Purpose and agenda

Purpose:
• To provide a periodic briefing to senior scientists on the current status of, and plans for SKA.
• To provide an opportunity for the audience to ask questions of the SKA senior team.
• The presentation is provided to all attendees and may be distributed freely and used in talks to your own communities.

Agenda:
• 0800 GMT/1500 GMT: Welcome, videocon start, introduction of SKAO senior team.
• 0805 GMT/1505 GMT: Presentation from Director-General
• 0835 GMT/1535 GMT: Q&A
• 0930 GMT/1630 GMT: End
Science
SKA—Key Science Drivers: The history of the Universe

- Cosmic Dawn (First Stars and Galaxies)
- Galaxy Evolution (Normal Galaxies $z \sim 2-3$)
- Cosmology (Dark Energy, Large Scale Structure)
- Cosmic Magnetism (Origin, Evolution)
- Cradle of Life (Planets, Molecules, SETI)
- Testing General Relativity (Strong Regime, Gravitational Waves)
- Exploration of the Unknown

Extremely broad range of science!
SKA Science Book 2015

- 135 Chapters, 2000 pages, 8.8 kg
- Plus new science directions that continue to emerge!
SKA Science Working Groups

- Current SWGs represent a wide range of scientific areas:
  - Extragalactic Spectral Line (non-HI)
  - Our Galaxy
  - Solar, Heliospheric & Ionospheric Physics
  - Epoch of Reionization
  - Cosmology
  - Extragalactic Continuum (galaxies/AGN, galaxy clusters)
  - Cradle of Life
  - HI galaxy science
  - Magnetism
  - Pulsars
  - Transients

- Technique focused Working Group:
  - VLBI

- Topical Focus Group:
  - High Energy Cosmic Particles

Membership open to any active researcher with willingness to contribute at appropriate level

Anyone can nominate themselves by contacting the current SWG Chairperson (per web site) or SKA Project Scientist/Science Director
Key Science Projects:

- **Notional** package of Key Science Projects emerged in Q1 2015 based on the highest priority science objectives recommended by science community that are:
  - Consistent with capabilities of the SKA1 design
  - Consistent with realistic observing schedule filled at 50 – 75% for the first 5 years of scientific operations

- KSP policy currently progressing in context of IGO negotiations
  - Building on KSP Discussion paper of June 2015
  - Total access (sum of KSP + PI) likely proportional
  - Mix of KSP/PI up to individual member countries
The Project
SKA Organisation: 10 countries, more to join

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

Interested Countries:
- France
- Germany
- Japan
- Korea
- Malta
- Portugal
- Spain
- Switzerland
- USA

Contacts:
- Mexico
- Brazil
- Ireland
- Russia

Full members
- SKA Headquarters host country
- SKA Phase 1 and Phase 2 host countries

African partner countries
(non-member SKA Phase 2 host countries)

This map is intended for reference only and is not meant to represent legal borders.

Exploring the Universe with the world's largest radio telescope
**Square Kilometre Array**

3 sites; 2 telescopes + HQ
1 Observatory

Design Phase: > €170M; 600 scientists+engineers

**Phase 1**
Construction: 2018 – 2024
Construction cost cap: €674.1M (inflation-adjusted)
Operations cost: under development (see below)

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

**Phase 2:** start mid-2020s
~2000 dishes across 3500km of Southern Africa
Major expansion of SKA1-Low across Western Australia
SKA: HQ in UK; telescopes in AUS & RSA

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

Construction: 2018 – 2024; Cost cap: €675M
Data Flow through the SKA

SKA1-LOW

~2 Pb/s

~7.2 Tb/s

SKA1-MID

8.8 Tb/s

~50 PFLOPS

100 PFLOPS

~5 Tb/s

130 - 300 PB/yr

Users
SKA1 capability vs state-of-the-art

Point-source sensitivity:
~ 4 – 20 times state-of-the-art

Survey speed:
~ 10 - 100 times state-of-the-art
Image Quality Comparison

- Single SKA1-Mid snap-shot compared to combination of snap-shots in each of VLA A+B+C+D
Image Quality Comparison

- Single SKA1-Low snap-shot compared to LOFAR-INTL snap-shot
Precursors: congratulations

Exploring the Universe with the world's largest radio telescope
SKA HQ

New, €20M building, complete March 2018
State-of-the art facilities
A nexus for astronomy
Operations Planning
Scope

SKA Observatory

- Observatory Operations
- Corporate Functions
- Development Support

SKA Regional Centres

SKA Development Centres

AUS Operator

SKAO

- SKAO AUS Office
- SKAO RSA Office

Science Processing Centre

GHQ

Science Processing Centre

RSA Operator

In Scope

Service Level Agreements

Memorandum of Understanding
SKA Regional Centres – outside SKAO scope

- **Required**
  - capacity for reprocessing data and their analysis
  - storage for a long-term archive
  - local user support

- **Intent**
  - SKA partner countries planning SKA regional Centres
  - National super-computing centres
  - Provide local support to scientists
  - Development of new techniques, new algorithms
  - Deliver SKA science

Sunway TaihuLight – 93 PFlops
Status
Headline: SKA System PDR passed in December, subject to some work now underway.
- Band 5 ECP160022 ECP approved
- $4.6 - 13.8 \text{ GHz}$ => eg. $(5.0 - 9.25)$ & $(9.0 - 16.7)$ GHz
Major meetings

2017 meetings:

12-16 June: Engineering in Rotterdam

19-23 June: Low Frequency astronomy in Bologna

26-27 June: EWASS Prague
Scientific Synergies of SKA, CTA & Athena

19-26 August: URSI GA, Montreal
Session on SKA

August 2018: IAU GA Vienna
SKA and precursor science

Stellenbosch all-hands Engineering meeting
2nd – 6th October 2016
Future Governance
• IGO = ‘Convention’ agreed between governments
  • Government commitment: Long-term 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 and so on
Negotiations by governments to establish an Inter-Governmental Organisation.

- Convention and protocols
  - All major disagreements resolved
  - Next step is so-called ‘legal scrub’
  - IGO5 in April: main aim is initialling of text
  - Formation of ‘Council Preparatory Task Force’ planned
  - Signing ceremony being planned for July → ratification 12-18 months thereafter
- SKA Observatory enters into force with 5 countries ratifying: target July 2018.
National engagement

- Germany:
  - MPG providing funding for a second SKA1-Mid prototype dish (first to go to site)
  - Germany attended IGO#4 following positive re-engagement with BMBF
- France: process of re-examination of Astrophysics section of National Science Infrastructure Roadmap has been accelerated
- Portugal: Letters written to Ministers of Science and Economy, awaiting reply
- Spain: Spanish State Secretary has written to D-G, supportive of joining SKA in near future – awaiting movement following formation of new Spanish government
- Switzerland: Swiss State Secretary requested observer status at SKA Board - granted; indication will join when an IGO
- Japan: Attended SKA Board in November.
- Korea: invited to SKA Board
- USA: establishing radio astronomy strategy for Astro2020. Ongoing discussions with Director NRAO.
Construction costs
& Schedule
Cost reduction

• Board-mandated cost cap: €674.1M (2016 euros)
• Cost estimates generated by consortia; wide-level of maturity at this stage, improving as industry estimates provided.
• November 2016 cost estimates:

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<td>SODP (upgrades etc)</td>
<td>€20M/yr</td>
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<tr>
<td>Total</td>
<td>€128.1M</td>
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• Straight-forward to identify ~€40M - €50M of savings with little or no impact on science
• Exercise underway to identify a range of options to reduce cost of construction and operations.
• Long-scheduled ‘deep dive’ on costs taking place in February/March

• Process:
  • options papers being prepared now as input to SKA Office; wide range of other options being investigated by the Office and consortia.
  • Office will prepare preliminary list of recommendations for March Board meeting
  • SEAC will advise on science impact of recommendations
Overall project timeline – to be confirmed.

Key dates:
- Convention signing July 2017
- CDRs Q4 2017 – Q2 2018
- IGO enter into force July 2018
- SKA1 Construction approval early 2019
Summary

• Overall progress is very positive
• Route to an IGO now appears firm
• Engineering moving to CDRs starting Q3 2017
• Cost reduction process a high priority
• Challenges remain, but the will is there to resolve them.

• SKA only possible through the drive, enthusiasm and support of the science and engineering community.