The Australian SKA Pathfinder

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ASKAP Director  
ATUC 25 October 2011
ASKAP Overview

1. ASKAP Recent Highlights

1. ASKAP Status and Progress
   1. Antennas
   2. Phased Array Feeds (PAFs)
   3. Digital Systems
   4. Computing
   5. Network connection to Pawsey HPC Centre for SKA Science
   6. MRO Infrastructure
   7. MRO Support Facility (Geraldton)

1. ASKAP Project Plan update – ADE

2. Current Status
ASKAP – Recent Highlights

- **MRO Infrastructure Construction:**
  - McConnel Dowell Constructors (Australia) Pty Ltd
  - Construction 65% complete

- **Testing on first antennas**
  - Used in eVLBI observations
  - Exceed specifications (surface RMS 0.5 mm)

- **Pawsey Centre**
  - Delivery of 100 Tf machine at Murdoch University (Pawsey 1A)
  - ASKAP an early developer on this machine, now developing larger software

- **Promising results with PAF**
  - First full-size (188 element) tested at Parkes Testbed Facility (12m)
  - Excellent results

- **Digital Systems**
  - BETA (6 antennas) digital system components now delivered
  - Integration underway
ASKAP – Recent Highlights

- Fibre link to Geraldton
  - Completed and in use
  - Link from Geraldton to Perth demonstrated (eVLBI)

- “X-band” VLBI – first successful tests at higher frequency

- Successful workshop with Fraunhofer Institute in Berlin on future power renewable power options for ASKAP and SKA
PKS 0637-752, observed at 1.4 GHz with the first e-VLBI observations to use the new ASKAP and Warkworth telescopes, and the NBN/CSIRO/NRN/AARNet fibre connection between the MRO and Perth. PKS0637-752 is thought to harbour a binary supermassive black hole.

Credit: CASS and ICRAR VLBI and ASKAP Teams
ASKAP – Wajarri Naming Ceremony

Photos: courtesy Steve Douglas
• **Wilara** - wi-la-ra (Moon)
• **Bundarra** - bun-da-ra (Stars)
• **Biyarli** - bi-yar-li (Galah)
• **Jirdilungu** - jir-di-lu-ngu (Milky Way)
• **Balayi** - ba - la –yi (Lookout)
• **Diggiedumble** - dig gee dum bull (Table top hill)
ASKAP – Wajarri Naming Ceremony
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ASKAP – Antennas

• Ten CETC54 engineers have been on site doing minor completion work on the first antennas along with 3 Boom Logistics and 4 – 6 TME staff from Geraldton involved in antenna assembly

• Nine antennas are completed

• Five more in assembly

• Average time is now 5 days per antenna

• Antennas continue to exceed surface RMS specification –
  • Specification is 1.0mm
  • Delivered RMS averaging 0.52 mm RMS (20 GHz ?)

• Completion of all 36 scheduled Q2 2012
ASKAP - Antennas
ASKAP Antennas
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ASKAP – PAF at Parkes

• First full size Phased Array Feed completed MATES integration testing and deployed to Parkes on 13 June 2011

• Initial ground based “aperture array” tests very successful
  • sub 50 K temp across much of the band

• Installed on the Parkes 12 metre on 26 July 2011
  • ground AA results confirmed
  • first sky scans very promising

• Second PAF shipped to MRO 10 October 2011
  • will be installed on ASKAP antenna this week

• Remaining 5 Mark I PAFs for BETA in various phases of build
Analog racks, power supplies, Digitiser and transport (shielded racks) in pedestal 3

23 October 2011
Approximate Beamformed Aperture Array Receiver Temperature $T_{rx} = 295/(y-1)$

Not Corrected for Sky Brightness
Beamformed on Radiated Noise at Boresight

Measurement: unpublished
Drift scan of Virgo across PAF, PTF, 64 MHz Preliminary

Hotan, Chippendale, Reynolds, O'Sullivan, Hay et al, CSIRO
Hay, IJMOT 5,6,2010 & ICEAA 2010.
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ASKAP – Digital Systems

- June 2011 – all BETA quantity Redback-2 and DragonFly-2 boards delivered
- 2 Tera-bits/second (2Tbps) communications from the digital receiver to the beamformer operational
- First full ACM (Array Covariance Matrix) in real-time achieved using ASKAP hardware
- Deployment to Parkes of first unit successful
- Deploying to MRO for 1st antenna and BETA
ASKAP – Digital Systems

Integration and test area (Digital)
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ASKAP – Computing

• ASKAP commenced “porting” and development on the Pawsey HPC for SKA Computing, phase 1A machine at Murdoch University

• Spectral line imager demonstrated at 1024 cores

• Version 0.4 of the Telescope Operating System released (ToS)

• PAF oriented software installed at Parkes 12 Metre (May)

• ASKAP Computer group in top 10 HPC users in Australia
  • top 3 in terms of s/w developers
ASKAP – Computing

Pawsey 1A machine:

- 10 % of full Petaflop machine

- Hewlett Packard “Computing in a can”
ASKAP – Pauwesey Centre – 1A computer
Murdoch University
ASKAP – Computing

Pawsey 1A machine (107th most powerful in the world)

- 10% of full Petaflop machine

- Hewlett Packard “Computing in a can”

- 800 nodes, each dual hex core Intel Xenon 2.8 GHz processors and 28 GB memory

  = 9600 core machine with 18 TB RAM

- Full Petaflop machine procurement opens 21 November 2013
  - Commission by mid-2013
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ASKAP – Fibre MRO to Geraldton to Perth

- CCTS completed the fibre installation in early June 2011
- Three repeater huts fitted with equipment by CSIRO staff (mid June 2011)
  - two huts solar powered, one hut grid connected
  - economical, low power
- First end-to-end (MRO to Geraldton) light on Sunday 19 June 2011
- First 1 Gb/sec transmission in mid-July 2011, allowing the eVLBI observation
- NBN link Geraldton to Perth completed and tested
- Expect full access MRO – Pawsey HPC for SKA Science at 10 Gb/s in mid-December 2011
  - 40 Gb/sec March 2012
- (Currently ADSL level from Geraldton to outside world)
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ASKAP – MRO Construction

• Good progress this year:
  • roads 90 % completed
  • fibre and power reticulation around site 60 % completed
  • all 36 antenna foundations are completed
  • runway refurbishment completed
  • Central Building foundation completed
  • 4 of 13 central building modules delivered to site
  • drilling for the geothermal cooling system for central building
    • 50 of 130 x 120 metre bores completed
  • Support for other projects (MWA etc) – 50 % installed
ASKAP – Control Building modules arrive at MRO
CSIRO is committed to maximising the use of renewable power sources

MRO Requirements:

- approximately 950+ kW, 24 hours, 365 days (1.4 MW peak)
- “medium” reliability (compared to DoD, communications, medical etc)
- major load is the electronics and processing (50 - 60 %)
- load variations dominantly due to diurnal cooling load
- RFI emission control to maintain pristine radio quiet site standards

“Demand side” management during design and operations planning critical

Working with Horizon Power (WA utility) to develop the design and supply model
Horizon Power – Marble Bar hybrid station
MRO Power Station Site Layout
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Notice to the industry of intent to release a tender given in region on 15 June 2011

RFT (Request for Tender) for the construction of the 800 sq m facility was posted on Austender on 27 June

Closed on 5 August 2011

Expect Contract award this week

Occupancy expected September 2012
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ASKAP Plan Overview

ASKAP:
- rapid development cycles in all areas:
  - PAFs – chequerboars, LNAs etc
  - Data Transport
  - Digital Systems
  - Computing

- New technologies coming on line quickly
  - laser modulation allowing RFoF economically
  - V7 of Xilinx FPGA family
  - Analog to Digital Convertors

CSIRO - ASKAP ATUC 25 October 2011
ASKAP Design Enhancements (ADE)

1. Apply “Lessons learnt” from current PAF knowledge, BETA etc. Areas include:
   - mechanical packaging, size, impacts of RFoF, cooling etc

2. Incorporate new technologies
   - RF over Fibre
     - recent rapid price drop of optical components
     - minimise cable loses, stability,
     - continuous fibre from PAF to beamformer in central building
     - removes 95% of equipment from pedestal – cooling, RFI, elec
     - Virtex 7 – newest Xilinx FPGA family – factor of 4++ reduction
     - Direct sampling – deletes entire heterodyning sub-system
     - Mk II systems will be compatible with Mk I (12 PAF observing)

Build and install 6 of these new Mk II designed systems on ASKAP Antennas by March 2013
Three primary components to the plan:

1. Complete BETA, including:
   1. 6 antennas with Mk I (existing) PAFs and Digital systems
   2. 36 antennas + infrastructure (pads, power and fibre)
   3. MRO infrastructure, fibre link to Geraldton, building, MSF, Power station

2. Commence ASKAP Design Enhancements (ADE)
   Apply learning from ASKAP, including;
   - RFOF (“RF over fibre”)  
   - PAF – RFOF-ready, high frequency fix, re-packaging  
   - Digital systems (Virtex 7, leaner, faster, cheaper)  
   - Equip additional 6 antennas with new Mk II PAFs (March 2013)

3. Seek additional funding for the completion of 24 more PAF systems for ASKAP (2012 – 2013)
ASKAP Key Milestone Overview

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<thead>
<tr>
<th>Event Description</th>
<th>Date</th>
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<tbody>
<tr>
<td>PAF on Parkes Testbed 12m</td>
<td>August 2011</td>
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<tr>
<td>PAF on MRO antenna</td>
<td>October 2011</td>
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<tr>
<td>Six Mk I PAF’s on BETA (digital systems included)</td>
<td>October 2011 – Feb 2012</td>
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<tr>
<td>SST Reviews</td>
<td>November 2011</td>
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<tr>
<td>Limited BETA observing – start</td>
<td>December 2011</td>
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<tr>
<td>- phase closure</td>
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<tr>
<td>- commissioning focus</td>
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<tr>
<td>- aim is to generate basic data files</td>
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<tr>
<td>- primary BETA capability early 2012</td>
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<tr>
<td>- preliminary BETA data measurement sets Q3 2012</td>
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<tr>
<td>MRO Infrastructure complete – January 2012</td>
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<tr>
<td>Six Mark II PAFs and Digital subsystems – March 2013</td>
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<td>(total 12 PAFs)</td>
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We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site.
Thank you

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