The Square Kilometre Array Radio Telescope Project : An Overview

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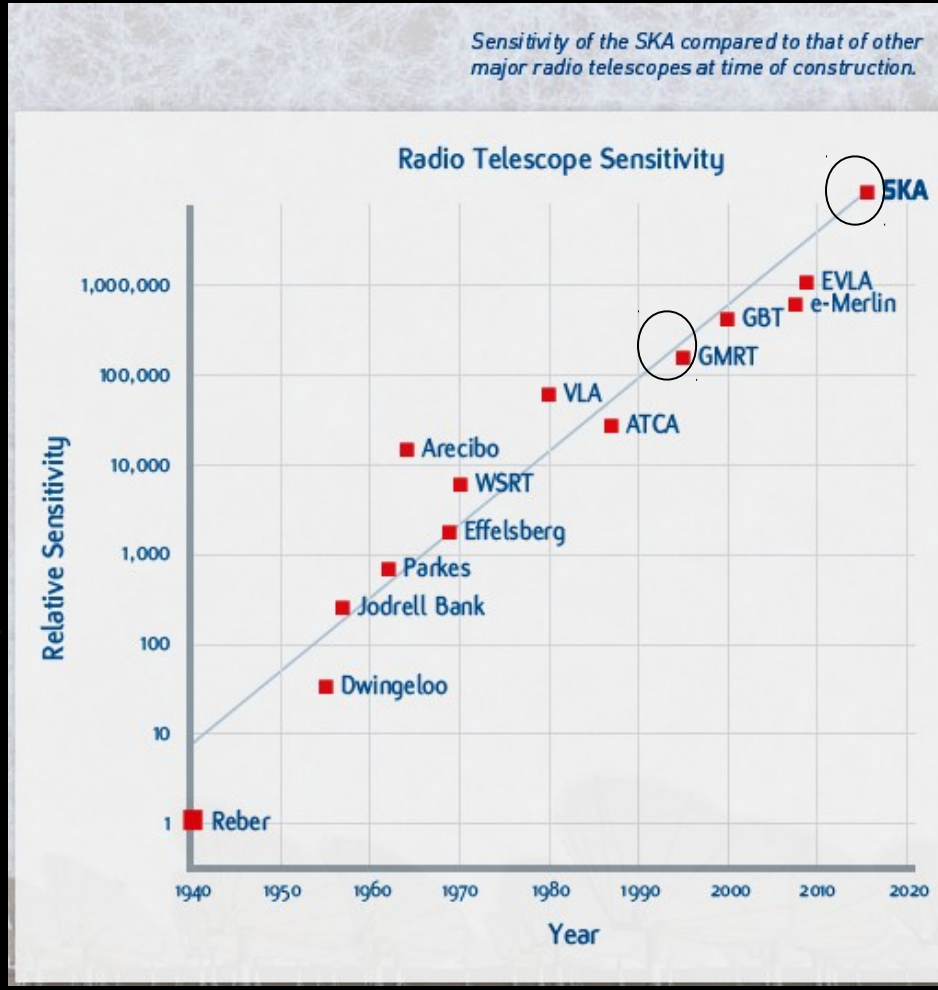
Background : what is the SKA ?

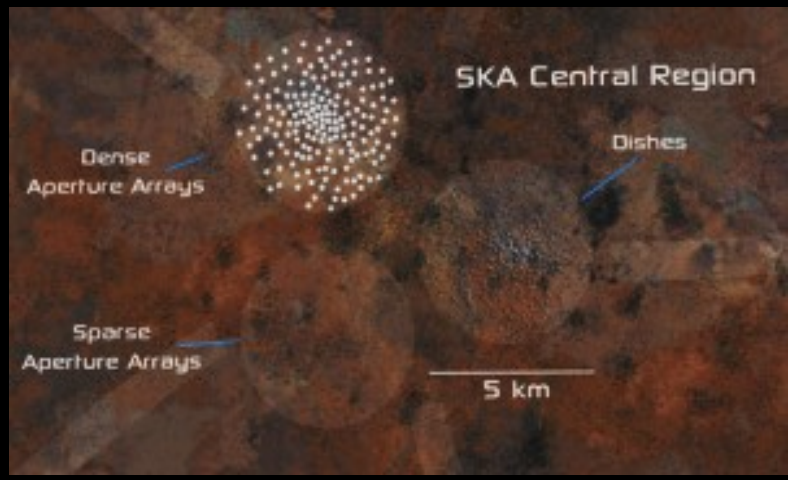
- The SKA is the most ambitious Radio Astronomy project ever attempted
- 1 square km (1,000,000 sq m) collecting area (~ 30 x GMRT !) ➔ ~ 3000 small sized antennas, with larger field of view
- High resolution ➔ antennas spread out over distances up to 3000 km, but connected in real-time (by optical fibre)
- Wide frequency range: 70 MHz - 10 GHz
- Location : Australia AND South Africa (radio quiet regions, far away from human habitat)
- Total estimated cost s for full SKA :
  Phase I : 650 M Euros
  Total : ~ 1.5 billion Euros (?)



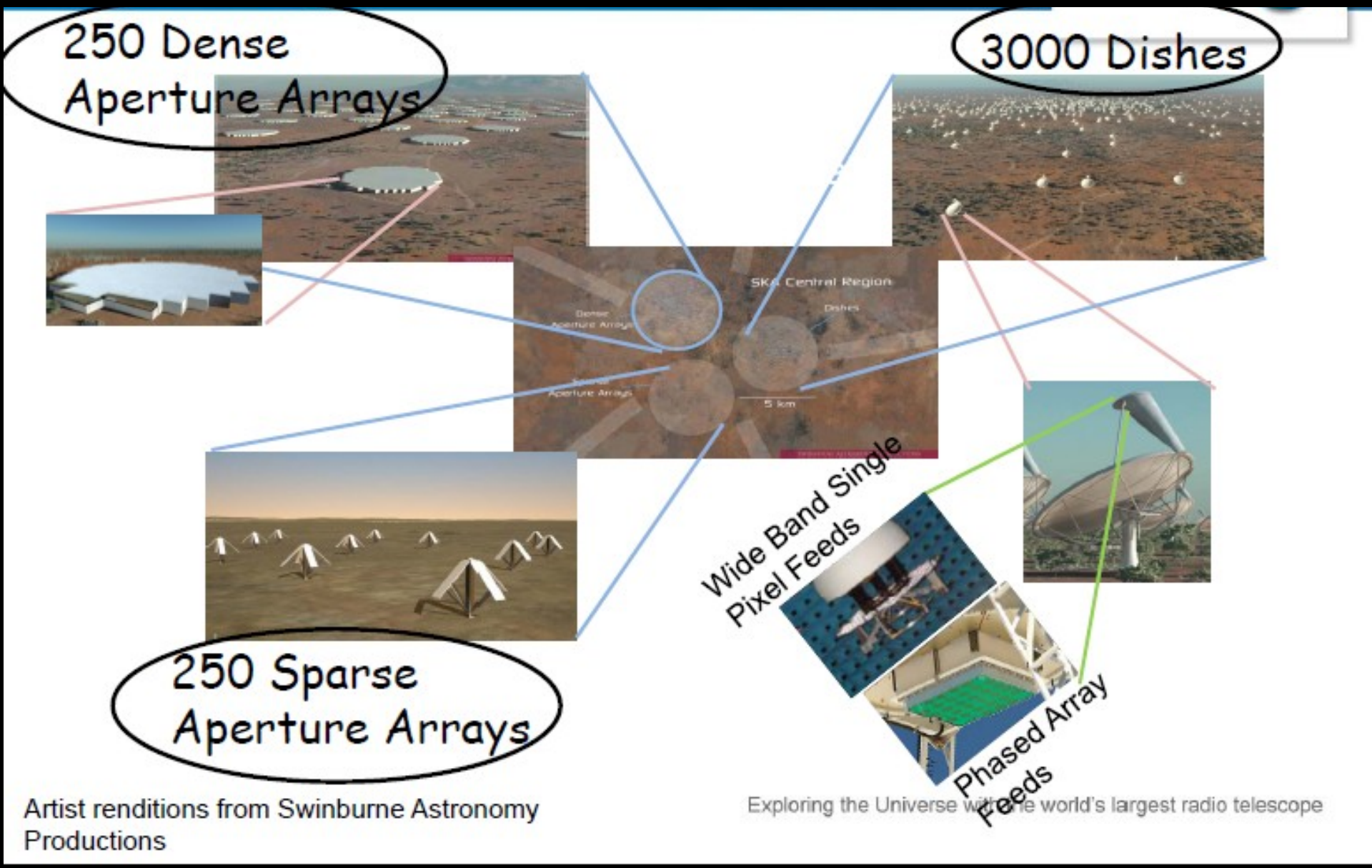
Sensitivities of radio telescopes over the years
The SKA will be 50x better than today's best !

SKA Design & Technologies

- Receptor stations spread out over a region of 3000 km ; highly compact & dense central core region
- Multiple detector technologies to cover the large frequency range : dishes (high frequency), sparse & dense aperture arrays (low & mid frequencies)
- Extensive optical fibre network (petabits/sec) : > total internet traffic)
- State of the art low noise electronics & real-time signal processing
- Supercomputing capability (petaflops) for post processing requirements
- Complex telescope management structure

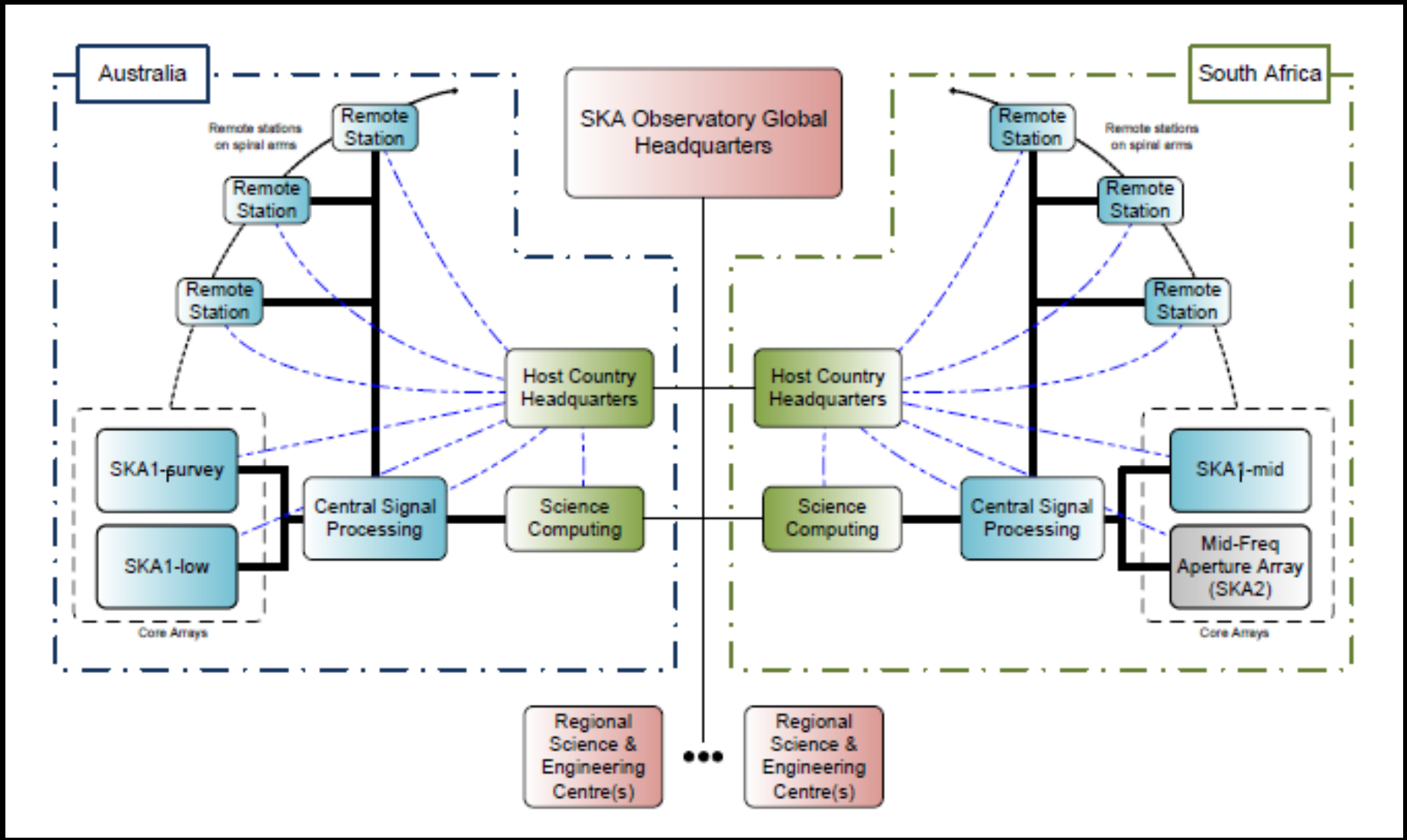


Full SKA : Reference Design Layout



Artist renditions from Swinburne Astronomy Productions

SKA : System schematic

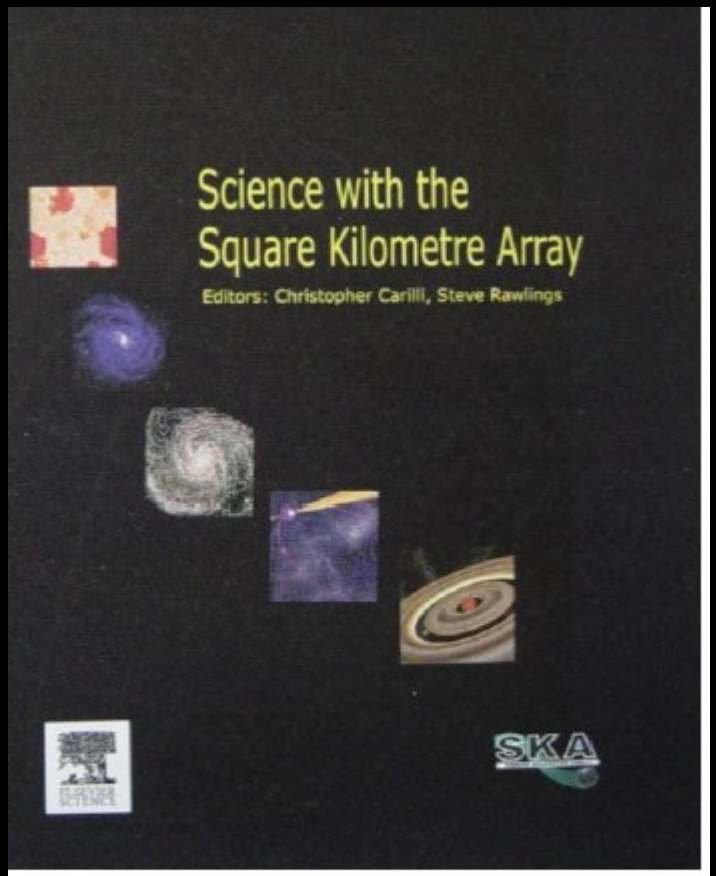


Science with the SKA

- Five frontline science drivers for the full SKA :
  1. DARK ENERGY, cosmology, galaxy evolution – mapping the cosmic distribution of hydrogen & understanding what is dark energy
  2. WAS EINSTEIN RIGHT ? -- strong-field tests of gravity using pulsars & black holes
  3. COSMIC MAGNETISM – what generates the magnetic fields in space ?
  4. probing the "DARK AGES" – how were the first black holes & stars formed ?
  5. the "CRADLE OF LIFE" – search for complex molecules (the building blocks of life), Search for Extra-Terrestrial Intelligence (SETI)

Serendipitous science : the power and sophistication of the SKA will provide plenty of opportunities for new, unexpected discoveries !

Science with the SKA



Science with the Square Kilometre Array
(2004, eds. C. Carilli & S. Rawlings, *New Astron. Rev.*, **48**)

Now being updated with a new & more comprehensive version that is due for completion by the end of this year

SKA Phase I

- Full SKA is a very ambitious project; for ease of implementation, it has been split into phases

- SKA Phase I :
  - ~ 10% of full SKA
  - Frequency coverage : 70 MHz to 3 (10) GHz
  - Max baseline : 200 km
  - 2 key science goals : EoR ; Pulsars & Gravity (+ minor goals)
  - All infrastructure and designs to keep in mind the full SKA
  - Total cost estimate : ~ 650 M Euro (Rs. 4550 cr)
  - Selection of site has happened (May 2012) and the project will be located in Australia and South Africa
  - 3 part telescope : SKA-LOW, SKA-MID & SKA-SURVEY
  - Detailed design & definition phase : 2012 -- 2016 (~ 90 M Euros)
  - Construction phase : 2017 – 2022 (~ 550 M Euros)

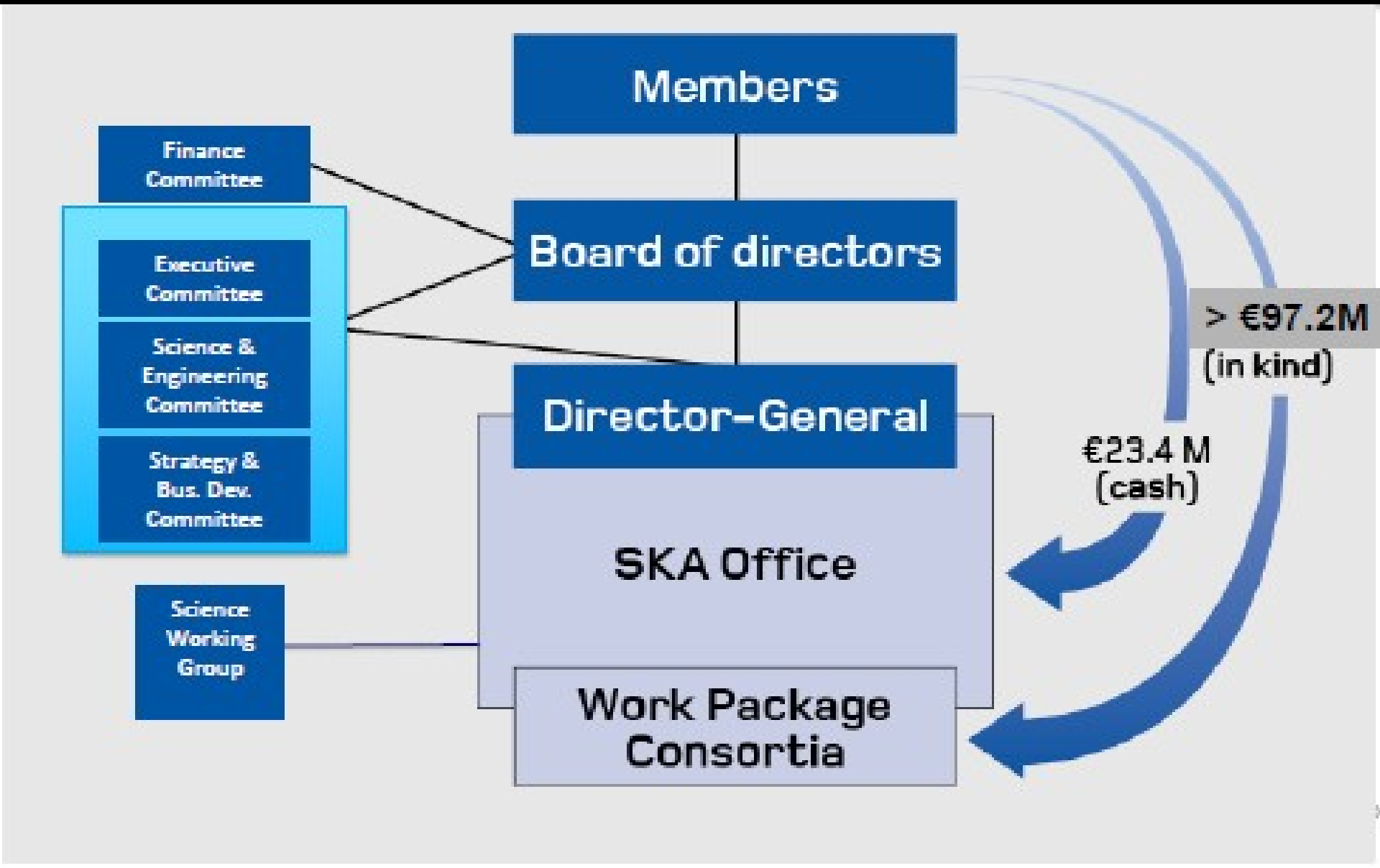
Realisation Plans for SKA-I

SKA1_MID
254 Dishes including:
64 x MeerKAT dishes
190 x SKA dishes

SKA1_LOW
Low Frequency Aperture
Array Stations

SKA1_SURVEY
96 Dishes including:
36 x ASKAP
60 x SKA dishes

SKA : Governance & Management



SKA-I : Management Structure

- Present management structure (2012 onwards) is as follows:
  - The SKA Project Office (HQ in Manchester, UK) coordinates all the technical activities
  - The work is divided into work packages for different elements of the SKA telescope
  - At a higher level, the affairs are managed & guided by the SKA Organisation : Board of Directors, representatives from scientific community and funding agencies of each member nation; Full Members vs Associate Members
  - Presently : Ten nations with Full Membership -- Australia, Canada, China, Germany, Italy, The Netherlands, New Zealand, South Africa, Sweden, UK.
  - India at present is an Associate Membership – looking to change shortly to Full Membership.

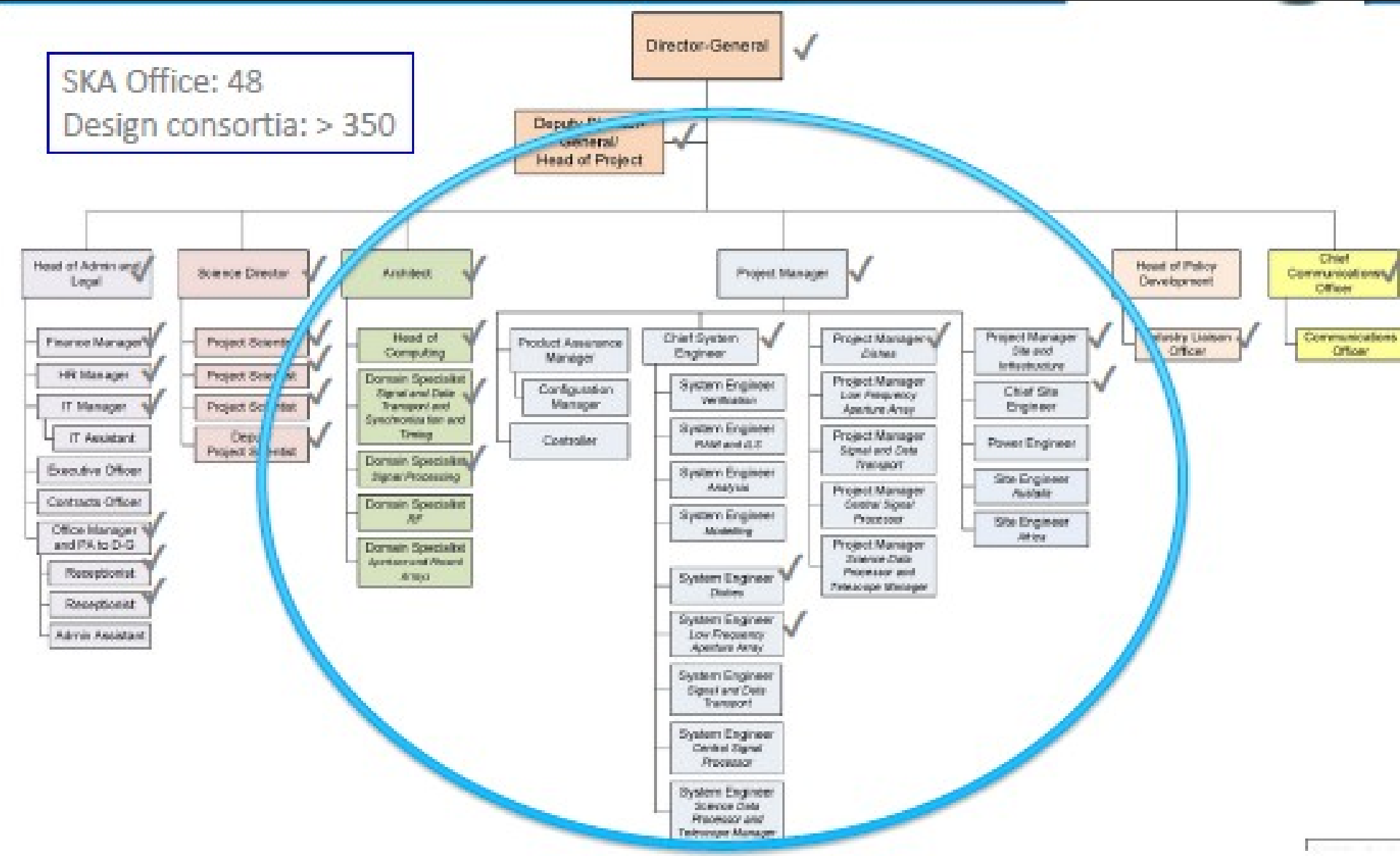
SKA-I : Design Process

- Design of the SKA is being undertaken by global consortia, acting as contractors to the central SKAOffice.
- SKA Office has direct control of the system engineering process, receiving and reviewing designs from consortia, monitor progress, analysing and allocating Earned Value etc.
- SKA Office issued a baseline conceptual design to serve as starting point for design, based on previous work and CoDRs.
- 10 consortia formed to undertake the design.
- First major target is the Preliminary Design Review (PDR) scheduled at the end of this year (2014).
- Inputs from the design and cost estimates from the work by the consortia will be used to rebaseline the design – by early 2015.
- SKA Office holds the design authority for the project.

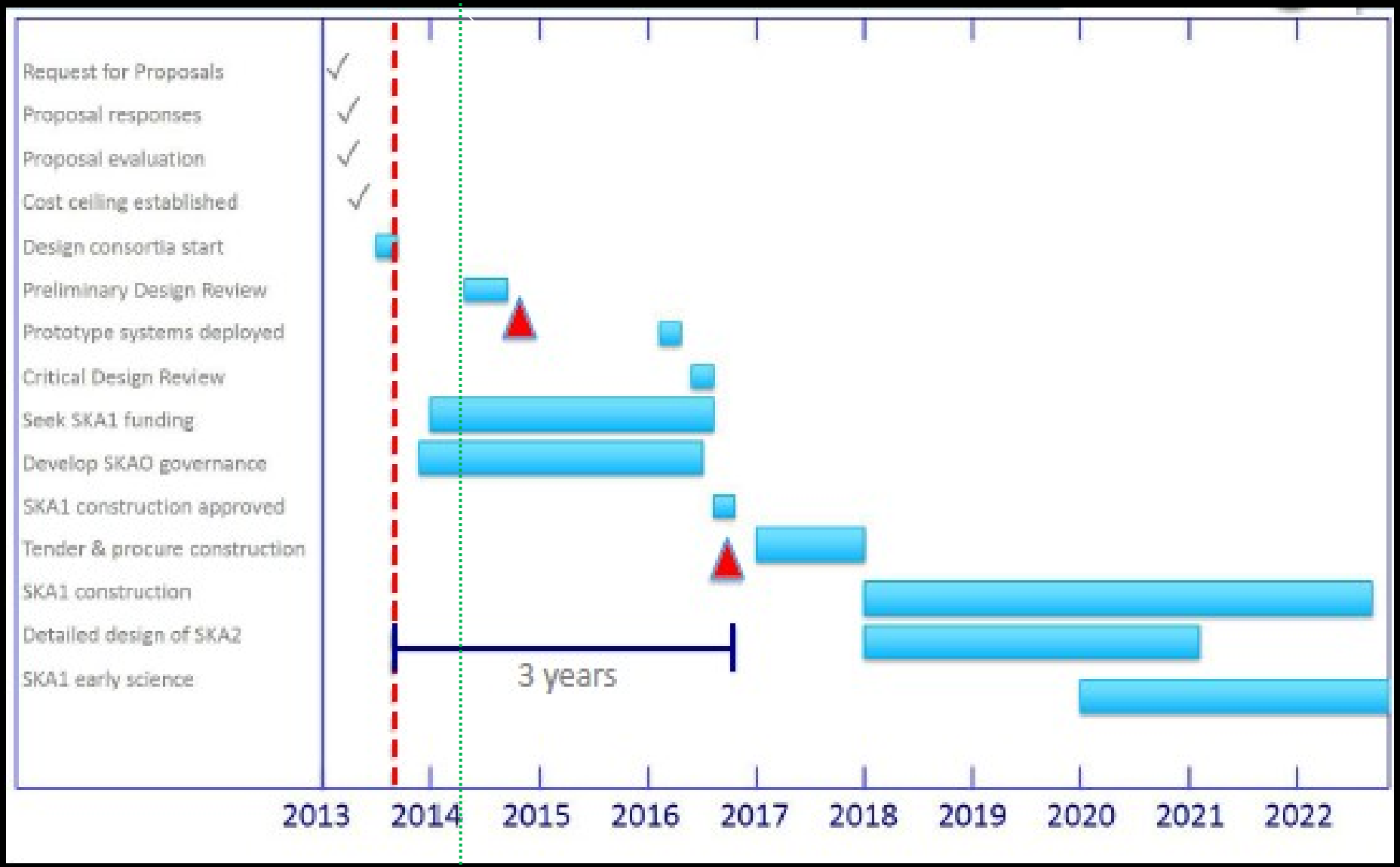
SKA-I : Work Packages

- Following are led by SKA Office :
  - Management
  - Science
  - System Design and system engineering
  - Maintenance & Support and Operations
- Following are carried out by Work Package Consortia :
  - Dish Array
  - Aperture Arrays
  - Signal and Data Transport (including synchronisation and timing)
  - Central Signal Processor
  - Science Data Processor
  - Telescope Manager
  - Infrastructure, including power
  - Assembly, Integration and Verification
- Additional packages on Advanced Instrumentation Programmes (to be integrated with Dish & AA WPs) by WP Consortia :
  - Mid Frequency Aperture Array
  - Wide Band Single Pixel Feeds

SKA : Governance & Management



SKA : Timelines



Importance of the SKA

- The SKA will revolutionise astronomy with exotic science capabilities
- The SKA project will spawn new developments in many technology areas : antennas, signal transport, signal processing, computing, software, data archiving… ➔ the "IT telescope"
- Besides benefiting the astronomy community, the SKA project will generate significant opportunities for industry : structural, electronics, computing, software, infrastructure facilities etc.
- The SKA is a global collaborative project : every country with interest and expertise in astronomy is planning participation in the SKA in a big way
- It is imperative that India express its interest & stake its rightful claim to be part of this mega-project .
- We need to prepare the Indian astronomical community to be ready

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SKA
SQUARE KILOMETRE ARRAY

Thank You for your attention !