SKA Status Update
Juande Santander-Vela
SKA SW Systems Engineer
SKA Key Science Drivers: The history of the Universe

- Testing General Relativity (Strong Regime, Gravitational Waves)
- Cosmic Dawn (First Stars and Galaxies)
- Galaxy Evolution (Normal Galaxies z~2-3)
- Cosmology (Dark Energy, Large Scale Structure)
- Exploration of the Unknown
- Broadest range of science of any facility, worldwide

Cradle of Life (Planets, Molecules, SETI)

Cosmic Magnetism (Origin, Evolution)
SKA Observatory Vision

3 sites
2 telescopes
1 observatory

Design Phase:
~ €200M; 600 scientists+engineers,
80% complete

SKA Phase 1 (SKA1)
Construction: 2019 – 2025
Construction cost cap: €674.1M
(2016 inflation-adjusted)
Operations cost: (estimate) €89M/yr

MeerKAT integrated
Observatory Development Programme
(€20M/year planned)
SKA Regional centres out of scope of centrally-funded SKAO.

SKA Phase 2: start mid-2020s
~2000 dishes across 3500km of Southern Africa
Major expansion of SKA1-Low across Western Australia

>50 years lifetime!
Drives need for reliability, and adaptability
SKA Organisation

- Australia (DoI&S)
- Canada (NRC-HIA)
- China (MOST)
- India (DAE)
- Italy (INAF)
- Netherlands (NWO)
- New Zealand (MED)
- South Africa (DST)
- Sweden (Chalmers)
- UK (BEIS/STFC)

In discussion with:
- Germany
- France
- Portugal
- Spain
- Switzerland
- Japan
- South Korea

In the process of becoming an Inter-Governmental Organisation
SKA1 Design Consortia

- Science Data Processor
- Telescope Manager
- Low-Frequency Aperture Array
- Central Signal Processor
- Signal and Data Transport
- Dish
- Assembly, Integration & Verification
- Infrastructure Australia
- Infrastructure South Africa

Exploring the Universe with the world's largest radio telescope
SKA1 Design Consortia

Exploring the Universe with the world's largest radio telescope
SKA1 Sites

SKA1-Low locations

SKA1-Mid locations

Exploring the Universe with the worlds' largest radio telescope
SKA1-Low Site

Murchison Radio Astronomy Observatory

Geraldton

Perth

300 km

Murchison Radio - astronomy Observatory

Pawsey supercomputing centre
SKA1 Telescopes

SKA1-LOW: 50 – 350 MHz
Phase 1: ~130,000 antennas across 65km

SKA1-Mid: 350 MHz – 24 GHz
Phase 1: 200 15-m dishes across 150 km
SKA1-Mid Report

66 x M1 moulds, each 12 tonnes, with average surface accuracy of ~50µm RMS.

Surface RMS 350 micron

80 µm – 110 µm RMS

Subreflector (M2) moulds
SKA1-Mid Report
SKA1-Mid Report: MeerKAT

49/64 antennas built
SKA1-Low Report

SKA1-Low Prototype Station (AAVS1)

Exploring the Universe with the world's largest radio telescope
SKA1-Low Report

2.6 MWhr lithium ion battery
Building a Nexus for Radio Astronomy

Exploring the Universe with the world's largest radio telescope
SKA Regional Centres

- Collaborative alliance
- Transparent and location agnostic interface to SRCs for users
- SKA users should not care where their data products are
- All SKA users should be able to access their data products, irrespective of whether their country or region hosts a regional centre
SKA Regional Centres

- SKA Regional Centres (SRCs) will host the SKA science archive
- Provide access and distribute data products to users
- Provide access to compute and storage resources
- Provide analysis capabilities & user support
- Multiple regional SRCs, locally resourced and staffed
SKA Control: TANGO

- Decided in March 2015
- Control Harmonisation Project started March 2016 → **CS_Guidelines**
- Good uptake from the community
- INAF, SKA SA, and SKAO are now members of the TANGO Controls Organisation

Talk by Lorenzo Pivetta

MOBPL03

TANGO is the collaborative effort of many people. It is a free open source project i.e. the source code is available under GPL and LGPL open source licences (on tango-cs and tango-ds on SourceForge) and it can be downloaded and modified by anybody. Anyone can send a patch with their changes but changes to the official source code are done by authorised developers. If you want your modifications to be included then send them to the TANGO Controls mailing list. TANGO Controls started at the ESRF but has since then been adopted by a number of sites. The following sites have committed to the sustainable development of TANGO Controls by signing a Collaboration Contract and committing to financing the development of TANGO:

- ALBA
- DESY
- ELETTRA
- ESRF
- INAF
- MAX-IV
- SKAO
- SKA-ZA
- SOLARIS
- SOLEIL

Exploring the Universe with the world's largest radio telescope
SKA1 Control Hierarchies

SKA1-Low

SKA1-Mid
SKA1-Low Control Hierarchy
Integrating TANGO Facilities

Focus on diminishing global, cross-facility traffic

Use of logviewer tools, and potential for viewers direct to the devices, but most monitoring in remote

Slide courtesy Lorenzo Pivetta
How to develop all this software?
Agile, Scaled Agile (Framework)
Agile Teams, 5-7 people (including Scrum Master), ±2 people

Agile Release Trains (ARTs) in Definition

Architectural Runway → Emulation & Simulation
CERN-SKA Agreement

Exploring the Universe with the world's largest radio telescope
SKA Treaty Organisation

SKA Organisation member governments agreed in 2015 to develop an Intergovernmental Organisation (IGO)

- Rationale:
  - Appropriate for a genuinely global research infrastructure of SKA’s scale
  - Government commitment: political stability, funding stability
  - A level of independence in structure
  - Availability of ‘supporting processes’ through Privileges and Immunities from members: functional support for project
  - ‘Freedom to operate’, specifically through procurement process, employment rules etc

- We are building an organisation analogous to successful IGOs such as ESO, EMBL, CERN
- Negotiations started October 2015 – four Plenary meetings led by Italian government;
- Expect Convention to be signed December 2017, ratified 12 months later
SKA Timeline

Ratification of remaining initial signatories

Prospective ‘new’ Members/AM/Cooperators interact informally with CPTF

Prospective ‘new’ Members/A. Members/Cooperating bodies negotiate with Council

Jan/Feb 2018; Convention Signing

Convention Ratification by signatories

3 hosts+2 = IGO Entry-into-Force

IGO Council meeting 1

Ratification of remaining initial signatories

Now 2018 2019 2020 2021

Convention Initialling

Procurement informal EoI

Dec 2018 System CDR complete

Construction Proposal to Council

Construction approval by Council

‘Construction start’

Construction/contract preparation
**SKA Timeline**

**Time for developing the core capabilities for TM and SDP**

- **Mar-19**: Construction proposal submission
- **Sep-19**: Council Approval for Construction

**Q3-2022**
- ITF QE
  - (4 dishes/stations)

**Q4-2023**
- Array Release 1
  - (8 dishes/18 stations)

**Q3-2024**
- Array Release 2
  - (64 dishes/64 stations)

**Q2-2025**
- Array Release 3
  - (128 dishes/256 stations)

**Q1-2026**
- Array Release 4
  - (197 dishes/512 stations)
Conclusion

SKA is happening

• Excellent technical progress
• Prototypes being constructed and deployed
• Cost control effective
• Inter-Governmental Organisation proceeding
• Construction will begin in 2019; operations in mid-2020s

The future?

• SKA time will be allocated to those who contribute to both construction and operations
• Young, vibrant community across the world
• Using industry-standard safe approaches, like SAFe and TANGO in construction
<table>
<thead>
<tr>
<th>Code</th>
<th>Author</th>
<th>Organisation</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOAPL3</td>
<td>Lorenzo Pivetta</td>
<td>SKAO</td>
<td>SKA Control System Guidelines</td>
</tr>
<tr>
<td>TUBPA06</td>
<td>Francois Joubert</td>
<td>SKA SA</td>
<td>Scalable Time Series Documents Store</td>
</tr>
<tr>
<td>TUCPL01</td>
<td>Paul Boven</td>
<td>JIVE</td>
<td>White-Rabbit for Radio Astronomy</td>
</tr>
<tr>
<td>TUDPL03</td>
<td>Athanaseus Ramaila</td>
<td>SKA SA</td>
<td>Control System Simulation Using DSEE High Level Instrument Interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and Behavioural Description</td>
</tr>
<tr>
<td>THAPL03</td>
<td>Valentina Alberti</td>
<td>INAF-OAT</td>
<td>Usability Recommendations for the SKA Control Room Obtained by a User-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Centred Design Approach</td>
</tr>
<tr>
<td>THBPA04</td>
<td>Anton Joubert</td>
<td>SKA SA</td>
<td>Orchestrating MeerKAT’s Distributed Science Data Processing Pipelines</td>
</tr>
<tr>
<td>THCPL04</td>
<td>Ralph Braddock</td>
<td>UMAN</td>
<td>SKA Synchronization and Timing Local Monitor and Control - Software</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Design Approach</td>
</tr>
<tr>
<td>THSH201</td>
<td>Athanaseus Ramaila</td>
<td>SKA SA</td>
<td>Integration of MeerKAT and SKA telescopes using KATCP &lt;-&gt; Tango</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Translators</td>
</tr>
<tr>
<td>FRAPL01</td>
<td>Juande Santander-Vela</td>
<td>SKAO</td>
<td>Status of the Square Kilometre Array</td>
</tr>
<tr>
<td>Code</td>
<td>Author</td>
<td>Organisation</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>TUPHA030</td>
<td>Matteo Canzari</td>
<td>INAF-Teramo</td>
<td>Using of Artificial Intelligence in the Predictive Model of the Fault Management of SKA Telescope Manager</td>
</tr>
<tr>
<td>TUPHA050</td>
<td>Simone Riggi</td>
<td>INAF-OACT</td>
<td>The SKA Dish Local Monitoring and Control System</td>
</tr>
<tr>
<td>TUPHA063</td>
<td>M. Marquarding</td>
<td>CSIRO-CASS</td>
<td>ASKAP: From Construction to Operation</td>
</tr>
<tr>
<td>TUPHA207</td>
<td>Matteo DiCarlo</td>
<td>INAF-Teramo</td>
<td>TM Service: An Architecture for Monitoring and Controlling the SKA Telescope Manager</td>
</tr>
<tr>
<td>TPHA004</td>
<td>Matteo DiCarlo</td>
<td>INAF-Teramo</td>
<td>Challenges and Solutions for the SKA TM Architectural Team</td>
</tr>
<tr>
<td>TPHA032</td>
<td>C. R. Haskins</td>
<td>CSIRO-ATNF</td>
<td>DiamoniCA: EPICS and Open-Source Data Analytics Platforms</td>
</tr>
<tr>
<td>TPHA066</td>
<td>L.R. Brederode</td>
<td>SKA SA</td>
<td>MeerKAT Project Status Report</td>
</tr>
<tr>
<td>TPHA085</td>
<td>Rajesh Warange</td>
<td>NCRA/TIFR</td>
<td>SKA Synchronization and Timing - Local Monitor and Control Project Status</td>
</tr>
<tr>
<td>TPHA137</td>
<td>Francois Joubert</td>
<td>SKA SA</td>
<td>Distributing Near Real-Time Monitoring and Scheduling Data for Integration With Other Systems at Scale</td>
</tr>
<tr>
<td>Code</td>
<td>Author</td>
<td>Organisation</td>
<td>Title</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>THPHA142</td>
<td>Alessio Marassi</td>
<td>INAF-Trieste</td>
<td>The SKA Dish SPF and LMC Interaction Design: Interfaces, Simulation, Testing and Integration</td>
</tr>
<tr>
<td>THPHA164</td>
<td>B. Xaia</td>
<td>SKA SA</td>
<td>Automated Software Testing for Controlling And Monitoring the MeerKAT Telescope</td>
</tr>
<tr>
<td>THPHA168</td>
<td>Rajesh Warange</td>
<td>NCRA/TIFR</td>
<td>Dockers With TANGO – Control System Approach for SKA</td>
</tr>
</tbody>
</table>
Thanks!
Subarray State Machine

Exploiting the Universe with the world's largest radio telescope