance interconnection.

CENTIE - Centre for Networking Technologies for the Information Economy

CHASS - Council for the Humanities, Arts and Social Sciences

CoE - Centres of Excellence

CRCs - Cooperative Research Centre

CSIRO - Commonwealth Scientific and Industrial Research Organisation

Co-investment - Purchasing a fixed-share in infrastructure such as a fixed share of access.

Data - Generally and in research, a term applied to a gathered body of facts. In IT the term refers to information converted into binary digital form so that it is convenient to move or process by computers and transmission media.

Database - A collection of electronic information organised in such a way that its contents can be easily accessed, managed and updated.

Data repository - A place where data and datasets can be stored and maintained.

Dataset - A collection of data relating to a particular discipline or theme. Datasets used by researchers are becoming increasingly large scale and distributed through networks, rather than located in one place. Datasets can contain various kinds of electronic material, eg files or images.

DSTO - Defence Science and Technology Organisation

DCITA - Department of Communications, Information Technology and the Arts

DEST - Department of Education, Science and Training

DHA - Department of Health and Aging

DISR - Department of Industry, Science and Resources

DITR - Department of Industry, Tourism and Resources

Designated user - A user who has been approved or funded to undertake research through a merit based allocation system

ELT - Extremely Large Telescope

FASTS - Federation of Australian Scientific and Technological Societies

GBIF - Global Biodiversity Information Facility

GDP - Gross Domestic Product

HDR - Higher Degree by Research

HEBAC - Higher Education Bandwidth Advisory Committee

HEFA - Higher Education Funding Act

ICT - Information Communication Technology

IGP - Infrastructure Grants Program

IGS - Institutional Grant Scheme

IPRIA - Intellectual Property Research Institute of Australia

K&I - Knowledge and Innovation

Leveraging - Requiring that funding programme recipients contribute to infrastructure capital (or other) costs as a condition of grant

LIEF - Linkage-Infrastructure, Equipment and Facilities

LOFAR - Low Frequency Array

Marginal operating costs - Incremental costs associated with the use of infrastructure by individual researchers or research projects such as the cost of consumables.

Merit based allocation system - A form of merit review such as peer review, assessment of conformity to strategic directions, or corporate or customer business objectives.

MHRIF - Medical and Health Research Infrastructure Fund

MNRF - Major National Research Facility

MRFP - Major Research Facilities Program

NBEST - National Board of Education, Science & Training

NCF - National Communications Fund

NHMRC - National Health and Medical Research Council

NMR - Nuclear Magnetic Resonance

NOIE - National Office of the Information Economy

NRIC - National Research Infrastructure Council

OECD - Organisation for Economic Co-operation and Development

Programme based - An individual project that is developed within a portfolio of projects that may be related but are not necessarily interconnected

Project based - An individual project that typically stands alone but may be interconnected to other projects

PFRA - Publicly Funded Research Agency

PMSEIC - Prime Minister’s Science Engineering and Innovation Council

PRIF - Premier’s Research and Innovation Fund

Quality - In the context of this Framework, quality research refers to research that is undertaken in universities, publicly funded research agencies, medical research institutes, museums, and other research institutions, the funding of which is subject to some form of merit review such as peer review, conformity to strategic directions, or corporate or customer business objectives.

Region - State and territory of combination thereof

R&D - Research and Development

RIBG - Research Infrastructure Block Grant

Research community - Research system stakeholders including researchers, universities, publicly funded research agencies, research funding agencies, medical research institute, or museum

SET - Science Engineering and Technology

Standing operating costs - Costs associated with maintaining and making incremental changes to infrastructure including salaries of administrative and technical staff

SII - Systemic Infrastructure Initiative

SKA - Square Kilometre Array

Thematic groups - Intra- or inter-disciplinary groups with a common research interest eg astronomy or bioinformatics

Thematic strategies and priorities - Strategies and priorities of a thematic group

Appendix A - National Research Infrastructure Taskforce – Terms of Reference

1 Background

The outcome of the Higher Education Review (Our Universities - Backing Australia's Future) announced in conjunction with the 2003 Budget, includes the establishment of a Taskforce to develop a nationally integrated research infrastructure Framework which will apply to public higher education institutions and all publicly funded research agencies.

Researchers need access to high quality infrastructure in order to carry out high quality research. This requirement is not limited to science and technology; increasingly all forms of research involve access to very large data repositories and cooperative work with colleagues around the world. Research instruments and high end computation and communications facilities are very expensive. Given its modest resource base, Australia cannot afford to continue with an uncoordinated approach to infrastructure provision. A coordinated approach is required to provide:

- appropriate high end research instruments, facilities and repositories in priority areas of research,
- targeted funds to ensure access to key overseas research instruments,
- a world class high performance computing capacity, and
- an integrated research telecommunications network linking researchers in Australia with each other and allowing them to access research instruments and repositories here and overseas.

2 The Task

The Taskforce will be required to develop a nationally integrated research infrastructure strategic framework which will apply to all publicly funded higher education institutions and research agencies. The strategic framework will act as a guide for the Government to consider the priorities for future investment in large scale infrastructure to support Australia’s research strengths in the national interest.

The Taskforce should take stock of existing expensive or large scale research infrastructure, including key research instruments, high end computing and communications facilities as well as data and knowledge repositories. While the Taskforce will need to collect additional data on existing infrastructure, it should also

draw upon information collected as part of the Mapping Australia's Science and Innovation System , which is currently underway, and the reports of the Higher Education Bandwidth Advisory Committee and the Information Infrastructure Advisory Committee .

While it will be important to map availability of and gaps in existing research infrastructure, the Taskforce will need to be forward looking and note domestic and international trends in research across a range of key disciplines and across the Government's identified national research priorities, namely:

- an environmentally sustainable Australia,
- promoting and maintaining good health,
- frontier technologies for building and transforming Australian industries, and
- safeguarding Australia.

The Taskforce should also examine trends in infrastructure integration and management, such as the concept of distributed research infrastructure emerging through the adoption of grid computing and data grids.

The Taskforce will be required to develop a general overview of likely needs to invest in major infrastructure projects over the next five to ten years and attempt to identify priority areas for investment.

The Taskforce will examine and make recommendations on the best approach to providing funds for major research infrastructure, including issues such as:

- the balance between capital funding for new infrastructure and funding for operating, maintaining and upgrading existing and new infrastructure,
- timing of demand for investment in infrastructure and how this relates to funding cycles,
- selection mechanisms,
- incentives for collaboration,
- the balance between domestic infrastructure development and access to overseas infrastructure or participation in international developments, and
- co-investment using non-Australian Government funds (including from State and Territory Governments and the private sector).

The Taskforce will need to examine existing programmes such as the Major National Research Facilities Programme and should examine and make recommendations on arrangements for the management of national research infrastructure assets to ensure their ongoing viability and appropriate regimes for researcher access.

3 Membership

The Taskforce will be chaired by Dr Mike Sargent AM, Deputy Chancellor of the University of Canberra, board member of the Australian Research Council and Chair of the Australian Research and Education Network Advisory Committee. Taskforce membership will be drawn from representatives of:

- The Australian Research Council
- The Australian Government Scientific and Industrial Research Organisation (CSIRO)
- The Australian Vice-Chancellors' Committee
- The National Academies Forum
- The Federation of Australian Scientific and Technological Societies
- The Council for the Humanities, Arts and Social Sciences
- The Minister for Education, Science and Training
- The Minister for Health and Ageing
- The Minister for Industry, Tourism and Resources
- The Minister for Communications, Information Technology and the Arts

Professor Laureate Adrienne Clarke, School of Botany, University of Melbourne, and Professor Max Bennett, Department of Physiology, University of Sydney, will both join the Taskforce in their personal capacity.

In addition to contributing to the deliberations of the Taskforce, the members will also provide a coordination point for consultations for those interest groups within the research community that they represent or with which they are associated.

4 Consultations

The Taskforce should operate in an open and consultative manner and will be expected to play a major role in setting its agenda and conducting its activities with the support of a DEST secretariat.

The Taskforce will need to conduct a process of consultation across the higher education sector, all publicly funded research agencies and the wider research community. To this end the Taskforce should also consult closely with the Chief Scientist and key organisations will be invited to make submissions.

The work of the Taskforce needs to be informed by the work of the related reviews, announced in Our Universities – Backing Australia's Future, concerning the scope for greater collaboration between universities and publicly funded research agencies and the evaluation of the Knowledge and Innovation reforms, both of which will be running in parallel to the work of the Taskforce. This will be essential as opportunities for collaboration in infrastructure acquisition and refinements to the national research priorities will need to be reflected in the report of the Taskforce.

Support may be provided as required for specialist groups to ensure that their perspectives and needs for critical research infrastructure are taken into account in the deliberations of the Taskforce.

State and Territory Governments often play a crucial role in facilitating investments in significant research infrastructure and it will be essential that the Taskforce consults with the relevant State and Territory Government portfolios and agencies.

5 Reporting

The Taskforce is required to report to the Minister for Education, Science and Training in the form of a progress report, outlining a draft strategic framework, by 30 September 2003 and a final written report by 31 October 2003.

Appendix B - Previous Research and Research Infrastructure Reviews and Evaluations

This appendix describes a number of research and research infrastructure reviews and evaluations that informed the development of this Framework.

1 Department of Education, Science and Training (DEST) 2002, ‘A Framework for an Australian Research and Education Network: The final report of the Systemic Infrastructure Initiative’, Higher Education Bandwidth Advisory Committee, Dr Mike Sargent AM Chair, Canberra.

This is the final report of the Higher Education Bandwidth Advisory Committee, which was established to advise the Minister for Education, Science and Training on the short to medium term bandwidth requirements of the higher education sector, with a particular focus on research needs.

The committee found that there was considerable disparity in the availability and affordability of bandwidth across the higher education sector. This disparity was the result of a number of factors, including changes in the nature of research activity, the need to access large databases,; the increasing need for advanced computing and storage capabilities and the growth in remote education. Specific contributing causes to the disparity in regional and remote areas included the diffusion of higher education into more locations, and charging regimes by carriers which were inappropriate for the needs of the higher education sector.

The Committee recommended that the higher education sector adopt a strategic approach to the problem and that the Australian Government intervene in order to establish a collaborative framework. The Committee recommended this should be accomplished by the establishment of the Australian Research and Education Network (AREN) as a collaborative venture between the Australian and State and Territory Governments and the higher education sector. It was estimated that the overall investment required was in the order of $50-60m.

2 Department of Education, Science and Training (DEST) 2002, ‘Research Information Infrastructure Framework for Australian Higher Education’, Systemic Infrastructure Initiative report, Canberra.

The purpose of the report was to make recommendations that would facilitate access to information infrastructure resources which would optimise the efforts of researchers in the higher education sector to create, manage, discover, access and disseminate knowledge. The Committee was required to identify gaps and to provide advice on priorities for funding in the 2002 round of the Systemic Infrastructure Initiative.

The Committee found that development of the national research information infrastructure has been uncoordinated and largely left to individual institutions. Whilst collaboration amongst libraries has improved access, researchers, particularly at regional universities or in specialised or emerging disciplines, often have difficulty. This situation is exacerbated by charging and/or licensing arrangements which can make access costly or impossible. The increasing pressure on researchers to publish and the rapid emergence of electronic publishing have created further pressure.

The Committee identified 12 priorities under the broad headings of Discovery and Management of Research Information, Access to Research Information Resources and Creation and Dissemination of Australian Research Information. Funding of these priorities was estimated to cost approximately $20m. The Committee further recommended that a management committee have oversight of funded projects and their evaluation, and that consideration be given to the establishment of a body to give strategic advice on the implications for the higher education sector of changes in information infrastructure needs.

3 Department of Industry, Science and Resources (DISR) 1999, ‘Report of the Working Group on Resource and Infrastructure Consolidation and Co-operation’, prepared for the National Innovation Summit, Canberra.

The purpose of this report was to identify strategies to improve Australia’s innovation capabilities through the strengthening of linkages within and between companies, the public research sector and the government.

The report recognised that innovation is a key driver for economic growth, and that more needed to be done to improve capabilities in creating and exploiting scientific technical and engineering knowledge. For Australia, with its small population clustered into relatively few cities distributed over a large landmass, it is particularly important that the national innovation system is both cohesive and encouraging of collaborative mechanisms that encourage alliances. Australia also relies crucially on international alliances and collaborations.

The report recommended cooperation between state and federal governments, industry and research leaders in order to establish a cohesive and effective framework for setting priorities and coordination funding programs. Industry clusters and networks are essential to the process of innovation and policy initiatives need urgently to be revised in order to facilitate their development. Further, technology transfer from research organisations presents major difficulties, and a national technology incubator program needs to be set up to facilitate the establishment of start-up companies.

4 National Health and Medical Research Council (NHMRC) 2000, Health and Medical Research Strategic Review: Implementation of the Government’s Response, final report, AusInfo, Canberra.

Following the release of *The Virtuous Cycle* in 1999, the government announced a doubling of the annual NHMRC budget over 6 years, and referred 56 specific recommendations of this report to the NHMRC for consideration and action. This

review described these recommendations and outlined the achievements and ongoing activities of the NHMRC in responding to them.

Whilst only two of the recommendations dealt explicitly with infrastructure, it was an underlying premise that adequate resources and equipment needs to be provided to support research activities. NHMRC anticipated that by 2005, around 10 per cent of its research budget will be allocated to support facilities and infrastructure that contribute to the national research capacity. Recommendations 11 and 16 dealt with arrangements for the sharing and support of infrastructure.

NHMRC reported that in response to the government's endorsement of recommendations 11 and 16, its funding mechanisms had been reshaped in order to encourage the sharing and support of infrastructure, and application criteria for the new Partnership grants require these issues to be addressed. Future support of facilities designated as part of the national research capacity will place emphasis on sharing infrastructure between research groups.

5 Department of Health and Aged Care 1999, The Virtuous Cycle - Working together for health and medical research, Health and Medical Research Strategic Review, Chair P. Wills, Ausinfo, Canberra.

The purpose of the review was to identify the threats to our health and medical research sector, investigate the likely future opportunities and recommend the most appropriate Framework to deliver the best health outcomes for Australia. The report included an implementation Framework as well as a number of specific recommendations.

The report identified a number of barriers to advances in the management of health and medical research, including barriers to industry involvement. The report argued that there needs to be a cycle of interaction between industry, government and research bodies in order to provide an adequately funded, well-managed and efficient research sector that is priority driven and responsive.

The conclusions of the report that concern infrastructure were that Government funding for health and medical research needed to be increased to a level that is consistent with other OECD countries in order to endure proper infrastructure funding; that a coherent and equitable system for public funding of research infrastructure needed to be developed, possibly by linking infrastructure funding to competitive grants; and that collaboration was vital in order to obtain economies of

scale for and improved access to infrastructure. The report made several specific recommendations in order to implement these goals.

6 Prime Minister's Science Engineering and Innovation Council (PMSEIC) 1988, 'Australian Involvement in International Science Facilities', Canberra.

This reported the findings of the working group which was established following the PMSEIC meeting on 29 May 1998 to consider and report on the merits of Australian participation in two international facilities, the Global Diversity Information Facility (GBIF) and the Square Kilometre Array (SKA). The report considered, amongst other things, the extent of the support that Australia should offer in seeking to host these facilities, and the need for amendment of Australian policy and procedures for funding participation in and access to major international research facilities.

Issues considered included the nature of any socio-economic benefits that might flow to Australia as a result of this participation; the problem of ensuring that the cost of construction and operation are apportioned equitably among the participating countries; and arrangements for access to such facilities, both by participating and non-participating countries.

The report recommended that, subject to favourable outcomes of any cost/benefit analysis, Australia should participate in GBIF from the outset, based on the significant opportunities it offers for Australian science and industry. Australia's contribution to GBIF should include input to work programs and the operation of the secretariat. Further, Australia should participate in international scientific activity towards the development of the SKA, limited to a contribution of $3m towards preliminary R&D, and should further assess the SKA proposal.

7 Higher Education Financing and Policy Review Committee 1998, Learning for life – final report: review of higher education financing and policy, Chair R. West, AGPS, Canberra.

The purpose of this review was to undertake a broad ranging examination of the state the Australia's higher education sector, the effectiveness of the sector in meeting Australia's social, economic, scientific and cultural needs, and the developments which are likely to shape the provision of higher education in the next

two decades. The review developed a comprehensive policy framework for higher education and identified options for funding higher education, including research.

Infrastructure related issues considered in the report include the reduction of the capacity of higher education infrastructure because of the escalation of research activity since the establishment of the unified national system in 1989; the doubling of the research student load since 1991; the increase in project-specific funding; and the growing costs and increasing obsolescence of much research equipment and facilities.

Recommendations of the review included the provision of additional funds to maintain research infrastructure and the alignment of research infrastructure funding with project grant funding to ensure there is necessary research infrastructure funding for approved research projects. It was further recommended that the ARC should develop a national Framework in collaboration with relevant agencies to address the need for research infrastructure collaboration nationally and internationally. The number of project grants should be reduced if necessary to ensure adequate infrastructure support for all projects. Additionally, researchers should include all research infrastructure costs in proposals including direct and project related infrastructure costs and adopt pricing policies consistent with the sharing of benefits of research between funding providers and performers.

8 National Board of Education, Science & Training (NBEET) 1993, Higher Education Research Infrastructure: report of the National Board of Employment, Education and Training, AGPS, Canberra.

The purpose of this report was to examine the adequacy of research infrastructure in the higher education system, the likely pattern of research infrastructure needs in the future, and the mix of allocative mechanisms for research infrastructure funding at the national level.

In its report, the Board considered the need for universities to retain adequate funds for discretionary purposes in order to promote institutional autonomy and the need for allocation mechanisms to allow institutional flexibility. A further issue was the requirement for research infrastructure funding to reflect Australian Government goals in relation to medical, social and economic needs.

The report recommended that The Australian Government funding for research infrastructure be increased by 37% ($125m pa), and that research infrastructure funding be distributed via 4 mechanisms – the Research Infrastructure Block Grant

(RIBG), the Infrastructure Allowance, the Equipment and Facilities Grant, and the Industry Incentive Grant. Other recommendations include that the Infrastructure Allowance be increased by 60 cents for every dollar in direct Australian Government research funding, that the RIBG be increased in direct proportion to HDR student load, that the Industry Research Incentive Grant be increased in relation to that proportion of institutional research which is eligible for the then 150% tax deduction, and that increases in the Equipment and Facilities Grant be tied to increases in the RIBG.

9 Australian Science and Technology Council (ASTEC) 1992, Major National Research Facilities: A National Program, AGPS, Canberra.

The purpose of this report was to establish criteria for assigning relative priorities to proposals for funding major national research facilities; to identify proposals likely to be developed over the next 5-10 years, including proposals for the replacement or upgrading of existing facilities; and to assess these proposals in the light of Australia's needs and priorities for science and technology.

In its report ASTEC considered the high and escalating cost of establishing major research facilities, their central importance to Australian science and technology and the long lead times necessary for informed decisions concerning the establishment, replacement or closure of such facilities.

The report recommended that the development of MNRFs be a national program subject to 4 yearly review. Proposals should be assessed according to a set of criteria which are based around the two fundamental principles of benefit to Australia and benefit to science and technology. The report further recommended a budgetary allocation of $40m pa to be provided over 10 years for the establishment of 7 facilities picked from a short-list on the basis of these criteria.

10 Australian Science and Technology Council (ASTEC) 1991, Funding the Fabric: should Government competitive research granting schemes contribute more to research infrastructure costs? Australian Government Publishing Service, Canberra.

The purpose of this report was to assess the effect on research infrastructure and core capacity in the higher education sector and on publicly funded research agencies of the growth in the proportion of research funding provided by competitive grants. The report aimed to suggest accounting measures and pricing guidelines that would assist in the proper allocation of costs in such a way as to overcome any problems with the existing arrangements.

The report argued that the growth in competitive grants has reduced the amount of infrastructure funding to the extent that in many cases such grants fail even to cover even the direct costs of the projects they fund. This puts pressure on existing infrastructure and affects the ability to carry out basic research and to perform strategic research in the national interest. The report further maintained that inadequate information on the full costs of research frustrates public scrutiny and leads to inefficiencies in the allocation of funds to competing research priorities and proposals.

The report recommended that measures and practices to allow the full disclosure of costs involved in research projects be adopted, and that that research funding and performing agencies should collaborate to determine the appropriate level of infrastructure support. The report suggested that the Coordination Committee on Science and Technology, which represented all Australian Government research funding and performing agencies was the obvious forum within which to pursue harmonisation of current Australian Government competitive research funding practices.

11 Australian Science and Technology Council (ASTEC) 1984, Guidelines for the operation of national research facilities: A report to the Prime Minister, Australian Government Publishing Service, Canberra.

The purpose of this report was to develop further the broad policy guidelines in place for the establishment and operation of national or regional research facilities, whilst recognising the need for flexibility to take account of the particular characteristics and needs of individual facilities. These guidelines had been previously suggested by ASTEC, and endorsed by the government in 1979. The report is intended to assist research groups or organisation wishing to propose new facilities, and agencies charged with the management of existing facilities.

The report considered issues such as arrangements for access to major national research facilities, including mechanisms for charges to users; the need to balance the advantages of management by a host institution against the requirement for impartiality in the operation of the facility; and the proper costing and funding of such facilities including adequate accounting measures.

The report recommended that an independent steering committee be appointed for each new national research facility to establish policy guidelines for its operation, to allocate timeslots and determine an appropriate scale of charges, and to promote wide and effective use of the facility. All research proposals requiring use of a facility are to be selected on the basis of merit, to be jointly decided by the steering committee and the host institution. A charging regime should put in place such that all project costs but not capital or operating costs are recovered. The report also made some specific recommendations about the funding and budgeting and accounting involved with the establishment and operation of major national research facilities.

Appendix C – International Comparisons of Research Infrastructure Policy and Programmes

International Comparisons of Research Infrastructure Policy and Programmes: Summary Findings from a Report by the Intellectual Property Research Institute of Australia (IPRIA, 2003)

Approaches to research infrastructure internationally are diverse and thus do not provide clear guidance for policy in Australia. However many trends are global so there are some interesting lessons from overseas approaches. Countries studied in the IPRIA report were the United Kingdom, Canada, Finland, Germany, the United States, Japan and Hong Kong and the European Union.

1 International Comparison of Policy Approaches to Research Infrastructure

1.1 Planning Mechanisms and Strategic Approaches

There are numerous international precedents for more systematic planning of research infrastructure. Increasingly OECD countries are identifying a need for or are actively seeking in some form to ensure that research infrastructure is subject to coordinated planning. This is because with the increasing costs and requirements in terms of research infrastructure it is increasingly necessary to prioritise. Demands on research infrastructure include the fact that more research infrastructure is required across a more diverse number of research fields and that costs are rising due to the increasing sophistication and reduced 'shelf life' of research infrastructure. Also, large pieces of infrastructure are becoming increasingly essential to producing quality research, including the use for example of high performance information and communication networks and systems to support research. Below are examples of OECD countries which are taking more strategic approaches to research infrastructure in response to such issues.

In the **United Kingdom**, the Government's Quinquennial Review of the Grant Awarding Research Councils in 2001 led to the creation of Research Councils UK (RCUK) to assist coordination and providing a strategic focus in the funding of science. An important function of the RCUK is to invest in major scientific infrastructure such as the UK's new synchrotron. A road map document is used by the RCUK to assist in investing in major scientific infrastructure. The purpose of the road map is to develop a long term vision of the future large scale scientific infrastructure requirements of the UK. In 2003, the plan was expanded to consider

management and acquisition issues. Strategic priorities include projects which have an international component which would facilitate cost sharing and develop beneficial relationships. Are of relevance to more than one institution. Require a capital investment of more than £25m.

The Large Facilities Capital Fund provides funds of approximately £50m per annum to access funds for funding large scientific facilities. The RCUK Strategy Group services a high level review and advisory board for the fund and for the Road Map.

While there have been efforts made in the **United States** to develop greater strategic focus and coordination, research infrastructure is not currently subject to national priority setting. Research proposals are considered along with other Federal expenditure proposals as part of the annual Federal budget. There is no budgetary committee that examines all research related proposals systematically. Thus it is essentially the budget process that determines research priorities and issues relating to infrastructure. While most R&D expenditure comes from industry (66% in 2002), the Government's role is significant and is critical to funding basic research and in relation to major research infrastructure. While the Federal Government is principally responsible for funding research, research funds can come from a wide range of sources (eg straight from Congress, from other levels of Government from different government agencies). Thus a key issue for the United States is the issue of coordinating research funding and priorities. To seek to institute better coordination, priority setting and cooperation, two federal advisory committees have been formed, the President's Advisory Council and the National Science and Technology Council. These aim to set strategic directions for public research and provide mechanisms for stakeholder participation in research policy decisions.

A Taskforce on Science and Engineering Infrastructure was established by the National Science Board in September 2000. The objective of the Taskforce was to inform dialogue on S&E infrastructure and the role of the main funding bodies. The report was also to provide a strategic assessment of the status of S&E infrastructure, its changing needs and future requirements.

The report expressed the view that all large future infrastructure projects should consider international partnering or close cooperation regarding competing national scale projects and that there be more interagency coordination of large programmes. The main recommendations were to increase overall funding and place greater emphasis on education and training, midsize infrastructure, instrument technology, large facilities and cyber infrastructure. Further, it was recommended that the infrastructure planning and budgeting process be strengthened.

Canada has also recently begun to adopt new approaches to establish clear strategic priorities. Many reforms have occurred since the release of the federal report Science and Technology for a New Century in 1996. Two advisory bodies the Advisory Council on Science and Technology and the Council of Science and

Technology Advisors were established to assist in identifying national priorities. An important entity, the Canadian Foundation for Innovation was established in 1997 as an independent corporation at “arms length from government and provide funding assistance to research institutions in building and maintaining research infrastructure.

A large proportion of higher education expenditures in Canada has been used to pay for indirect costs such as research infrastructure, and up until recently there have been few other mechanisms for paying these costs. As in the US, the Federal Government traditionally has funded the direct costs associated with research projects with funds for public universities coming mainly from the provinces and from tuition fees. In 2000, a comprehensive review was undertaken by the Advisory Council on Science and Technology. The study found that universities paying for indirect costs was leading to an inability to meet overall objectives and generally weakening the overall research effort. It was estimated that indirect costs amount to between 25-35% of the total costs of a project, although these estimates vary significantly. In the 2001 budget, a $200 million one off investment was made to help universities pay for indirect costs which was accessed by 79 universities.

Canada launched an Innovation Strategy in February 2002 which provides strategic focus for a 10 year period. This has provided for a range of new R&D programmes and funding mechanisms through a “road mapping” process which provides, for example, for future market needs and goals for international collaboration. Specific funds are being channelled for example in programmes considered to be of national priority such as Genome Canada.

Two distinctive research infrastructure programmes were introduced as part of the Innovation Strategy, namely certain programmes within the Canadian Foundation for Innovation which pays for capital costs of infrastructure and support grants in aid to researchers, and programmes within the Canada Research Chairs (CRC) which can be used to pay for salaries and indirect costs. Another programme through the CRC has just been announced as part of the 2003 Budget, the Indirect Costs Programme. Payments for indirect costs are based on percentages of total funding received for direct support of research from the granting councils in previous years. For the FY2003-4, universities will receive payments based on rates calculated from the previous 4 years of grant allocations.

Germany has used a strategic policy document, called Futur to assist in developing strategic priorities. The Futur facilitated web-based dialogue between 1500 experts in economics, science and the social sciences. The results of the dialogue were formed into four visions and were announced in 2002. The Futur has been used by the Science Council and the Federal Ministry for Education and Research to inform policy making. The Science Council is a highly regarded body which advises the government on research priorities. The Futur directly impacts on public funding administered by the Ministry of Education and Research.

Japan has long used a central planning document called the Science and Technology Basic Plan as part of its centralised industry planning processes. The Basic Plan is a government wide plan coordinated at Cabinet level through the Council for Science and Technology Policy. The current plan covers the period 2001 – 2006. In terms of research infrastructure Japan selects its priorities through two high level advisory bodies, the Council for Science and Technology Policy and the Science Council. The Council for Science and Technology Policy is a ministerial level council whose members include the Prime Minister, six ministers with research funding responsibilities, and representatives from the Science Council, academia and industry. The Science Council is a longstanding body whose role includes advising on science matters, promoting science and coordinating research programmes. Foresight programmes have been undertaken in Japan since the 1970s. Studies are conducted every five years to help inform policy based on survey work amongst R&D stakeholders.

The **European Union** is seeking to provide a mechanism to provide for the research infrastructure needs common to all member countries through the European Strategy Forum on Research Infrastructure which was established in 2002. The legal basis for strengthening the scientific and technological bases of Community industry is provided for in the treaty establishing the European Community. Functions of the European Strategy Forum include providing technical assistance such as scientific advice and cost benefit analyses as well as providing policy advice. It is guided by a roadmap document, called the Framework Programme on Research, Technological Development and Demonstration 2002-2006, which provides a strategic focus for policy making for research infrastructure which is transnational in purpose across Member countries.

1.2 Specific Programmes to Improve Information and Communication Technologies

The need to provide high performance capacity in Information and Communications Technology (ICT) is emerging as an important issue in supporting research globally. Several OECD countries have specific programmes for research infrastructure aimed at improving some aspect of information systems (including the European Union, Finland and Canada).

The **European Union's** efforts to improve ICT is a good example. The EU's 6th Framework Programme on Research, Technological Development and Demonstration outlines "information society technologies" as a priority focus in terms of its research infrastructure strategy. Under this strategy, €200m have been earmarked for development of communication networks. Under the programme, communication network development initiatives must involve a networking activity,

and may involve specific service activities and promote joint research activities. In this way it is intended that networking activities will encourage coordination and pooling of resources and achieve in the long term, critical mass and economies of scale.

1.3 Programmes to Fund Research Infrastructure

No country studied in the IPRIA report was found to have programmes which provided funds for the very largest major research infrastructure items. The United States however does have relatively large scale funding programmes because of the large scale nature of its research budget. In the US programmes are the Major Research Equipment and Facilities Construction Account which pays research infrastructure costs ranging from tens to hundreds of millions of dollars; the Research and Related Activities Account which funds research infrastructure between millions to tens of millions of dollars and the Major Research Instrumentation Programme which funds costs ranging from $100,000 to $2m.

Canada's funding programmes are much smaller in scale and fund research infrastructure in three categories, with costs ranging from C$7,000 for Category 1 funds and >C$325,000 for Category 3 research infrastructure funding. The recent Innovation Strategy has also led to the creation of a number of other programmes to support research infrastructure costs pertaining largely to the capital and indirect costs of research infrastructure (discussed above).

The UK also has a dedicated research infrastructure programme. The Large Facilities Capital Fund is a fund of approximately £50m per annum which is used to access funds for funding large scientific facilities.

1.4 International Collaboration for Research Infrastructure

The need to collaborate internationally to cover the growing costs of research infrastructure is a global trend even amongst the largest economies such as Japan and the US. Many strategies discussed above have also identified as priorities the need to prioritise projects which can foster international collaboration in order to share costs, the benefits of technologies and build beneficial relations between research groups.

The IPRIA report identified two main types of international collaboration. These are:

- Negotiations between governments on a bilateral, multilateral or broad scheme basis.
- Schemes for researchers to access facilities.

International collaboration is managed often through government negotiations or by negotiations between Research Councils. Collaboration may also be facilitated through supranational organisations such as the OECD Global Science Forum and the EU Strategy Forum on Research Infrastructure.

Many countries also have schemes to fund travel by individual researchers to access facilities. Japan funds a large number of exchanges both for Japanese scientists to travel abroad and for researchers to visit Japanese facilities. The European Union through the European 6th Framework also has a programme for researcher mobility. Countries that host major facilities like the United States often receive international collaborators and requests on a merit basis.

Two interesting programmes set up by Canada as part of a one off grant are the International Joint Ventures Fund and the International Access Fund which both require international partners. The former supports the establishment of a number of high profile research infrastructure projects in Canada. The latter aims to provide access for Canadian institutions and their best researchers to facilities in other countries and major international collaborative programmes. According to the OECD Global Science Forum, it is not uncommon for time and access to a facility to be allocated according to the originating country's investment. This fund allowed Canada to participate in a number of such projects in the United States. Grants were announced in 2002 so it is too early to judge the success of expenditure in this area.

Appendix D - Australian Government Funding Arrangements for Research Infrastructure

1 Australian Government Funding Arrangements for Research Infrastructure

The **Advanced Networks Programme (ANP)** is a key element of the Building on IT Strengths (BITS) initiative. BITS aims to build the strength and competitiveness of the Australian information industries sector, including fostering much stronger commercialisation linkages with R&D organisations and the creation of clusters of innovative IT&T businesses. The ANP's objective is to contribute to the development of advanced network infrastructure in Australia that will deliver long term benefits to the Australian economy. In pursuit of this objective the program supports progress towards the establishment of a national advanced backbone network. There are no further applications for ANP funding being considered. ANP is administered by the Department of Communications, Information Technology and the Arts. Between 2003 and 2006, $37.2m will be provided for research infrastructure funding through ANP.

The **Australian Institute of Nuclear Science and Engineering (AINSE)** provides a mechanism for users in its member organisations to access major nuclear science and engineering and associated facilities at Australian Nuclear Science and Technology Organisation (ANSTO) and other agreed sites for research purposes. In 2003, $2m will be provided for research infrastructure funding through AINSE.

The **Cooperative Research Centres (CRCs)** bring together researchers from universities, CSIRO and other government laboratories, and private industry or public sector agencies, in long-term collaborative arrangements which support research and development and education activities that achieve real outcomes of national economic and social significance. It emphasises the importance of developing collaborative arrangements between researchers and between researchers and research users in the private and public sector to maximise capture of benefits of publicly funded research through an enhanced process of commercialisation or utilisation by users of research. CRCs are administered by the Department of Education, Science and Training. In 2003-04, approximately $16m will be provided for research infrastructure funding through CRCs.

The **Equipment Grants** funding scheme provides funding to support competitively funded medical research. Funding is allocated on a pro-rata basis to administering institutions (ie. those in receipt of NHMRC funding) according to their share of the total funding awarded by the NHMRC for research in a particular year. Equipment

Grants are administered by the National Health and Medical Research Council. In 2003, $9m will be provided for research infrastructure funding through Equipment Grants.

The **Institutional Grants Scheme (IGS)** supports the general fabric of institutions' research and research training activities and assists institutions to respond flexibly to the research environment in accordance with their own strategic judgements. The IGS is a performance based block funding scheme allocated on an annual basis. Institutions are eligible if included in Schedule 1 of Higher Education Funding Act 1988 (HEFA). This includes all universities. IGS is administered by the Department of Education, Science and Training. In 2003, $277.5m will be provided for research infrastructure funding through IGS.

The **Linkage-Infrastructure, Equipment and Facilities (LIEF) Programme** aims to enhance institutional resources including associated indirect costs essential for mounting high-quality research projects in particular fields. It supports major facilities and equipment, and non-capital aspects of library and information infrastructure. Institutions are encouraged to develop collaborative arrangements among themselves, across higher education sector and with organisations outside the sector, in order to develop research infrastructure. LIEF is administered by the Australian Research Council. In 2003, $25.2m will be provided for research infrastructure funding through LIEF.

The **Major National Research Facilities (MNRF) Programme** was a non-ongoing programme that provided funding for enhanced access for Australian researchers to world-class, specialised facilities not otherwise available, increased opportunities for scientific R&D, to attract overseas researchers and firms to Australia, and to retain local talent. The MNRF Programme provided up to 50% of the funds for large facilities (costing more than $5m), with the balance provided by participant organisations, supporting agencies and facility users. Facilities funded under the scheme comprised expensive, large equipment items or highly specialised laboratories vital for conducting leading-edge research in science, engineering and technology. The MNRF Programme, which was administered by the Department of Education, Science and Training, has ceased. Its 2001 round allocated $155m in research infrastructure funding to fifteen facilities, to be received over 5 years.

The National Health and Medical Research Council (NHMRC) **Equipment Grants** funding scheme provides funding to support competitively funded medical research. Funding is allocated on a pro rata basis to administering institutions (ie those in receipt of NHMRC funding) according to their share of the total funding awarded by the NHMRC for research in a particular year. Equipment Grants are administered by the NHMRC. In 2003, $9m will be provided for research infrastructure funding through Equipment Grants.

The **Research Infrastructure Block Grants (RIBG) Scheme** aims to enhance the development and maintenance of research infrastructure in higher education institutions and thus support high quality research in all disciplines. Its primary objective is to meet the project-related infrastructure costs associated with competitively won grants for research. RIBG funds non-capital aspects of facilities (ie. libraries, laboratories, computing centres, animal houses, herbaria, experimental farms), equipment purchase, installation, maintenance, hire and lease, and salaries of research support staff employed to provide general support for activity in a given area. Funding through RIBG is distributed to higher education institutions on the basis of the proportion of institutions' success in attracting competitive research funds in the previous year (ie. proportion of funds from schemes listed on the Australian Competitive Grants Register). Therefore, it is retrospective in its allocation mechanism. Funding is allocated on an annual basis. Institutions are eligible if included in Schedule 1 of Higher Education Funding Act 1988. This includes all universities. RIBG is administered by the Department of Education, Science and Training. In 2003, $136.7m will be provided for research infrastructure funding through RIBG.

The **Systemic Infrastructure Initiative (SII)** is a current but non-ongoing programme that provides funding for the upgrade of systemic infrastructure in universities to meet demonstrated needs. It is provided for innovative approaches that link or expand access to shared facilities (eg. libraries, information and communications technology, specialised equipment, technical and administrative assistance). One proposal for funding under the scheme may be submitted by each University. However, a university may be involved in an unlimited number of collaborative proposals. A maximum of three years funding is permitted under the scheme. There is no maximum amount that can be claimed as part of a particular proposal. Institutions are eligible if included in Schedule 1 of Higher Education Funding Act 1988 (HEFA). This includes all universities. SII is administered by the Department of Education, Science and Training. In 2003, $21.7m will be provided for research infrastructure funding through SII.

2 State Government funding for research infrastructure

2.1 Funding schemes available on frequent and formal basis sector wide

The Queensland Government **Smart State Research Facilities Fund (SSRFF)** seeks to assist the development of research infrastructure in Queensland by establishing the world-class science and technology infrastructure needed to facilitate specialised research not otherwise possible. It also aims to foster partnerships between industry, the research sector and government. One of its purposes is to

provide a platform for the leveraging of other funding, including Australian Government and private sector funding. Proposals must involve collaboration and be capable of generating net economic benefit for Queensland. SSRFF is administered by the Department of Innovation and Information Economy. In 2003, $29.1m will be provided for research infrastructure funding through SSRFF.

The South Australian Government **Premier's Research and Innovation Fund (PRIF)** was announced in the 2003-04 South Australian Budget and will support bids for science projects in partnership with the Australian Government, South Australian universities and industry. Funding of $4m per annum will available between 2003-04 and 2007-08.

The Victorian Government **Science, Technology and Innovation Infrastructure Grants Programme** is intended to build on Victoria's strengths and position as a pre-eminent location for research and development, new industry development, innovation and investment in science and technology. It supports the development of new private and public sector infrastructure in priority industry sectors and strategic technologies. STI is administered by the Department of Innovation Industry & Regional Development. In 2003-04, $20m will be provided for research infrastructure funding through STI.

The Western Australian Government **Centres of Excellence (COE) in Science and Innovation Programme** seeks to encourage, catalyse or leverage opportunities to expand and enhance Western Australia's science and innovation capability and performance. It will provide support for, and facilitate existing and proposed science and innovation related centres, with a significant base in Western Australia. WA CoE is administered by the Office of Science & Innovation. Funding of at least $3m per annum will available through the WA CoE.

The Western Australian Government **Major Research Facilities Program (MRFP)** aims to build a number of high impact scientific research facilities in Western Australia to help obtain maximum leverage of Australian Government, industry and international funding to attract at least one major research facility to Western Australia. MRFP is administered by the Office of Science & Innovation. In 2003, $4m will be provided for research infrastructure funding through MRFP.

3 Funding schemes available on frequent and formal basis for specific sectors

The New South Wales Government **Infrastructure Grants Program (IGP)** provides infrastructure funding for outstanding state-wide research organisations. It aims to align this funding with NSW health system priorities. It seeks to promote the dissemination and application of research results. Organisations are eligible to receive funding under the scheme if they are established to carry out health and

medical research and development as a primary function, are affiliated with a NSW Area Health Service and/or public hospital, and are located in NSW. Funding is available for a maximum of 3 years, on a competitive basis to research organisations of state-wide significance with track record of innovation and excellence in research and development. Funding is allocated according to the proportion of peer-reviewed grant earnings received by eligible organisations, averaged across each of financial years 1999/2000, 2000/01 and 2001/02 and weighted towards the most recent year of operation. 50% of RIBG funding received by organisations from affiliated universities is subtracted before allocating funds from IGP. IGP is administered by NSW Health. In 2003, $20m will be provided for research infrastructure funding through IGP.

The Queensland Government **Smart State Research Facilities Fund Biodiscovery Fund** is a component of the SSRFF and facilitates investment in infrastructure to assist development and commercialisation of biodiscovery, bioproducts and biotechnology within Queensland. The Biodiscovery Fund is administered by the Department of Innovation and Information Economy. In 2003, $7.2m will be provided for research infrastructure funding through the Biodiscovery Fund.

The South Australian **Adelaide Integrated Biosciences Laboratories Labs Infrastructure Fund (AIBLABS)** aspires to establish shared infrastructure within South Australia's biosciences research community and facilitate establishment of "virtual facility" in South Australian research organisations. AIBLABS is administered by Bio Innovation SA. In 2003-04, $300,000 will be provided for research infrastructure funding through AIBLABS.

The West Australian **Medical and Health Research Infrastructure Fund (MHRIF)** promotes excellence in medical and health research in Western Australia by providing infrastructure support to support research activities. Funding is available to assist health and medical researchers from institutes, hospitals and universities. The criterion of excellence is defined as minimum receipt of $200,000 in support of research from all national and international competitive peer-reviewed granting sources during previous three consecutive calendar years. MHRIF is administered by the Department of Health. In 2003-04, $4m will be provided for research infrastructure funding through MHRIF.

4 Funding schemes available on an ad hoc basis

The Northern Territory Government **Support for Research and Education** is provided for health research and education in the Northern Territory. Funding is available through a fixed annual grant year to support on-going research. The programme is administered by the Department of Health and Community Services. In

2003-04, $3.2m will be provided for research infrastructure funding through this program.

The South Australian Government **Support for Hospital-based Research Programme** is provided for research conducted in South Australian state hospitals. Funding is allocated proportionally according to funding received by South Australian hospitals through NHMRC competitive funding schemes. This program is administered by the Department of Human Services. In 2003, $5.9m will be provided for research infrastructure funding through this program.

The Victorian Government **Operational Infrastructure Support Program** operates to support independent biomedical research institutes. Eligible organisations are those established to carry out fundamental or clinically-based biomedical research and development as their primary function. This program is administered by Department of Innovation Industry & Regional Development. In 2003-04, $20m will be provided for research infrastructure funding through this program.

Appendix E - Submissions

1. Australian Academy of Science
2. Southern Cross University
3. Professor Mark A. Ragan and other Researchers
4. John William Boldeman
5. Professor Tony Moon
6. Building on IT Strengths
7. Professor B.L.N. Kennett
8. National ICT Australia
9. John Cogill
10. Professor Penny D. Sackett
11. Dr Michael Burton
12. Avondale College
13. Commonwealth Scientific & Industrial Research Organisation: Australia Telescope National Facility
14. Neuroscience
15. Griffith University
16. Council of Heads of Australian Herbaria
17. Mark Harrison
18. Association of Australian Medical Research Institutes
19. Dr Alfredo Martinez-Coll
20. Austin Biomedical Alliance
21. Bond University
22. Walter and Eliza Hall Institute of Medical Research,
23. Brain and Mind Research Institute
24. Australian Catholic University
25. University of Melbourne

26. Australian Maritime College
27. Dept of Geology, Australian National University
28. Faculty of Medicine University of New South Wales
29. Council of Australian University Librarians
30. La Trobe University
31. University of New England
32. University of Sydney
33. Users of Southern Surveyor
34. Victoria University
35. James Cook University
36. Monash University
37. Queensland Institute of Medical Research Brisbane
38. University of Western Australia
39. Royal Melbourne Institute of Technology
40. Associate Professor William Hart & Professor Ed Byrne
41. Curtin University
42. Australian Academy of Technological Sciences and Engineering
43. Dr Robert Ackland
44. Prof David J Young
45. University of Western Sydney
46. Charles Sturt University
47. Museum Victoria
48. University of Newcastle
49. Australian Astronomy Major National Research Facility
50. Grains Research and Development Corporation
51. Queensland University of Technology
52. Motion Capture Animation – CONFIDENTIAL

53. The Australian Institute of Health and Welfare

54. Provisor

55. Extremely Large Telescope Working Group

56. Anglo-Australian Observatory

57. Menzies School of Health Research

58. Australian Academy of the Humanities

59. National Committee for Astronomy

60. Australian Institute for Commercialisation

61. Commonwealth Scientific & Industrial Research Organisation

62. Western Australian Museum and Australian Museum

63. Council of Australian University Directors of Information Technology

64. Dr Sianna Panagiotopoulos

65. Australian Geoscience Council

66. Deakin University

67. University of New South Wales

68. Australian Nuclear Science and Technology Organisation

69. Associate Professor Lindsay I. Sly

70. Professor Linda Rosenman

71. National Stem Cell Centre – CONFIDENTIAL

72. Rural Research and Development Corporations

73. Federation of Australian Scientific and Technological Societies

74. Australian Society for Medical Research

75. University of Queensland

76. Dr Marcus Buchhorn

77. University of Ballarat

78. University of Adelaide

79. Professor Michael Ashley

80. Associate Professor Tony Sorensen

81. Murdoch University

82. Murdoch Children's Research Institute

83. University of Newcastle

84. University of Canberra

85. Charles Darwin University

86. Australian Institute of Nuclear Science

87. Edith Cowan University

88. University of Tasmania

89. GrangeNet

90. Australian National University

91. University of South Australia

92. SIRCA

93. Hanson Institute

94. Central Queensland University

95. Western Australia Department of Health

96. Australian Research Council

97. Associate Professor Matthew Bellgard

98. Janine Schmidt, and Andrew Bennett

99. Defence Science and Technology Organisation

100. National Health and Medical Research Council

101. Australian Institute of Marine Science

102. National Office of the Information Economy

103. Australian Partnership for Advanced Computing

104. South Australian Government

105. Research Australia

106. Pest Animal Control Cooperative Research Centre

107. Northern Territory Department of Chief Minister

108. Australian Vice-Chancellors Committee

109. Industry Advisory Network

110. Australian Technology Network

111. Australian Society of Archivists

112. Queensland Government

113. Department of Industry, Tourism and Resources

114. Victorian Government

115. Distributed Systems Technology Centre

116. Associate Professor Simon Fleming

117. Synchrotron

118. Matthew England

119. Dr Max Day

120. Bio Innovation SA

121. University of Technology, Sydney

122. Dr Robert Burford

123. Australian Computational Earth Systems Simulator

124. Nanostructural Analysis Network Organisation

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