Australia Telescope National Facility

Future ATNF Operations

ATNF Leadership Team
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Executive summary

The ATNF will make the changes necessary to operate its radio astronomy facilities as a single entity:

1. restructure activities into Science Operations and Engineering Operations;
2. establish a Science Operations Centre (SOC) at a central location, initially at the Radiophysics Laboratory, Marsfield;
3. streamline supported modes according to scientific priorities.

This model will establish a structure to the ATNF that is scalable, that will more easily cope with a suite of telescopes enlarged by the addition of ASKAP. The changes we describe here have three principle motives:

- to achieve the Decadal Plan strategy of operating four world-class radio telescopes in 2012 while minimising the need for additional continuing resources;
- to establish integrated and scalable practices and structures to position CSIRO and Australia for the SKA;
- to build on existing operational differentiators that have been beneficial to Australian radio astronomy.

The ATNF telescopes produce world-class science over a broad range of radio astronomical research. This is made possible by excellent instrumentation (including software) and by very effective operation of the facilities. The changes proposed here are not motivated by a need to improve a mature operation, but rather by the need to anticipate a future in which Australia has a major new radio telescope and the world radio astronomy community is working hard to design, construct and operate the SKA.

To make the changes a number of tasks need undertaking, including the improvement of certain technical capabilities of ATNF facilities. We envisage four key restructuring projects: Automation, Telescope Safety, Scheduling, and Building a Science Operations Centre. Although we are yet to plan these projects in detail, it is our intent to begin the implementation of the new operation model in July 2008, with completion by mid-2010.

Implementation of the changes, and operation of four observatories from 2012 onwards, will require an increased commitment of resources from ATNF's Engineering and Astrophysics groups to Operations.

Significant milestones	
Concept Development/Consultation Phase	May 07 – December 07
• Working Group Reports to ALT • Initial Framework agreed by ALT • Revised Framework presented to ATUC • Framework presented to ATNF • Concept Design Review by ATSC • Agreed Concept Plan	• Late September 07 • Late October 07 • Early November 07 • mid November 07 • mid December 07 • mid December 07
Planning Phase	December 07 – June 08
• Key appointments made and announced • Project leaders announced • Development project plans developed and approved • New management structure in place	• 17 December 07 • February 08 • March/April 08 • 30 June 08
Implementation Phase	April 08 – Dec 2011
• Science Operations centre completed and in use • ASKAP begins science operations	• June 2010 • December 2011

1 The Model

The ATNF will make the changes necessary to operate its radio astronomy facilities as a single entity. The chief actions are as follows.

Restructure the Operations "theme" into two "streams" Science Operations and Engineering Operations, and structure activities by function within those streams, replacing the current location-based structure.

Establish a single Science Operations Centre (SOC) at a central location. Initially this will be at the current ATNF headquarters in the Radiophysics Laboratory, Marsfield. The observer-operator model will be retained as the default for Parkes, ATCA and Mopra. Most observations will be conducted from the SOC and full observing support will be available only at the SOC. Observations will be possible from remote locations (other than the SOC) subject to certain conditions, and when necessary users will conduct observations from the observatories. Increased automation of systems will allow certain observations to be made without full-time human attention.

Streamline supported modes according to scientific priorities. Measures will include reducing the frequency of Compact Array reconfigurations and Parkes receiver changes, limiting the range of instrumentation available, limiting the availability of telescope time for certain observation types, shutting down telescopes for prescribed periods, limiting the response to certain technical faults, and synchronising the schedules of all telescopes to allow a modest-sized engineering group to manage, ultimately, four telescopes. Driven by the science priorities of the community, the extent to which these measures will be implemented will depend on the operational funds available, mitigating the risk of carrying an unsustainable operational burden.

This model will establish a structure to the ATNF that is scalable, that will more easily cope with the addition of ASKAP to the suite of telescopes. The new model will derive its scalability from having a fixed number of functional teams, a number that will not change with the addition of ASKAP to operations. Moreover, it will set the practices and culture in place that will be necessary for successfully managing a large automated facility. In this regard, ASKAP should be considered a pathfinder for the operations of the SKA as well as for its design and scientific application. The plan outlined here will lead the ATNF along this track over the period up to ASKAP's commissioning.

The changes we describe here have three principle motives.

1. To achieve the Decadal Plan strategy of operating four world-class radio telescopes in 2012 while minimising the need for additional ongoing resources
   - Duplication of critical skills across a number of individuals is necessary, but duplication of effort is very inefficient. In the current observatory-based structure parallel work tends to emerge—several solutions being developed for a single problem when one solution would suffice. Changing the communications boundaries by moving to a functionally-based structure will improve efficiency.
   - Interruptions to workflow are costly. Operations staff juggle a number of tasks, but maintaining continuous operation always takes precedence. Reducing the frequency of major system reconfigurations and increasing the automation of the systems will increase reliability. This will reduce the need for unplanned work on the telescopes leading to less interrupted workflow and so a more efficient use of resources.
2. To establish integrated and scalable practices and structures to position CSIRO and Australia for the SKA
   - An integrated operation of geographically separated facilities is required; a support structure organised on functional lines will be essential for the operation of an SKA-scale telescope.
   - A more formal Systems Engineering approach to development and maintenance will be required as CSIRO moves from the operation of its current telescopes towards

ASKAP with its much greater multiplicity (~9000 receiver signal streams). Implementation of a Systems Engineering approach will be absolutely essential for SKA, whose number of receiver signal streams will approach one million.

- A single SOC serving three and ultimately four observatories anticipates the needs of remote operations centres and the development of regional science centres for the SKA.

3. To build on existing operational differentiators that have been beneficial to Australian radio astronomy

   - Although a data pipeline model is essential for ASKAP, ATNF will retain the very successful observer-operator model for its existing telescopes. The implementation of a single SOC will maximise the interactions between users of all the ATNF telescopes, including ASKAP, and with ATNF staff who will provide systems and scientific expertise at the SOC.
   - Continued practical hands-on experience in observing and data reduction for students will be provided.
   - Observing systems and data interfaces that are transparent to the principles of operation will continue to be provided, benefiting all users, support and engineering staff.
   - Changes to the working environment will required to continue stimulating meaningful interactions between practicing astronomers and technologists; an expanded program of workshops on astronomical techniques (building on the bi-annual Synthesis Imaging Workshops) and specific support for observing proposals that involve innovative observing approaches or system configurations will compensate for any loss of interaction currently derived from observatory visits.

Implementation of this model will require ATNF's future development focus to be directed towards just two major activities, the development of ASKAP and the restructuring of operations. No major new instrumentation projects will be undertaken beyond those already commenced or approved. Significant resources from the engineering group will be directed towards the restructuring projects once CABB is installed in the third quarter of 2008.

2 Establishing the model

2.1 New functional structure

The establishment of a new functional structure is necessary to realise the scalability sought in the new operating model. The new structure (Figure 1) is based on the division of activities into Science Operations (SO) and Engineering Operations (EO). Generally, personnel working in EO need proximity to the telescopes. Most of the SO activities can be performed remotely. In CSIRO the successively finer definition of output activities are referred to as themes, streams and projects[1]. Figure 1 shows the division of SO and EO.

[1] Use of the word project here makes it awkward to distinguish between true projects—activities that are bounded in time with a start and finish—and the finest division of operations. When the distinction is important we refer to these, perhaps clumsily, as "development projects" and "operational projects", respectively.

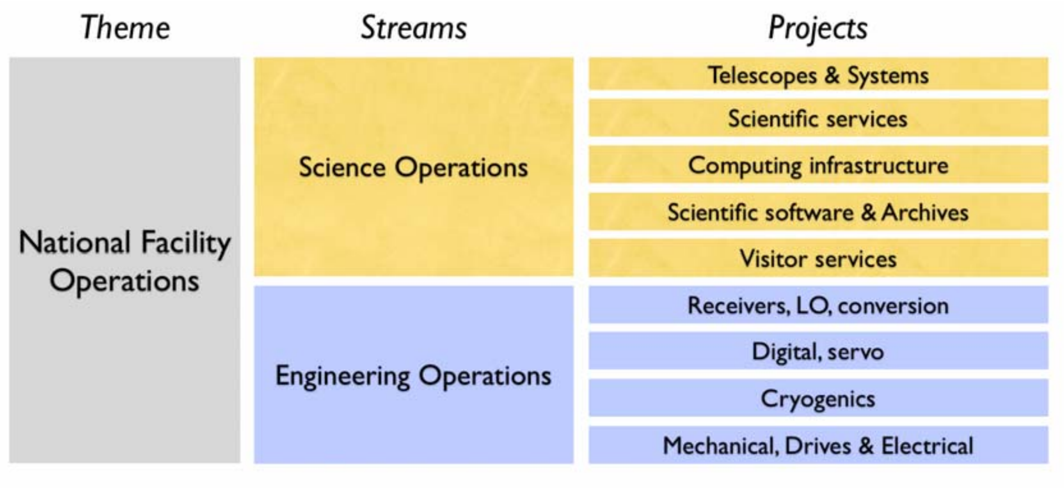

Figure 1 The theme management structure for the new operating model.

Table 1 summarises the activities of each operational project. Under the new scheme, there is considerable scope for a redistribution of resources between projects. The final distribution of resources needed across operations will not be known until some experience is gained with the new model. The implementation plan for the model will include an estimated resource profile for each project consistent with the activities planned for the implementation phase. Table 2 gives an initial estimate of this profile.

Table 1 Functional teams and their activities

Operational project	**Functions**
Telescope Operations and Systems	Coordination with Engineering Operations Telescope calibration and systems analysis (incl. weather); Time Assignment Committee; Usage statistics; Facility safety and integrity Web: Schedules, telescope status, data access, other
Scientific Services	Calibration sources and catalogues; Off-line data verification; User friend support (all stages); User guides and wiki pages on web (for proposals, observing, data reduction & analysis); On-call support; Observing support for ToO requests and queue scheduling Web: Other information associated with science services
Computing Infrastructure	Coordination with CSIRO IM&T; Procurements; Operating systems; Site-site communications (conference links etc); Observers environment (terminals etc); User and email accounts and passwords; Data back ups and management (excluding archives); Infrastructure: Networks, servers, data storage; Network services (email systems, authentication, etc) Website structure and security, support for content writers Web: Content to support infrastructure
Scientific Computing and Archives	ASKAP software instruments and data archives (from 2012) Other data and data product archives (ATOA); Proposal application system (OPAL); Scheduling software; Telescope control and monitoring software Data reduction, image analysis & VO software Web: Technical manuals and other documentation
Visitors Services	Visitor administration, accommodation bookings and invoices Lodge services – maintenance, cleaning, purchases, meals, laundry Office allocation Web: Visitors information, guides, travel, other
Receivers, LO, conversion	Monitor performance, diagnose faults, manage spares, replace faulty modules, arrange for repairs, manual configurations
Digital & servo electronics	Monitor performance, diagnose faults, manage spares, replace faulty modules, arrange for repairs, manual configurations
Cryogenics	Monitor performance, diagnose faults, manage spares, replace faulty modules, arrange for repairs, schedule maintenance program, conduct maintenance work
Mechanical, Drives & electrical	Monitor performance, diagnose faults, manage spares, replace faulty modules, arrange for repairs, schedule maintenance program, conduct maintenance work

The staff estimates in Table 2 cater for the base effort needed to operate the facilities. They do not include the development of new instruments or software; nor do they include the general advice given to the user community on ATNF capabilities, how to apply for time, hosting long-stay users and so on. They do include the direct assistance given to users during their actual use of the telescope. The uncounted contribution towards advising users probably amounts to about three FTEs (included in the Astrophysics Theme). Note also that the figures in Table 2 do not include the effort that will be needed to effect the transition to the new model, particularly to execute the development projects described in section 3. Many of those resources will be provided by the engineering groups once the current ATCA upgrade work is complete.

Table 2 Estimated resource profile for the operational projects.

Project	2005	2007	2009	2011	2013
Telescope operations & systems	8	6.0	6	5	8
Scientific services	7	6.0	6	5	7
Computing infrastructure	2.2	2.2	3	3	6
Scientific computing and archives	6	5.3	6	7	9
Visitor services, Admin	8	7.0	5	4	5
Receivers, LO, conversion	7	6.6	6	4	8
Digital & servo electronics	10	9.2	9	5	8
Cryogenics	5	4.4	4	3	5
Mechanical, Drives & electrical	7	6.5	6	5	8
Total	**60**	**53.5**	**50**	**41**	**64**

Looking forward to 2013 when AKSAP will have joined the operational telescopes, Figure 2 shows a possible distribution of effort (final column of Table 2) across the Operations projects from staff belonging to the different ATNF research programs, in the CSIRO "matrix". According to this model, members of staff belong to research teams, groups and programs and are considered as "inputs"; the projects on which they work are the products or "outputs", and in general a member of staff works on several projects.

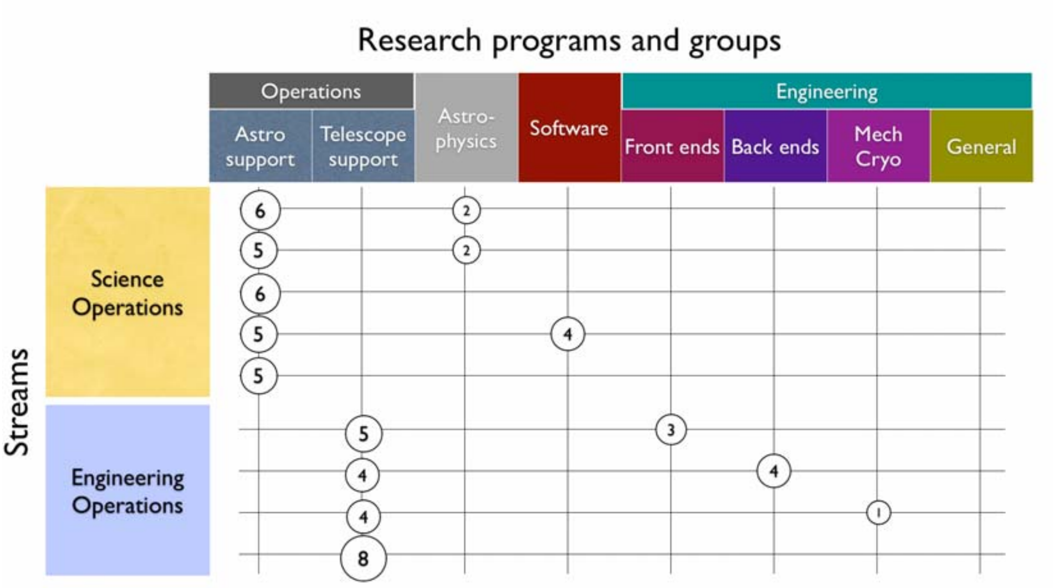

Figure 2. Schematic view of numerical contributions (FTEs) to Operations from ATNF Research Groups.

The two operational projects identified in Figure 1 as *Telescope operations and systems* and *Scientific services* deserve special discussion. Personnel responsible for these activities will be most affected by the proposed changes. Some of those currently based at the observatories will need to move to the SOC to fulfil their roles. The new structure has no place for Officers-in-Charge of observatories, and so providing their astronomer support function and telescope system expertise needs close attention. We define three roles to be filled by scientific staff working in *Telescope operations and systems* and *Scientific services*, and a fourth related role, the Project Scientist, found in the instrument development projects, noting that an individual may contribute to more than one of these roles. To resource this model, it is anticipated that these roles will occupy, on average, half of the job description of all members of the Astrophysics research group, leaving 50 per cent of time available to pursue personal research.

- An **Application Scientist** takes a professional interest in a particular instrument or technique and ensures that the ATNF operates it to its best effect. Any use of the telescopes needs knowledge and techniques common across radio astronomy with additional techniques specific to the type of observation being made. The new operational arrangements will ensure that the ATNF continues to provide its users with expert advice in the main modes of telescope use[2]. Application Scientists will be identified or appointed to provide this advice and to ensure that ATNF systems continue to perform well in their area of expertise. Application Scientists will be drawn from the ATNF's astrophysics group; the newly appointed mm-Scientist is such a position.
- A **System Scientist** is a broad specialist, an individual with rare skills enabling them to have system-wide knowledge of both principle and practice of operation. Such a person can be applied to special problems such as major commissioning tasks and telescope performance problems that do not submit to the standard diagnoses. A characteristic of the successful system scientist is a tendency to explore the poorly understood aspects of the instrument, even in the absence of immediate need. The system scientist needs to have the ability to experiment with the system, to change hardware configurations and to write software for special control modes, data analysis or system modelling. Ideally, the system scientist conducts research with the telescope that extends its normal capabilities. Each telescope needs a System Scientist. An ATCA System Scientist position is being advertised at present. System Scientists for other telescopes need to be identified.
- A **Project Scientist** is concerned with the design and construction of an instrument, has a clear idea of the scientific aims of the instrument and knows how to verify that those aims are met. It is the Project Scientist's responsibility to keep in touch with the designers and builders and protect the most important features against possible loss from financial or time constraints. The Project Scientist should design tests of the completed instrument that will determine its performance.
- Each **SOC Astronomer** will be familiar with the operation of the telescopes from the observer's perspective. The SOC Astronomer will have enough general knowledge and experience to give useful advice on most types of observation and knows who to ask for help with difficult problems. The SOC Astronomer's role will be to support the observer to make the most efficient use of time on the telescope. At present Duty Astronomers fill this role for the ATCA, and are rostered on for one week terms.

2.2 Establish the Science Operations Centre

A Science Operations Centre will be established to host users of the ATNF telescopes and be the control centre for all astronomical operations of AT facilities. Initially the SOC will be located at ATNF headquarters, currently the Radiophysics Laboratory in Marsfield, Sydney.

All astronomers needing support will be required to observe from the SOC. The observer-operator model will be retained as the default for Parkes, ATCA and Mopra. However, the automation project (see section 2.1) will allow certain observations to be made without full-time human attention. Observations by experienced users not requiring full support will be possible from remote locations other than the SOC (similar to the present remote observing option for the ATCA). When necessary, users will be able to conduct observations at the observatories.

[2] **Aperture synthesis**: mm spectroscopy, mm continuum, cm spectroscopy, cm continuum, High Dynamic Range and Widefield Imaging, Polarization imaging. **Single dish**: mm spectroscopy, mm continuum, cm spectroscopy, cm continuum, Pulsar timing Pulsar searching Polarization imaging. **VLBI**

ASKAP will be operated differently; it will be a "pipeline", with telescope control, data collection, data reduction and some forms of data analysis, all integrated into a single process. ATNF staff at the SOC will oversee its operation. Astronomers will interact with ASKAP in the initial specifications of the observations and through an interface to the archive of data products. They will be best served by visiting the SOC before and after the observations for advice and assistance on data retrieval, reduction and analysis, and for collaboration with ATNF scientists.

The establishment of the SOC is a major shift for the ATNF. It is driven by the need to develop the best approach for ASKAP operations and ultimately the SKA, and by economics. Only now, with the new high-bandwidth links, is it feasible to design a successful SOC servicing several remote observing sites. It has a number of likely advantages, but the ATNF may lose something from this change.

The SOC will be very visible at ATNF headquarters and will raise the profile of our telescopes within the ATNF and other parts of CSIRO. A properly set up SOC will be a stimulating environment for ATNF staff and users. We already see benefits from co-locating ATCA and Mopra observers, and there are strikingly vigorous interactions between teams of astronomers conducting different observing projects on the ATCA and Mopra from the common control room. The move to a single ATNF Science Operations Centre will bring users of all our facilities together. Users will be closer to the ATNF astrophysicists and engineers—major sources of astronomical expertise. It is particularly important that the establishment of the SOC includes the identification of systems scientists or instrument scientists for the major systems, observing techniques, and instruments, and that these specialists are seen as an integral part of the SOC structure.

On the negative side, there is a risk of losing the value of interactions between astronomers and observatory staff. Observing from the SOC may not have the same inspirational value for astronomers as sitting in a control room in or next to a telescope at an isolated and exotic observatory location. Certain projects may suffer scientifically from the distance between scientist and instrument. These are serious factors and the model includes measures to offset their effect.

Features of the model listed below aim to address these points:

- a dedicated space within the Marsfield site (or other future ATNF location) to become a Control Room for all four observatories; users of each facility should be close enough to interact, but isolated enough to concentrate when necessary;
- nearby space for astronomers to work while not observing;
- sufficient visual and auditory monitoring at the telescopes and the SOC to enable useful interactions between people at all locations;
- sufficient support and scientific staff at the SOC to enable the majority of observations to be conducted from that location;
- an SOC support role, to be resourced by ATNF staff, users and students in a similar way to the present Duty Astronomer role, to provide simultaneous support and assistance for observers across all three user-operator telescopes;
- sufficient support structures at Parkes and the ATCA to host observers with special needs, including experienced astronomers exposing their students to the telescopes, and those needing direct access to the telescope for scientific reasons;
- a "studentship" scheme to host students at a telescope for a period of practical experience, currently provided through the Duty Astronomer program;
- and a program of inter-site travel for operations staff.

2.3 Streamline observing, equipment and support

A number of measures will be taken to reduce the load of operating the facility while maintaining scientific productivity. These measures will target operations that are expensive, such as receiver changes at Parkes and array reconfigurations, as will services currently provided that produce relatively little return to the scientific community. Some, but not all of these measures will require consultation with the user community to allow a proper assessment of the impact before decisions can be taken on their implementation.

2.3.1 Streamline operations

A range of measures will be implemented to lessen and level the support load by relaxing the "maximise time available for observations" principle, and by scheduling fewer expensive operations on the telescopes.

We propose the following measures.

- Limit Mopra single-dish operations to six months per year (over winter).
- Limit ATCA 3mm observing to six months per year (over winter).
- Close all observatories from 24 December to 2 January.
- Restricted response to technical faults except when human or telescope safety is threatened. Addressing faults that require staff at the telescope will be restricted to hours between 6am and 9pm. Fault conditions that can be resolved by telephone or computer connection will be addressed between 6am and midnight. There will be no support available for resolving faults between midnight and 6am.
- Reduce the number of Compact Array reconfigurations per year and perhaps restrict compact configurations to the millimetre season
- Reduce the number of receiver changes at Parkes from the current 30 or so to about five.
- Cease operation of CDSCC facilities at Tidbinbilla for single dish radio astronomy.

More input on the scientific impact of the last two measures is required, and user consultation has begun. The proposed reduction in frequency of Parkes receiver changes may have a negative impact on science that requires frequent measurements to be made in several wavelength bands such as VLBI astrometry and pulsar timing programs. An example of a one-year schedule for receiver availability at Parkes is shown in Figure 3. The details of receiver availability will differ from year to year, and we intend to advertise the availability to users for the upcoming two or three years prior to each call for observing proposals. Scientific demand will dictate the duration of periods when the smaller receiver packages are available. The example shown in Figure 3 satisfies the requirements of the long-term and strategically important Parkes Pulsar Timing Array project.

We anticipate that together these measures will be sufficient to allow continued operations without a significant increase in ongoing resources, or an unacceptable negative impact on scientific productivity. We note that several hundred hours is made available on Tidbinbilla facilites for astronomical observations through the Host Country Agreement. Prior to an extended shut-down of the 70-metre in July 2005, single-dish use accounted for most (>80%) of this time, but since the antenna returned to service there have been pointing difficulties making those observations difficult. With the new 12mm receiver soon to be commissioned on Parkes, alternate means of catering for the single-dish science are becoming available. Not offering single-dish support would either mean increasing VLBI use (which may prove impractical from a scheduling perspective) or reducing the fraction of time used at Tidbinbilla for astronomical research. In either case, careful negotiations will be required with NASA and CDSCC. The management of CDSCC through another part of CSIRO is a further complicating factor in this issue.

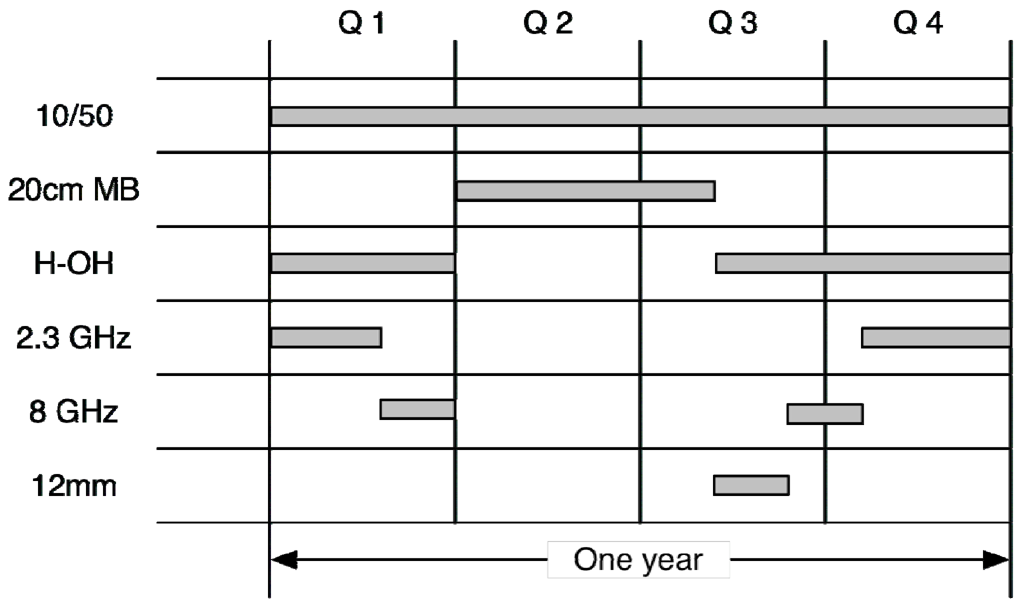

Figure 3 An example one-year plan for Parkes receiver usage. Another year would, in general, have a different pattern of receiver usage.

Should these measures prove insufficient in reducing the ongoing resources required for operations, more extreme measures will be undertaken. We would consider implementing the following measures, proceeding progressively down the list.

1. Cease all radio astronomy use of CDSCC facilities at Tidbinbilla (noting the comments above).
2. Further reduction of after-hour response to technical faults: only telephone or on-line help out of normal business hours (excluding observer/telescope safety issues).
3. Further reduction of the Mopra season to 4 months.
4. No receiver changes at Parkes.
5. Close Mopra.

The following options have also been considered, but are viewed as untenable from a cost-benefit perspective; that is they would have a major impact on scientific productivity with minimal cost savings.

- Offering only 3-12mm observing with the ATCA over the winter season, and only centimetre band (1.4 – 10 GHz) observing over the summer.
- Decommissioning the ATCA centimetre band systems completely.

2.3.2 Consolidate instrumentation

The complement of instruments currently offered on ATNF telescopes will be reduced to ensure that effort is being expended in the most scientifically productive way. The expected state of instrumentation in 2012 is summarised below in a set of tables and figures. Table 3 and Figure 4 describe the suite of receivers and spectral coverage; Table 4 describes the backend signal processing units; Table 5 lists the instruments we expect to be decommissioned over the next five years.

Table 3 ATNF receiver systems in 2012.

Telescope	Receiver	Band (GHz)	T_{rec} (K)	
Parkes	10/50cm	0.64-0.70	40	
	20cm MB	1.2-1.5	23.5	13 beams
	H-OH	1.2-1.8	28	
	13cm	2.2-2.5	20	
	10/50cm	2.6-3.6	30	
	3cm	8.1-8.6	25	
	12mm	16-26	25	
ATCA	L/S	1.2-3.0	30	6 antennas
	C/X	4.0-12.0	30	6 antennas
	12mm	16-26	25	6 antennas
	7mm	32-50	75	6 antennas
	3mm	84-106	280	5 antennas
Mopra	L/S	1.2-1.8, 2.2-2.5	30	VLBI only
	C/X	4..4-6.9, 8.0-9.2	30	VLBI only
	12mm	16-26	25	
	7mm	32-50	75	
	3mm	79-119	280	
ASKAP	100 elements	0.7-2.4	35	45 antennas

Significant operational savings could be made at Parkes by adding a 2.3 GHz capability to the existing 8GHz receiver. This would reduce the number of receiver changes need to support important astrometry projects, and would allow the decommissioning of the "multiband" receiver.

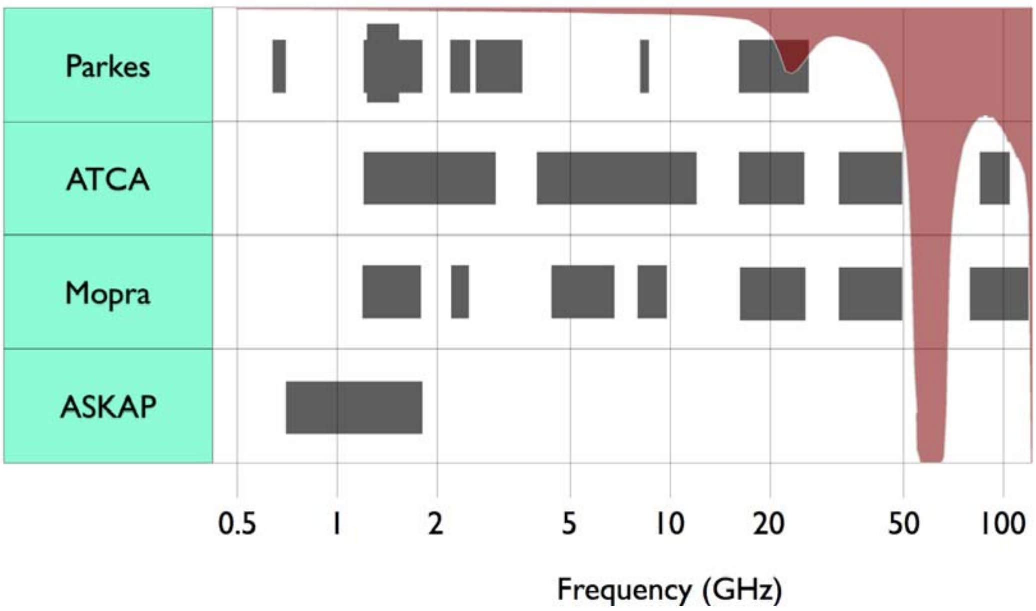

Figure 4 Spectral coverage of ATNF telescopes in 2012. The shading indicates the atmospheric opacity; features due to H_2O (22GHz) and O_2 (60 GHz, 120 GHz) are visible.

Table 4 ATNF backend signal processing units in 2012.

Telescope	Backend	Bandwidth	Channels, time bins	Notes
Parkes	PDFB2/3	2 × 1GHz	2048 ch × 2048 bins	1,2
	APSR	2 × 1GHz		3
	13-beam digital filterbank			4
ATCA	CABB	8 × 2GHz	8192 ch	1
Mopra	MOPS	2 × 8GHz	8192 ch	1
ASKAP		2 × 256MHz	65536 ch,	1,5

Table 4 notes:

1. Digital signal processing backends are highly configurable and trade-offs can be made between bandwidth, number of quantising levels, number of channels and time bins and so on. Parameters given merely indicate the general level of performance achieved.
2. PDFB3 has an input dedicated to a reference signal and firmware to use this for RFI mitigation—excision of interfering signals from the sky signal.
3. ATNF Pulsar Swinburne Recorder: provided by Swinburne University, this is a computer cluster used for base-band signal processing for pulsar observing and for real-time VLBI correlation.
4. The Swinburne University is developing a digital correlator to work with the 13-beam 20cm receiver.
5. ASKAP digital systems are not yet completely specified, but will process dual polarization signals from 30 beams across 256MHz of bandwidth. There is a requirement for 5kHz frequency resolution and high time resolution for pulsars and transients.

Table 5 Provisional list of equipment to be decommissioned.

What	Where	When
1.3cm receiver	Parkes (replaced by 12mm rx)	2008
AT Correlator	Parkes, ATCA, Mopra	2007,2008,2008
WideBand Correlator	Parkes	2008
AT multiband receiver	Parkes	2009
Analogue Filter Bank	Parkes (replace with 13-beam digital FB)	2009
Methanol Multibeam	Parkes (send to JB)	2009
DAS units	Parkes, ATCA, Mopra	2010
HI multibeam	Parkes (if ASKAP FPA viable)	2012

2.3.3 Reduce observatory accommodation support

The move to a single SOC will result in reduced demand for on-site accommodation at Parkes and Narrabri. The number of astronomers visiting the observatories will decrease significantly, but is likely to be partially offset by an increase in the number of visits by Engineering Operations staff based at other ATNF sites. A gradual reduction in the resources devoted to visitor accommodation at the observatories will occur over the three years needed to move to a fully functional SOC.

In the first one or two years significant changes are envisaged as an integrated approach to the delivery and administration of visitor accommodation and support is implemented across the three sites (Marsfield, Parkes and Narrabri) via the move to a single visitor support group. Changes to the levels of service are also planned within the first year (2008) including ceasing the provision of hot lunches and staffing of the visitor quarters on weekends for fresh meal preparation. Ultimately, once the SOC is fully functional, it is possible that the lodges will be operated only intermittently and that they could then be serviced and provisioned by contract according to demand.

Immediate next steps

December 2007 Appointments to senior leadership positions announced

February 2008 Finalise operational project structure and announce leaders for each project

February 2008 Explore implications of reduced support for Tidbinbilla astronomy

February 2008 Announce limits to Mopra single-dish observing season

3 Development Projects

Four major projects will be required to effect the changes proposed:

1. Automation
2. Telescope safety
3. Scheduling
4. Building the SOC

These projects will require time, money and expertise, and it is anticipated that they will draw heavily on resources from ATNF's Engineering capability and theme to supplement the expertise and effort of operations staff. We will attempt to manage these projects so that the total staff budget remains constant over the period of operational change and into the ASKAP commissioning period.

3.1 Automation

In general, manual operations on the telescopes' equipment cost time and reliability. The operations that should be reduced include manual configuration of hardware and software, and the entering of observing commands at the keyboard. Two particular areas need attention and will be addressed as part of the new model.

1 Introduce computer control for the whole Parkes signal path, and those telescope operations currently accessible through the Manual Control Panel. This will require replicating much of the functionality already available at Mopra and the Compact Array. The aim should be to enable switching between observing programs without any manual operation on the hardware (unless a change of receivers installed in the focus cabin is required).

2 Change observing software to enable unattended operation for periods of days. This will require the ability to deliver all commands from a "schedule file", and to provide observing software with the ability to assess the success of operations and to make at least a rudimentary assessment of the quality of data. The observing software needs to be able to execute simple control logic of the kinds "`if … then … else`" and "`do … until …`".

Automation of Parkes will amount to a significant upgrade that will enhance scientific opportunities, particularly in the important Pulsar timing and transient search domain (see Science section).

3.2 Enhance telescope safety

To enable increasing amounts of remote and unattended operation of the ATCA and Parkes telescopes, new systems that ensure the safety of the facilities will be required. The "primary monitor" at Narrabri aims to protect critical systems on the ATCA so that the ultimate safety of the instrument is not dependent on the attentiveness and judgement of possibly inexperienced operators and staff. This project will review the protection provided by the ATCA primary monitor, upgrade it if necessary, determine the requirements for and implement an equivalent system at Parkes to allow remote and unattended operation. New requirements for the levels of human attention for the operation of all ATNF telescopes will be defined as part of this process.

3.3 Schedule telescopes collectively

Telescope schedules will be coupled so as to level the load on operations staff, particularly on the engineering operations teams whose members may be required to travel between the sites to perform maintenance and upgrade works. Additional measures that will influence schedules are described in section 2.3.1. In its initial form, the three-telescope schedule will have the structure illustrated below (Figure 3). This scheme ensures that large maintenance blocks are never scheduled on two telescopes simultaneously, and it provides sufficient time for all three to be scheduled for simultaneous astronomy such as VLBI. A four-week cycle is shown here, but the actual parameters may change after more careful analysis.

The effect of imposing the cyclic structure on the schedule will be to simplify its construction and the scheduling of operations staff's work, possibly at a small expense to the efficiency of filling the available time with astronomy programs. The potential for numerical algorithms to improve the quality of the schedule is already being investigated.

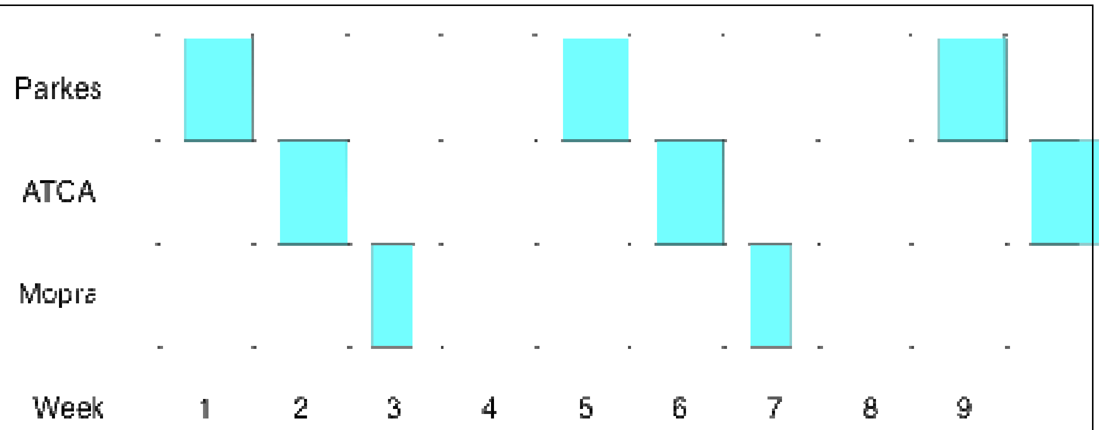

Figure 5 Schedule fragment illustrating the proposed timing of maintenance periods (blue shading) for Parkes, the ATCA and Mopra.

3.4 Build the SOC

The construction of an appropriate Science Operations Centre will be a substantial project. This will include detailed planning of the requirements for all four telescopes, building modifications, communications requirements and equipment at both the SOC and at the observatories, and fundamental infrastructure such as a reliable power supply and backup system at Marsfield. Input from specialists in human interactions, particularly interactions at a distance, will be a priority.

Immediate next steps

December 2007 Define arrangements between ATNF and CSIRO Mathematics & Information Sciences and scope the scheduling project *February 2008* Define development projects and announce project leaders	*April 2008* Development project plans prepared and approved by Project Review Board

4 Underpinning practices and disciplines

Communication practices and system engineering will play an important role in determining the success of the proposed changes to the way that the ATNF operates its facilities. A systematic approach to both is proposed.

4.1 Communications

Good communication, particularly within the functional teams that will be distributed across the ATNF sites, but also between the functional teams, is essential. ATNF will seek to identify and implement "best practice". The CONRAD collaboration between ATNF staff and staff at the Karoo Array Telescope in South Africa is a model, and lessons learnt from this will be applied within the operations activities. Practices adopted in other institutions and international observatories such as the Australian Antarctic Division, La Silla/Paranal and MERLIN will all be investigated.

We have various media for communicating within groups of geographically distributes colleagues: electronic mail, audio and video conferencing, collaboration tools such as the *trac wiki* (see `trac.edgewall.org`), which is an integrated internet-based project management system. We will consider establishing a continuous tele-presence between the SOC and local control rooms at each telescope. We will seek advice from 'human factors' specialists, possibly through collaboration with the ICT Centre. And we will work with staff to find the communicating medium most appropriate for each of the different circumstances that will be encountered.

4.2 System Engineering

Systems Engineering *is an interdisciplinary field of engineering that focuses on the development and organization of complex artificial systems. [Wikipedia, www.incose.org]* The term generally applies to a formalised approach for the integration of subsystems that are developed or maintained by independent teams by carefully specifying and managing the interactions between the subsystems.

The ATNF has never attempted a systems engineering approach to the management of its facilities and we have little current expertise in this discipline. It may be argued that the overhead and cost involved in a fully-fledged systems engineering approach is hard to justify for a research facility, and that it introduces a degree of inflexibility that could limit the innovative use of the facility and therefore its scientific impact. However, the complexity and scale of ASKAP (with 9000 simultaneous data streams), and ultimately of the SKA, will require the adoption of systems engineering practises. Such practices will also benefit the move to functional rather than regional teams, and the increased distinction between engineering and scientific operations.

The elements of Systems Engineering that we expect to benefit operations include:

- configuration management such that the complete state of the instrument (which hardware and software is in use, and how they are connected) is known whenever the system is functioning;
- maintenance and repair history of each component, complemented by a preventative maintenance program where relevant;

- documented standards for interfacing to, configuring and operating the instrumentation;
- monitoring and diagnostic software that can report the state of performance at any time.

The ATNF will assess the feasibility of systems engineering techniques, and determine the appropriate level of rigour for their introduction. A minimum outcome from should be a standardization of equipment, interfaces and procedures to allow fewer staff to cope with the operation, and to obviate the use of resources to maintain parallel systems.

Immediate next steps

March 2008 Seek Systems Engineering expertise and advice on "telepresence" methods

5 Science

Australian radio telescopes produce world-class science. Both the development of ASKAP and the operational changes described in this document aim to hold that leading position.

The southern location of Australia gives ATNF telescopes the best view of the central part of our own galaxy and of the Magellanic system. Astronomers exploit this in research into pulsars, star formation, the interstellar medium, Galactic structure and the Magellanic system, together with other special objects in the nearby Universe, like the nearest massive black hole powering Centaurus A. Instrumentation and techniques have been developed to strengthen the research in these areas, particularly to allow large-scale imaging of the sky and to make the most precise pulsar timing measurements. Wide field imaging uses the ATCA with its high brightness sensitivity and efficient mosaicing mechanism, and the Parkes telescope to provide the total power measurements necessary for a complete image. ASKAP will exploit not only the southern sky, but also one of the quietest radio sites on Earth. It will build on the large-scale imaging techniques and will be, for its size and spectral window, the ultimate all-sky radio imager.

The ATCA, Mopra and Parkes are well equipped for short-wavelength radio astronomy in the 2.5 - 18 mm range (see Figure 4). This suite of telescopes operating in this band has begun to make important advances in areas that will be tackled by ALMA. During the pre-ALMA era ATNF operations will continue to support mm astronomy while ever it remains scientifically profitable.

The southern hemisphere niche is equally important for the Long Baseline Array (LBA), which continues to deliver publications in proportion to its fraction of resources. It has recently benefited greatly from the introduction of broadband data transport between observatories and the emergence of viable software correlation.

Key Science Focus of ATNF Facilities

The scientific roles of the current and planned ATNF facilities are in the process of being critically reviewed. Operational priorities will be closely tied to the perceived potential for high impact science in a global context. Capabilities with low perceived potential are the most likely to be discontinued. The current assessment has had input from the "Science at Parkes" meeting of 5 November 2007. A similar meeting focused on ATCA science will take place in early 2008.

For each facility we outline the anticipated major science focus below and comment on the operational implications of that focus. Capabilities falling outside of the focus will receive reduced priority for operational support. If cuts need to be made, then they will occur in those areas first.

ATCA

A key science role for the ATCA is anticipated in the areas of:

- Star formation at low, medium and high z. This will involve observations primarily in the 12/7/3 mm bands and utilize compact array configurations. Suitable dry observing conditions are most often available in the winter months.
- Broad-band spectro-polarimetry. This will involve primarily observations in the 20/13/6/3 cm bands and utilize fairly extended configurations. Such observations can be undertaken at any time of year, but given the demand for high frequency winter observing, could form a complementary yearly schedule for the summer months.

Both of these applications make good use of the full 2 GHz bandwidth that CABB will provide by mid-2008. Since all ATCA receivers are continuously accessible without manual receiver change, the biggest operational issue is that of reconfiguring antennas. Reconfigurations might be kept to a minimum by adhering to the basic summer/winter pattern sketched above.

Parkes

Key science drivers for the Parkes telescope in the years leading up to full ASKAP operations are anticipated to be:

- Pulsar Timing. This is a long-term, high impact program that requires observations throughout the year at intervals of two weeks using several receiver systems; the 10/50cm system for an accurate determination of the (time variable) Dispersion Measure and a 20cm system (either the Multi-Beam or H-OH) for the most sensitive Time of Arrival determination.
- Pulsar Searching. The survey speed of the 20cm Multi-Beam receiver is still unsurpassed for pulsar surveys anywhere on the planet. Deeper surveys will continue to play an important role in identifying unique new targets for follow-up until a superior system is deployed.
- Ultra-deep HI. Extreme surface brightness sensitivity coupled with a multiplexed field-of-view enable uniquely deep HI observations of the local “Cosmic Web” using the 20cm Multi-Beam receiver.

The applications listed above can be carried out with only two receiver systems that could be available continuously. In addition to these anticipated high impact areas there will be demand for the new 12 mm receiver for H_2O maser studies and NH_3 studies of star-forming regions, as well as diffuse polarimetric work on the Galaxy magnetic field at 20, 13 and 6 cm. If receiver changes are required to access these systems, then their use may be restricted. Note also that Parkes, as the largest readily available element of the LBA, has a great influence on the sensitivity of the LBA.

A summary of the Science with Parkes Workshop appears as an appendix to this document.

Mopra

A key role for Mopra is foreseen in the area of:

- Star formation studies of the Galaxy and nearby galaxies. All three of the 12/7/3 mm bands will be utilized with the remarkable 8 GHz bandwidth MOPS spectrometer. Useful observing is restricted to the winter months only.

Tidbinbilla

The 70-metre antenna at Tidbinbilla is, when accessible, a major contributor to LBA sensitivity. The good performance of the antenna’s 22 GHz system has made it very effective for single-dish studies of H_2O masers, although in the recent past antenna pointing problems have been a limitation. A new 12mm receiver for Parkes will be completed early in 2008 and consideration must be given to the value of continuing to use of the 70-metre for single-dish astronomy.

LBA

The most significant application foreseen for the LBA in the coming years is follow-up of sources discovered with the GLAST mission, due for launch in May 2008. Exotic or transient γ-ray sources discovered in the Southern sky will have no other high-resolution radio follow-up possibilities.

ASKAP

The different modes of operation of AKSAP will be encapsulated in "software instruments"—end-to-end telescope control, data acquisition and reduction software. The initial scope of the ASKAP construction project includes software instruments for continuum and HI surveys. Software instruments to support other modes of operation are planned but will require resources beyond those currently committed to the project.

The key ASKAP science will be in the following areas.

- HI surveys. Truly transformational science is expected from all three forms of envisaged extragalactic HI surveys, namely the shallow, medium and deep fields. The best matched configuration for this application has ~2 km extent.
- Continuum surveys. The unprecedented ASKAP survey speed will permit routine all-sky imaging down to sensitivities that are currently only achieved over small regions (like the Hubble Deep Fields). In order to avoid the limitations of source confusion as well as permit accurate source identifications, it will be necessary to have a configuration that extends out to ~8 km.
- Pulsar surveys and timing. ASKAP has enormous potential as a pulsar search instrument because of its large collecting area and field of view. Pulsar surveys are extremely computationally intensive and will likely require significant external resources to develop the necessary software instrument. To be competitive in the most demanding pulsar timing applications ASKAP would need timing precision equal or superior to that achieved with Parkes. This field presents significant technical challenges that are yet to be explored and a successful outcome is not assured. Once the functional requirements of pulsar observing modes have been defined, support can be sought within the community to realise these capabilities. All pulsar work is best done with the most compact possible configuration, for example of ~500 m extent.
- Transients. The high survey speed at GHz frequencies opens the door to discovery of completely new classes of time variable phenomena that are currently inaccessible. Optimised detection strategies will depend on the nature (luminosity function, duty cycle, and so forth) of the object classes.

A group of ATNF liaisons has been defined with responsibilities in the science areas listed below. This group, under the coordination of ASKAP Project Scientist Simon Johnston, is charged with ensuring timely input to the ASKAP "Functional Requirements Document" (this FRD has an end of 2007 deadline, as input to the full ASKAP operational model in the first quarter of 2008) as well as ensuring continued communications with the software team during the subsequent resourcing and implementation phases for "software instruments" designed to carry out ASKAP surveys in each of these areas. This input will be critical since:

- Surveys will need to piggy-back. As each of the key science areas outlined above will require several years of observing time to achieve its objectives, it will be necessary to define all surveys such that they can be carried out simultaneously as far as possible.
- User interaction is with the archive. The "software instruments" will provide essentially "final" data products stored in the archive, making product definition in the FRD and during the implementation phase critical.

Table 6 ASKAP Scientific liaison

ASKAP Science Area	ATNF scientist
Extragalactic HI	Baerbel Koribalski
Extragalactic Continuum/Polarimetry	Ray Norris
Galactic HI/Continuum/Polarimetry	Naomi McClure-Griffiths
Transients	Simon Johnston
Pulsars	George Hobbs
VLBI	Tasso Tzioumis

The ASKAP science liaison role outlined in Table 6 above is just one example of the commitment of ATNF Astrophysics staff to science support. These are current examples of the “Application Scientist” role defined in Section 2.1 above and they will grow to encompass support for these science applications across all ATNF telescopes. About half of the effort of Astrophysics staff is currently, or will soon be, committed to the support of both instrumental initiatives and facility users.

Table 7 The anticipated impact of streamlining measures on scientific programs is summarized in the table above. Planned measures are not high-lighted, while possible additional measures are high-lighted in orange. Key science programs are not high-lighted, while possible additional measures are high-lighted in orange. Key science programs are not high-lighted, while additional programs are high-lighted in yellow. The circle colours encode the anticipated negative impact, from no impact (white), through increasing severity (light yellow, yellow, gold, orange, and brown), to terminal – (black).

Anticipated Impact of Streamlining Measures on Scientific Programs	ATCA: mm-spect.	ATCA: cm-polar.	ATCA: other	Parkes: Pulsar Timing	Parkes: Pulsar Surveys	Parkes: Deep HI	Parkes: other	Mopra: mm-spect	Mopra: other	LBA: other	Tidbinbila: other
Mopra: SD 6 winter months	white	white	white	white	white	white	white	white	yellow	white	white
ATCA: 3mm 6 winter months	white	white	white	white	white	white	white	white	white	white	white
All: Christmas Shut-down	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow
All: Tech. response M/F, 6 – 22	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow
ATCA: Cut-back reconfig	white	white	gold	white	white	white	white	white	white	white	white
Parkes: Cut-back recvr. change	white	white	white	white	white	white	gold	white	white	orange	white
Tidbinbilla: Stop SD use	white	white	white	white	white	white	white	white	white	white	black
Tidbinbilla: Stop all use	white	white	white	white	white	white	white	white	white	orange	black
All: Tech. response M/F, 8 – 16	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
Mopra: SD 4 winter months	white	white	white	white	white	white	white	gold	orange	white	white
Parkes: No recvr. change	white	white	white	white	white	white	brown	white	white	white	white
Mopra: Stop all use	white	white	white	white	white	white	white	black	black	gold	white

Table 7 summarises our assessment of the impact of streamlining on science programs, showing that the planned measures should have only minimal negative impact on the anticipated key science programs (by design). The more drastic streamlining measures are expected to begin adversely affecting even the key programs. Reducing non-emergency technical response to only a single week-day shift, would lead to some loss in observing efficiency across the board. The magnitude of that loss is difficult to estimate, but might well be at the 10% level. Substantial shortening of the Mopra single dish observing season, would rapidly diminish the scientific output of that facility. The most serious negative impact would follow from the closure of the Mopra telescope.

Immediate next steps

December 2007 Science liaison input to ASKAP Functional Requirements Document.

March 2008 ASKAP Functional Requirements Document/Operations model complete

March 2008 ATCA science meeting

6 Schedule of work

Figure 6 shows an approximate schedule for the work needed for implementing the model. At the top are the three main legs of the model (see section 1). An operational SOC cannot exist until the four projects are all complete. The underlying discipline required for successfully operating ATNF telescopes will be developed throughout the period and must be sustained indefinitely.

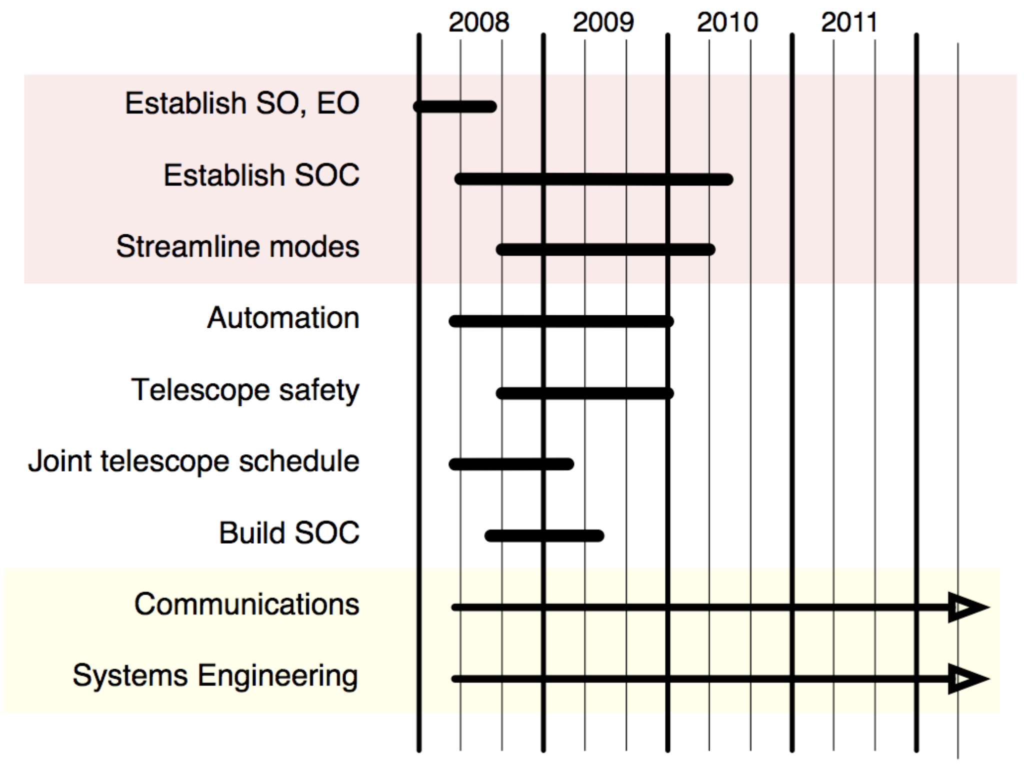

Figure 7 shows an approximate schedule for the work.

7 Implications for staff

The implications of the new operating model for staff are significant. The challenges of reorganising staffing structures, completing the development projects while maintaining the effective operation and scientific impact of ATNF's telescopes, should not be underestimated.

Communication of the principal features of the model, the implications for staff, and the schedule began immediately following their finalisation at the ATNF Leadership Meeting on 30-31 October. In the new model most jobs within operations will change, some will move from one ATNF site to another, and a small number (fewer than 10) are likely to cease. In addition, there are expected to be changes to a number of roles that currently sit within the astrophysics and technologies themes.

The development projects (see section 3) will create jobs in some areas over the period from 2008-2010. From 2011-2012 when ASKAP becomes operational there will be an increase in the staff required for the operation of the whole set of ATNF telescopes.

Pressures for staff to relocate are likely to be greatest in the Science Operations area, with some shift of staff towards Marsfield from Parkes and Narrabri being required. However it will not be necessary or desirable to move all such staff to Marsfield since some Science Operations activities will continue to require a physical presence at the observatories.

Engineering operations staff will remain distributed across three sites (Marsfield, Parkes and Narrabri), and it is unlikely that many relocations will be necessary. A reduction in duplication of skills and effort will be possible as a result of the move to functional rather than regional groups and in those instances ATNF will seek to take maximum advantage of natural attrition to reduce staffing, though a small number of redundancies may occur.

There will be a gradual reduction in the demand for services provided by observatory lodges resulting in a decrease in the staff resources required. Some of this reduction will be made by decreasing casual staffing, but on a timescale of one to three years (depending on location) more substantial reductions are likely. The ATNF will have considerable flexibility in determining job descriptions, locations and the timing of changes, and will take full advantage of that flexibility to maximise the retention of its highly skilled, motivated and effective workforce.

7.1 Next steps

Discussions are already underway with the Parkes and Narrabri Officers-in-Charge to identify their future roles, and with the staff who have been identified as the best candidates to lead components of the new operations structure, particularly the Engineering Operations stream, the Science Operations stream and the leadership of the key projects. Dave McConnnell, Head of Operations will remain as leader of the National Facility Operations theme and an ATNF Assistant Director. We intend to appoint the leaders of these key activities by the end of December 2007.

The next step will be to work with them to finalise the next level structures within Engineering Operations and Science Operations, to finalise the set of functional teams and the names and functions discussed in section 2.1. We intend to finalise those structures and appoint leaders for each functional team by the end of February 2008.

The likely staffing needs across the whole operation will be established by 1 July 2008, and then work can begin to match individuals to roles within those teams and activities from July 2008 onwards. We aim to have clear plans for each staff member's role by the end of 2008. It is possible that some positions or roles will be advertised internally within ATNF, calling for expressions of interest. However it is not intended to undertake any broad 'spill and fill' process.

The ATNF is committed to open and transparent communication and discussion with staff throughout the process, and will consult with staff at each and every significant stage in the process.

8 Risk Assessment

Inherent severity refers to unmitigated risk. Residual severity refers to the risk that remains following effective mitigation as proposed.

Likelihood is assessed as low, medium or high with scores of 1, 2 or 3 respectively. Consequence is assessed as minimal, significant or severe with scores of 1, 2 or 3 respectively. The levels of inherent risk and the residual exposure are the product of likelihood and consequence. Levels and exposures below are referred 1 to as negligible, 2 as low, 3 - 4 as moderate and 4 and above 4 as high. Focus will be on high/moderate risk items. This risk register will be maintained and updated regularly. Detailed risk assessments for individual implementation projects will be carried out as part of the planning process.

	Inherent Severity			Mitigation strategies	Resic	
	Like-lihood	Conse-quence	Level		Like-lihood	C q
:el	Medium 2	Significant 2	High 4	• Effective real time two-way communication technology from SOC to observatories. • Encourage staff travel. • High value focussed interaction periods at observatories such as expanded astronomical techniques workshops.	Low 1	Sig
ion if :scopes.	Low 1	Significant 2	Low 2	Encourage some visits to the Observatories	Low 1	Sig
vatories dback d hence	Medium 2	Significant 2	High 4	• Require use of observer feedback forms. • Encourage visitors to sites to give talks.	Low 1	Sig
ıology						
ɔecomes EeVLA	Medium 2	Severe 3	High 6	• Undertake a thorough analysis of science goals for the Compact Array over the next 5 Š 10 years. • Set up collaborative programs. • Promote capabilities and availability of ATCA to the international community.	Low 1	S
ads to ıering ı ATNF rge ime.	Low 1	Severe 3	Moderate 3	• Provide outstanding facilities. • Provide external remote observing for experienced users and routine setups.	Low 1	S

	Inherent Severity			Mitigation strategies	Residu	
ystems and tractable.	Medium 2	Significant 2	High 4	• Adopt a systematic approach to development. • Use ASKAP interfaces for existing telescopes.	Low 1	Signi
bservatory in	Medium 2	Significant 2	High 4	• Require use of fault reporting. • Good communications from SO to EO staff. • Engineering staff to check with observers on their progress and any problems.	Low 1	Signi
tion flow latestnewsÓ rvers.	Medium 2	Significant 2	High 4	• Require ÒCurrent StatusÕ reporting from EO & SO staff to user/operators. • Use technology-based solutions. Determine the cultural changes needed for these to be used effectively.	Low 1	Signi
to poorer h engineers p in	Low 1	Significant 2	Low 2	• Good coordination between SO & EO staff. • Explicitly encourage innovative use of instrumentation and observing from the observatories for these projects. • Promote key roles of System Scientist and Instrument Scientist	Low 1	Signi
make it some types ms.	Medium 2	Minimal 1	Low 2	• Consult with user community. • Restrict changes to those with smallest science impact.	Low 1	Min

Appendix: Science with Parkes workshop

ATNF Lecture Theatre, Radiophysics Laboratory, Marsfield, 5 November 2007
The summary of the meeting prepared by Naomi McClure-Griffiths appears below.

Parkes Science Strengths

- Pulsar timing:
  - Young pulsars
  - Millisecond pulsars
  - Pulsar searching
- 22 GHz science - big gains, largely unexplored:
  - H2O masers (star formation, evolved stars)
  - Ammonia (star forming regions, ISM evolution)
- Diffuse HI
- Diffuse polarization:
  - Magneto-ionic medium
- Key to sensitivity for eVLBI:
  - pulsar astrometry
  - starburst galaxies

Why Parkes?

- Parkes is big
  - Collecting area exceeds ATCA, competitive with ASKAP*
  - Surface brightness sensitivity exceeds both
- Location:
  - Best view of Milky Way, Magellanic clouds
  - Only large dish in the Southern Hemisphere
- Crucial for VLBI (both sensitivity and u-v coverage)
- Only way to get total power from 1 GHz - 22 GHz
- Only view of pulsars at dec < -30
- Frequency coverage:
  - ~0.6 - 22 GHz
- Agility (e.g. Huygens experiment)
- Education + science

Why Parkes?: Pulsar timing

- Most interesting pulsars for GLAST require Parkes monitoring.
- Most accurate long-term MSP timing programme in the world with sensitivity to gravitational waves in nHz regime.
- Frequency range:
- High precision pulsar timing requires multi-frequency observations in order to track dispersion measure changes. The restricted ASKAP frequency coverage limits the timing precision achievable with the telescope.
- Flexible scheduling:
- High precision pulsar timing requires regular observations over long time spans. Gaps in the data sets can significantly reduce the ability to measure a parameter of interest and, for example, significantly reduces sensitivity to gravitational wave signals.

Why Parkes?: Pulsar searches

- Parkes represents the most sensitive pulsar discovery instrument in the world for wide field untargetted searches.
- PKS is the only large-scale facility with a view of pulsars at < -30 dec.
- 2/3 of all pulsars have been discovered at Parkes.

Why Parkes?: Diffuse Emission

- Surface brightness sensitivity:
  - Only telescope now available with interesting TP survey speed for diffuse low column HI
- Provides complete spatial frequency sampling:
  - imperative for RM synthesis
  - complements ATCA higher resolution data
- The diameter is very well suited to providing zero-spacing information for ASKAP diffuse projects:
  - Diffuse Galactic and extragalactic HI
  - Diffuse OH
  - Diffuse polarization

Why Parkes?: VLBI

- Adds significantly improved sensitivity (especially for continuum observations),
- Provides improved (u,v) coverage, and
- Enables calibration techniques to be employed to increase dynamic range.
- A VLBI instrument combining the LBA/Parkes with ASKAP can achieve improved resolution, sensitivity
- and (u,v) coverage - aiding standard VLBI
- observations of AGN, pulsars and OH masers.

Why Parkes?: Spectral Line

- Large collecting area is critical for spectral line sensitivity (including spectral line VLBI).
  - Parkes is more sensitive than Mopra and many configurations of the ATCA
- Large aperture + multiple beams are the most efficient spectral line survey instruments (will provide targets for and complement ALMA).