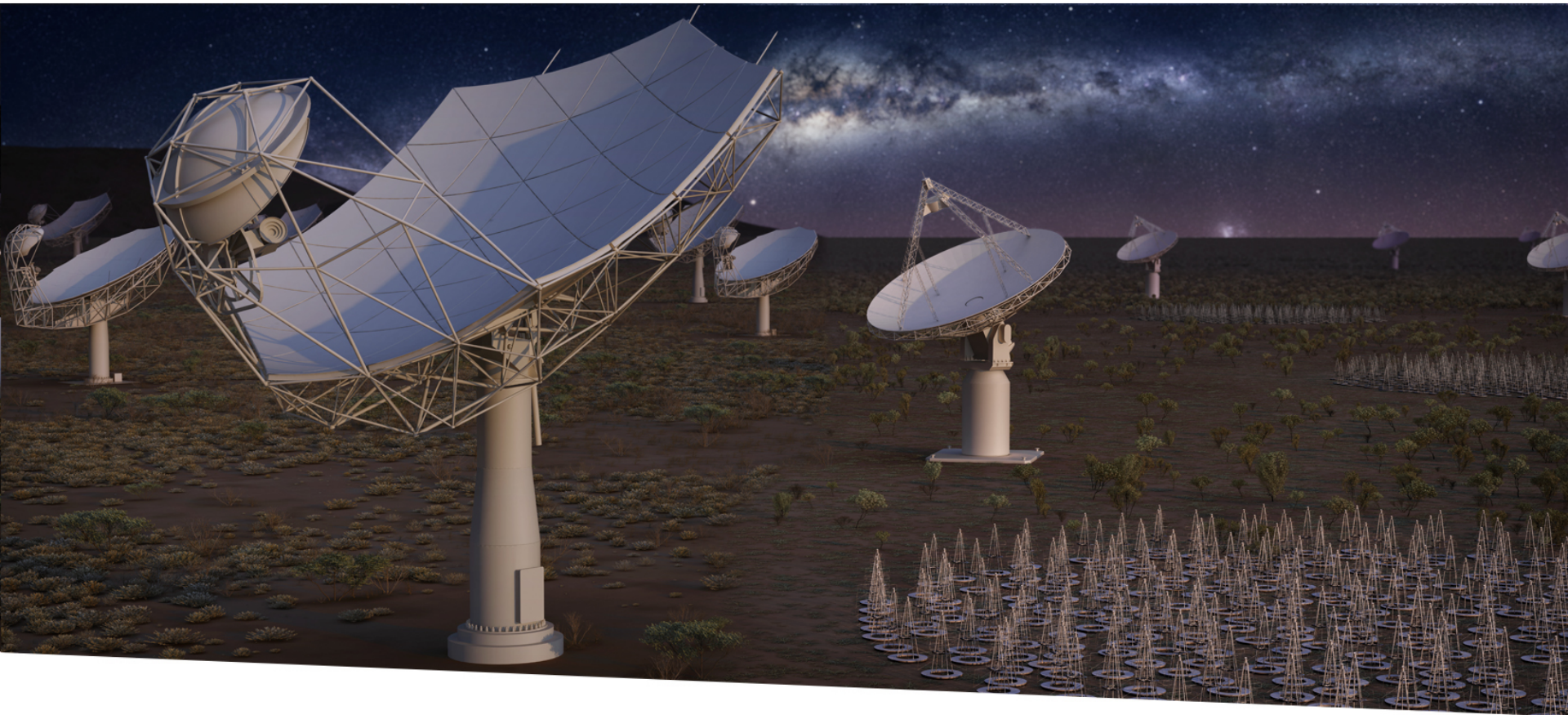


SKA1 Project Execution Plan

Shanghai Nov 2019



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

J. McMullin

25 Nov 2019

Outline

- Purpose
- Approach
- Structure
 - Components

PEP Purpose

Provide a succinct description of the construction project planning and processes by which the SKA1 project scope can be delivered within budget and schedule.

The Project Execution Plan refers to:

- A parent document (SKA-TEL-SKO-0001100) which provides a broad summary of the plan but mainly refers to other documents for detailed information.
- The confederation of documents that together realise the overall execution scope and plan for the SKA1 construction.

The Project Execution Plan is a resource whose intended audience is the Project staff who will execute the plan; as such, it must provide sufficient detail to inform that execution and to ensure alignment across areas to achieve the SKA1 mission.

PEP: Approach and Scope

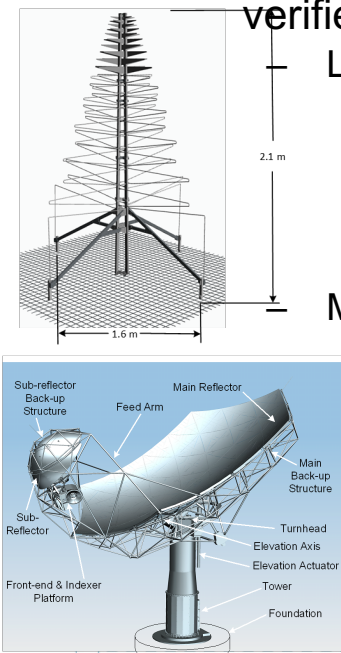
- ISO standard 21500: Guidance on Project Management
- Scope of SKA1 project is as set out in the Design Baseline Description and the PEP suite of documents, in particular the WBS Dictionary
- Start of construction, T0: approval of Construction Proposal and the Construction and Operations Plans by the SKA Observatory Council and provision of sufficient funds
 - Key dependency on ratification of the SKA Treaty by member countries, followed by Entry into Force and organisational transition
- End of construction: successful Operations Readiness Reviews following the completion of the final Array Assembly (AA4) milestones for each telescope, requiring the following verified science capabilities

LOW

- Demonstrate imaging with full LOW array; optimised direction-dependent calibration.
- Demonstrate pulsar search, pulsar timing and dynamic spectrum with multiple beams.
- Demonstrate commensal imaging and transient search.
- Demonstrate full end-to-end operation, including proposal submission, scheduling block generation, scheduling array and data processing, data processing at full scale, data delivery to Regional Centres.

MID

- Demonstrate imaging with full MID array including MeerKAT dishes in Bands 1 and 2 and with all SKA1 dishes in Band 5.
- Demonstrate pulsar search, pulsar timing and dynamic spectrum with multiple beams.
- Demonstrate commensal imaging and transient search.
- Demonstrate full end-to-end operation, including proposal submission, scheduling block generation, scheduling array and data processing, data processing at full scale, data delivery to Regional Centres.



PEP Exclusions

- Pre-Construction activities, i.e. work prior to T0
- SKAO activities in the “Business Enabling” budget
- SKAO activities in the “Development” budget
- SKAO activities in the “Operations” budget such as maintenance and repair of accepted products, including those in the construction period
- Provisions under the Hosting Agreements
 - Australia: Science Operations and Engineering Operations Centres (SOC & EOC - both new build or lease) and Science Processing Centre (SPC - expansion of existing facility) and a new power station
 - South Africa: SOC (new build or lease), EOC (expansion of existing facility) and SPC (new build)
- Inflation and currency fluctuations after 2017
- Tax

Project Execution Plan structure



Document Component	SKA Project Document Location
1 Introduction	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0000007 Science Requirements (L0) SKA-TEL-SKO-0000307 SKA1 Operational Concept Document (L0) Description of scientific objectives and impacts motivating the proposal.
2 Organization	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of Internal and External Organisation, Governance and Communications (including key roles and responsibilities) as well as staffing plans.
3 Design and Development	SKA-TEL-SKO-0001075 Design Baseline Document Brief summary of Pre-Construction Design Development phase; link to Design Baseline Description.
4 Construction Project Definition	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0001101 SKA1 WBS Dictionary SKA-TEL-SKO-0001102 SKA1 Project Management Baseline Cost Book SKA-TEL-SKO-0001103 SKA1 Integrated Project Schedule SKA-TEL-SKO-0001104 SKA1 Risk Register Description of WBS, Scope Management plans, cost estimating plans, cost reports and baseline budget, funding profile, baseline schedule and all contingencies.
5 Risk and Opportunity Management	SKA-TEL-SKO-0001200 SKA1 Project Management Controls System SKA-TEL-SKO-0001204 SKA1 Risk Register Description of Risk Management Plan and Contingency Management Plan.
6 Project Engineering	SKA-TEL-SKO-0001201 SKA1 SKA1 Engineering Management Plan Description of the planning and methodology (processes, procedures) and overall approach for the delivery of the engineering project scope to the observatory.
7 Configuration Control	SKA-TEL-SKO-000120 SKA Configuration Management Plan SKA-TEL-SKO-0001200 Project Management Controls System Description of the configuration management and both change control and document control plans and processes.
8 Acquisitions	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-GOV-0000069 SKAO Procurement Policy Description of acquisition plans, processes and contracting strategy, including time-phased list of acquisitions and procurement actions. Project approval process for acquisitions. We note this points directly to the Observatory Procurement Policy & Procedures.

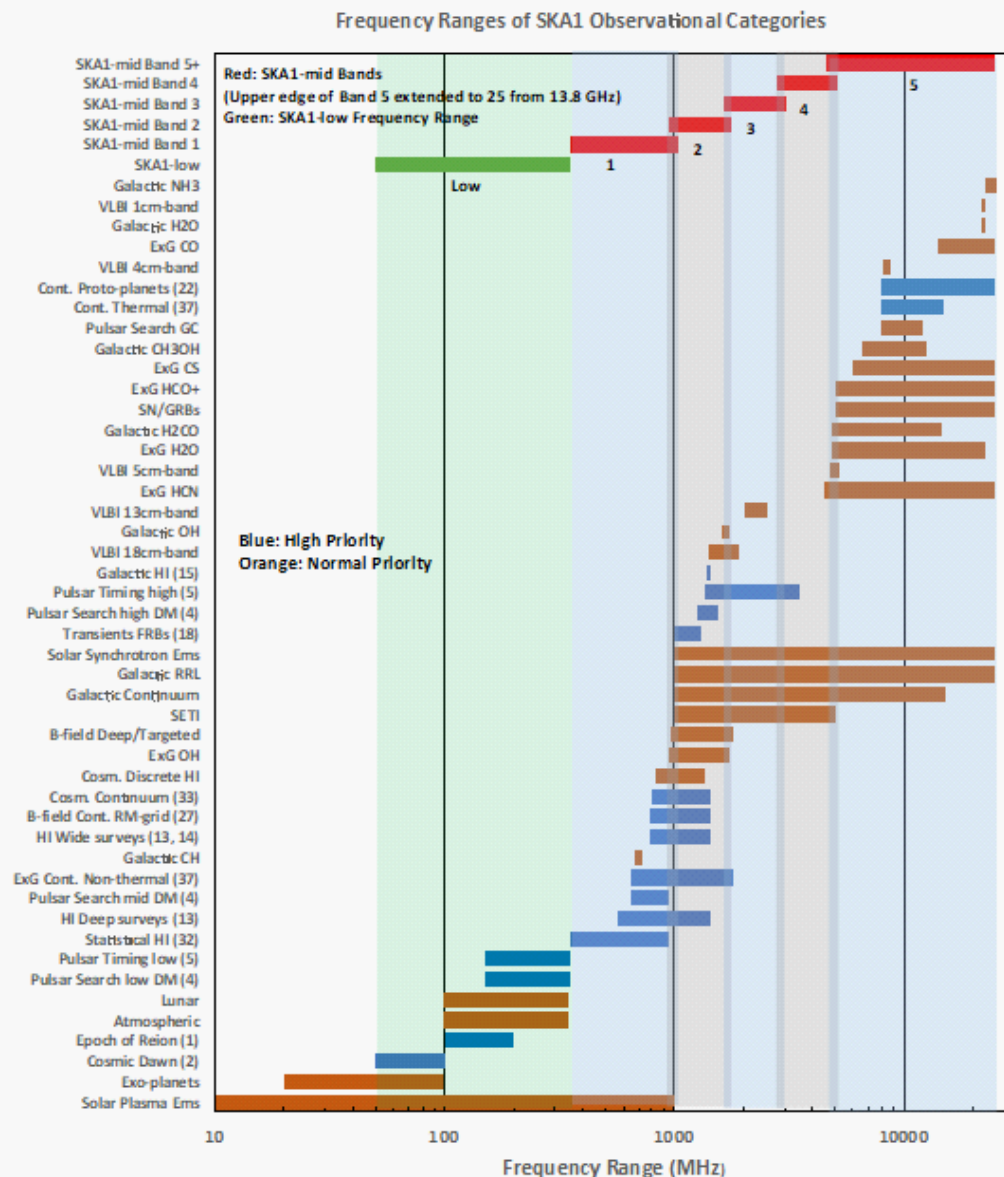
9 Project Management Controls	SKA-TEL-SKO-0001200 SKA1 Project Management Controls System Description of project management organization and processes including EVMS and Financial and Business Controls.
10 Site	SKA-TEL-SKO-0001040 South Africa Site Information and Instructions SKA1 Mid SKA-TEL-SKO-0001041 Australia Site Information SKA1 Low Summary of site environments and all permitting and compliance management aspects.
11 Computing and Software	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan Plan for maintaining security of data, hardware and networks during all stages of the project life cycle; plans for writing, testing and verifying, deploying and documenting software including configuration control during the stages of development.
12 Safety, Health and Environment	SKA-TEL-SKO-0000740 SKAO Health, Safety and Environmental Management Plan Description of the Health, Safety and Environmental strategy during all stages of observatory life cycle; includes context of SKAO, leadership, worker participation, planning support, competence, operational planning and control, performance evaluation, improvement, software and safety, functional safety, construction, AIV and HSE culture.
13 Quality/Product Assurance	SKA-TEL-SKO-0000739 SKA Product Quality Assurance Description of the PQA requirements and management activities during construction.
14 Review and Reporting	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of the planned reporting from the project to its oversight/stakeholders as well as regular planned reviews.
15 Integration and Commissioning	SKA-TEL-SKO-0001201 SKA1 Systems Engineering Plan SKA-TEL-SKO-0001350 SKA1 Science Commissioning and Verification Plan SKA-TEL-AIV-4430001-SE-DIVP-PLN-Rev2-Integration and Verification Plan for SKA1 Low SKA-TEL-AIV-44100001-SE-RP-MPL-Rev8-Roll-Out Plan for SKA1 Low SKA-TEL-AIV-24300001-SE-DIVP-PLN-Rev2-Integration and Verification Plan for SKA1 Mid SKA-TEL-AIV-24100001-SE-RP-MPL-Rev8-Roll-Out Plan for SKA1 Mid Detailed planning and procedures to perform and verify the system performance against both the Level 1 and the Level 0 requirements (for a subset of identified observing modes).
16 Project Close-out	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Note the close-out of the construction phase and the handling of the observatory decommissioning phase and responsibilities as

Introduction

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1 Introduction	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0000007 Science Requirements (L0) SKA-TEL-SKO-0000307 SKA1 Operational Concept Document (L0) Description of scientific objectives and impacts motivating the proposal.



- Breadth of science sets the engineering design
- Science Requirements & Operational Concepts flow to the System Technical Requirements



Science Drivers and Requirements

Cradle of Life

Cosmology and the Cosmic Dawn/EOR

Evolution of Galaxies

Strong-field tests of gravity; transient radio sky

Exploring the unknown

High Spatial, Spectral & Temporal Resolution

Imaging Sensitivity, Speed, Pulsar Search/Timing

Polarimetry

Broad Frequency Coverage

IMPACT

- Understand how rocky planets form
- Understand the origins of life
- Understand exoplanet characteristics

IMPACT

- Understand the first 700 M years of the universe
- Understand when the first stars formed

IMPACT

- Understand how galaxies replenish their gas
- Understand relationship between HI and AGN

IMPACT

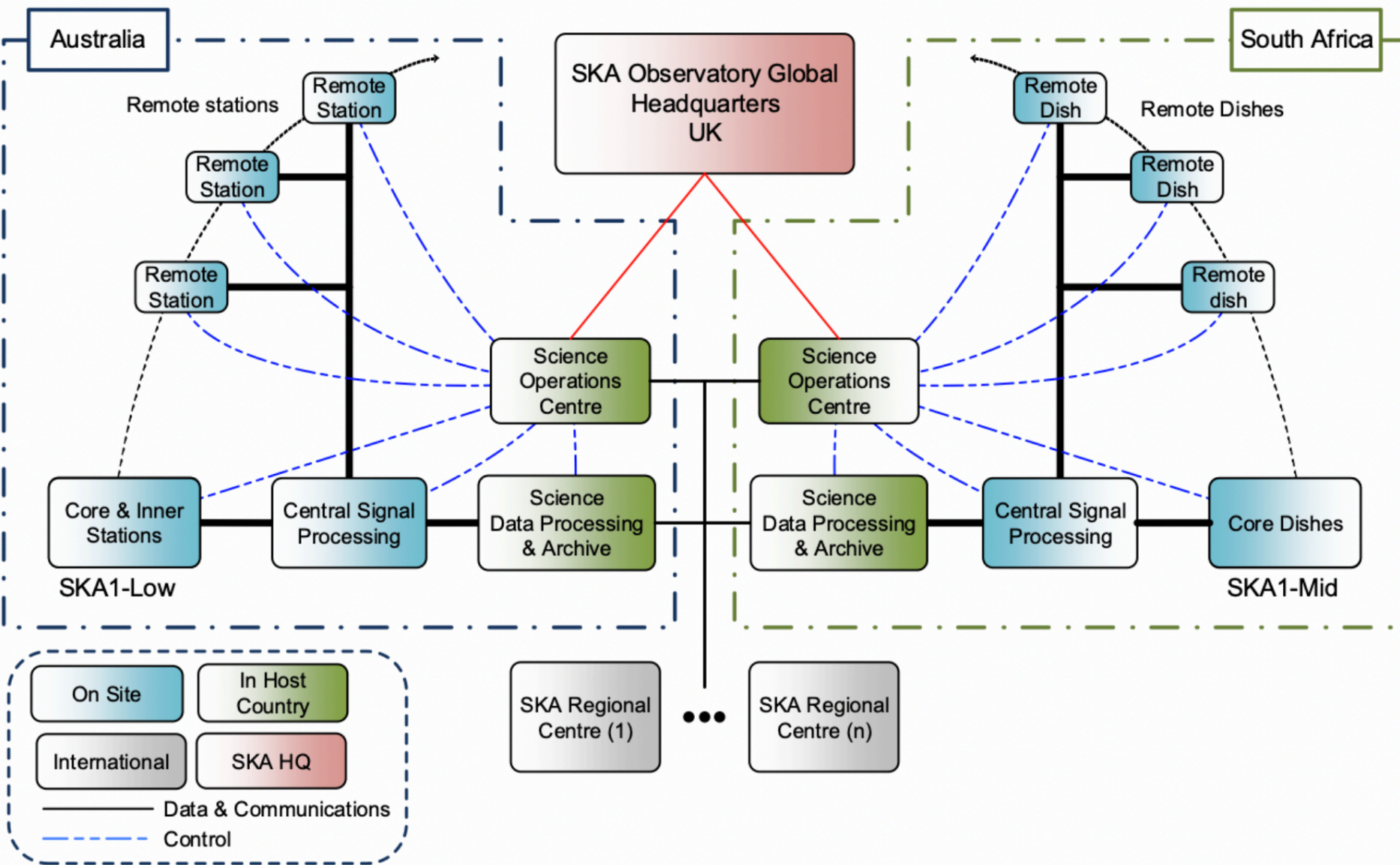
- Understand gravity in extreme environments
- Understand multi-messenger astrophysics

IMPACT

- Open new radio science windows
- Provide next generation radio telescope

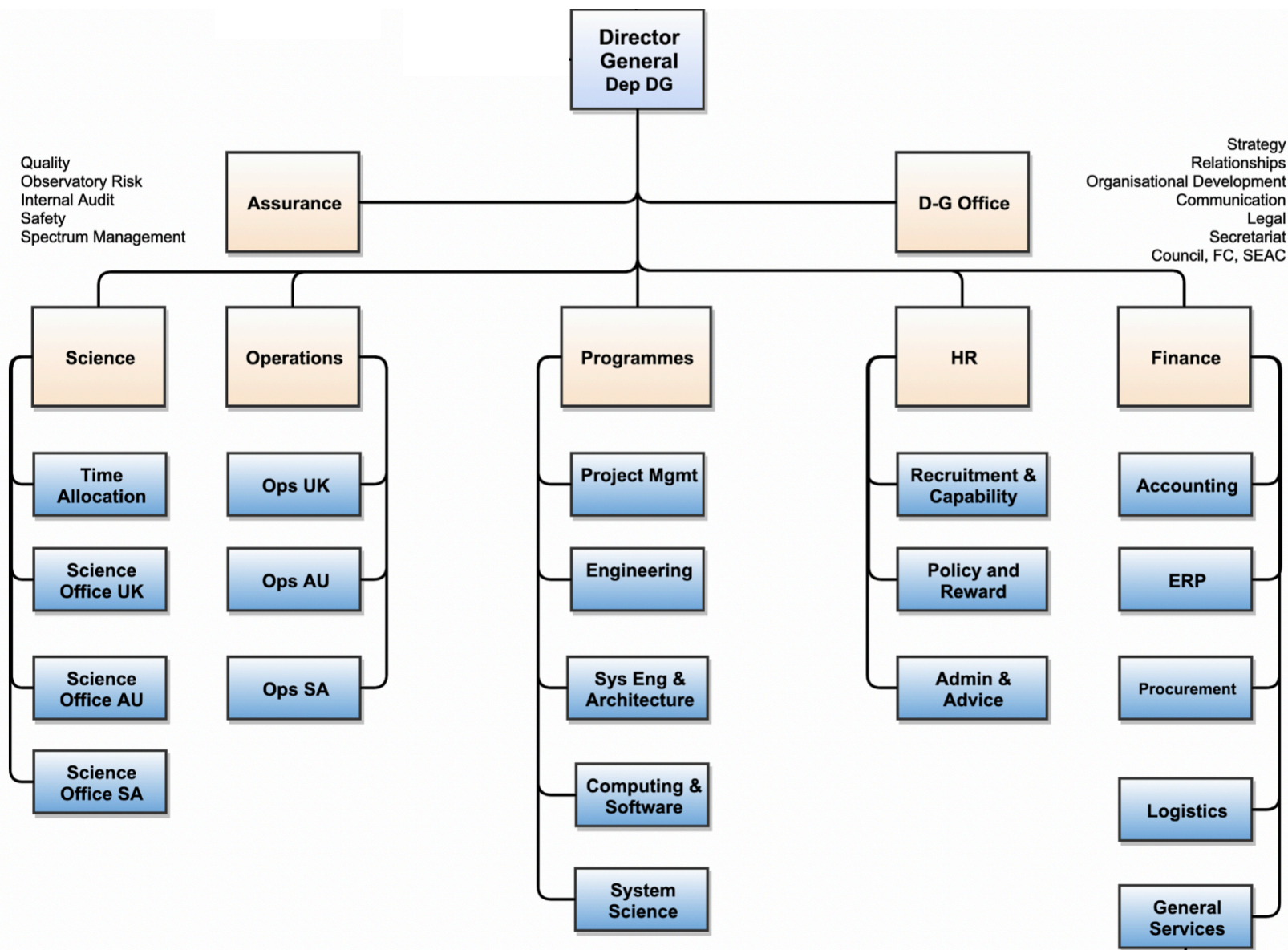
Organisation

Document Component	SKA Project Document Location
2 Organization	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of Internal and External Organisation, Governance and Communications (including key roles and responsibilities) as well as staffing plans.



Organisation

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Design

Document Component	SKA Project Document Location
3 Design and Development	SKA-TEL-SKO-0001075 Design Baseline Document Brief summary of Pre-Construction Design Development phase; link to Design Baseline Description.



- Summary of the Baseline Design
 - Stringhetti: Overall Design & Budgets
 - Labate: Low
 - Swart: Mid
 - Bassem: Signal Chain Performance
 - Rees: Software Development, SAFe

Project Definition

Document Component	SKA Project Document Location
4 Construction Project Definition	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0001101 SKA1 WBS Dictionary SKA-TEL-SKO-0001102 SKA1 Project Management Baseline Cost Book SKA-TEL-SKO-0001103 SKA1 Integrated Project Schedule SKA-TEL-SKO-0001104 SKA1 Risk Register Description of WBS, Scope Management plans, cost estimating plans, cost reports and baseline budget, funding profile, baseline schedule and all contingencies.



- WBS Dictionary – SKA-TEL-SKO-00001101
- Cost estimate – SKA-TEL-SKO-00001102
- Schedule – SKA-TEL-SKO-00001103
- Risks – SKA-TEL-SKO-00001104

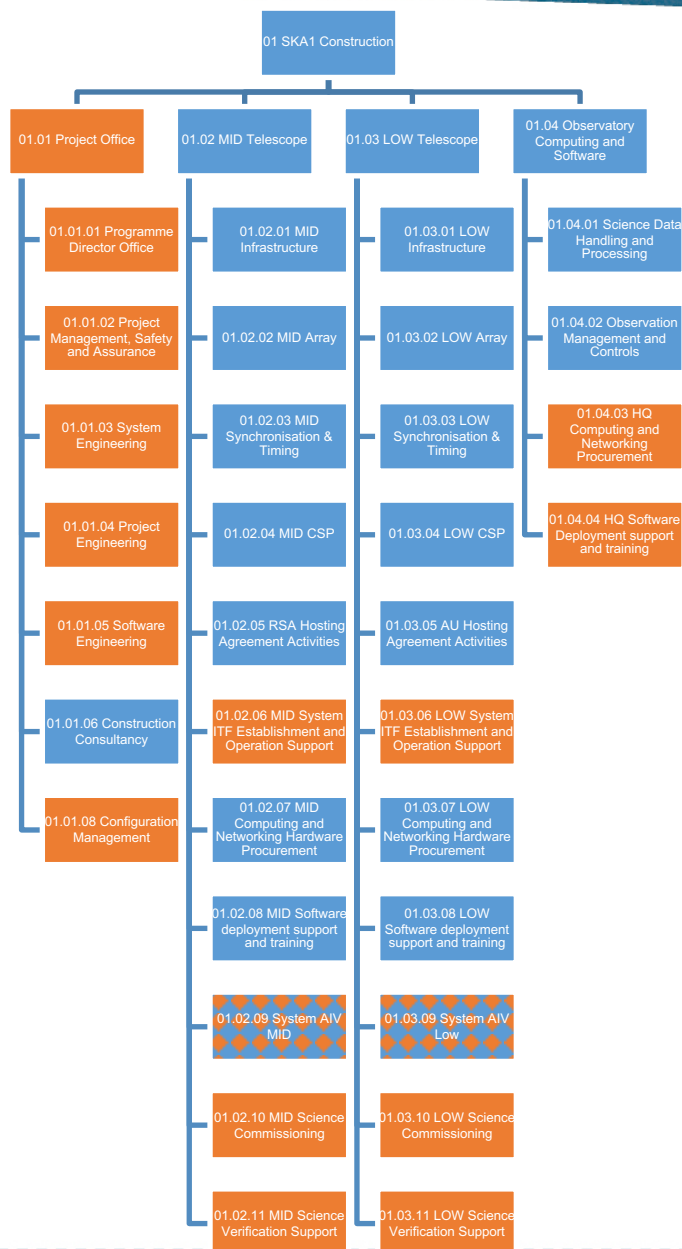
WBS to L3

Orange = SKA-delivered/led, in construction support budget

Blue = Member-delivered, via contracts, in capital cost of construction budget

Orange/blue = SKA-led, in capital cost of construction budget

PBS fully mapped to WBS



In general, Mid and Low specific work is contained within 01.02 and 01.03 whilst 01.01 and 01.04 contain Observatory level work common to both telescopes

Schedule – key milestones



Key project milestone	Designation (scale)	LOW Telescope	MID Telescope
Start of construction	T0	1 st January 2021	1 st January 2021
Earliest start of major contracts	C0	1 st July 2021	1 st July 2021
Array Assembly 1 science commissioning complete	AA1 (18 stations / 8 dishes)	October 2024	January 2025
Array Assembly 2 science commissioning complete	AA2 (64 stations / 64 dishes)	November 2025	February 2026
Array Assembly 3 science commissioning complete	AA3 (256 stations / 128 dishes)	October 2026	November 2026
Array Assembly 4 science commissioning complete	AA4 (512 stations / 197 dishes)	August 2027	August 2027
Operations Readiness Review complete	ORR	September 2027	September 2027
End of Construction		September 2028	September 2028

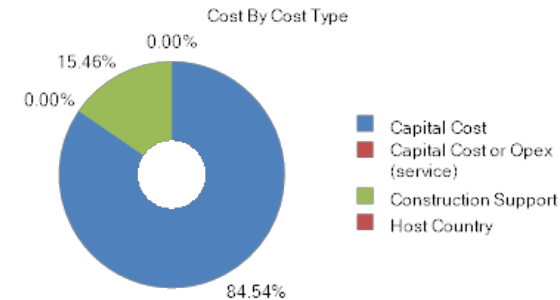
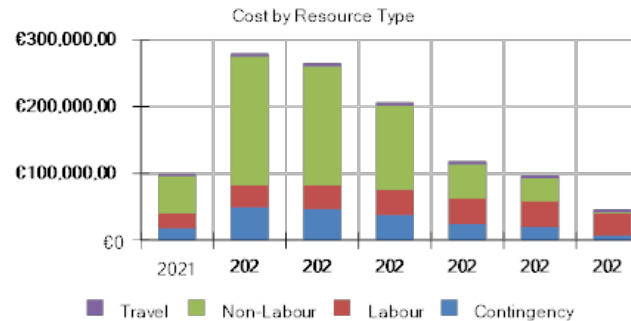
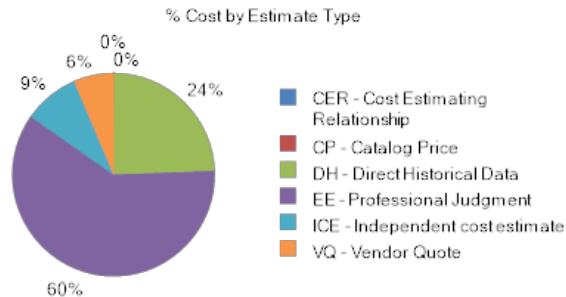
Design Baseline scope

Schedule contingency added at end as a block

Cost estimate



01 Square Kilometre Array Estimate Type with Cost Profile by Work Breakdown Structure (WBS)



Time Phased Cost by Resource Type

	2021	2022	2023	2024	2025	2026	2027	Total
Contingency	€18,226,194	€49,857,858	€47,078,597	€38,209,015	€24,362,185	€20,224,585	€7,323,481	€205,281,915
Labour	€22,154,442	€32,843,699	€35,130,299	€37,604,693	€38,839,334	€38,677,008	€32,989,386	€238,238,861
Non-Labour	€55,970,532	€192,443,774	€178,272,958	€125,444,014	€50,589,137	€33,987,069	€1,799,743	€638,507,226
Travel	€2,647,878	€3,197,944	€3,653,727	€3,679,478	€3,672,967	€3,633,833	€3,132,788	€23,618,614
Total	€98,999,046	€278,343,275	€264,135,581	€204,937,200	€117,463,623	€96,522,495	€45,245,397	€1,105,646,617

Time Phased Cost by Cost Type

	2021	2022	2023	2024	2025	2026	2027	Total
Capital Cost	€0	€0	€0	€0	€0	€0	€0	€1
Capital Cost or Opex (service)	€64,870,041	€211,061,701	€197,740,581	€145,365,283	€70,958,849	€54,155,321	€16,979,884	€761,131,661
Construction Support	€15,902,809	€17,423,713	€19,316,400	€21,362,900	€22,142,589	€22,142,589	€20,942,032	€139,233,031
Contingency	€18,226,194	€49,857,858	€47,078,597	€38,209,015	€24,362,185	€20,224,585	€7,323,481	€205,281,915
Host Country	€1	€3	€2	€1	€0	€0	€0	€7
Total	€98,999,046	€278,343,275	€264,135,581	€204,937,200	€117,463,623	€96,522,495	€45,245,397	€1,105,646,617

- All 2017 Euros, escalation to be added for Construction Proposal version
- Design Baseline scope
- Bottom-up contingency estimate here, based on risk factoring, is Euro 205M
- Contingency spend profile from risk register will be used

Risk Management



Document Component	SKA Project Document Location
5 Risk and Opportunity Management	SKA-TEL-SKO-0001200 SKA1 Project Management Controls System SKA-TEL-SKO-0001204 SKA1 Risk Register Description of Risk Management Plan and Contingency Management Plan

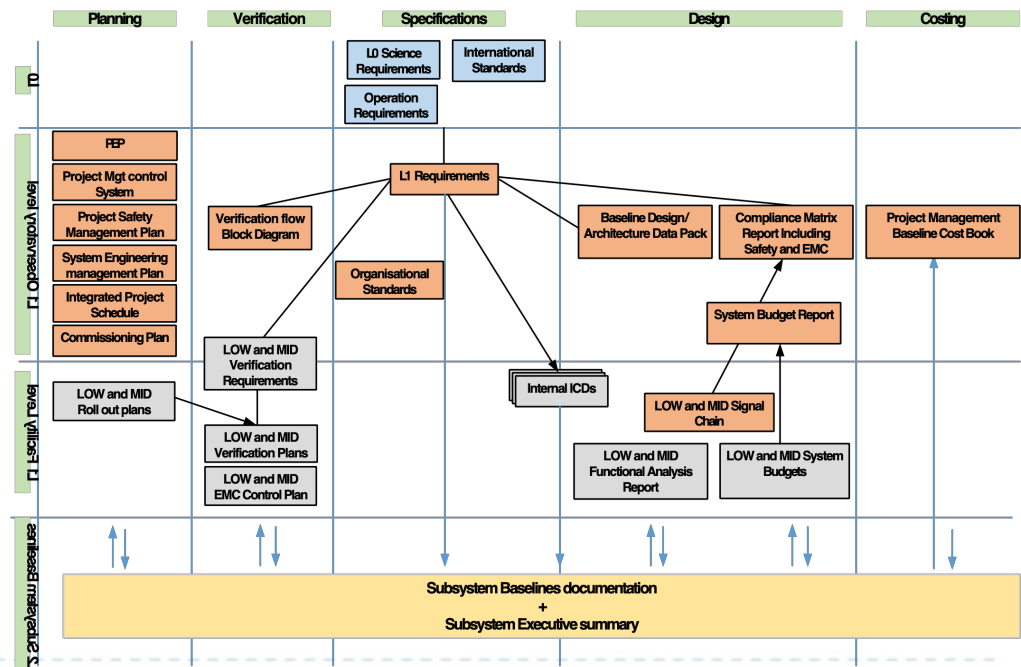
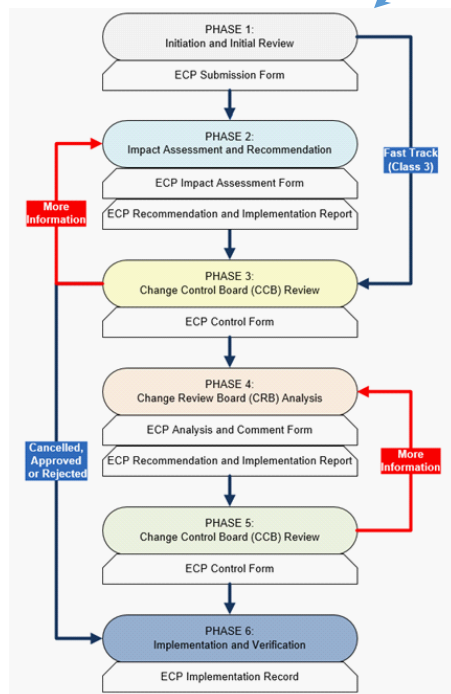
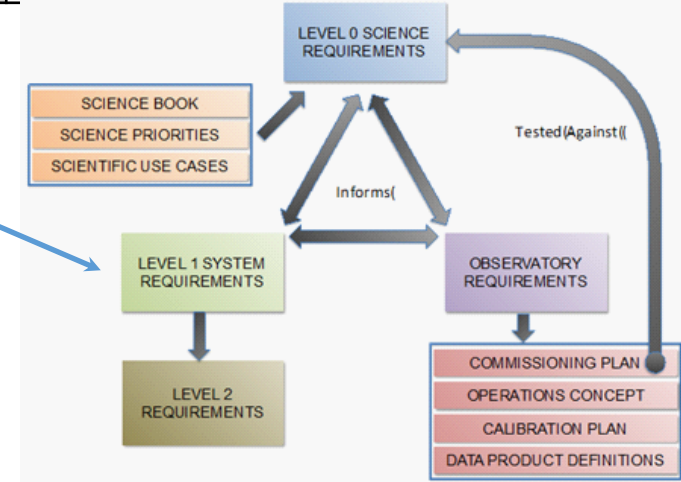
WBS area	Number of risks	Risk exposure €M
01 SKA1	24*	126
01.01 Project Office	5	4
01.02 MID Telescope	20	16
01.03 LOW Telescope	17	28
01.04 Observatory Computing and Software	14	11
Totals	80	185

- Identification of risks via: consortia E-CDR risk registers, project-level risk register, planning workshops and checklists
- Only construction phase risks for delivery of WBS included
- Corporate risks not included
- Risk exposures estimated for T0, start of construction, assuming risk reduction activities remaining in Pre-Construction are successful
- *Many risks still at project level, some to be decomposed later
- Risk Register is a live document
- Probability-weighted risk exposure of Euro 185M (21%) compares with bottom-up WBS risk factoring contingency total of Euro 205M (23%)
- Reference case projects suggest a contingency of Euro 180 – 270M (20% – 30%)
- Monte Carlo analysis on the risks @ 80% probability of success results in a contingency total of Euro 244M (27%)

Project Engineering

- System Engineering
 - Requirements management and flow-down.
 - Document tree, including ICDs.
 - Engineering Change Procedure.

Document Component	SKA Project Document Location
6 Project Engineering	SKA-TEL-SKO-0001201 SKA1 SKA1 Engineering Management Plan
	Description of the planning and methodology (processes, procedures) and overall approach for the delivery of the engineering project scope to the observatory.



Project Engineering

Document Component	SKA Project Document Location
6 Project Engineering	SKA-TEL-SKO-0001201 SKA1 SKA1 Engineering Management Plan Description of the planning and methodology (processes, procedures) and overall approach for the delivery of the engineering project scope to the observatory.

- Caiazzo: Systems Engineering
- Rees: Software & SAFe

SKA Engineering Management Reconciliation

- SKA1 construction adopts a Project-level synchronisation cadence of 3 months, following from the SAFe practice. This synchronisation enforces an alignment in priorities between all development areas.
- SKA1 construction adopts a Project-level reporting cadence of 1 month (aligned with the Program Increment 3 month cadence) for review and communication of status and KPIs (earned value, risk exposure, estimate-to-complete, etc).
- SAFe Agile Teams work with the Product Delivery Teams to ensure successful integration of component/subsystem hardware and software, often delivering to the Product Delivery Teams.
- SAFe Agile Release Trains works with the Product Delivery Teams and the Telescope Delivery Teams to ensure integration across the different SAFe teams at all levels.
- Observatory Level Integration will occur through the Observatory Delivery Team.

The distinction between work packages in which SAFe is applied versus the lean engineering will be apparent through:

- Management process incorporates SAFe roles and responsibilities for their management (i.e., Release Train Engineer, Product Management, Architect guidance vs. Product Delivery Team guidance alone) but with many common review and reporting needs.
- Contracting structure (Time and Materials with elaborated work priorities vs SOW referencing specifications, etc; see Section 8 for details) coordinated through the Project-level alignment meetings.

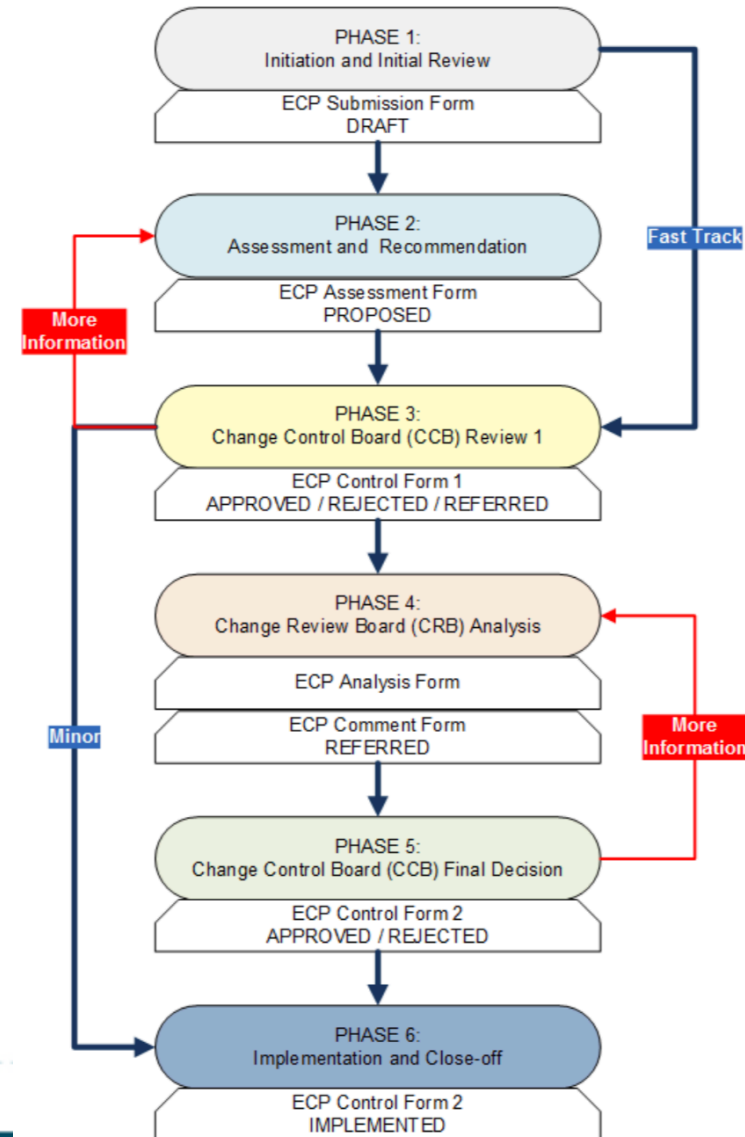
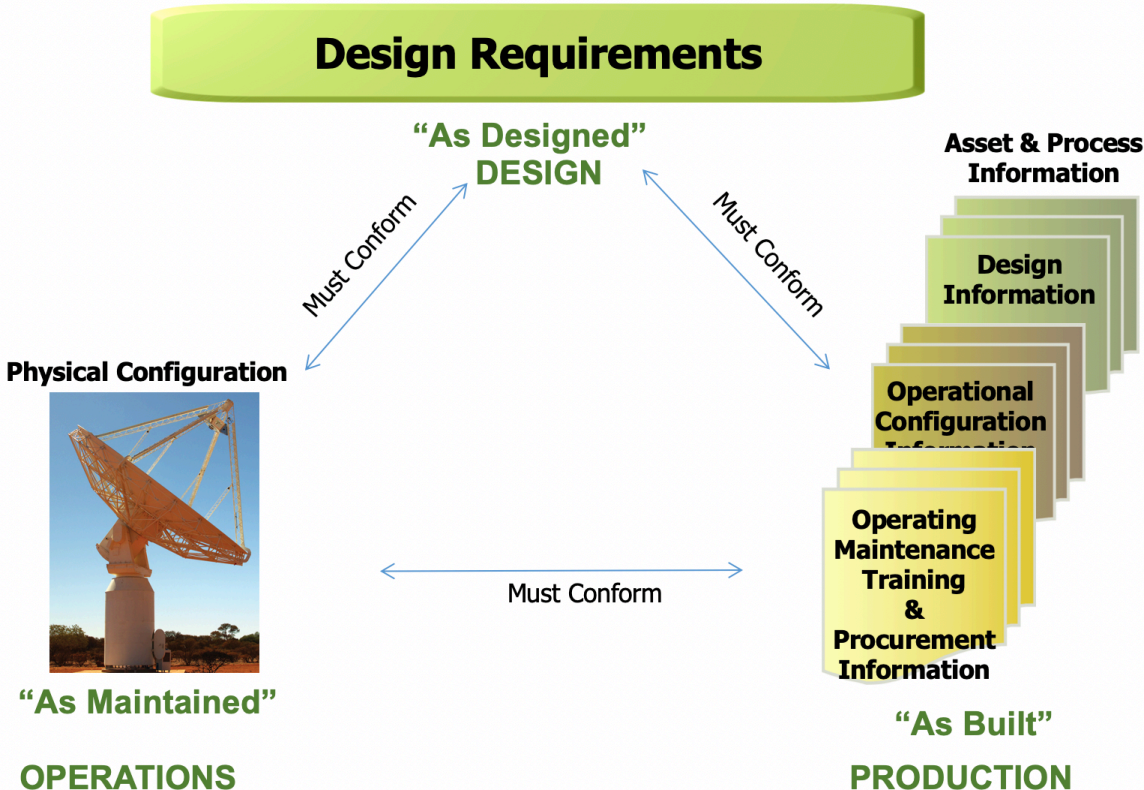
Configuration Control

Document Component	SKA Project Document Location
7 Configuration Control	SKA-TEL-SKO-000120 SKA Configuration Management Plan SKA-TEL-SKO-0001200 Project Management Controls System Description of the configuration management and both change control and document control plans and processes.



CM provides an infrastructure that can:

- (1) **accommodate change,**
- (2) **keep documented requirements clear, concise and valid**



Acquisitions

Document Component	SKA Project Document Location
8 Acquisitions	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-GOV-0000069 SKAO Procurement Policy Description of acquisition plans, processes and contracting strategy, including time-phased list of acquisitions and procurement actions. Project approval process for acquisitions. We note this points directly to the Observatory Procurement Policy & Procedures.



There are three fundamental processes for performing SKA1 construction scope:

- Self-performance: Work scope achieved through SKAO staff effort; labeled as Construction Support (entails work activities, engineering and management throughout construction)
- Procurement: Work scope achieved through procurement process including contracting.
- In-kind: Work scope achieved through contributed in-kind effort.

Latter two processes cover the areas labeled as the Capital Cost of Construction

Acquisitions



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LOW AIV PSC1
LOW AIV PSC2
LOW CLOCKS
LOW CPF
LOW CSP
LOW DIGITISATION
LOW FIELD NODE
LOW INFRA 1
LOW INFRA 2
LOW INFRA 3
LOW INFRA 5
LOW INFRA 6
LOW INFRA PSC
LOW NETWORK
LOW SOFTWARE SUPPORT
LOW SPC
LOW TIMING
MeerKAT Integration PSC
MID AIV PSC1
MID AIV PSC2
MID BAND 1
MID BAND 2
MID BAND 5

MID CLOCKS
MID CPF
MID CRYO
MID CSP
MID DIGITISER
MID DISH PSC
MID DISH STRUCTURE
MID INFRA 1
MID INFRA 2
MID INFRA 3
MID INFRA 4
MID INFRA 5
MID INFRA 6
MID INFRA 7
MID INFRA PSC
MID NETWORK
MID SOFTWARE SUPPORT
MID SPC
MID SPF SERVICES
MID TIMING
OBS MGT (~6 contracts)
SCIENCE DATA HANDLING & PROCESSING (~6 contracts)

- Subject to ongoing CPTF negotiations
- 57 Tier 1s now, containing 127 workpackages (Tier 2s)
- Some PSCs, e.g. Infra, help SKAO manage other T1s
- T1s may be combined or split where this is beneficial for member country interests/Fair Work Return and this makes sense from the PM point of view

SKAO-CPTF-08.11_Procurement Model

Regardless, of the type of acquisition (cash vs. in-kind, competition vs allocation) a procurement documentation pack will be assembled according to the guidance in SKA-TEL-SKO-0000710 Technical Preparation for SKA1 Procurement:

- Statement of Work,
- Technical Specifications
- Interface definitions including all relevant ICDs
- Applicable Contract Drawings (if any)
- Verification plan
- Reference Design
- Applicable SKA Observatory Organisational standards
- Applicable National/International standards (also see Section 10 on Site Information).

The member country/institution will express interest and provide a proposal for the performance of the service/production of the product which is reviewed/pre-qualified by the observatory.

SKAO-CPTF-08.11_Procurement Model

- Overall, for the Capital Cost of Construction work scope, the acquisition process is organised according to a set of Tier 1 contracts which are NEC4 contracts (<https://www.neccontract.com/About-NEC/NEC4-suite-of-contracts>) between the SKAO and an institution for the delivery of a broad set of project scope.
- Underlying these Tier 1 contracts is the lower level work package decomposition provided within the dash360 representation of the Cost Book;
 - These have been referred to as the Tier 2 contracts which are anticipated to be sub-contracts between the Tier 1 leading institution and potentially another member country institution responsible for delivering components or subsystems to the Tier 1 lead.

Role and Responsibilities - SKAO

SKAO is client & overall systems integrator - core roles include:

1. **Engineering & Design**
 - telescope design authority – overall management of performance budgets and quality
 - manage interfaces between major system elements
2. **Contract Management**
 - source major system elements from Tier1 contractors
 - manage Tier1 contractor compliance
3. **Planning & logistics**
 - bring all the major system elements together at the right time and place
4. **Systems Integration**
 - integrate major system elements to deliver 2 telescopes
5. **Other Responsibilities**
 - overall change management
 - overall financial management and governance
 - overall custodianship and protection of the 2 host sites
 - Management of Fair Work Return

Responsible for the on-time and on-budget delivery of the overall observatory including two technically compliant SKA1 telescopes.

Role and Responsibilities – Tier1

Delivers a complete and compliant major system telescope element to SKAO - core roles include:

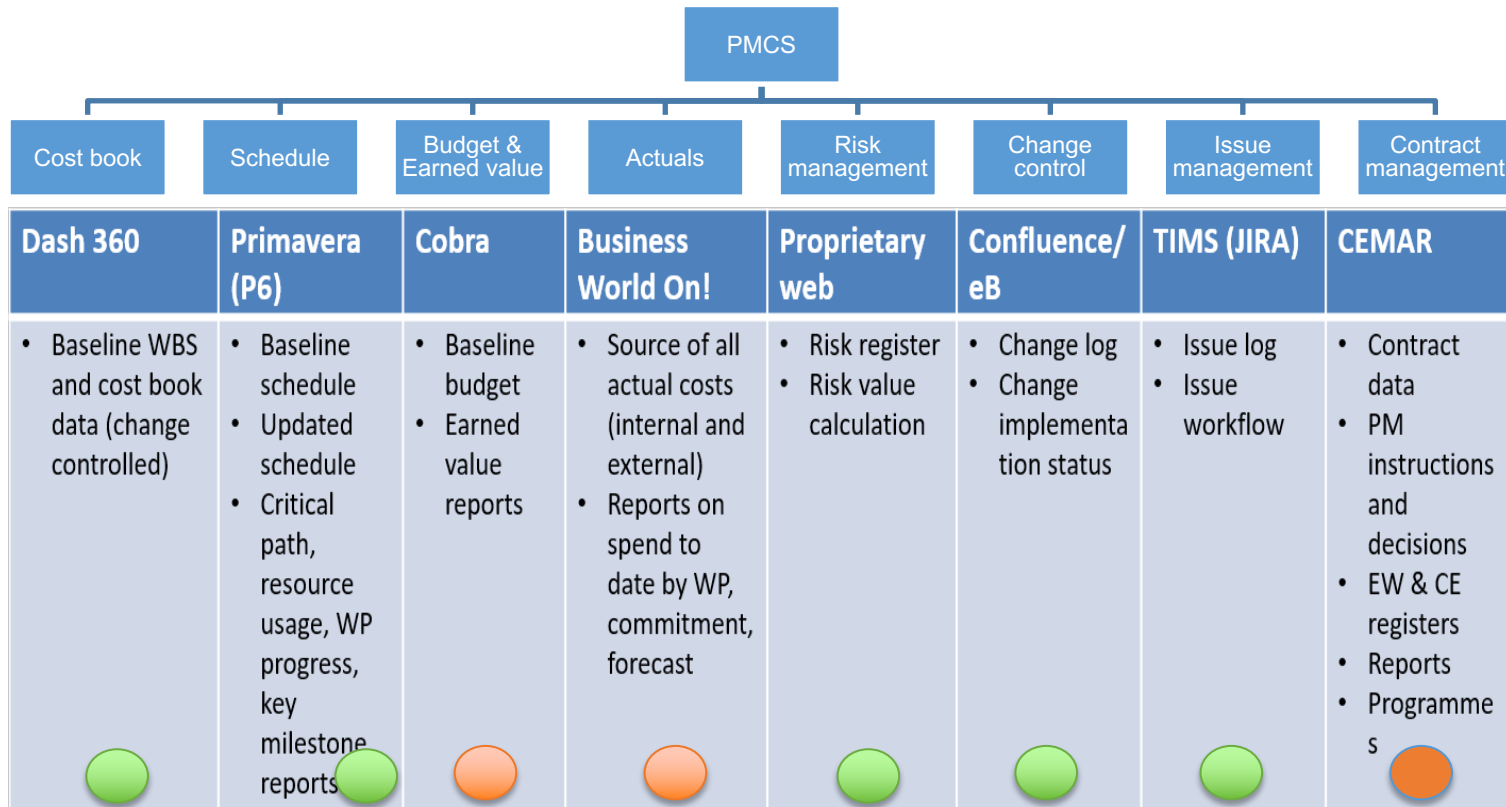
1. **Engineering & design**
 - finalise overall system element design (from reference provided by SKAO)
 - develop technical and programme requirements for Tier2 sub-contractors
 - manage all interfaces between sub-system elements
2. **Sub-contract management**
 - source sub-systems from Tier2 sub-contractors, including any specified by SKAO
 - manage Tier2 sub-contractor compliance
3. **Manufacturing**
 - Tier1 contractor *could* manufacture a significant sub-system in-house
4. **Integration**
 - Integrate all sub-systems into a finished system for delivery to SKA

Responsible for system element engineering, in-house manufacture of a sub-system, sub-contractor management, system integration & on-time delivery of a compliant telescope system.

PMCS

9 Project Management Controls

SKA-TEL-SKO-0001200 SKA1 Project Management Controls System
Description of project management organization and processes
including EVMS and Financial and Business Controls.



- All tools procured except CEMAR and Cobra
- Business World On! launched earlier this year for basic accounting
- Key interfaces will be between:
 - Primavera and Cobra (work performed vs budget)
 - Business World On! and Cobra (actual costs vs budget)

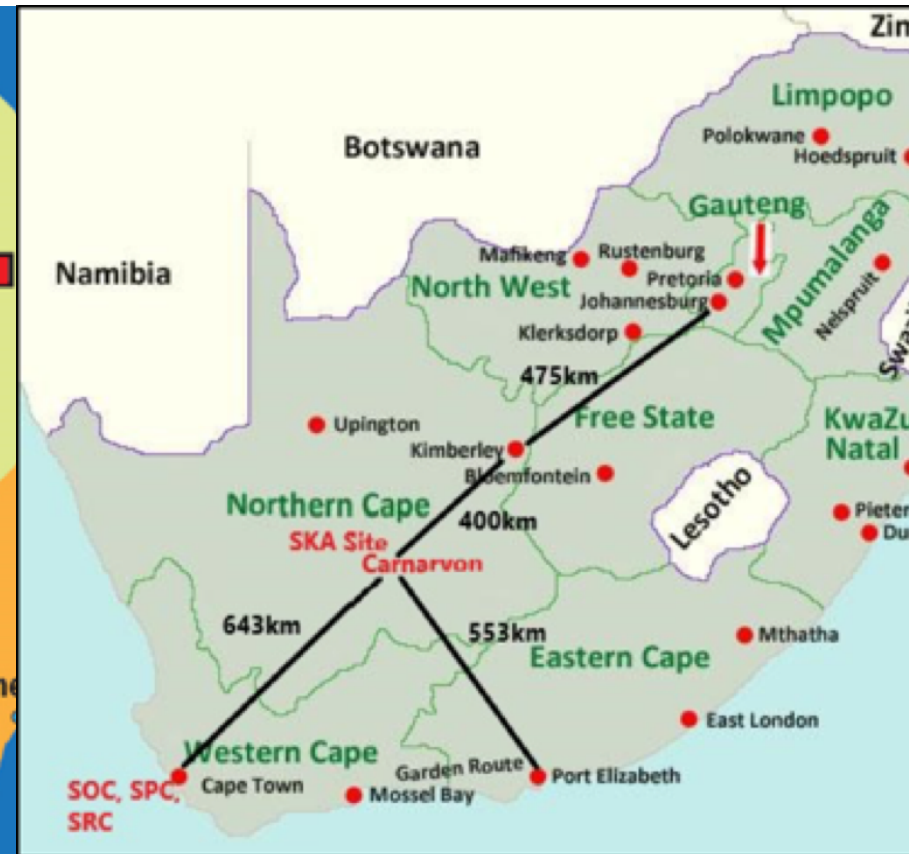
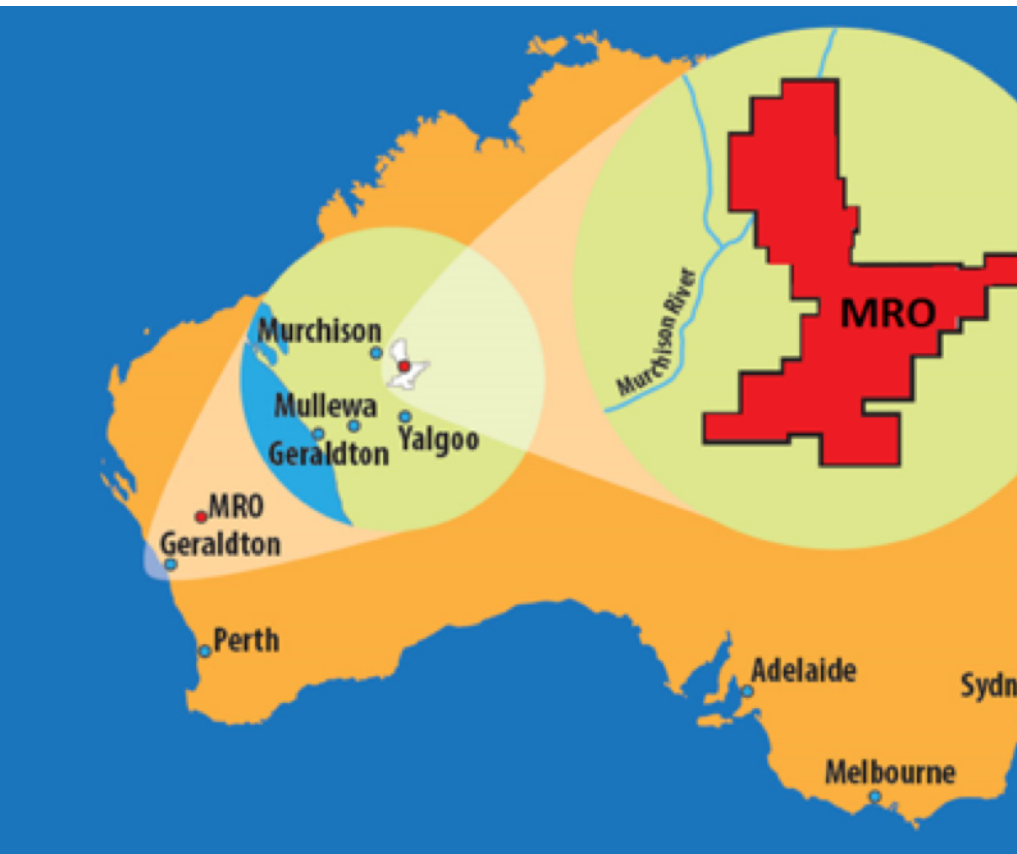
Site

10 Site

SKA-TEL-SKO-0001040 South Africa Site Information and Instructions SKA1 Mid
SKA-TEL-SKO-0001041 Australia Site Information SKA1 Low
[Summary of site environments and all permitting and compliance management aspects.](#)



Site Information Documents pull together the complex geographical, environmental, cultural and safety aspects of the sites.
Informs the contractor requirements.



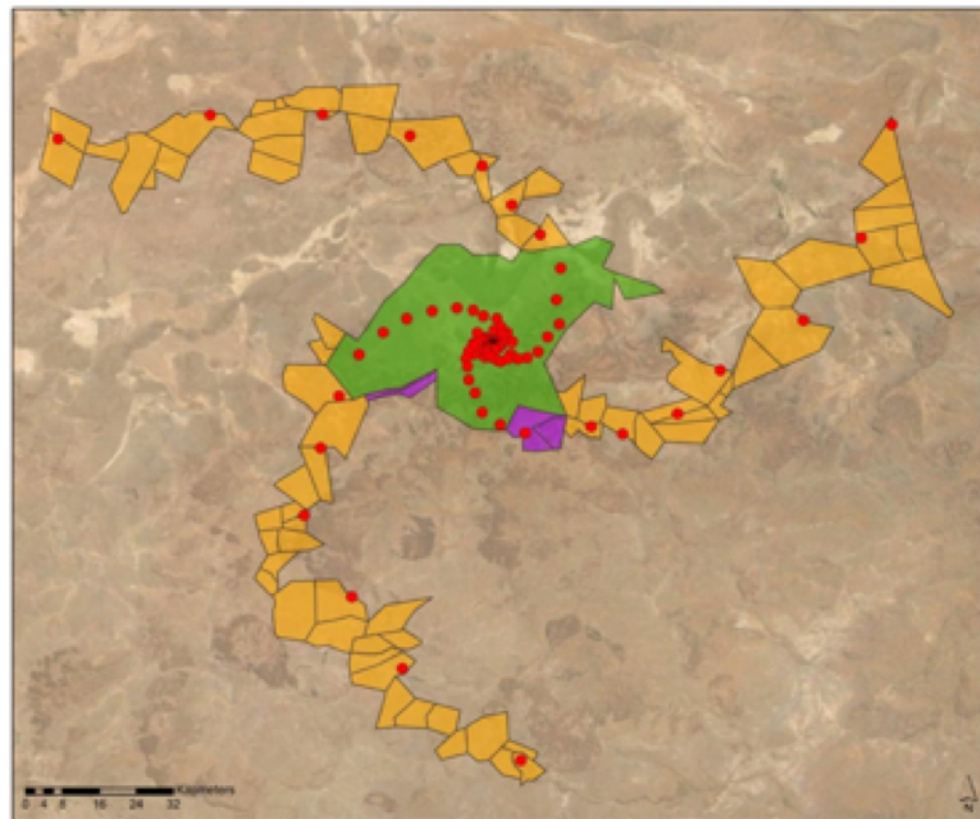
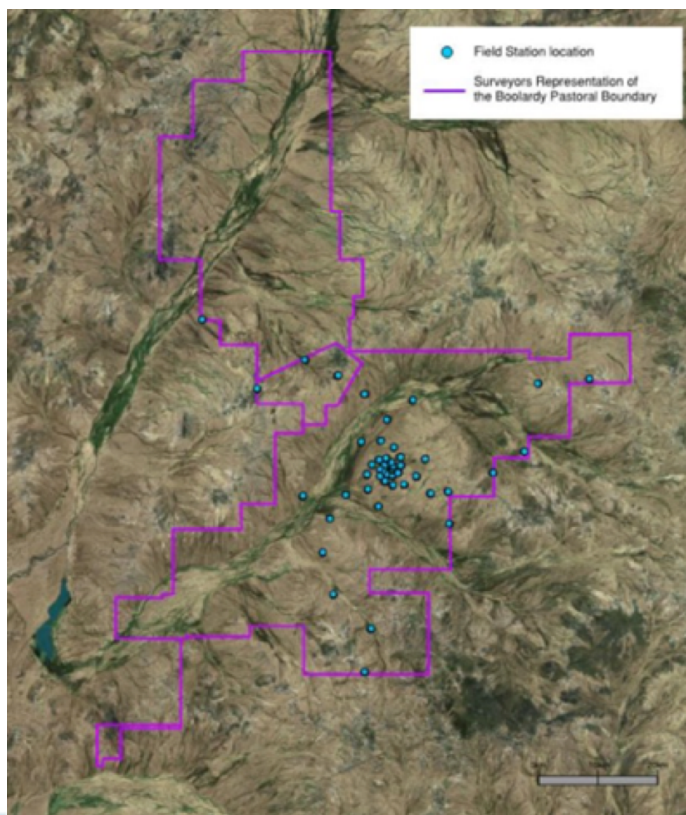
Site

10 Site

SKA-TEL-SKO-0001040 South Africa Site Information and Instructions SKA1 Mid
SKA-TEL-SKO-0001041 Australia Site Information SKA1 Low
[Summary of site environments and all permitting and compliance management aspects.](#)



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Computing

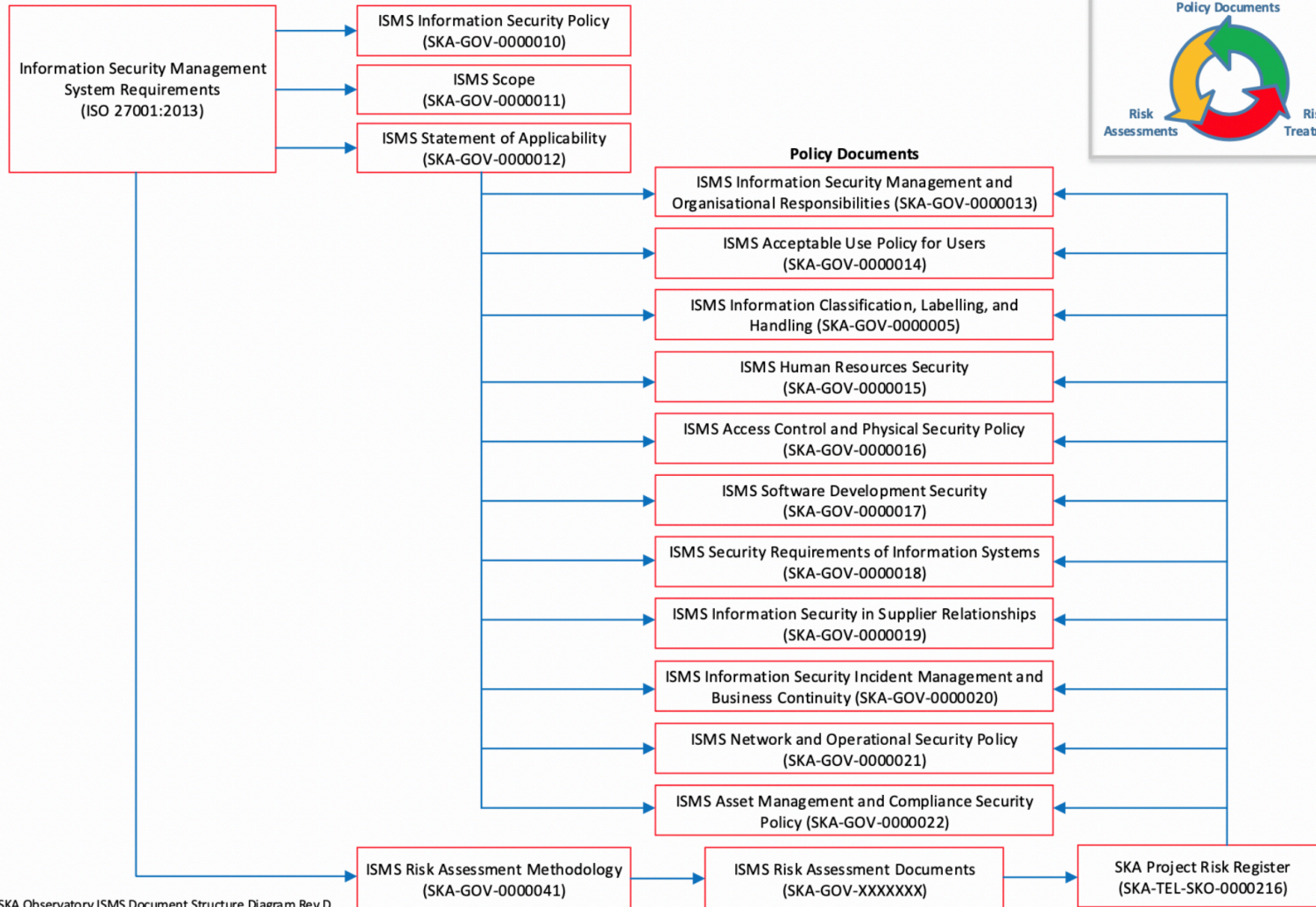
11 Computing and Software

SKA-TEL-SKO-0001100 SKA1 Project Execution Plan
SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan
Plan for maintaining security of data, hardware and networks during all stages of the project life cycle; plans for writing, testing and verifying, deploying and documenting software including configuration control during the stages of development.



SKA Observatory Information Security Management System Document Structure

Continuous Improvement Lifecycle



SKA Observatory ISMS Document Structure Diagram Rev D

Safety, Health & Environment

12 Safety, Health and Environment

SKA-TEL-SKO-0000740 SKAO Health, Safety and Environmental Management Plan

Description of the Health, Safety and Environmental strategy during all stages of observatory life cycle; includes context of SKAO, leadership, worker participation, planning support, competence, operational planning and control, performance evaluation, improvement, software and safety, functional safety, construction, AIV and HSE culture.



- SKAO HSE philosophy is to integrate good health and environmental performance as a core element in every planning, design and construction operation to achieve our aim of being safe and secure.
- The SKAO HSE Policy (SKA-GOV-000063) sets out our general approach to health and safety and environmental issues. It explains how we, as an employer, will manage health and safety in our business. This policy applies to all aspects of SKAO work and is implemented in the SKA1 project through the Project Execution Plan. Implementation by suppliers and industry partners is achieved through contracts and agreements developed by the SKAO in accordance with the Construction and Operations Plans.
- Our integrated SKAO HSE Plan (SKA-TEL-SKO-0000740) draws on requirements from Occupational Health and Safety Management Standard ISO 45001:2018 and Environmental Management Standard 14001:2015.
- The existing work of the SKA precursor and pathfinder telescope sites (ASKAP and MeerKAT) in the area of operational safety management is acknowledged and referenced with a view to incorporating best practice, lessons learned and coordination. Our HSE planning is also informed by similar plans from other major telescope projects.

South Africa - Occupational Health and Safety Act 1993

South Africa - Construction Regulations 2014

Australia - Work Health and Safety Act 2011

Australia - Work Health and Safety Regulation 2011

United Kingdom - Health & Safety at Work Act 1974

United Kingdom - Management of Health and Safety at Work Regulations 1999

South Africa - National Environmental Management Act (NEMA) 1998 and amendments

Australia - Environmental Protection and Biodiversity Conservation Act (EPBA Act) 1999,

Australia - Environmental Protection Act 1986 (WA) (EP Act)

United Kingdom - Environment Act 1995

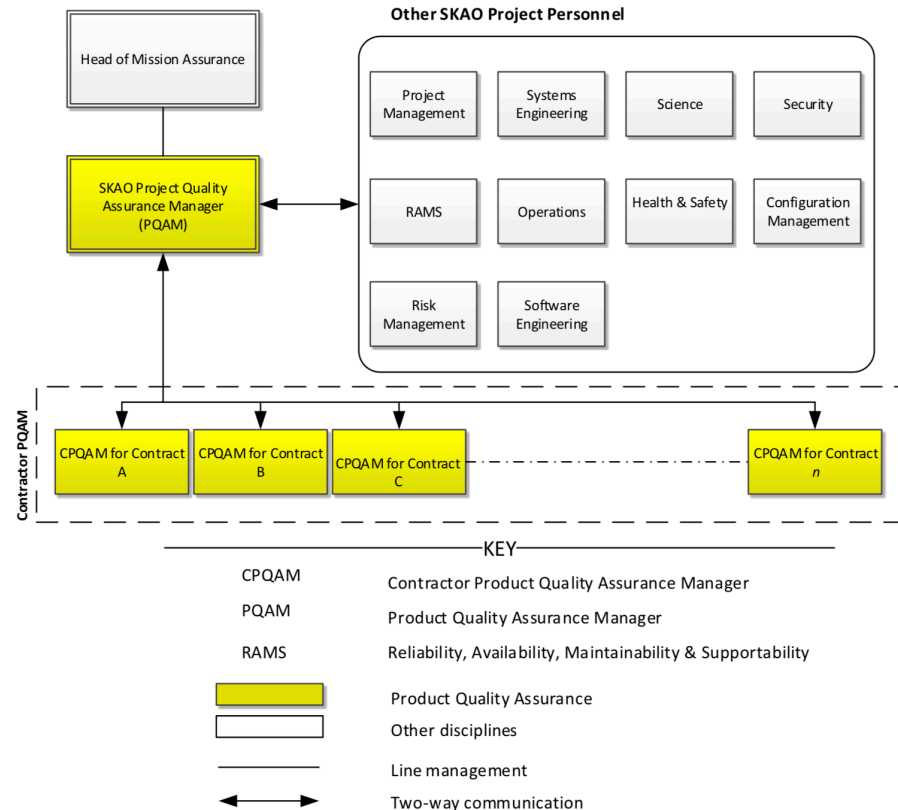
Quality

13 Product Quality Assurance

SKA-TEL-SKO-0000739 SKA Product Quality Assurance
Description of the PQA requirements and management activities during construction.



- Tiered reviews and acceptance
 - Manufacturing Inspection Points
 - Production Readiness Review
 - Test Readiness Review
 - Qualification Test Review
 - Acceptance Review
 - Operational Readiness Review



Review & Reporting

14 Review and Reporting

SKA-TEL-SKO-0001100 SKA1 Project Execution Plan
Description of the planned reporting from the project to its oversight/stakeholders as well as regular planned reviews.



Stakeholder group	Interest
IGO Council	Governance
Science Working Groups	Users
Science & Engineering Advisory Committee	Advice
Finance Committee	Compliance
Member Countries (e.g. government, funding agencies, industrial liaisons)	Fair Work Return, publicity, <u>national contract awards</u>
Member Contributing Institutions	Continuity of funding, published papers
Host Countries	Long term continuity of facilities, funding and employment
Telescope site local communities	Preventing disruption, employment opportunities
Science Regional Centres	Distribution to users
National Regulatory Organisations (e.g. <u>ITU</u> for radio frequency interference; health, <u>environment</u>)	Compliance
SLT	Governance
SKAO programme staff (project management, engineering, software, product assurance, configuration management, HSE)	Personal fulfilment, co-ordination, employment
Other SKAO staff outside the programme team (Operations, Science, Finance, Comms,	Users and supporters, employment
Tier 1 contractors	Reputation, Profit
Tier 2 contractors	Reputation, Profit
Wider engineering community (e.g. other observatories or science infrastructure projects)	Collaboration/mutual benefits in exchanging reviewers, employees, lessons learned etc

- Monthly Report
 - Project Status
 - Current Photos
 - Integrated Project Schedule
 - Financial Summary and Projections
 - Risk Management
 - HSE Commentary
 - Key Issues
 - Appendix: Product status (as needed)

Integration & Commissioning



15 Integration and Commissioning	<p>SKA-TEL-SKO-0001201 SKA1 Systems Engineering Plan</p> <p>SKA-TEL-SKO-0001350 SKA1 Science Commissioning and Verification Plan</p> <p>SKA-TEL-AIV-4430001-SE-DIVP-PLN-Rev2-Integration and Verification Plan for SKA1 Low</p> <p>SKA-TEL-AIV-44100001-SE-RP-MPL-Rev8-Roll-Out Plan for SKA1 Low</p> <p>SKA-TEL-AIV-24300001-SE-DIVP-PLN-Rev2-Integration and Verification Plan for SKA1 Mid</p> <p>SKA-TEL-AIV-24100001-SE-RP-MPL-Rev8-Roll-Out Plan for SKA1 Mid</p> <p>Detailed planning and procedures to perform and verify the system performance against both the Level 1 and the Level 0 requirements (for a subset of identified observing modes).</p>
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- Caiazzo: Systems Engineering and Compliance
- Laing: Science Commissioning and Verification

Project Close-out

16 Project Close-out

SKA-TEL-SKO-0001100 SKA1 Project Execution Plan
Note the close-out of the construction phase and the handling of the observatory decommissioning phase and responsibilities as currently understood.



- Operational Readiness Review
 - Demonstrated compliance to Level 0 for a subset of Observing modes. Some level 0 requirement compliance will not be demonstrated within construction (give example)
- Administrative Close-out
 - Contracts, etc
- Recognition of responsibility to decommission facilities at the end of Operational lifetime

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

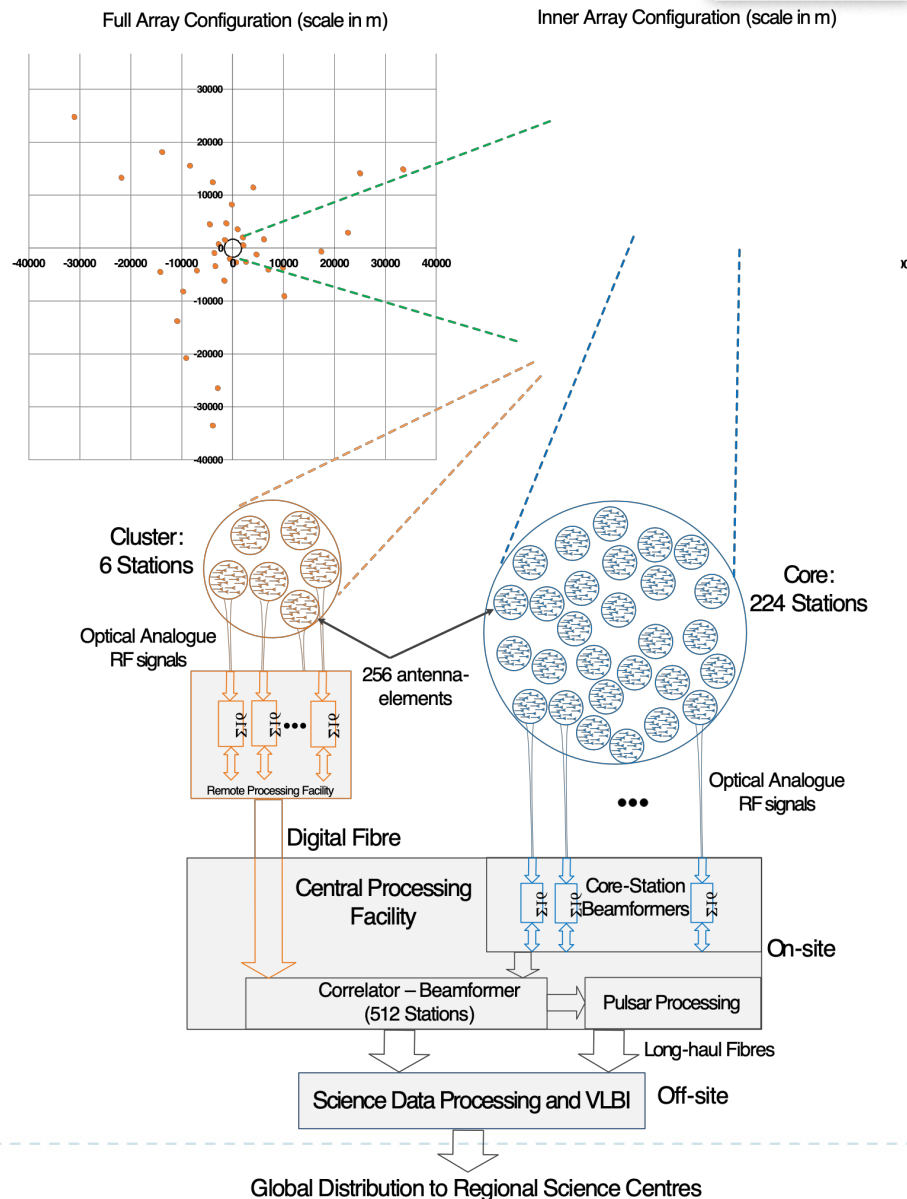


- Questions?

SKA1-Low Telescope Design



- The big picture
 - emphasising the array configuration.
 - But showing the whole system.
- Features:
 - Central condensation of collecting area.
 - Scale-free outer configuration.
 - Good azimuthal coverage.
 - 65-km max baseline.
 - ~131000 log-periodic antenna elements.
 - 512 antenna-elements per station.
 - ~38-m diameter stations.
 - 50-350 MHz frequency range (7:1).
 - Clusters of stations beyond a certain radius.
 - Multi-beam beamformers.
 - Sub-stations.
 - Signal-processing on-site.
 - Science data processing, VLBI off-site.



SKA1-Mid Telescope Design



- The big picture
 - emphasising the array configuration.
 - But showing the whole system.
- Features:
 - Central condensation of collecting area.
 - Scale-free outer configuration.
 - Good azimuthal coverage.
 - 150-km max baseline
 - 133 SKA dishes (15 m)
 - 64 MeerKAT dishes (13.5 m)
 - 0.35 – 20 GHz frequency range (dish spec).
 - 0.35 – 15 GHz in 6 front-end bands
 - Signal-processing on-site
 - Science data processing, VLBI off-site

