The first day of the year saw the International SKA Project Office transform itself into the SKA Program Development Office, and its official location become the University of Manchester. The Memorandum of Understanding between the ISSC and the University to facilitate this was signed on 4 October 2007 by Brian Boyle, Chair of the ISSC and Alan Gilbert, President of the University, at a ceremony (see Figure 1) at Jodrell Bank during the celebration of 50 years of active service for the Lovell Telescope. The Jodrell Bank Centre for Astrophysics will host the SPDO for the next four years in the run-up to the submission of a proposal for construction funding. I would like to thank ASTRON in Dwingeloo for their generous hosting of the ISPO Director and support staff for the last 5 years, and CSIRO-ATNF for their likewise generous hosting of the International Project Engineer.

PrepSKA received full funding for 3 years from the European Commission to conduct a work program to (i) integrate the worldwide R&D effort on the SKA into a costed system design, (ii) carry out further site characterisation including deep RFI measurements at the candidate core sites, (iii) investigate options for governance structures for the SKA, (iv) investigate procurement issues and the involvement of industry in the development and construction of the telescope, and (v) to investigate options for construction funding. Funding for the 4th year, foreseen in the PrepSKA proposal for the system design work, will be sought at a later date. This is a fantastic result, and full credit to Phil Diamond and his global team for bringing this off. Commitment of the matching funds is in progress. PrepSKA will start formally on 1 April 2008, with most of the senior engineers in the Central Design Integration Team (CDIT), funded by PrepSKA, in action in Manchester as soon as possible thereafter.

PrepSKA has been funded, preliminary top-level specifications for the SKA have been generated, SKADS passed its crucial mid-term review with flying colours, the US Technology Development Program began work, three MoAs have been signed, the Chinese FAST project has been funded, the new SKA brochure has appeared, and SKA2007, the Modern Radio Universe Symposium and the first meeting of the SKA Forum have taken place. Where it really counts, on the work-floor, good progress has been made on the contributing technologies. One fine example is the composite material antennas built by the Canadians and South Africans which have both demonstrated excellent surface accuracy.

It has been another action-packed six months since the last Newsletter appeared! A draft of the preliminary top-level specifications and representative implementations for the SKA was debated vigorously by the 120+ astronomers and engineers at SKA2007 last September and further discussed by the ISSC and the Forum at their meetings after SKA2007. The SKA Specifications Review Committee, chaired by Roy Booth, will review the specifications at its meeting on 29 and 30 January, and the result will
guide the work done by the CDIT in its first year.

The ISSC-University of Manchester agreement was just the first of the MoAs signed before the end of 2007. The second was the International Collaboration Agreement for the SKA Program and signed by the European, US, and Canadian SKA Consortia, the Australian SKA Coordination Committee, the National Research Foundation in South Africa, the National Astronomical Observatories in China, and the National Centre for Radio Astrophysics in India. This agreement established the SKA Science and Engineering Committee to replace the ISSC, and took effect on 1 January. The third agreement was the MoA to establish the SKA Program Development Office and the Common Fund to support the SPDO activities. This was signed by the CSIRO Australia Telescope National Facility, University of Calgary, Cornell University, the Joint Institute for VLBI in Europe, and the National Research Foundation in South Africa.

Noteworthy progress has been made on the regulatory issues governing radio quietness at both candidate sites. In South Africa, the National Assembly has passed the South African Astronomy Geographic Advantage Act which will enable the establishment of astronomy reserves. The Australian Communications and Media Authority has authorised a Radiocommunications Assignment and Licensing Instruction to provide first stage regulatory protection for the core site at Boolardy and surroundings.

Finally, I’m sure you will all join me in saying thanks to Peter Hall for his outstanding leadership of the international SKA engineering effort over the past 4 years. Peter is leaving the SPDO on 1 February 2008 and will take up a Professorship at Curtin University in Perth, Western Australia. He assures me that he will remain an active contributor to the international SKA program, which is very good news. His successor is being sought as I write. Another major figure in the international project, our Project Scientist Bryan Gaensler, has also stepped down after two years on centre-stage. As Deputy Project Scientist and Project Scientist, Bryan has helped guide the Science Working Group for 4 years during which time the full science case was published and considerable work was put into the Phase 1 science plan amongst many other activities. The first task for his successor as Project Scientist, Joe Lazio, will be to generate a phased science plan for the SKA that takes us from the Pathfinder stage through early science with Phase 1 and then on to the full SKA at mid and low bands. Another person to leave the project is Nanuschka Csonka, ISPO Office Manager, perhaps less well-known to you all than Peter and Bryan, but no less indispensable to the smooth running of the project. Thanks to all three, and I wish them well in their future endeavours.

I look forward to seeing many of you in Manchester during the coming years.

Richard Schilizzi
Director
ENGINEERING

The engineering component of the SKA project has made considerable progress over the last 12 months. Along with substantial technical innovation within regional Pathfinders and Design Studies, as an international project we are now set to embark on a central design and integration exercise via the PrepSKA program. Before starting PrepSKA, the engineering community was keen to see a set of preliminary SKA specifications to guide the new Central Design and Integration Team (CDIT), allowing it to begin well-directed efforts on what is a demanding start-up phase.

From my perspective the recent publication of the SKA Preliminary Specifications document has fulfilled admirably the initial PrepSKA requirement. After examination by the SKA Specifications Review Committee (SSRC) in early 2008, the document will be used as the basis for the first year of the CDIT work; this work is concerned largely with delineating further the SKA concept and mapping out sub-systems suitable for a range of receptor options. At the end of the first year of PrepSKA the design efforts will be subject to more scrutiny by the International Engineering Advisory Committee, which will help the CDIT verify its directions for the ensuing three years. Thanks to all the engineers and others who contributed to the drafting of the Preliminary Specifications whether directly within the Tiger Team, via collaboration with Team members, or through discussions at SKA2007.

It is very gratifying to see that as the SKA project progresses, we remain strong in our ability to work effectively and cordially across national and discipline boundaries. My own view is that this will be incredibly important in the years ahead. For example, as we rightly strive to build the formal structures and processes needed to deliver the SKA, it's clearer than ever that progress in overcoming our key design challenges is likely to emerge from the less-than-defined “twilight zone” between pure astronomy, engineering, operations and probably a number of other disciplines.

At the operational engineering level, the previous EWG Newsletter report listed in detail a number of important activities, including performance-cost modelling. These are either complete or on-track, taking us into the PrepSKA era in good shape. Events on the horizon in the next few months include the SSRC review in Manchester in late January, and a top-level review of the meerKAT project in early February.

This is my final column as International Project Engineer and EWG Chair since, as many of you know, I’ve elected not to make the move to the new SPDO (the ISPO successor). I’d like to take the opportunity to thank the many colleagues who have given so much of their effort – usually as volunteers – to the EWG and related groups over the past years. Having been in the EMT/EWG role since 2001 (and associated with the SKA since 1997), I’ve seen some remarkable efforts by teams and individuals. I’d particularly like to thank Richard Schilizzi for his leadership, dedication and friendship over the past five years. At the time of writing, my successor has not yet been selected but I wish him or her well in what is a great job. I’m very excited about my new role as foundation Professor of Radio Astronomy Engineering at Curtin University in Perth, and I look forward to working closely with the whole SKA community in coming years.

Peter Hall
International Project Engineer, and Chair EWG.
OPERATIONS

The Operations Working Group (OWG) met in Manchester on 29 September 2008, as part of the SKA2007 activities. The OWG heard the following reports from members on the operation of other major national and international science projects with the aim of learning from their mistakes and successes:

- ALMA - Tony Beasley
- LOFAR- René Vermeulen
- HESS - Bernie Fanaroff
- MeerKat - Bernie Fanaroff
- Pierre Auger - Ron Ekers
- DSN - Dayton Jones for Joe Statman
- International Linear Collider - Ken Kellermann*
- ITER - Richard Schilizzi*
- ASKAP - Dave DeBoer

* Written report only

The oral presentations may be viewed at http://www.skatelescope.org/pages/presentations_main.htm.

The OWG is preparing a report on the lessons learned from these other projects. Some of the main points are summarised below:

- Strong central project management is important because the founding partners often want to keep control. Strong international organisations such as ESO and CERN have been very effective. Two equal partners could result in a difficult management structure.
- Beware of hidden costs which might develop due to policies or practices of “Juste Retour,” the costs of maintaining involvement of the scientific community, and for maintaining Intellectual Property Rights.
- Developing innovative power sources, e.g., wind, solar, thermal, might appear attractive and politically correct, but might not result in realistic cost savings.
- From the beginning, it is important to listen to the engineers who might be more realistic than the optimistic scientists.
- Do not separate R&D activities and personnel from maintenance and operations. Otherwise, it can be difficult to retain a high quality maintenance staff.
- There is a delicate balance between maintaining an efficient operation by a professional operating staff and having important input from hands-on scientific involvement.
- It is important to plan for operating costs from the beginning and not begin construction until operating costs are secured.

The OWG noted that, typically, operations costs are about 10% per year of construction costs. About half of this is due to the direct cost of operations and instrumental maintenance, with the remainder being about equally divided between instrument upgrades and user support. Thus, life cycle costs of the SKA are likely to reach €5,000 M to €7,000 M.

The OWG adopted the following resolution, which was unanimously passed by the ISSC and presented to the SKA Forum on 8 October 2008:

“Recognising that open access to all qualified scientists, independent of institutional, national, or regional affiliation will give the best scientific returns, the ISSC believes that the allocation of SKA observing time or access to data obtained with the SKA should be based solely on merit, without regard to quotas, financial, or in-kind contributions to the construction or operation of the SKA.”

Ken Kellermann
Chair OWG.
OUTREACH

The Outreach Committee has been extremely active over the past six months. The main outcome of its work was the production of an updated SKA brochure (Figure 2). Appearing in a new modified style, the content has been brought up to date, reflecting the large changes and progress that has been achieved since the production of the previous brochure. As usual, the brochure will be widely distributed and is downloadable as a PDF file from the SKA website at www.skatelescope.org/PDF/SKABrochure_2007.pdf. We are grateful to all colleagues who contributed material and comments to the new brochure!

Figure 2. SKA Brochure

Other outreach material, such as flyers and bookmarks, has been updated as well. Major efforts have also been going into the new version of the SKA animation, which will show not only the SKA core as before but will take the viewer now on a trip to the outer stations. A first short clip produced by the Italian team at XILOSTUDIOS was ready for the press conference at the celebrations of the 50 year anniversary of the Lovell telescope. It has meanwhile been shown on television by the BBC and Sky. The completed animation will be available shortly.

With the end of the year 2007, a few changes have also been happening at the Outreach Committee itself. For me, it is time to step down as the Chair in order to concentrate on my research during my sabbatical from teaching. It is a pleasure to thank all committee members for their help, support and contribution during the last few years. It has been a very productive time, and even more challenging and interesting tasks lie ahead. I am very happy to continue serving as a member of the Outreach Committee, but I am grateful that Ian Morison (Figure 3) has agreed to take on the role of Outreach Committee Chair. Ian is very experienced in coordinating outreach activities, and he has been at the forefront of the Jodrell Bank Observatory's outreach activities for many years. Ian holds the prestigious post of Gresham College Professor of Astronomy. Gresham College, founded by Sir Thomas Gresham in 1597, is an independently funded educational institution based in the centre of London. At any one time it has eight professors in a wide variety of subjects, all professors are all involved in providing lectures on science to the general public. In name of the Outreach Committee, we are looking forward to work under Ian's leadership.

Figure 3. Ian Morison

Michael Kramer
Chair Outreach Committee
SCIENCE

A very successful and enjoyable workshop, "Pulsar Key Science with the SKA", was held in Krabi, Thailand, in April 2007 (Figure 4). More than 30 scientists participated, including many researchers new to the SKA. Science Working Group (SWG) members are now preparing a detailed report on SKA specifications resulting from these discussions.

As part of the SWG efforts within SKADS, the Bonn group has recently completed a very detailed set of simulations of the polarised sky as seen with SKA, and has examined the constraints that these data will put on the large-scale magnetic fields of external galaxies. This work, by Rodion Stepakov et al., has now been accepted for publication in Astronomy & Astrophysics; the preprint is available at http://adsabs.harvard.edu/abs/arXiv:0711.1267

SWG members Chris Carilli, Joe Lazio and Bryan Gaensler have all been appointed to a committee formed by Associated Universities, Inc., to prepare a set of recommendations on the future of United States radio astronomy. This committee has written a series of white papers on various scientific topics and radio astronomy experiments; these papers are now being collated into a final report which will be submitted to the US Decadal Review. A public website on the committee's work is available at http://www.aui.edu/future_committee/.

The SWG is now working on developing a full phased science case for the SKA, over the time line of construction, commissioning and beyond. What started as a "Phase I Science Case" is now quite detailed, and is being delineated into very early science, 5% science, and science with 10% of the array and beyond. This will next be merged with the forthcoming SKADS Virtual Telescope scheduling exercise to produce an overall phased science case.

There was excellent attendance from the SWG at the SKA2007 meeting in Manchester. Of particular note during the various science discussions at that meeting was a first meeting between the SWG and the SimWG, regarding the constraints which the science goals place on array configurations. A sub-committee will examine this issue in further detail in 2008.

SWG members Joe Lazio, Michael Kramer and Bryan Gaensler have written an article on SKA science for the popular magazine "Sky & Telescope". The final version of this article has now been accepted, and will be published some time in 2008.

And finally, the end of 2007 also marks the end of Bryan Gaensler's two-year appointment as SKA Project Scientist and SWG Chair. Joe Lazio took over the roles of SKA Project Scientist and SWG Chair with effect from 1 January 2008.

Bryan Gaensler
Project Scientist,
Joseph Lazio
Deputy Project Scientist
SIMULATIONS

The Simulations Working Group (SimWG) met for the first time during the SKA 2007 meeting in Manchester. The requirement for at least three different types of receptor for the SKA, as outlined at SKA 2007, creates a new dimension for the configuration study that had not previously been considered. The condensed cores of the different receptors will need to be physically separated, and while the configuration of the different receptors must share as much of the network infrastructure as possible, there is some freedom to consider the optimisation of each somewhat independently. After some discussion, it became clear that more details of the requirements for the dynamic range and field of view as a function of baseline and frequency are required, considering both the Key Science Projects and other interesting projects with different constraints. These issues were discussed in a joint meeting of the Science working Group (SWG) and SimWG, and a decision was made that the SWG should coordinate a memo on this issue.

In addition, Andrei Lobanov, leading the SKADS configurations study, presented a preliminary version of an interesting 'skipped spiral' configuration which appears to meet the configuration constraints of the KSPs while still producing an array with excellent imaging capabilities. This offers encouragement that the differing constraints of the various KSPs can be accommodated by one straightforward configuration.

Cormac Reynolds
Chair SimWG

SITE EVALUATION

The two SKA short listed sites, one in South Africa and one in Australia, are preparing to construct SKA pathfinder projects and are developing their respective sites.

In September 2007, the ISSC received a letter from Australia indicating that the core site had been moved from Mileura to Boolardy, about 90 km away because of the risk of Mileura being too close to mining operations. The Boolardy Station has significantly better access to infrastructure and is more remote from known mineral deposits (see Figure 43, p36, in the US Report).

The coordinates of the Boolardy site are: Latitude 26 degrees, 42 minutes, 15 seconds South; and Longitude 116 degrees, 39 minutes, 32 seconds East. The new core site is also known as the Murchison Radio Observatory (MRO).

In South Africa, the National Assembly has approved the South African Astronomy Geographic Advantage (AGA) Bill. This new Act will enable the establishment of astronomy reserves that provides protection across all wavelengths. It allows the declaration of three types of frequency dependent protected areas:
(i) Core Area - encompassing the physical extent of the astronomical facility, where it provides for the most stringent levels of protection required by the facility,
(ii) Central Area - surrounding the core area, here activities that are deemed to be detrimental to the operation of the astronomy facility are prohibited, and
(iii) Co-ordination Area - surrounding the central and core area, and where operators of high powered transmitters require co-ordination with the astronomical facility in order to operate. More details are provided in the South African report.

The site characterisation studies for the two short listed sites will be conducted as part of PrepSKA Work Package 3, probably after mid 2008. Additional RF monitoring will be conducted as well as a
host of other studies including investigations of ionospheric fluctuations, tropospheric turbulence, array configuration and site physical characteristics. The SKA Program Development Office will advertise the post of Site Engineer in early-2008 and the candidate selected will lead this effort.

The SKA Science and engineering Committee (SSEC) is aiming to start construction of Phase 1 SKA at mid-band frequencies (from about 300 MHz to 10 GHz), early next decade. Given the possibility of a frequency as high as 10 GHz, the phase stability and water vapour at the proposed sites will be investigated.

Yervant Terzian
Chair SEWG

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**MEETINGS**

**European Conference on Research Infrastructures**
Hamburg, Germany (4 - 6 June 2007)

**SKA2007 Inter-WG meeting**
Manchester, UK (27 - 29 September 2007)
[www.jb.man.ac.uk/ska2007/](http://www.jb.man.ac.uk/ska2007/)

This event was held on 27-29 September 2007 at the new Turing Building, The University of Manchester, UK. More than 110 participants from around the world participated in the event, which provided a forum for the international radio astronomy community to discuss the technical and scientific aspects of the draft preliminary specifications for the SKA. These preliminary specifications will be the starting point for the SKA design work to be carried out in Work Package 2 of the PrepSKA project.

Day 1 commenced with presentations by Peter Hall on PrepSKA WP2 and by Bryan Gaensler on the science case for the SKA. There followed a series of presentations on the status of key technologies. In the afternoon, there were SWG-led and EWG-led discussion about the draft preliminary specifications document in preparation for general discussions the next day.

Day 2 commenced with presentations by Peter Hall and Paul Alexander on the performance-cost estimation tool used to establish trade-offs in the preliminary specifications report. There then followed presentations by the Specifications Tiger Team to provide background information on the 3 technology options (Dish + Single Pixel Feed, Aperture Array, and Dish + Focal Plane Array) under consideration in the draft preliminary specifications document. Structured general discussions on the draft preliminary specifications were held in the afternoon.

On Day 3, internal Working Group meetings were held in the morning to debate the science-engineering trade-offs presented in a draft preliminary specifications document, followed by reports from these meetings in the afternoon. The meeting was closed following final discussion to wrap-up and agree a consolidated view of the draft preliminary specifications.

The preliminary specifications document and the performance-cost estimation tool were both seen as significant advances by participants. However, there was a general feeling that early-stage SKA must be more closely linked to the relevant on-site Pathfinder instrument; the role of the Central Design Integration Team (CDIT) and regional Liaison Engineers will be critically important in this respect. The feedback received at SKA 2007 guided subsequent revisions of the preliminary specifications document, including the recasting of Phase 1 to increase performance of the mid-band SKA instrument. The preliminary specifications for Phase 1 of the SKA provide approximately $5 \times A_{\text{eff}} T_{\text{sys}}$ of MeerKAT and 25-30x Survey Speed Figure of Merit of ASKAP. This performance increase has been achieved, in part, by re-using sensors of the relevant on-site Pathfinder instrument in the SKA.
In a further change to the preliminary specifications, a budget of €30 M has been set aside in Phase 1 for approximately 10,000 m² of Aperture Arrays, offering the prospect of a high survey speed instrument and sky monitor at mid- to low frequencies. The decision on whether this will be a sparse or dense aperture array will be dependent on scientific priorities and technical readiness.

The ISSC gave conditional approval of the International Collaboration Agreement which provides the framework for governance of the SKA Program through the creation of the SKA Science and Engineering Committee (SSEC). The conditions were met subsequently and the agreement was signed by collaborating partners. The ISSC also gave conditional approval of the Memorandum of Agreement to establish the SKA Program Development Office (SPDO). Again, these conditions were met subsequently and the MoA was signed by participants. The SPDO replaced the International SKA Project Office (ISPO) on 1 January 2008, assuming the responsibilities for co-ordinating joint development of the SKA. The SPDO is based at the University of Manchester, UK.

Other business at ISSC 18 included the approval of the appointment of Joe Lazio to the posts of International Project Scientist (a 0.5 FTE in-kind contribution from the USA) and Chair of the Science Working Group (SWG) from 1 January 2008. The ISSC also approved the appointment of Ian Morison to the post of Chair, Outreach Committee (OC) from October 2007. The ISSC expressed their gratitude to Bryan Gaensler (outgoing International Project Scientist / Chair, SWG) and Michael Kramer (outgoing Chair, OC) for their hard work and contributions to the SKA program.

The ISSC approved a resolution proposed by the Operations Working Group (OWG) on open skies and open data products, see OWG report on p5.
The second half of 2007 has been a busy and exciting 6 months for the SKA project in Australia and New Zealand, with infrastructure being deployed at the candidate SKA core site in Western Australia and astronomy experiments getting underway.

Commonwealth and WA State Government support for the Australian SKA Project

Following the A$56.7 million in Australian Government funding for the Australian SKA Pathfinder (ASKAP) announced in May 2007 (see the International SKA Newsletter Vol 12, July 2007), a bi-lateral agreement between the Australian Commonwealth Government and the State of Western Australia has been established. The two governments also announced the formation of the Australian SKA Coordination Committee (ASCC), an inter-governmental body of senior officials to coordinate Australia’s SKA activities. The scientific community is represented on the ASCC by Brian Boyle and Peter Quinn, from CSIRO ATNF and University of Western Australia respectively.

The ASCC will be supported by a number of working groups and advisory groups, covering industry/procurement, regional issues, observatory governance, site coordination, communications and stakeholder management, education, international issues and science and technology. A new Australian SKA Project website (http://www.ska.gov.au) has been established and Commonwealth funding of $350,000 has been awarded to develop educational resources, provide information on the SKA, and to outline the benefits that the project will bring to Australia.

Links to the full text of the Memorandum of Understanding, as well as to Commonwealth and WA State Government media releases, can be found under “Latest News” on the new Australian SKA web page. This web page also provides links the Australian SKA Newsletters - now known as auSKA Newsletters.

Radio-quietness protection for Australia’s candidate SKA site

In an important first step to legally establish and help protect the radio-quietness of the Murchison Radio-
astronomy Observatory, the Australian Communications and Media Authority has authorised a Radio-communications Assignment and Licensing Instruction (RALI No. 171), with effect from 24 September 2007. This first stage of radio-quietness regulatory protection extends over an area of up to 260 km radius from the Murchison Radio-astronomy Observatory site.

The RALI document (a pdf file) with full details of regulations, thresholds and radii of the restricted and coordination zones can be downloaded at http://www.acma.gov.au/webwr/radcomm/frequency_planning/frequency_assignment/docs/ms32.pdf.

In addition to this legislation, CSIRO will be monitoring and enforcing appropriate self-interference standards for the various radio-astronomy projects that will be accessing the RQZ. CSIRO will also be working with local communities to encourage and assist with voluntary reduction of existing levels of radio interference.

Approval for early radio astronomy activities on the Australian candidate SKA site.

A Deed of License was recently provided to CSIRO by the State of Western Australia through the State’s Minister for Lands. CSIRO has signed the deed which will allow it to conduct and supervise low impact radio astronomy activities on an Early Research Area (ERA) within the candidate SKA site. The licence will enable access to the site, under CSIRO supervision, before the Murchison Radio-astronomy Observatory is established for the long term. While such measures are ongoing, it has been a high priority for the ASCC to provide early opportunities for scientific research teams to exploit the excellent scientific quality of the site. Thus, in July 2007, access to the site was facilitated for the PAPER experiment, led by the University of California, Berkeley (see report on p12). A survey expedition by a team from the Murchison Widefield Array and CSIRO was also carried out on the site in September 2007 (Figure 5).

Archaeological and anthropological surveys have been conducted over the Early Research Area with the assistance of local indigenous community members. The traditional land claimants have expressed support for the deployment of the various experiments on site.

PAPER experiment gets underway in Western Australia

The PAPER experiment is a growing collaboration between scientists at the University of California, Berkeley (Don Backer, Aaron Parsons, Dan Werthimer, Mel Wright), NRAO (Rich Bradley, Erin Mastrantonio, Chris Carilli), University of Virginia (Nicole Gugliucci), Curtin University (David Herne, Merv Lynch), and UVA (Chaitali Parashare). The long-term goal of this experiment is to unveil the era in the history of our expanding Universe when the first stars formed about a billion years after the Big Bang.

Measurements at 2 m wavelength are difficult in areas of high population density - this band sits between the FM band on our radio dial and one of the channels on our TV dial. The band is also heavily used by aircraft and other communication services. While the team has a test and development site in the remote NRAO site at Green Bank, WV, the faint, red-shifted 21 cm signals require deployment at a much more remote site. The radio astronomy park at the candidate SKA site in Western Australia is very attractive for this experiment owing to the very low population density. The radio frequency interference at the Murchison Radio-astronomy Observatory (MRO) site is
demonstrably better than that experienced with our array at the NRAO Green Bank site. In Green Bank, television channel 7 is now digital, which corrupts the entire 180-186 MHz window. The aircraft bands below 137 MHz are much more active, and transmissions often lead to saturation of the analog-to-digital converter. Only very occasional saturation (less than once per hour) occurs at MRO.

Figure 6. One of the PAPER dipoles on site at the Murchison Radio-astronomy Observatory

During July 2007, Don Backer and his team (including collaborators from CSIRO and WA’s Curtin University) carried out some initial experiments at the site in mid-west WA. During the visit, a 4-dipole Precision Array to Probe the Epoch of Reionization was deployed (Figure 6).


Don Backer
PAPER Team

Infrastructure arrives at the Early Research Area

To support initial activities within the Early Research Area (ERA) of the Murchison Radio-astronomy Observatory, CSIRO ATNF staff have deployed initial facilities onto the site. These temporary trailers comprise a site office and two equipment huts and allow phone and internet access into the site office. In addition, trailers for water and diesel are located on-site. The site office has a roughly 500W solar photovoltaic system and batteries for ongoing power, as well as generators for experiments. This support infrastructure is in place just in advance of the upcoming visit by members of the Murchison Widefield Array (MWA) project to deploy the first "tiles" of the instrument. Figure 7 shows (a) the trailers rolling out from the CSIRO ATNF NSW site on 23 October 2007, (b) then onto the Early Research Area on 27 October 2007, and (c) finally the trailers are installed in place. Additional trips will finish the installation of various pieces of equipment to support the on-site facilities.

Figure 7. Infrastructure for the ERA (a) leaves Sydney, (b) arrives at the ERA, and (c) is installed on site

New Zealand SKA Industry Events

Recent developments in New Zealand, e.g. the purchase of a new 12 m radio
telescope by the Auckland University of Technology (AUT), have generated significant industry interest in SKA-related projects.

During July 2007, a dedicated team from New Zealand - Sergei Gulyaev (AUT and Australia), Brett Biddington (Chair, Australian Telescope Steering Committee), Phil Crosby and Carole Jackson (CSIRO ATNF) - gave a series of presentations to audiences in Christchurch, Wellington and Auckland (Figure 8). The success of the events was reflected in the attendance figures, the level of interest and engagement in discussion by the attendees and the support from a number of key NZ organisations, including Canterbury Development Corporation, Connect New Zealand, New Zealand Supercomputing Centre, Telecom, and AUT Technology Park - which provided excellent venues and event promotion.

The team were particularly pleased to note New Zealand’s developing supercomputing capacity, i.e. a 2000 CPU NZ Supercomputing Centre in Wellington plus a dual IBM BlueGene P-series supercomputer at the University of Canterbury, Christchurch.

CSIRO, AEEMA, RF Technologies and Global Innovation Centre has been working collaboratively to provide a strong industry foundation for the ‘mega-science’ Square Kilometre Array (SKA) initiative.

The AusIndustry-sponsored “Australian Industry Cluster mapping project” concluded in June 2007. The industry consortium has recognised the value in these activities and has agreed to fund and support a continuing initiative for at least the next two years. CSIRO will be a partner in the Australian SKA Industry Cluster Consortium as before.

Further information on the Cluster project and links to the SKA Technologies Roadmap and other publications can be found at www.atnf.csiro.au/projects/ska/industry.html

The first of the ‘Phase II’ events was the ASKAP briefing at CSIRO ATNF Marsfield on Thursday 23 August 2007. Other briefings and public talks have been held in Perth, Geraldton and Adelaide. Details of these and other cluster events can be found in the Australian SKA Newsletters (http://www.atnf.csiro.au/news/auska-newsletter) and via the links at http://www.atnf.csiro.au/projects/ska/industry.html.

Carole Jackson
CSIRO ATNF
Business Development Manager

Networks create “instant world telescope”

At the end of August 2007, a CSIRO telescope near Coonabarabran NSW was linked in real time with one near Shanghai, China, and five in Europe (Figure 9) to observe the quasar 3C273.
Data from the telescopes were streamed around the world at a rate of 256 Mb per second - about ten times faster than the fastest broadband speeds available to Australian households - to the Joint Institute for VLBI in Europe (JIVE), where it was processed with a special-purpose digital processor.

The results were then transmitted to Xi’an, China, where they were watched live by experts in advanced networking at the 24th APAN (Asia-Pacific Advanced Network) Meeting.

From Australia to Europe, the CSIRO data travelled on a dedicated 1 Gb per second link set up by the Australian, Canadian and Dutch national research and education networks, AARNet, CANARIE and SURFnet respectively.

Within Australia, the experiment used the 1 Gb per second networks that now connect CSIRO’s NSW observatories to Sydney and beyond. The links, installed in 2006, were funded by CSIRO and provided by AARNet (the Australian Academic Research Network).

The institutions that took part in the experiment are all collaborators in the EXPReS project (Express Production Real-time e-VLBI Service), which is coordinated by JIVE in The Netherlands.

Tasso Tzioumis,
ATNF VLBI Coordinator

Updates from the ASKAP computing team

At the end of September 2007, two members of the CSIRO ATNF computing team (David Brodrick and Euan Troup) spent two weeks in Cape Town, South Africa, working with the KAT team on the collaborative CONRAD software project. The KAT team were very hospitable and the trip was very productive.

David Brodrick and Euan Troup are working on the telescope control and monitor component of the software, called CTOS, and had many detailed discussions with Simon Ratcliffe who heads the CTOS effort. They also had a site visit to the PED interferometer (Figure 10) and witnessed the first dry run of the software acceptance test procedure for South Africa’s XDM telescope.

Figure 10. David Brodrick and Euan Troup at the PED interferometer in South Africa


Tim Cornwell,
ASKAP Computing Project Engineer

Compact Array Broadband Backend (CABB) Update

The CABB Project - a test bed for future SKA technologies - is delivering a new backend system for the CSIRO Australia Telescope Compact Array (ATCA) that will deliver an increase in bandwidth from the current 128MHz to 2GHz, a factor of 16 improvement.

Installation and testing of CABB antenna-based equipment (IF conversion, LO generation, digitiser, and data transmitters) was conducted during the split array operation in August and September 2007, with Antenna 1 outfitted. The system was able to tune remotely and was interfaced to the C band and K band receivers. A single 2GHz bandwidth IF feeding a 40GBit data link was implemented, with transmission to the central site, where data was successfully decoded. A preliminary RFI test of the installed equipment was also performed, with no obvious self generated RFI. Antenna 5 underwent a similar antenna outfitting in mid-October 2007 and, in early November, the team was buoyed by the first astronomy conducted using these prototype systems, made possible when the first two CABB signal processing (DFB/Correlator) cards were installed in their rack located in the control building’s screened room. Auto-correlations from
the two antennas revealed several molecular lines in the 2 GHz segment centred around 22 GHz with the spectra dominated by a water maser.

A production run of the CABB signal processing card (Figure 11) is currently underway. The complexity of this card is testing the limits of the newly acquired equipment that makes up the in-house circuit board production facility; however, for boards of less complexity, the process automation achieved by this equipment is saving considerable effort.

Figure 11. The complex CABB signal processing board

Much effort has been devoted to the design of firmware and the near future should see the successful development of delay compensation, fringe rotation and correlator firmware. This will allow the outfitted antennas to be used as interferometers and provide valuable insight to the system’s capabilities.

Graeme Carrad,
CSIRO ATNF
Assistant Director Engineering

ASKAP’s Parkes Phased Array Feed Test Bed

ASKAP commissioned a single, 12 m diameter antenna built by Patriot Antenna Systems at Parkes Observatory during December 2007 and January 2008. This antenna will provide a dedicated platform for field tests of the phased array feeds (PAFs). The Parkes RFI environment is significantly better than Marsfield, and furthermore the 64 m telescope provides a platform for deeper, more sensitive testing of the PAF in tandem with the new 12 m instrument.

Although the functional specification and design of this particular 12 m antenna differs from that for the actual ASKAP antennas, it will provide a single dedicated system to test successive generations of PAFs in readiness for ASKAP itself. In particular the antenna will be equipped with a feed rotator at the prime focus to allow the PAF to maintain a constant parallactic angle during observations. This ‘de-rotation’ of the sky means that the data stream from the PAF will be significantly easier to process in the imaging software.

Site preparations, including foundations and services for the Parkes 12 m antenna have been completed by CSIRO ATNF Parkes staff in consultation with Patriot (Figure 12). The new antenna will be located approximately 400 m east of the 64 m Parkes ‘dish’, parallel to the EW interferometer track, on a level area of land previously leased for farming.

Figure 12. Foundation pad and bolt ring for the 12 m ready for the antenna to be constructed at Parkes. In the background (looking west) is a decommissioned 60 ft antenna, which is about to be relocated to the eastern end of the track, and the Parkes 64 m dish. Photo: Barry Turner

The antenna reflector comprises ‘stretch-formed’ solid panels, and is very similar to the Patriot antenna built for NASA-JPL. The pedestal will house an ASKAP-style beamformer, and one of the challenges for ASKAP is to determine a ventilation system for the pedestal due to its high heat output (estimated to be about 5 KW). An underground fan-duct system has been installed to provide naturally-cooled forced air to the pedestal.

The 12 m antenna is currently being shipped to Australia, and some integration
work is being done by United Rail at Taree, under sub-contract to Patriot.

Carole Jackson,
ASKAP Antennas Project Manager

ASKAP related electronics project wins EDN Innovation Award

Electronics engineers and researchers from La Trobe University’s Centre for Technology Infusion (CTI), Peregrine Semiconductor Australia (PSA) and the CSIRO’s Australia Telescope National Facility (ATNF) have won an international design award for a prototype LNA based on Peregrine’s Silicon-on-Sapphire process technology, see Figure 13.

The collaboration has won the 2007 EDN Innovation Award for best Application of Analogue Design by international electronics publisher EDN magazine for a Low Noise Amplifier (LNA). Fresh out of design and manufacturing, and now undergoing rigorous performance testing at CSIRO, the LNA has been designed to meet the extremely challenging requirements required by radio astronomy receivers.

After three months in design at La Trobe University’s Centre for Technology Infusion, Bundoora, the chip was fabricated at Peregrine’s foundries in Australia and the United States, and is now being undergoing performance testing at CSIRO’s ATNF facilities at Marsfield.

Only stringent testing will reveal whether the actual performance of the LNA is as good as the design model. Buoyed by the results so far, the LNA team are now considering as their next project the design and implementation of a fully integrated receiver system using the same advanced Peregrine process.

Figure 13. Andrew Brawley, Executive Director Peregrine Semiconductor Australia Pty Ltd and Dr Harris Lee accepting the EDN award

Carole Jackson,
Business Development Manager,
CSIRO ATNF

News from the Australian SKA Coordination Committee (ASCC)

At the SKA Forum meeting of funding agencies in Manchester, UK, on 8 October 2007, it was agreed that the second International SKA Forum would be held in Perth in April 2008. It was also agreed that the third Forum would be held in South Africa in 2009.

The SKA Forum will be held around the time of several other major international SKA meetings in Perth, including the Deep Surveys of the Radio Universe with SKA Pathfinders conference and meetings of the Funding Agencies Group and the SKA Science and Engineering Committee.

The ASCC is currently making preparations for the SKA Forum meeting, which will feature a varied programme of speakers and discussions on the key science, technical and policy issues for the SKA project.

The event will be an excellent opportunity for astronomers, engineers and policy makers with SKA interests from around the world to catch up on the latest developments and contribute to moving the project into its next phase. An international Forum Reference Group is currently being established to assist the organisers. Further information on the SKA Forum will be provided in subsequent editions of the auSKA newsletter and on the Australian SKA website www.ska.gov.au.
The ASCC is continuing to work towards the permanent establishment of the Murchison Radio-astronomy Observatory (MRO) and protection of the outstanding radio-quiet qualities of the site. This work will build on the CSIRO Early Research Area, already established at the MRO site, and the Australian Communications and Media Authority (ACMA) Radiocommunications Assignment Licensing Instruction which created the Mid-West Radio Quiet Zone.

The ASCC is also working with the National Centre for Science and Technology (Questacon) and Scitech in Western Australia to develop an innovative education and public outreach program for the SKA. The program is being developed with a $350,000 grant from the Australian Government.

Following the recent Federal Election in Australia, and subsequent change of government, the SKA responsibilities of the former Department of Education, Science and Training have been transferred to the new Department of Innovation, Industry, Science and Research, headed by Senator Kim Carr, the Minister for Innovation, Industry, Science and Research.

The latest announcements from the ASCC are available from the Australian SKA website at www.ska.gov.au

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Canada

With colleagues in Australia, the Canadian SKA Consortium has established an ASKAP Science Working group co-chaired by Simon Johnson and Russ Taylor. Other Canadian members are Sean Dougherty, Ingrid Stairs and Jasper Wall. The first task of the working group was the development of an ASKAP Science case. The science case focussed on key survey science that can be done with the pathfinder as a step toward Phase I SKA. A synopsis of the science case will appear in the Publication of the Astronomical Society of Australia (Johnston et al. 2007). The full science case will be published as a special issue of Experimental Astronomy in 2008.

The University of Calgary Centre for Radio Astronomy

In June 2007, the Office of the Vice-President Research of the University of Calgary approved the formation of a Centre for Radio Astronomy at the University of Calgary. The Centre for Radio Astronomy combines groups in the Faculty of Science and the Schulich School of Engineering and builds on a long-standing research partnership between the University of Calgary and the National Research Council of Canada, Herzberg Institute of Astrophysics. As part of establishing the Centre, the University of Calgary will provide $2.1 M of support toward a mandate to promote and facilitate Canadian participation in the next-generation international radio astronomy facilities prioritised in the Canadian Long-Range Plan for Astronomy, including ALMA and the Square Kilometre Array.


Canadian SKA Technology

In Canada, SKA-related technology development is targeting low-cost, high-performance solutions in three areas vital to the SKA: (i) wide field-of-view, (ii) low system-temperature, and (iii) large collecting area. These three areas are being addressed respectively by phased focal-plane array feeds (the PHAD project), reflector antennas fabricated with composite materials (the CART project), and high-performance uncooled low-noise amplifiers. In this issue, two new areas of
research at the University of Calgary are reported: low-power high-speed A/D converters, and multi-dimensional filters as beam formers.

PHased-Array Demonstrator (PHAD)

End-to-end integration of the Phased-Array Feed Demonstrator (PHAD) has now been completed. The system is shown in Figure 14 prior to installation in the anechoic chamber for spherical near-field scanner tests. A rear-view of the array in Figure 15 shows the receivers subsystems. The signals from the Vivaldi elements are amplified and down converted to baseband, then combined onto twisted-pair CAT-5 ethernet and LVD SCSI cables. The signals are delivered to an SMA patch panel and fed to a commercial digital-signal processing system, purchased from Lytrech Signal Processing in Quebec, for sampling and recording for off-line analysis and beam forming.

The PHAD array has 180 elements (9x10 for each orthogonal linear polarization), spaced half-wavelength at 2 GHz, capable of operating from 1-2 GHz with a system temperature of ~70K. There are 32 additional elements around the perimeter of the array that are terminated. The maximum sample rate is 100 Msamples/s with 12-bit resolution. There are a number of important aspects to this system. First, the signals from all the elements will be recorded for off-line beam forming. Recording the data permits experiment and direct comparison of various beam-forming techniques on the same data. Second, the array is sufficiently large that truncation effects are minimal at the centre of the array. Lastly, both polarisations are sampled in order to measure polarisation properties, explore calibration techniques, and devise methods to mitigate instrumental effects.

The Vivaldi array was put through a series of tests prior to integration with receivers. The radiation patterns of many representative elements were measured. The key result is that the patterns are well behaved and suitable for reflector illumination. The impedance match of the inner elements was also found to be acceptable. Unlike some arrays described in the literature that had strong resonances, the PHAD array has only one weak resonance.

The complete PHAD has now been installed in the anechoic chamber to commence a system shakedown and initial beam forming experiments. During 2008Q2 and 2008Q3, PHAD will move outdoors onto the CART 10 m composite reflector for testing.

In addition to the hardware, a number of outstanding issues are being addressed which relate to the astronomical performance of phased-array feeds using simulation software developed at DRAO.
Composite Reflector Antennas

The ability to build large collecting areas with cost-effective reflectors having excellent radio-frequency performance remains a significant technology challenge for future radio telescopes. The CART project (Composite Applications for Radio Telescopes) at DRAO is addressing this challenge by applying composite materials and fabrication techniques to low cost-per-unit-area radio-telescope applications.

CART achieved a major milestone in September 2007 when the first 10 m prototype reflector was removed from the mould and mounted on a positioner (Figure 16). The reflector weighs 1 tonne and has a surface accuracy of ~1mm rms. The weight is a small fraction of the weight of a conventional metal reflector of similar size. This high strength-to-weight ratio provides a surface that has very little change in deflection with elevation and will allow substantial reduction on the mechanical load requirements of the telescope mount.

Holography measurements were made in mid-October 2007 to confirm physical measurements made with a laser tracker. Using a receiver built from commercial parts, a correlator provided by ATNF, and the help of Mike Kesteven (ATNF), two Ku band geostationary satellites were raster scanned at a frequency of about 12 GHz. The results (Figure 17) show that the RF reflector is consistent with the laser tracker measurements and confirm that low-cost vacuum infused composite reflector technology, developed at DRAO, can yield high performance reflectors that operate well up to 15 GHz. This is an excellent first result and the prospect of making 30 GHz reflectors at costs comparable to 10 GHz metal appears achievable.

Although these results demonstrate excellent performance for the prototype reflector, they also show that improvements can be made, and the team is now busy designing and planning the Mk 2 reflector to be built from the same 10 m mould in 2008Q2 at DRAO. The Mk 2 program will target improvements in cure characteristics, structural design, design-for-production and mass production methods.

CMOS Low-Noise Amplifiers

The availability of very-low-noise amplifiers operating at room temperature is key to producing sensitive, low-cost, phased-array receiver systems, since cryo-cooling systems for the large number of amplifiers required for such feeds would be very expensive. Although traditional HEMT technology has had little improvement over the past decade, the CMOS technology used in computer chips has been advancing at an exponential rate described by Moore's Law. As transistors are made smaller, they not only work at higher frequencies, but they also have lower noise.
Although this reduction in noise has been predicted for some time, only recently has it been demonstrated. The University of Calgary Centre for Radio Astronomy team working on high performance room-temperature low noise amplifiers has completed measurements of two CMOS LNAs designed in 90 nm CMOS. A single-ended LNA designed to interface with an 85 Ohm antenna has achieved less than 0.2 dB (<14 K) of noise figure at room temperature over a bandwidth of 0.8-1.4 GHz (Figure 18). The results of this work have been published in the November 2007 issue of the IEEE Journal of Solid-State Circuits. A differential LNA designed for 100 Ohm differential antenna impedance was measured using a novel differential noise measurement technique developed at the University of Calgary. These measurements verified the expectation that a differential LNA and a single-ended LNA achieve similar noise figures (Figure 19). The measurement technique and the measurement results have been accepted for publication by the IEEE Transactions on Instrumentation and Measurement. Currently, the researchers at Calgary are developing a new LNA design for 65 nm CMOS.

The Calgary and HIA-DRAO teams will be working together in the near future to integrate phased array feed elements with the room temperature CMOS LNAs.

The Multidimensional Digital Signal Processing Group at the University of Calgary has pioneered the synthesis, design and implementation of directional 2D and 3D digital filters. The group has shown that such filters are capable of selectively enhancing propagating broadband plane waves, received over an array of antennas, with high fidelity up to almost half the Nyquist frequency. Over the last several years, this work has led to high-throughput systolic VLSI architectures for 3D IIR narrow beam filters, using novel pipelining and look-ahead techniques, to synchronously process all A/D-converted antenna signals in a single clock cycle. High-speed prototypes have been implemented in FPGA technology. The group is now exploring the application of this method to the beam-forming problem for both aperture and focal-plane arrays.

Low-power high-speed A/D converters

The Radio-Frequency Integrated Circuit (RFIC) research group at the University of Calgary is developing a new architecture for a high-speed low-power time-based analog-to-digital converter (ADC). The time-based architecture consists of two stages. The first stage, known as a voltage-to-time converter (VTC), takes in an analog voltage signal and outputs a series of pulses. Each pulse is delayed by an amount proportional to the input signal at that particular moment. As a result, the signal is transferred from the voltage domain to the time domain, since the signal information is entirely contained within these delays. The function of the second stage, the time-to-digital converter (TDC), is to measure the delay of each pulse with respect to a reference clock and
produce an N-bit digital output. The signal is thus transferred from the time-domain to the digital domain, completing the analog-to-digital conversion. This ADC architecture has been shown to produce excellent dynamic performance, low power, and high sampling rate, and has an advantage of being able to directly trade speed for resolution.

The first prototype time-based ADC is a 5 bit 1 GSample/s design in 130 nm CMOS which has a measured power consumption of 2 mW (Figure 20). The second-generation design, a 3-bit 20GS/s ADC in a 90 nm CMOS process, is currently being fabricated (Figure 21). Future plans include the development of a 4 GSample/s time-based ADC with increased resolution (5-8 bits). It is projected that such a 5 bit, 4 GSample/s ADC will consume ~25 mW and occupy less than 2 mm² of silicon area in the 90 nm CMOS semiconductor process. The ADC power consumption using the time-based ADC architecture is projected to increase linearly with each extra bit of resolution. Process and temperature variations will be addressed by implementing an advanced digital calibration scheme.

On behalf of the Canadian SKA Consortium:

Sean Dougherty
Herzberg Institute of Astrophysics,
Russ Taylor
University of Calgary

CHINA

The FAST reflector panel experiment

Development of a 1:1 scaled model of the FAST (Five hundred meter Spherical radio Telescope) reflector panel is in progress at a site near to the Miyun FAST model, north of Beijing. Construction of the base has been completed (Figure 22), and manufacture of the supporting shelf and reflector panels being in progress. Two types of panel layout are being developed: a single layer layout and a Beam String Structure (BSS). The test programme will include deformation and motion tests of the panel, and possibly other kinds of test, such as processing tests.
In terms of the actuators used in the experiment, three kinds of newly developed a 1:1 scaled models of FAST winches have been designed and manufactured. In addition, three types of reducer have been used: (i) ball screw-worm reducer, (ii) ball screw-gear reducer, and (iii) normal screw-planet gear reducer. Figure 23 shows the ball screw-worm reducer on-site. The testing is expected to be completed in the summer of 2008.

End-to-end simulation of the FAST feed suspension system

An end-to-end simulation of the FAST feed suspension system has been undertaken recently, in co-operation with NAOC, MT Mechatronics GmbH Mainz and Technische Universität Darmstadt, Germany. The combined engineering experience and analytical tools of these organisations were utilised to produce a 1:1 scaled end-to-end model, which is able to describe the overall system from the commands of the telescope operator to the outcome of the science instrument observing a target in the sky.

Two kinds of conceptual design are being tested in the simulation, with performance comparisons being made against a baseline design concept (Figure 24). The simulation model establishes an overall control architecture for the system, as shown in Figure 25, consisting of a coarse (main) positioning loop, a fine positioning loop and a vibration control loop. Much simulation work and analyses have been specified for important components, such as the capstans, dynamics of the cabin-cable system (finite element model), X-Y positioner, Stewart stabilizer, reaction mass damper, wind disturbance, total station (sensor) and master controller.

Two kinds of operational scenarios, identified as “source changing” and “sidereal tracking” modes, are simulated and tested for the performance verification of the system.

Three kinds of disturbance, which probably have a great influence on final control errors, are studied specifically in the simulation: (i) friction and backlash of the capstan, (ii) measuring error and time delay of total station, and (iii) wind disturbance. The results of the simulation have proved the feasibility of the baseline design concept. With the existence of three kinds of disturbances, the final rms control error is less than 10 mm, within the limit of the telescope specifications. Wind disturbance has proved to contribute most to the error.

The simulation also provides a configurable range of six cable tension forces and shows that the steady state force is dominant. Thus, it is possible to greatly reduce the required power of capstan motor by introducing a so-called counter-weight, by which the steady state forces are counteracted.
Progress of the FAST Project

After 14 years of industrious effort, the FAST project received funding approval from the National Development and Reform Commission (NDRC) of China; the official funding approval document was signed on 10 July 2007. However, the budget approved is still tight, since Chinese Yuan 600 M (≈ €60 M) has been allocated to the project, compared to the figure of Yuan 688 M requested in the project proposal. Thus, the project must continue to search for this shortfall of Yuan 88 M.

The policy for large-scale scientific projects in China, stipulates the following four step process: (i) appraisal and review, (ii) feasibility study, (iii) preliminary design, and (iv) the opening report of construction. Each step takes approximately 10 months. The FAST project has completed the first step of this process and has nearly completed the second step. Currently, a technical company is helping the FAST project to evaluate and review the site environment and land usage; this activity is expected to finish around January 2008.

NAOC, China

EUROPE

ESKAC

During 2007, the European SKA Consortium prepared for the transition of the SKA project towards the international collaboration and SPDO agreements. At a meeting in Bonn, on 28 November 2007, steps were taken towards a new formal Memorandum of Understanding governing the ESKAC activities over the next few years, in particular supporting the activities of the SPDO through contributions to the common fund. Initially, 2008 funding will come from the current contributors in England, Italy, France, Germany, Netherlands, RADIONET and SKADS. It is expected that new member organisations will join in early-2008 to broaden the base for SKA development in Europe. Thijs van der Hulst will assume the chairmanship of ESKAC on January 1, 2008.

A. Zensus
Chair ESKAC

SKADS

SKADS Mid-Term Review “Exceeding Beyond Expectations”

SKADS successfully completed a mid-term review which was held at the Paris Observatory on 12 October 2007. The external review was conducted by John Seiradakis, University of Thessaloniki, Greece, and Elena Righi-Steele, European Commission, who concluded that "SKADS is exceeding beyond expectations, unifying Europe in developing a common technological concept for the SKA" (Figure 26). Such a positive judgement firmly establishes SKADS in the international arena as it heads into its final two years.

Figure 26. Flanking the SKADS poster are EC Programme Manager Elena Righi-Steele (left) and John Seiradakis, the external reviewers for the SKADS mid-term review.
“Simulations for the Square Kilometre Array”,
Pushchino, July-August 2007

The historic Pushchino Radio Astronomy Observatory was the venue for a milestone event in the SKADS project. The workshop entitled "Simulations for the SKA" brought together elements from simulations efforts in pure science, telescope configurations, network, and costing.

From 30 July to 1 August 2007, Pushchino welcomed over 30 participants, including 20 from outside Russia (Figure 27). A major goal of SKADS is the synthesis of efforts in science and technology, ultimately leading to the design of a cost effective and high performance SKA. Within SKADS, this workshop was a joint effort of Design Studies 2 and 3 (Science and Networking) together with design and costing work carried out with input from DS4 (Enabling Technologies) and Design Studies 5 and 6 (EMBRACE and BEST).

The Pushchino workshop proved to be an excellent forum for everyone to review the science simulations accomplished within the first two years of SKADS. There was considerable discussion on the future direction of this work. In particular, the science simulations will be ever more focused on the technical capabilities envisioned for the SKA, and these results will feed directly into the technical design and costing work underway within SKADS. All together, the SKADS science simulations and technical design and development work will coalesce into a detailed design and reliably costed SKA.

Proceedings from the Pushchino meeting are available from the SKADS website at www.skads-eu.org/p/pushchino20070730.php

Marie Curie Conferences and Training (MCCT-SKADS)
http://mcct.skads-eu.org

The First MCCT-SKADS Training School, organised by the Istituto di Radioastronomia, (Bologna, Italy) was held in the Conference room of the Visitor Centre "Marcello Ceccarelli", a facility of the Medicina Radio Observatory, during the week 23-29 September 2007. The school was fully funded by the Sixth Framework Programme of the European Commission.

The main aim of MCCT-SKADS is to train young researchers for the benefit of new instruments in radio astronomy and most particularly for the Square Kilometre Array. Specific objectives are to: (i) educate young and less experienced astronomers and technical scientists about SKADS, (ii) provide both young astronomers and young technical scientists with a common framework, (iii) provide a coherent training program, (iv) promote a large foundation of expertise in the fields of SKA and SKA-enabling technologies, and (v) disseminate the SKA and SKADS approach, advancements and results.

Out of 67 applicants for the first MCCT-SKADS workshop, 46 students were accepted. Students came from various national affiliations including: France (1), Finland (1), Germany (4), Hungary (1), Italy (15), Portugal (2), Spain (6), Sweden (1), The Netherlands (6), UK (7), India (1), and Nepal (1), see Figure 28. There were approximately 50% male and 50% female students, and thus the participants satisfied both the national and gender requirements for an MCCT school.

Lecturers at the MCCT workshop were from European institutes and universities, as well as two from Australia. The programme is available on the web page of the school (www.irai.inaf.it/~school_loc) where all the presentations are also available for download. The lectures will be written-up, and will soon be available through the "Proceedings of Science" (PoS) website at http://pos.sissa.it
Second SKADS Workshop, 10-11 Oct. 2007

More than 80 participants attended the two day SKADS Workshop in Paris in October (Figure 29). This event capped a very busy October which saw the Joint Working Group meetings in Manchester, followed by the Modern Radio Universe conference, also in Manchester, which celebrated 50 years of the Lovell Telescope. The SKADS workshop was held at the Observatoire de Meudon, on the outskirts of Paris, and participants braved the vagaries of the Paris public transport system, arriving en-masse at Bellevue station with the beautiful prospect of the Avenue de Chateau before them. This was appreciated by many, though the brisk walk uphill came rather as a surprise.

The SKADS Workshop was an opportunity to see the details of progress in technological development, and science simulations. All the presentations are available on the SKADS website at www.skads.eu.org/ParisWorkshop20071010/

SKADS Virtual Telescope: Early Science with the SKA

The SKADS programme is on the verge of delivering a set of sky simulations and a report on the SKADS "Year-in-the-life" exercise.

The former are to be submitted as refereed publications and distributed via a database. The large-area sky simulations have been completed by the Oxford team under the leadership of Steve Rawlings. Basic checks are underway which will be quickly followed by a draft paper. The Oxford SKADS team, together with Oxford e-science colleagues (http://e-science.ox.ac.uk) are developing a means of distributing the huge catalogues and images. This material will be released after the peer-review process, hopefully as early as January 2008.

The SKADS Virtual Telescope material is being drawn together into a report. Twenty-four proposals were received, each proposing observations with a pre-Phase-I SKA. Ultimately, the proposals will be scheduled on the SKADS Virtual Telescope, giving a "Year in the Early Life of SKA". This activity naturally fits into the "Phased Science Case" currently under development within the SKA Science Working Group. While the scheduling activity is ongoing, the proposals themselves are available. Please contact Steve Rawlings for the necessary link and password.

SKADS Design and Costing Round 2

Following a crystallisation of the new SKA specification after the SKA working group meetings at the end of September in Manchester, we are now able to start work in earnest on the second version of the SKADS Design and Costing document (SKA Memo #93). The SKADS Benchmark Scenario is a specific implementation of the SKA Reference Design (SKA Memo #69) which emphasises the use of aperture-plane phased-array technology, thus maximising the field-of-view and mapping speed of the SKA. The updated SKADS Design and Costing document will correspond more closely to the International SKA specifications Tiger Team option C, which is led by Paul Alexander and Andrew Faulkner.

As part of this process, SKADS continues to collaborate with the SPDO and CSIRO on the development of the SKAcost tool. We are building up a library of
components for the costing database, as well as contributing to the development of a Graphical User Interface to the SKAcost tool. Early in the new year, the SKAcost tool development will reach a level of maturity to handle a full SKA design costing. Meanwhile, the revised Design and Costing document will use the spreadsheet implementation developed for SKA Memo #93.

The revised document will be submitted to the SSEC by February 2008, and will contain more detailed information about individual components, as well as system level costs.

Steve Torchinsky
SKADS Project Scientist

LOFAR

As previously reported, the first LOFAR core station (CS1) was constructed in the fields of Exloo during the summer of 2006, with 96 low band antennas distributed over 4 station locations; 48 antennas were placed in a central field and the remaining were distributed over 3 stations yielding a variety of baselines of up to 450 m. The set-up was chosen to enable performance tests of a single station at full bandwidth and to emulate a small test version of a LOFAR-type interferometer with 24 micro-stations at reduced bandwidth.

The LOFAR prototype station CS1 started operations at the beginning of October 2006. The imaging pipeline has now all its main software elements in place. Beams are formed at the station level and transported to the BlueGene correlator through an optical fibre network and subsequently visibilities are produced. All sky maps have been made from these visibilities. In the beginning, there was a low signal to noise ratio, but as more has been learnt about calibration and imaging, the all sky images have become more detailed and reveal more sources beyond the current existing source catalogues at these frequencies. An example is shown in Figure 30.

Figure 30. This is a LOFAR/CS1/LBA image observed at about 50MHz (36 sub-bands of 156 kHz each and about 96 hours of observation time). The image has been corrected for the average attenuation due to the dipole beam over 24 hours. After correction, the relative fluxes of the 3C and 4C sources (which are well known) have the expected values, to within a few percent. This suggests that the calculated beamshape is correct to that accuracy, even at low elevations. The left panel shows the full hemisphere centred on the north celestial pole (NCP). On the right side is a zoomed-in view of the area around the NCP. The two brightest sources (Cas A and Cygnus A) have been subtracted. The brightest remaining sources are Tycho (top centre), Taurus A (right) and Virgo A (bottom). (Photos: Sarod Yatawatta)

While the LBA design seems to have been tested rather well, the HBA tile design still needs to be justified by intensive testing. For that reason, just before the summer of 2007, the first 6 HBA tiles were placed in the fields of Exloo. On the 14 June 2007, these 6 HBA tiles were pointed at the zenith as the radio pulsar B0329+54 passed overhead. The signals from the tiles were added incoherently and the source was observed for 15 minutes while it remained completely in the beam. The pulsar could be clearly detected with the tiles. Unfortunately, there have been technical problems since then with the tiles. These problems have now been solved but they delayed testing, which has now restarted and will conclude in a delta Critical Design Review (CDR) for the HBA before the end of 2007.

An important milestone for LOFAR was the successful BSIK mid-term review which took place in September 2007. LOFAR is one of 37 projects funded from the ICES/KIS-3 (also known as BSIK) subsidy programme. In order to monitor these projects, regular progress reports are sent to a monitoring committee, composed of experts. A milestone in this regard was the mid term review which was held half-way through the period of the BSIK projects to give the Government
insight into their progress and quality. An independent panel lead by Ed van den Heuvel, and including Richard Schilizzi, was asked to conduct a review of the project’s progress. The review focussed on the LOFAR’s scientific quality, substantive coherence, management of progress and milestones as well as its vision and strategy for the future of the project after the end of the grant period (which is 2010 in LOFAR’s case).

The panel was provided with extensive documentation which included previous reviews of the project, such as the Critical Design Review, held in April 2007, as well as the Calibration and Data Processing Review, held in November 2006. The Review Panel met in Dwingeloo on 21 September 2007 and in Groningen on 25 September 2007. The project received a favourable report from the committee, which rated the (scientific) quality in all four target areas (astronomy, geophysics, precision agriculture and ICT) to be very high. The panel were impressed with the results achieved with the first Core Station and the way the BlueGene/L based central processor was being used - including work on improved I/O protocols that makes new use of BlueGene’s fast internal network. At the end of October 2007, the official handover of the operation of CS1 from the R&D department to the newly established LOFAR/WSRT observatory took place. With this, a new era for LOFAR operations began. The software infrastructure is now in place to enable operators in Dwingeloo to run observations and monitor the antennas from Dwingeloo.

In November 2007, the first international LOFAR station (IS DE-1) was completed; it is a collaboration between ASTRON and MPIfR and is located in close proximity to the 100 m Effelsberg radio telescope (Figure 31). The costs of the station are borne by the Max Planck Society. Currently, 96 dipole antennas for the low frequency range of 30 to 80 MHz are operational. Final acceptance and handover took place on 20 November 2007 and the Effelsberg astronomers are very excited and eager to start using the station for astronomical experiments. As Effelsberg is connected to the high-speed network in Germany, it is only a matter of weeks before the link to the LOFAR array can be established and the first real-time correlation can take place within BlueGene/L in Groningen. Meanwhile, astronomers at Effelsberg and ASTRON are preparing for the first long-baseline VLBI type experiment between Effelsberg and Exloo, on a baseline of about 250 km.

Following the CDR in Spring 2007, LOFAR has been preparing for the roll-out phase, starting with the construction of 20 stations in the Netherlands. Ultimately, the ambition is to build 77 LOFAR stations in the Netherlands, but funding still has to be secured for the final phase of up to 35-40 stations. Recently, LOFAR re-scope workshops were held to discuss the first phase of LOFAR which concluded in the major recommendation from the science team to deploy smaller stations to keep the station number as high as possible and secure the excellent science which will be done with LOFAR.

With the procurement phase starting at the end of 2007, in addition to the 20 stations for Dutch LOFAR, stations for Germany, France, the UK and Sweden will be ordered from LOFAR/ASTRON as these countries become ready to do so.

On behalf of the LOFAR Team: Corina Vogt
Several projects are under way to provide the required infrastructure to support the MeerKAT project in the Northern Cape Province. At the same time, the project team has commissioned two important studies: (i) a survey of the socio-economic and demographic profile of households, business and institutions in the areas, which is almost complete, and (ii) a study of the benefits to South Africa and the SADC region accruing from the construction of the MeerKAT and its possible extension to the SKA Phase 1 array, which should be completed by the end of February 2008.

Upgraded Road and Support Base for MeerKAT

Two contractors have been appointed to share the upgrading of the gravel road linking the MeerKAT site with the main road between Carnarvon and Williston. Both companies will use labour from the local communities. The contracts were awarded by the Northern Cape Department of Roads, Public Works and Transport. Work will begin in early-January 2008 and should be completed by October 2008.

The MeerKAT project has signed a Memorandum of Agreement with the Northern Cape Department of Agriculture and Land Reform in January 2008 for the use of several existing buildings located at the Agricultural Research Centre 10 km outside Carnarvon. These buildings will serve as the support base for KAT-7 and MeerKAT, with the possible establishment of additional buildings for MeerKAT. The Department of Roads, Public Works and Transport have appointed a professional team who will assist with the renovation of the buildings during the first half of 2008.

Tracy Cheetham, 
SA SKA Project Manager

KAT-7 and the path to MeerKAT

Over the past months, the MeerKAT project team has been developing the scope, specifications and development strategy for the MeerKAT. In a process similar to the one adopted by the SKA Specifications “Tiger Team” to draft preliminary specifications for the SKA, a four-person “drafting team” developed the MeerKAT document. MeerKAT Project Scientist Justin Jonas is a member of both the SKA Specifications Tiger Team and the MeerKAT drafting team, and so the two documents share synergies.

The draft Preliminary Specification for the SKA document outlines various scenarios for the implementation of the phases of the SKA. One scenario specifies the use of medium sized dishes (10 - 15 m) with “single-pixel wideband feeds” as the receptor for the SKA mid-frequency band (500 MHz – 10 GHz). The MeerKAT scope document specifies MeerKAT as a demonstrator for this SKA concept. The reference design specification for MeerKAT is an array of 80 x 12 m dishes with single-pixel wideband feeds covering the 500 MHz to 2.5 GHz frequency range. The receivers will be cryogenically cooled to achieve the best sensitivity possible. The array configuration will be centrally concentrated to provide good brightness temperature sensitivity, but will also extend out to nearly 10 km in order to provide sufficient resolution for optical cross-identification.

The MeerKAT scope document outlines the development path necessary to ensure that MeerKAT is implemented successfully, within budget, and on time. An important phase in this development path is the construction of the KAT-7 prototype array at the Karoo site. KAT-7 will primarily be an engineering test-bed, but it will also be capable of scientific observations and will be the first seven antennas of the full MeerKAT array.

The MeerKAT scope document is currently being reviewed, and will be circulated for comment once the review process is completed.
Progress update on the MeerKAT XDM Antenna Structure

The MeerKAT team has installed the last of the control system components on the MeerKAT prototype, and commissioned and tested the dish. A myriad of tests were performed, the most important of which were related to proof of the surface (accuracy and efficiency) and the pointing/tracking capability of the dish.

The surface was measured using theodolites and photogrammetry (see Figure 32) - the results from these two methods were consistent and therefore resulted in a high degree of confidence in the measurements.

Dr Mike Gaylard of HartRAO led the effort to build two receivers to test the flame-sprayed aluminium dish surface (Figure 33). The purpose was to test the efficiency of the antenna and check the integrity of the surface, as well as to verify the surface accuracy measurement results from the theodolites and photogrammetry.

Adriaan Peens-Hough from the System Engineering team performed the tests and analysed the results. Figure 34 shows a typical scan of a radio source carried out with the XDM.

The conclusions from all these tests were that the flame sprayed surface performs very well, the surface accuracy is better than 2 mm RMS (the original specification was 4 mm RMS) and the dish efficiency is as expected.

IST (the company awarded to contract for designing the XDM antenna) also performed a number of pointing and tracking tests in order to refine the pointing
model. Figure 35 shows an example of the tests (this was done optically).

Figure 35. Optical pointing test.

The pointing and tracking performance of the antenna seems to be significantly better than the 0.04 deg. specified. Some refinement on the pointing model will still be done after the XDM receivers have been fitted, but overall the MeerKAT team is very happy with the performance of the dish. The better than specified surface accuracy and pointing performance will allow operation to higher frequencies than originally specified, which may be important to SKA, depending on the SKA science case. The XDM dish is essentially complete and will be signed off after the final documentation has been completed.

The rest of the year will be spent on changing the design of the prototype to a 12 m dish (as that is the likely size of the dishes for MeerKAT), as well as to optimise the antenna structure for cost, since achieving the SKA cost target is the main remaining challenge.

Willem Esterhuyse,
MeerKAT Project Office,
Cape Town

MeerKAT prototype computing subsystem update

A large part of the recent focus has been to develop and integrate the complete software chain for the MeerKAT prototype (XDM) dish and engineering experiments. Since August 2007, the software runs end-to-end in the laboratory using actual XDM computing hardware. This includes end-to-end facility monitoring and control using web and scripted components, antenna control software with a simulated XDM dish, the data filter and data processing software, simulated RF and DSP subsystems, and simulated environmental monitoring.

Preliminary work on XDM integration with the real DSP subsystem has already commenced and lab integration with the other subsystems started in September 2007.

The CONRAD computing collaboration with the Australians is proceeding well with the code base maturing in a number of areas such as the synthesis code for pipelined imaging and the various monitor and control components (also used in the XDM system as described above). Recently, the CONRAD computing architecture, which is expected to be used for KAT-7 and MeerKAT, has also been given attention and international review (see www.conradsoftware.org).

Work continues in various areas to help in the KAT-7 and MeerKAT definitions. A particular focus at present is to determine the array configuration and unpack the science requirements in terms of engineering implications. The powerful array configuration design tool, known as AntConfig, is available from www.kat.ac.za.

Jasper Horrell,
MeerKAT Project Office,
Cape Town

MeerKAT Optic Fibre Work Session

A work session was held in Cape Town on 21-22 November 2007 with InfraCo, Roshene McCool, a fibre optics engineer from Jodrell Bank Observatory in Manchester; Richard Hughes-Jones from Manchester University and the project team to review the proposed plans for the optic fibre network for the MeerKAT project. InfraCo is a public entity established by South Africa’s Department of Public Enterprises to reduce broadband costs and to provide a national backhaul infrastructure including the optic fibre network for MeerKAT. They will finalise the various cost modelling options by the end of 2007.

Tracy Cheetham,
SA SKA Project Manager,
Rosebank, Johannesburg
New Legislation for Astronomy Reserves in South Africa

South Africa’s National Assembly has given its final approval of the South African Astronomy Geographic Advantage (AGA) Bill and it is about to be signed into law by the country’s President, Mr Thabo Mbeki.

This new Act will enable the establishment of astronomy reserves that provide protection across all wavelengths, from radio through optical to gamma-ray. It allows the declaration of three types of frequency dependent protected areas:

- **Core Area** - encompassing the physical extent of the astronomical facility. It provides for the most stringent levels of protection required by the facility;
- **Central Area** – surrounding the core area. Activities that are deemed to be detrimental to the operation of the astronomy facility are prohibited as regulated;
- **Co-ordination Area** – surrounding the central and core area. Operators of high powered transmitters will be required to co-ordinate with the astronomical facility to ensure radio astronomy operations are not compromised by new / existing transmitters.

Figure 36 illustrates a Central Area, with the South African SKA configuration superimposed, appropriate for frequencies below 1 GHz. This Central Area is over 400 km in extent.

It is only through the excellent co-operation and support of the major stakeholders in South Africa that the progression of the AGA Bill has been relatively smooth, and generally accepted as a necessity to protect South Africa’s natural astronomical advantage.

A series of case studies are being undertaken with a number of operators of wireless communication services in the affected areas, using the proposed central zone as a basis for these discussions. These seek to find feasible solutions to re-engineer existing wireless communication infrastructure to be compatible with the operation of a major radio astronomy facility, as well as prevent the establishment of further infrastructure and other activities that could be detrimental to astronomy, and in particular the SKA. Solutions include: migration of mobile communications to frequencies beyond those used by the SKA, the use of phased array antennas for fixed transmitters and the discontinuation of high powered transmitters in favour of localised satellite downlinks and low powered repeaters.

Figure 37 indicates the signal coverage of a typical GSM base station. Following the implementation of mitigation techniques using phase array antennas, the signal is reduced by almost 50 dB in the direction of the core site, illustrated in Figure 38.
Students Impress at Second SKA Bursary Conference in South Africa

About 80 delegates, including 27 postgraduate astronomy and engineering SA SKA bursary holders, attended the 2nd Annual Postgraduate Bursary Conference of South Africa’s SKA / MeerKAT project (Figure 39). The conference was held from 26 - 30 November 2007 at the South African Astronomical Observatory in Cape Town and was also attended by leading astronomers from Jodrell Bank Observatory, Caltech, Oxford University, ASTRON and the Universities of Mauritius and Antananarivo, see Figure 40.

“South Africa is the future of radio astronomy”, commented Dr Clive Dickinson of Caltech towards the end of the conference, and added that “the work done by the South African students were on par with anywhere else in the world and deserved world recognition.”

The students were encouraged and inspired by this feedback from the international visitors who were uniformly impressed with the high quality and relevance of their work. South Africa’s success in capacity development in this field is significant, since it emerged from the conference that most countries face similar challenges in terms of attracting young achievers to careers in astronomy.

Mike Jones of Oxford University assured the students that they have earned their membership into the international astronomy community and that they would be welcomed and accepted in this “club” anywhere in the world. He encouraged the students to gain international work experience and then take the expertise back to their home country. “Your work is comparable with that of top students in other countries, and even with the work of professional astronomers,” he told the students. Arnold van Ardenne of ASTRON was similarly impressed with the South African students and he told the SKA South Africa team, “Your deliberate and concentrated capacity development is unique in the world, and is clearly working”.

As in 2006, the students competed to be recognised for the best presentation. Renee Hlozek, an MSc student at the University of Cape Town (UCT) was presented with the “overall best

Figure 38. Coverage of GSM base station following implementation of mitigation techniques by GSM operator.

Adrian Tiplady, SKA Project Office, Johannesburg (atiplady@ska.ac.za)

Figure 39. Delegates at the 2007 SA SKA/MeerKAT Postgraduate Bursary Conference

Networking, information sharing and future collaboration were the key objectives of the event. Local and international scientists and engineers, as well as all 27 students, presented an update on their current work and future plans over four, full days.
presentation award" for her talk on the "Detection, classification and parameter estimation of cosmic transients". Six more students also received book vouchers for their excellent presentations; they were Tana Joseph, Jason Salkinder and Andile Mngadi (UCT), Paul van Merwe and Gideon Wiid (Stellenbosch University), and Ryan Wane (University of KwaZulu-Natal) - see Figure 41.

The conference provided all participants with a big-picture understanding of all the sub-systems of the MeerKAT project, and how these fit together. The importance of effective collaboration between the science and engineering communities working on the MeerKAT and SKA projects in South Africa emerged as an important outcome of the conference.

Figure 41. Winners of the presentation awards with international guests and project leaders and supervisors

Kim de Boer,
Manager: Human Capital Development,
Communications and Outreach

USA

Technology Development Program (TDP)

The TDP has been funded by the US National Science Foundation as a four-year project from October 2007 to September 2011 at USD 3 M per year. The TDP Project Director is Jim Cordes (Cornell) and the TDP Project Office is at Cornell University. The US SKA Consortium is directly involved in the TDP.

The focus of the TDP is on areas that are key to providing options for the SKA design while meeting anticipated cost targets. The TDP is complementary to and integrated with the EC-funded PrepSKA project. Particular work areas that bear strongly on cost and basic performance \( (A_{\text{eff}}/T_{\text{sys}}, \text{bandwidth}, \text{polarisation capability, and high-performance processing}) \) include:

- Low-cost manufacturing methods for reflector antennas for LNSD dish arrays;
- Costing information for reflectors + mounts vs. diameter and upper frequency development of single-pixel wideband feeds (four concepts);
- Optical designs for reflectors and secondary optics that will accommodate single-pixel feeds and multiple-pixel systems (feed clusters or phased-array feeds);
- Delivery of an SKA-optimised, fully outfitted antenna to demonstrate sensitivity performance using feeds and receivers developed under the TDP;
- Calibration and processing algorithms for LNSD arrays that bear on the choice of antenna diameter; and
- Cost modelling information.

The TDP will also leverage as much as possible its resources in order to obtain additional funds for studies of synoptic surveys for dark energy, transients, pulsars and other source classes. Additional funds will also be sought for education and public outreach.

Dark Energy proposal

A proposal has been submitted to the U.S. Department of Energy in response to their program “Discovering the Nature of Dark Energy.” The SKA was identified in the report of the Dark Energy Task Force as a promising future facility for making significant progress in the study of dark energy. This proposal is aimed specifically at investigating the SKA design from the standpoint of dark energy studies as well as identifying potential systematics related to such studies.
U.S. Demonstrator Arrays

Expanded Very Large Array (EVLA)

As of 2007 December, 13 EVLA antennas have been retrofitted and returned to the operational VLA; they now account for nearly 50% of all antenna hours used for routine scientific observations. In support of this, the EVLA deformatter racks were relocated to the new correlator room (Figure 42). The rollover to the EVLA Monitor and Control (M&C) Transition System took place during the last week of 2007 June, and the old VLA Modcomps were decommissioned. Thus, all VLA observing since then has used the EVLA M&C Transition System.

Cryogenic testing of the C-band orthomode transducer (OMT) prototypes shows excellent sensitivity across the full 4–8 GHz frequency range, with the receiver temperature across most of the band being less than 10 K. The RF design of the new S-band (2–4 GHz) OMT was completed. The top level design of a new L-band cryogenic dewar for cooling the large 1–2 GHz OMT was completed. The designs for the Ku-band (12–18 GHz) feed horn and its mounting tower were completed. The new Ka-band (26–40 GHz) receiver was assembled and successfully tested, and requisitions were issued for the receiver’s production components. A contract was awarded to the successful vendor for the 3-bit, 4 Gsps samplers.

The WIDAR correlator chip is now in full production. Many of the components for the correlator racks have now arrived in Penticton, and the assembly of the racks has begun. The new connectivity scheme for the EVLA correlator was formally reviewed and accepted at a review in July 2007. The new scheme improves the processing capability of the correlator and improves reliability by reducing the number of modules, racks, and high speed interconnect cables.

Long Wavelength Array (LWA)

The LWA Project is currently undergoing the Systems Requirements Review (SRR) by its Technical Advisory Committee. This process should complete around the end of the year and keep us on track for a Preliminary Design Review (PDR) in late Spring of 2008. Virginia Tech and the University of Iowa officially joined the LWA project in July 2007, though they have been contributing for some time prior to this date.

NRAO has allowed us to fence off an additional piece of land roughly 300 m to the east of the LWDA. This is being used to locate the Rapid Test Array, a set of 16 single-polarisation dipoles for testing mutual coupling of elements within the primary site.

The LWA project participated in a moonbounce experiment on 27-28 October 2007. It worked well, with transmissions at 7.4 and 9.4 MHz from HAARP in Alaska received at the LWDA site. The experiment was designed by Paul Rodriguez and implemented by Ken Stewart and Brian Hicks with support from UNM. Three different sets of antennas were deployed to provide redundancy, including a modified big blade LWA antenna. This experiment demonstrates that the LWA design can work at low frequencies, albeit at reduced efficiency. Many other technical developments in the project are described in the LWA memo series (www.phys.unm.edu/~lwa/memos).

Murchison Wide-field Array-Low Frequency Demonstrator (MWA-LFD)

Major progress continues on the MWA project. In November 2007, a team of 10 people travelled to the Murchison Radio
Observatory (MRO) site at Boolardy in Australia to install 32 antenna tiles in a roughly 300 m diameter configuration. Over the next 3-4 months, digital receiver and correlation capabilities will be added to the installation to provide an integrated end-to-end engineering test bed system capable of high quality imaging and precision measurement of many kinds. The tile installation team, led by Brian Corey (Haystack), endured summertime temperatures as high as 120º Fahrenheit (49º Celsius). Despite the challenging conditions, installation was quick and efficient, thanks to a terrific job and outstanding effort by the individuals involved. An aerial view of the 32-tile (32T) system is shown in Figure 43, illustrating the scale of the operation and the nature of the terrain. The colour of the tiles has been artificially enhanced to make them more visible in this image. Three vehicles, used by the expedition team, and a small hut housing a Faraday cage for the processing electronics can be seen in the centre of the tile distribution. The hut was provided by CSIRO, along with additional preliminary infrastructure on site some 2 km away, including an internet link and office space. The project gratefully acknowledges this support from CSIRO.

Between 14-19 December 2007, an expedition team led by Anish Roshi of the Raman Research Institute (Bangalore) went back to the 32T site and achieved “first light” through a complete set of MWA analog and digital hardware, from the sky through to channelised digital data in disk files, suitable for software correlation. The resulting data from this highly successful trip will be analysed in depth to assess a variety of properties of the equipment and the site environment. Two more expeditions are planned by March 2008, culminating in the ability to generate correlated data from all 496 baselines. A project meeting was held in Hawaii during early December 2007, at which good progress on all technical fronts was reported. Completion of the full hardware 512-tile system is still targeted for the beginning of 2009, followed by commissioning, and key science investigations starting in earnest by mid-2009.

Allen Telescope Array

The Allen Telescope Array (ATA) was formally dedicated on 11 October 2007. The ATA has begun conducting initial scientific observations with the observing duty cycle expected to begin to increase significantly as experience is gained with the instrument.

Joseph Lazio
US SKA Consortium

Figure 43. Aerial View of the Boolardy Site (Photo: Bob Burns)