ATNF ATUC Memorandum

To: ATUC
From: Director
Subject: National/International Developments
Date: 28 October 2004

There are a number of issues relating to the SKA at the National level that ATUC may wish to review:

- The development of the NTD project plan
  - The NTD project plan has now been submitted to AABoM. The project plan is available from the ATNF's project pages. A concept design review took place on November 18.
- The development of the SKA roadmap.
  - ASKACC have produced an SKA roadmap under version control. The NCA distributed the roadmap to the community in late October.
- The national site selection process
  - Following an ASKACC meeting on Nov 5, the Mileura site was chosen as the Australian central site for the SKA that would be proposed in the response for proposals (RFP) to the International SKA Steering Committee.
- Whole-of-Government engagement in the SKA program.
  - Following the PMSEIC presentation, efforts have been made to engage broad high-level Government support for the SKA program. This included the establishment of a RQZ forum comprising all key stakeholders in the RQZ issue (State and Federal). A successful initial meeting of the RQZ forum was held in Parliament House in August. The next round of RQZ forum meetings are currently planned for December.
  - More recently an SKA Steering Group was established to look into ways in which Government might consider and guide Australia's potential involvement in the SKA. The group comprises representative from various Government Departments and agencies. ASKACC have observer status on this group. At the first meeting in Nov 18, an action plan was established to develop a business case for the SKA (including cost benefit analysis) and other areas where Government departments might usefully provide input (e.g. International SKA structure, RQZ, industry links). This development currently carries with it no financial commitment on behalf of the Government.
- Development of a case to use the asset replacement reserve for funding the xNTD.
  - A case for funding the xNTD from CSIRO's Asset Replacement Reserve has been developed (see attached). Following initial feedback from the CSIRO Executive, a more comprehensive case will be submitted to CSIRO in February as part of the next triennium budget planning process.
- Mileura Widefield Array
  - The ATNF is continuing to work with its partners (MIT, Melbourne, ANU and CfA) in the development of a project plan/management model for the proposed MIT-led Low Frequency Demonstrator (LFD). The LFD and NTD will together make up the Mileura wide-field array (MWA). Currently the ATNF is looking at areas, particularly in correlator design, where development costs may be shared between the LFD and NTD. As part of our joint risk mitigation strategy, however, both projects need to be robust against the failure of the other. A joint statement of intent between the MWA partners is attached.

The Extended New Technology Demonstrator

A breakthrough development in the scientific capability of the ATNF

Proposal

The Australian SKA Consortium Committee (ASKACC) has endorsed a roadmap for the Australian participation in the Square Kilometre Array (SKA). The Australian roadmap sees the development and extension of the MNRF New Technology Demonstrator (NTD) as a key strategy towards maintaining Australia's leadership in radioastronomy and maximizing Australia's participation in the SKA (CSIRO 2003-06 Strategic Plan Objective 2.4).

In particular, ASKACC has identified that beyond the initial development phase of the NTD, an additional A$10-$15m would be required to:

- address outstanding risks for the International SKA pathfinder (ISKAP)
- deliver a world-class astronomical facility capable of addressing important science questions in key areas in which Australia possesses significant research strengths. Specifically xNTD will enable:
    - neutral hydrogen to be detected in galaxies to unprecedented distances; revolutionizing our knowledge about the evolution of galaxies
    - radio surveys of the entire Southern sky to be carried out in a single day; transforming our knowledge of the variable Universe
    - high-resolution, high-sensitivity surveys of gas in the Milky Way; gaining new knowledge about the formation of our own galaxy
    - the detection of up to 5000 pulsars; potentially including black hole pulsar binary systems and sub-millisecond pulsars

The broad range of science and its impact argues strongly that the extended version of the NTD (xNTD) should be developed as a National Facility (NF) for the entire Australian community. In low frequency (<3GHz) low resolution survey applications it would deliver a 20-fold increase in speed over the existing Australia Telescope Compact Array (ATCA).

The xNTD therefore provides a highly cost-effective solution to maintaining the technology capacity of the Australia Telescope National Facility (ATNF). As a telescope in its own right, the xNTD would provide a world-class facility maintaining Australian research at the forefront of radioastronomy well into the next decade.

Being on a direct pathway to ISKAP, it also paves the way forward to leverage international funds to support the eventual replacement of the Australia Telescope Compact Array in the next decade.

Under CSIRO's financial procedures memorandum no 84 CSIRO policy funds have been set aside in the asset replacement reserve (ARR) to:

- Maintain the technological capacity of the NF asset, including substantial refurbishment of a capital nature needed to maintain the NF asset as state-of-art and
- Replace the NF assets as and when they come due for replacement.

The xNTD provides a breakthrough enhancement in the technology capacity and scientific capability of CSIRO's ATNF asset. Combined with its role in advancing the ISKAP program, the xNTD should be considered for funding within the capital expenditure program under this policy.

Financing and Timing

The NTD project plan identifies that a decision on moving forward with the xNTD can only occur when the key risks in the areas of antenna design and focal plane array development have been successfully mitigated. Under the current project plan this milestone is due to occur in December 2005.

At this stage of the NTD project, it is appropriate to include a 50% contingency factor on the final cost of the xNTD; to reflect the current level of engineering risk. By December 2005 this risk level will have significantly reduced, and the contingency will be reduced accordingly. This translates to a current cost estimate of $10m-$15m for the additional resources required to build the xNTD.

The NTD project plan is supported by the MNRF at the level of $5.6m (including in kind contributions) until June 2007. However, additional expenditure on the xNTD would need to occur in 2006 to deliver a system by 2008, in time to influence the technology down select on the ISKAP.

Notwithstanding the outstanding areas of risk the currently proposed capital expenditure on the xNTD is as follows:

2005/06	$1m
2006/07	$3-5m
2007/08	$6-9m

The bulk of this capital expenditure lies three years out, as stipulated in the policy requirements in the Financial Procedures Memorandum. It is noted that some expenditure is required in earlier years, and it may be possible to manage the short-term (1-2 year) cash flow using ATNF's operational budget on the basis that full support from the asset replacement reserve would be forthcoming on the 3-4 year basis.

This capital expenditure excludes infrastructure (roads, cabling), currently estimated at $4.6m for which State Government support is being sought as part of the SKA co-investment model within Australia.

The total $21.5m capital expenditure on the xNTD would therefore comprise:

MNRF	$5.6m
xNTD (CSIRO ARR)	$10-$15m
Infrastructure	$4.6m

Beyond the capital expenditure phase of the project, the whole-of-life cost of the facility also needs to be considered. The operational cost of the facility is predicted to be 10% of the capital cost per annum. At $2m/yr this could be obtained from the ATNF appropriation, on the basis that it continue to be indexed at current levels. The savings required would be achieved by removing support for scientific and/or technical capability on existing telescopes (e.g. ATCA) superceded by the xNTD.

It is envisaged that this facility would grow into the ISKAP with a total lifetime of over 25 years. Depreciation expense would also need to be covered within Divisional expenses to reflect the ongoing consumption of the new assets. The anticipated long life of the assets would be likely to reduce these amounts on an annual basis. The Division would attempt to cover these expenses, including through reallocation of existing depreciation expenses. However, in keeping with CSIRO practice on funding national facilities, there may need to be some call on appropriation funds to cover additional depreciation expense if this is not able to be absorbed within the Division.

The Mileura Widefield Array Project Update

The first stage of the MWA project is underway as a collaboration between MIT (US), the CSIRO Australia Telescope National Facility (ATNF) (Australia), the Centre for Astrophysics of Harvard University, Melbourne University, the Australian National University, and the Government of Western Australia. An MWA Executive Group is being set up to coordinate the collaboration. The goal of the first stage of the MWA is to create, by 2008, complementary demonstrator radio telescopes, one in the 80-300 MHz frequency range, and the other in the 800-1600 MHz range. Both demonstrator designs are optimized for extremely wide fields of view and high sensitivity for a variety of survey applications. It is planned that the demonstrators, while exploring different frequency ranges and antenna technologies, will use common, configurable backend digital technology designs, and software. The further development of the full MWA would build on expertise gained with the demonstrators. The full MWA may be co-located with, or part of, the planned international SKA pathfinder, depending on choices within the international SKA project.

The two initial demonstrators are targeted at ambitious experiments to detect signals from the early Universe using extremely wide fields of view. Such experiments require the most stringent radio-quiet conditions possible. It is, therefore, proposed to site the demonstrators on Mileura Station in the sparsely populated inland region of Western Australia. Mileura Station will be proposed as the Australian candidate site for the international SKA project and plans are underway to create a comprehensive radio-quiet zone over the site. The Western Australian Government has committed to supporting shared infrastructure costs for both the demonstrator projects and the two demonstrators will share infrastructure as appropriate.

ATNF already has funding for the development of an 800-1600 MHz technology demonstrator, through the New Technology Demonstrator (NTD) Project of the Australian Government Major National Research Facility in Astronomy. Funding is being sought to extend the NTD to incorporate 20 parabolic dishes of ~15 meter diameter, each equipped with a 10x10 phased array focal plane receiver system supported by a digital beamforming system. This focal plane array subsystem is a challenging, key technical innovation, and represents the enabling technology for wide field observations at frequencies near 1 GHz. Total instantaneous fields of view will be of order 100 square degrees. The extended NTD (xNTD) carries a total budget of order AU$20M (US$15M), and would be implemented as a national facility with peer-reviewed competition for observing time. Key xNTD science goals include surveys for galactic and extragalactic HI emission, pulsars and OH megamasers, as well as continuum monitoring, and a variety of other topics. Critical design review for the NTD/xNTD is scheduled for December 2005.

MIT is leading the development of the 80-300 MHz demonstrator, known as the Low Frequency Demonstrator (LFD) of the MWA project. In addition to ATNF, several university groups in Australia have committed initial resources to a partnership in the LFD, and plan to apply for further funding for the project. MIT have sought a share of the funding for the LFD from the NSF in the US. The result of the funding submissions is expected to be known in Q3, 2005. In the meantime design work and initial deployment of antennas in WA for testing and environmental conditioning is continuing.

MWA collaborators
November 19, 2004