PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

SECOND MEETING, 4 December 1998

AGENDA ITEM 7

AUSTRALIAN INVOLVEMENT IN INTERNATIONAL SCIENCE FACILITIES

Executive Summary

The Working Group was established following the meeting of the Prime Minister's Science, Engineering and Innovation Council on 29 May 1998 to consider and report on the merits of Australian participation in two international facilities: the Global Biodiversity Infrmation Facility (GBIF) and the Square Kilometre Array radio telescope (SKA). Professor Vicki Sara, Chair of the Australian Research Council, has acted as Chair. The terms of reference of the PMSEIC working group are at Attachment A.

Australia as a member of the OECD, and its Megascience Forum, has an opportunity to be involved in two projects, both major international research facilities. The scientists responsible for Australian involvement are both from the CSIRO: Dr Ebbe Nielsen (Director, Australian National Insect Collection) for GBIF and Professor Ron Ekers (Director, Australia Telescope National Facility) for SKA.

The two facilities would play important roles in helping Australia remain at the forefront of research and applied science in the fields of biodiversity, information technology and radio astronomy. Further, both would support Australia's growth in biotechnology, information technology and communications, each sectors identified by OECD countries as critical to members' economic growth and prosperity into the 21st century.

These sectors reflect also the Australian Government's priorities in *Investing for Growth*, released by the Prime Minister in 1997, sectors acknowledged as the key to Australia's future industry development and economic growth.

Background

Australia is recognised as a significant player in the international research arena, a country that maintains its competitiveness through its focus on excellence in scientific research. The Commonwealth currently provides for the expenditure of $3.7 billion on a broad range of research related programs supporting science and innovation. This funding provides for the provision of access to leading edge facilities, the support of excellent research and researchers, quality training, international benchmarking, and opportunities to follow international market possibilities.

The leading edge quality of Australia's own research base, and its science and technology skills, will continue to contribute to industry innovation to enable Australia to improve its competitiveness in the international market.

Major international research facilities, capable of pushing back the barriers of knowledge, are no longer able to be funded within the resources of one country. The need for international action has been recognised by members of the OECD science community, who are seeking to broker international partnership such as GBIF and SKA.

The OECD's Megascience Forum was established to provide an opportunity for discussion by senior officials from science ministries in 27 countries on the coordination of science programs costing more than one hundred million dollars. It promotes collaboration and international cooperation on such programs, which are usually focussed on basic or pre-competitive research, where individual member countries are no longer able or willing to provide for such large expenditures independently.

Major facilities can be distributed, such as ocean drilling research vessels or centralised, such as the international Gemini optical telescopes project. They are of the scale that require combined funding across a group of nations.

They also reflect various forms of organisation. A facility can be built by one country, which then allows foreign researchers access to it; a private international company could be established; an international organisation governed by an agreement ratified by each participating country could be set up; or a consortium which operates for a limited period only could be formed.

The Megascience Working Group, set up in 1996, has been considering four areas of science: neutron sources, nuclear physics, radio astronomy and biological informatics. Australia's interest has been focussed on the latter two because of its leading position in those disciplines. Delegations in the Group are working towards the next triennial meeting of OECD science ministers, currently scheduled for June 1999, at which it is expected a number of OECD member countries will indicate their interest in funding the GBIF.

Issues

The costs and benefits of Australian participation in these projects need to be assessed and if possible placed in priority order, so that the benefits to the nation are maximised in proportion to the funding contributions. Our participation can take the form of either hosting the facilities or securing access to the facilities if they are located in other countries. Different costs and benefits are associated with each of these options.

The scientific benefits arising from participation in megascience activities are clear. They include participation in world leading research and training; access to knowledge; international

benchmarking; prestige; and opportunities to join with other nations in broad global initiatives. A recent study commissioned by the then Department of Industry, Science and Tourism in 1998, identified and broadly described the extra-scientific socio-economic benefits of participation to be:

- revenue from foreign researchers
- industrial contracts and industrial development opportunities - hosting a major facility leads to the capture of low technology contracts during the construction phase. High technology spin-offs depend on the arrangement for management and returns of the facility, but there is an increase in prestige for local contractors, increases in industry networks and a role as a 'showcase' for high technology industrial capability;
- increased employment;
- benefits to those progressing the particular fields of science and technology;
- regional development stimulated by new infrastructure through the provision of roads, power supplies etc and an increase in tourism;
- an influence on management of the operation of the facility;
- improved international relationships; and
- prestige.

The Department of Industry, Science and Resources is commissioning a further study, to examine in more detail and to quantify the economic, international and technological benefits which may accrue to Australia from hosting these facilities.

The two projects, the Square Kilometre Array (SKA) and the Global Biodiversity Information Facility (GBIF), will be large-scale facilities planned, constructed and operated on an international collaborative basis. This will require coordinated efforts by scientists on a global basis. Major challenges will be to ensure that the costs of their construction and operation are apportioned equitably among participating countries, that agreement is reached on the basis upon which access will be provided to scientists from countries that have not contributed, and on the basis that the information will be available to all. Concurrently the participating governments also need to ensure their scientific communities have the resources required, including information technologies, to participate effectively in intrinsically international activities.

The Square Kilometre Array

The SKA, the next step in radio astronomy following current developments in synthesis radio telescopes now being sited in Chile, will provide an order of magnitude increase in sensitivity over existing instruments. The facility would provide a million square metres of collecting area. Such an effort is logically international in scope for reasons both of cost and the world wide distribution of interest. However, there are challenges to the future of radio astronomy, the major one being the explosive growth in the use of the radio spectrum for commercial telecommunications purposes.

With a collecting area some 100 times that of the largest current radio telescope array the SKA will be able to capture extremely weak signals. This additional collecting area in the longer radio wave lengths will help answer questions about the nature of the universe in the so-called cosmological 'Dark Ages' (the period before the stars and galaxies had begun to form).

There could be 80 array stations, each typically consisting of 100 closely packed (small) 13 metre antennas. These individual antennas would be closely packed across an area of 200 metre diameter.

The optimum site for SKA requires a large land area with low levels of radio interference and effective protection against any expansion of communications services in the region adjacent to the site. With low population density Australia is seen as having a natural advantage. The Western Australian Government has shown an interest in siting the facility.

The SKA would provide benefits to the construction and engineering industries if established in Australia capturing some contracts for basic array infrastructure and ongoing maintenance and upgrades.

THE GLOBAL BIODIVERSITY INFORMATION FACILITY

GBIF would link available biodiversity information data bases into an interoperable system, and thus help fill critical gaps in biodiversity knowledge. GBIF would allow Australians across the natural sciences access to all linked databases and natural history collections.

GBIF would provide infrastructure for the convention on Biological Diversity Clearing House Mechanism through its main project, 'a telephone directory of life', or *Global List of Life*. This project will list the 1.6 million named species of a total of the estimated 7 million species of living organisms on Earth - the first complete and maintained directory to all named species, accessible to all though the World Wide Web. It would comprise large infrastructure elements such as electronic databases, and require the development of information systems to support large projects in the biological sciences, with special emphasis on biodiversity.

By hosting such a facility, and bringing the data it can access closer to the user market, Australia would be able to build on its current global leadership in the science of biodiversity, and on current exciting developments in information technology and informatics. Australia could become a leader in the emerging international area of bioinformatics which would improve understanding of biodiversity and interpretation of genetic information. This would provide a rich source of information, which could be used by industry to identify new biological products. Australia could, as a consequence, develop as a world leader in bioinformatics.

Contributing to the development of GBIF would add support to our growing role in bioinformatics, bioprospecting, pharmaceuticals and natural land-use management issues.

The ACT government has expressed an interest in hosting the facility.

Attachment B summarises the benefits, as now identified, from possible Australian participation, in both SKA and GBIF.

Options for Commonwealth action

There are several options for the Commonwealth:

- Not to be involved in either facility;
- To be involved as a participant in either or both facility; or
- To be involved as both a participant in and host of either or both facilities

Should Australia decide to participate, contributions would be made in stages to cover research and development, construction and operation over periods of up to 15 years, then followed by continuing operational costs for the life of the project (SKA: an annual cost of about $7m, about $2m greater than the existing allocation for the Australia Telescope National Facility which it would eventually replace). GBIF's expected life is 50 years and that of the SKA, a little longer.

Support of SKA and GBIF would be consistent with the Government's policy of targeting international S&T collaboration in those areas which can best enhance access to leading edge technology, improve access to overseas markets, attract foreign direct investment and increase business competitiveness. It would also maintain Australia's global leadership role in basic and applied research in the fields of radio astronomy and biodiversity.

There is, as yet, no defined international process to follow for countries seeking to contribute to such international projects. The OECD's consideration of these two proposals is helping establish the necessary international arrangements to achieve this. Similarly, the process for Australian involvement is not yet clear

Recommendations

Subject to favourable outcomes of current studies of the costs and benefits of each facility:

1. Australia should participate in GBIF from the outset, based on the significant opportunities it offers for Australian science and industry, and on our leadership in the development of the concept and the required technologies. Australia should contribute to the GBIF work programs and the operation of the Secretariat and should bid to host the GBIF Secretariat.

2. Australia should participate in international scientific activity towards the development of the SKA facility, limited to making an Australian contribution of $3 million to the preliminary R&D over the next three years. The Government should address the issue of Australia participating further, or hosting this facility in the year 2001.

ATTACHMENT A

Working Group Terms of Reference

The terms of reference for the PMSEIC working group on megascience are to consider and report on:

1. The reports of the OECD Megascience Forum Working Groups and their relevance to science, technology and innovation in Australia.

2. The merits (both scientific and non-scientific) of Australian participation in international facilities proposed by the OECD Working Groups.

3. The economic, industrial, social and scientific/engineering costs and benefits of Australia hosting one or both of the facilities, and the extent of the support which Australia should offer in seeking to host the facilities in the event that this is considered to be an attractive option.

4. The need for amendment of Australian policy and procedures for funding participation in and access to major international research facilities.

ATTACHMENT B

COMPARISON OF COSTS AND BENEFITS OF GBIF AND SKA FACILITIES

Issue	GBIF	SKA
Australian cost : participation	$A35-40m over 10 years, 2000 - 2010, of total cost of $A1 000m (half of which will need to be met by participating members). Long term, beginning in 1999	$A80m over 15 years, 1999 - 2014, of a total cost of $1 000m. ▪ R&D, proto-typing, industry development, 1999-2006, $A20m (includes CSIRO contributions of $A6.5m). ▪ Construction and R&D, 2007-2014, $A60m (CSIRO, $A8m). ▪ Operation, 2012 onwards, $A7m p.a.(CSIRO, $A5m p.a.). Long term, beginning in 1999.
Cost:- hosting (additional to that above)	$A4m 'set up' cost in first year. $A20m over 10 years, 2000-2010	Additional $A20m representing contribution to site infrastructure works.
Scientific benefits	Considered to be high. Australia's biodiversity is particularly rich, and we have a long and substantial tradition of exploration, classification and research. The area is particularly active at present world-wide, and is recognised as increasingly important both scientifically and in terms of potential non-scientific benefits. Prestige. Opportunities for postgraduate students, both local and overseas. The facility represents a particularly important and innovative 'cutting edge' combination of biological knowledge and information technology. Australia has advanced biodiversity informatics technologies and provides global leadership.	The facility, if built, is likely to make substantial contributions to advancement of knowledge in radio astronomy, and significant contributions to aspects of electronics, communications and computing. Prestige. Opportunities for Australian postgraduate students to interact with overseas experts while in Australia.

COMPARISON OF COSTS AND BENEFITS OF GBIF AND SKA FACILITIES (CONT)

Technology/ Industry benefits	The project will use new technology, some 'beyond the cutting edge' requiring facilities additional to those now available at ERIN. The spin-off benefits would flow to the IT sector in terms of software, storage and data transfer. Beneficiaries from its development and access to the information are: the IT; publishing; biotechnology; health related sectors; and agriculture, forestry and fishing as export sectors. GBIF would provide more tools for effective environmental planning.	Likely to be high. Based on experience with the Australia Telescope National Facility, Australian participation in (and particularly hosting of) the facility could lead to spending in Australian industry at least equivalent to the Australian government contribution to the facility, and could foster the development of new technologies in industry, and new industries, with export potential. ▪ At least 50 percent of the funds for early research would be spent in Australian industry, CRCs and universities. ▪ Spinoffs to the IT and communications industries ▪ More local industry university linkages ▪ Inflow of foreign funds ▪ More Australian firms working collaboratively with overseas companies The linkages between radio astronomy and engineering have always been strong . We predict 40 externally based engineering researchers during the R&D phase.
Returns	From participating: access to global information for research, training and industry. From hosting: local industry development, employment, travel and hospitality, education, technology development and training. Probably, a net gain.	The ATNF report of August 1998 cites a possible contract expenditure of $85m, an ongoing expenditure of $18m annually on maintenance and an annual net tourism benefit of about $5.5m.
Degree of commitment at present	CSIRO supports (in kind, more so that cash). ACT government has expressed interest in hosting. CSIRO and the Australian National University have expressed considerable interest.	CSIRO prepared to commit $6.5 million over 8 years to preliminary R&D. WA government has expressed interest in providing financial support as hosts, but commitment dependent on initial Federal support.

COMPARISON OF COSTS AND BENEFITS OF GBIF AND SKA FACILITIES (CONT)

Should Australia participate?	Yes. Biological resources is an area of intrinsic interest to Australia, as the only developed 'megabiodiverse' country. Industries based on knowledge of these resources are expected to become increasingly important and valuable. Australia needs to signal its intentions as an active player in these industries. Not to be involved would make access to scientifically and potentially industrially valuable information more difficult and be a major setback to Australia's future opportunities in information technology.	Yes. Australia has had substantial success in radio (and optical) astronomy over many years, and has developed an international reputation. The program also involves substantial research in electronics, communications and computing, and Australian participation in this research could have valuable industrial spin-offs. This has been demonstrated with development of existing facilities.
Should Australia host?	Decision possibly to be made during 1999. Australia's advantage as host is based on our rich biodiversity, advanced biodiversity informatics capacity as well as the global leadership Australia demonstrates under the Convention on Biological Diversity (CBD). It may be possible to reach global consensus about Australia's role as host. Hosting may well be positive to Australia. Australia's international scientific prestige would be enhanced.	Decision not needed until year 2001. Australia has advantages as a host in terms of relatively uninhabited large land areas, climate, southern hemisphere location, and lack of electromagnetic interference at the preferred site. Hosting would cost the Australian government more, but would ensure that most site infrastructure spending ($A100 million over 8 years) would be in Australia. Hosting could also give Australia (including industry) enhanced opportunities to win contracts for other parts of the facility, including antennas, electronics and any upgrades. Australia's international scientific prestige would be enhanced by hosting the facility.
Competing interests	Netherlands, UK, Italy and Denmark (the US is probably not bidding and may support Australia).	Netherlands, China, India and the US

COMPARISON OF COSTS AND BENEFITS OF GBIF AND SKA FACILITIES (CONT)

Risk	Considered to be low: existing communications, hardware, software, processing and storage technology can be used to establish the facility. New technology developments are expected to allow upgrades as necessary. No commitment yet considered to fund the *Global List of Life.* Low number of people engaged in Secretariat (about 20); others will be employed by Australian institutions and elsewhere.	Operating agreements need to safeguard the operational costs of the facility over a period of, say, 20 years. International demand for the instrument is predicted to be very high, so risk to Australia would depend on the conditions in the negotiated host country agreement. Australian capture of scientific benefit would be determined by the number of Australian researchers active in this area (~100). May be inadequate R&D expertise in industry for research phase. There are challenges to the future of radio astronomy, the major one being the need to regulate the explosive growth in the use of the radio spectrum for commercial telecommunications purposes.
Lifetime	Workplan established for first ten years but GBIF will be an ongoing evolving facility.	50-80 years (site) 30-50 years (facility); upgrade path to extend life
Organisation	Governing Board of all delegates whose countries chose to support GBIF. Technical Advisory Group of delegates from all participating countries. Secretariat as needed with national nodes coordinating internal activities with GBIF initiatives. Will work under the aegis of the OECD, or possibly independently.	The scientific case is being developed by a working group of the Union Radio Scientifique Internationale (URSI). OECD is discussing international coordination through its Megascience Forum working group in radio astronomy. An MOU for coordinated R&D has been signed by individual organisations in Australia, Netherlands, Canada, China, India and the US. Possible establishment and operational arrangements under consideration are: ▪ An international management corporation with negotiated country contributions. ▪ An existing international organisation such as the European Southern Observatory (ESO), governed by internationally ratified agreements.

		• Inter-governmental ventures or new international organisations.
Possible Drivers	CSIRO, ERIN, ARC Funding and technical advice across Commonwealth portfolios and industry/CSIRO/universities	CSIRO

All costs calculated at $A1 = $US 0.59