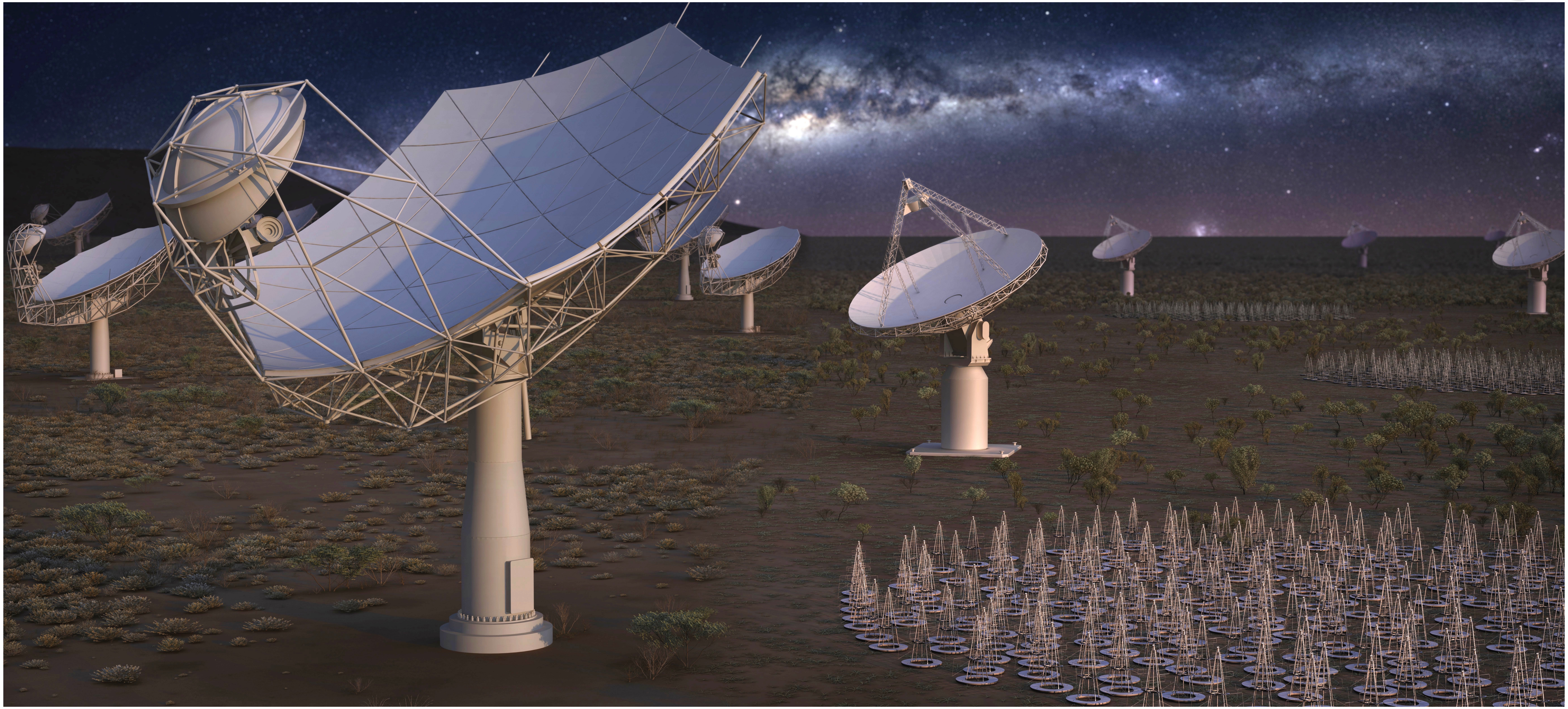
SKA Operational Model & the SRCs



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

www.skatelescope.org

Antonio Chrysostomou

a.chrysostomou@skatelescope.org

@astroant

Outline

Functional Structure of the Observatory

Operational Model

SKA Regional Centres

One Observatory Model

One Observatory - Two Telescopes - Three Sites

The SKA Observatory will operate the SKA1-Low and SKA1-Mid telescopes in Australia and South Africa. Its Global Headquarters will be in the UK.

Facilities present at each of the host countries to enable and support the operation of the SKA Observatory.

One Observatory Model

One Observatory - Two Telescopes - Three Sites

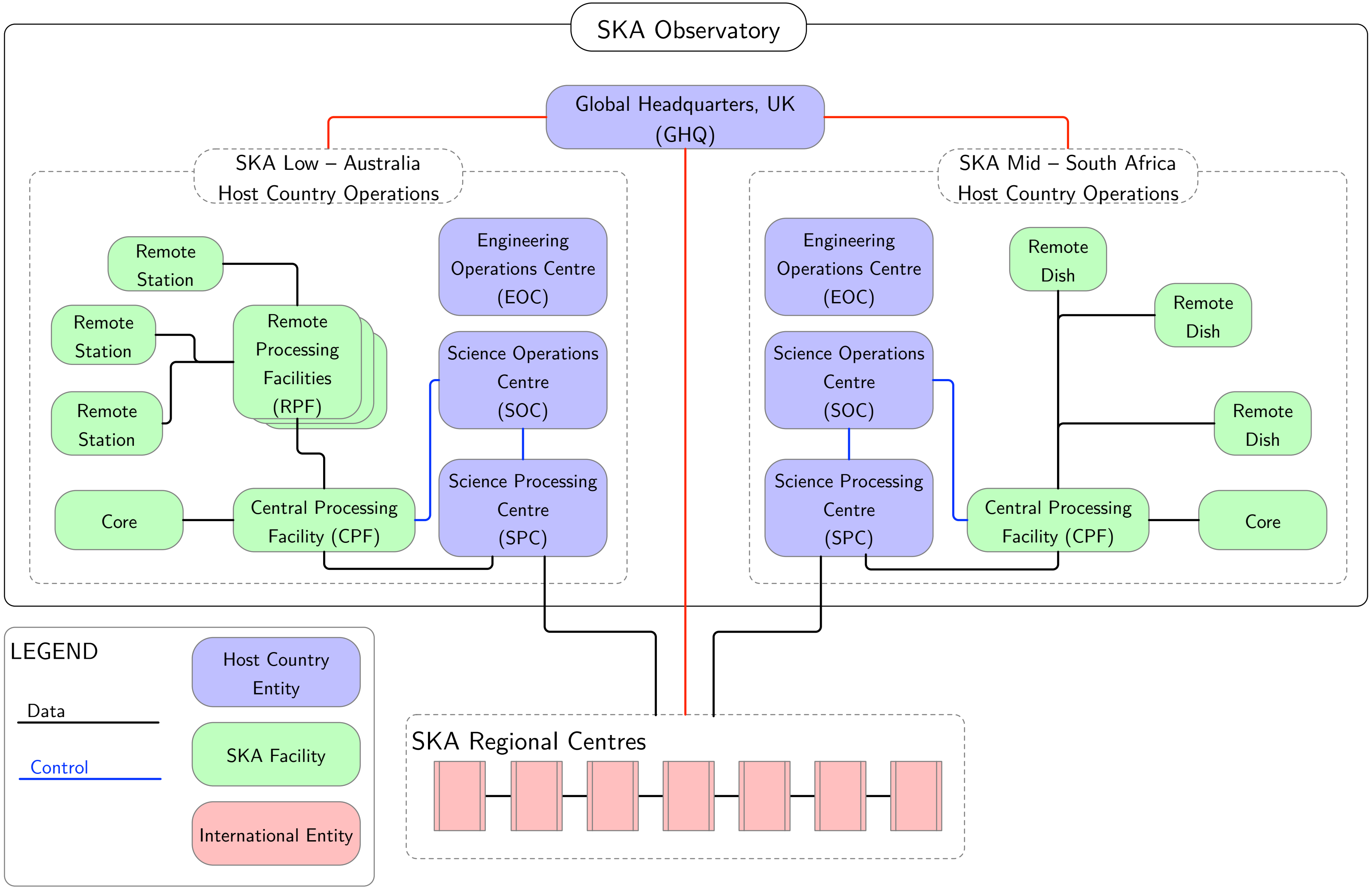
Global Headquarters (GHQ)

Engineering Operations Centre (EOC)

Science Operations Centre (SOC)

Science Processing Centre (SPC)

Functional Structure



Distributed Operations

13 Member Countries

AUS, CAN, CHI, FRA,
GER, IND, ITA, NED,
NZL, RSA, SPA,
SWE, UK

In discussion with other countries interested in become members in the future

Distributed Operations - SKA in Australia

131,072 antennas

512 stations

Densely populated core

(∼ 1-km diameter)

Three log-spiral arms

65-km baselines

50 ⟶ 350-MHz

instantaneous bandwidth

Distributed Operations - SKA in S. Africa

133 SKA1 dishes (15-m)

64 MeerKAT dishes (13.5-m)

Densely populated core

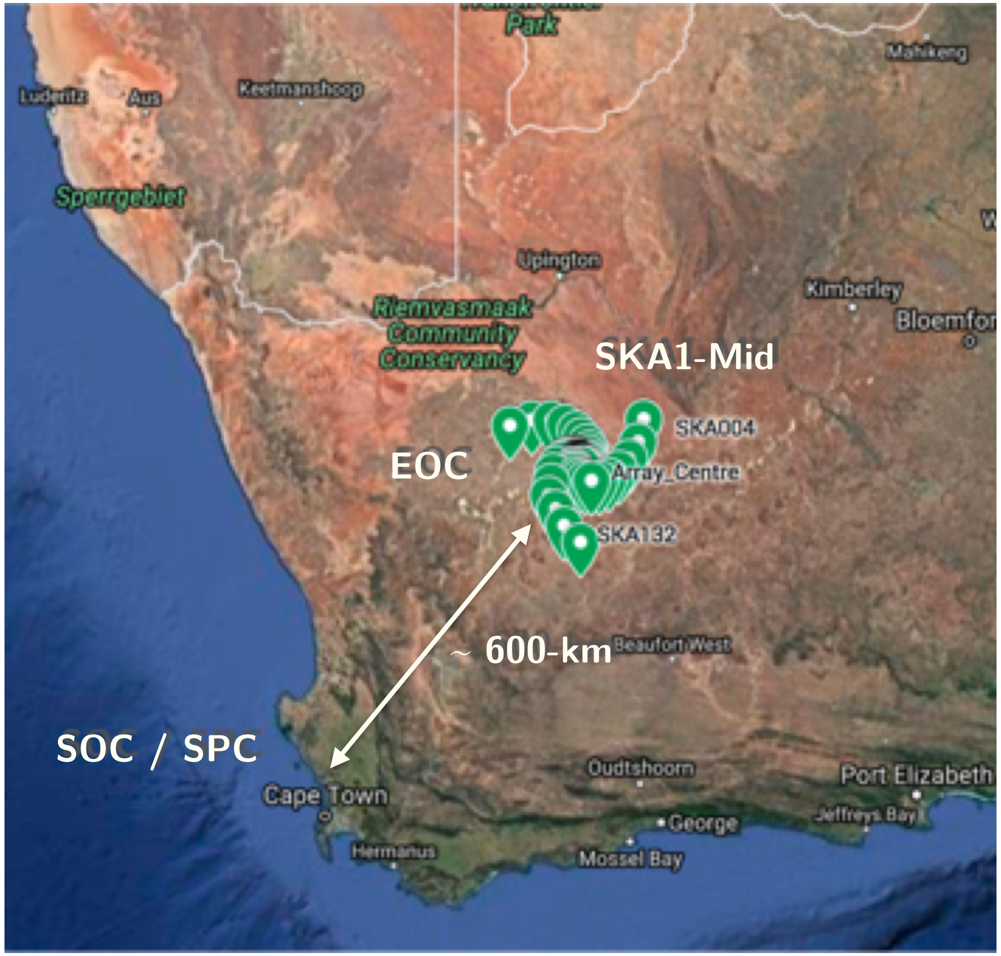
(~ 2-km diameter)

Three log-spiral arms

150-km baselines

0.35 ⟶ 15 GHz

5 receivers



SKA Operational Model

Conventional Features

- periodic proposal cycles
- service observing (no visiting astronomers)
- flexible/dynamic scheduling
- 24/7 operations

Observing Modes

- imaging (continuum & spectral)
- beam forming for pulsar search & timing, VLBI
- transient search

Complex/challenging features

- operations from a distance
- high operational availability
- rapid response to transients and ToOs
- subarrays and commensality

Proposal Types

- Standard PI proposals
- Key Science Projects
- Long Term proposals
- Coordinated proposals

Subarrays and Commensality

Allows execution of more than one observation at the same time

Subarrays will be available in various templates, e.g.

- core subarray
- fraction of core + spiral arms
- whole array

Three types of commensality

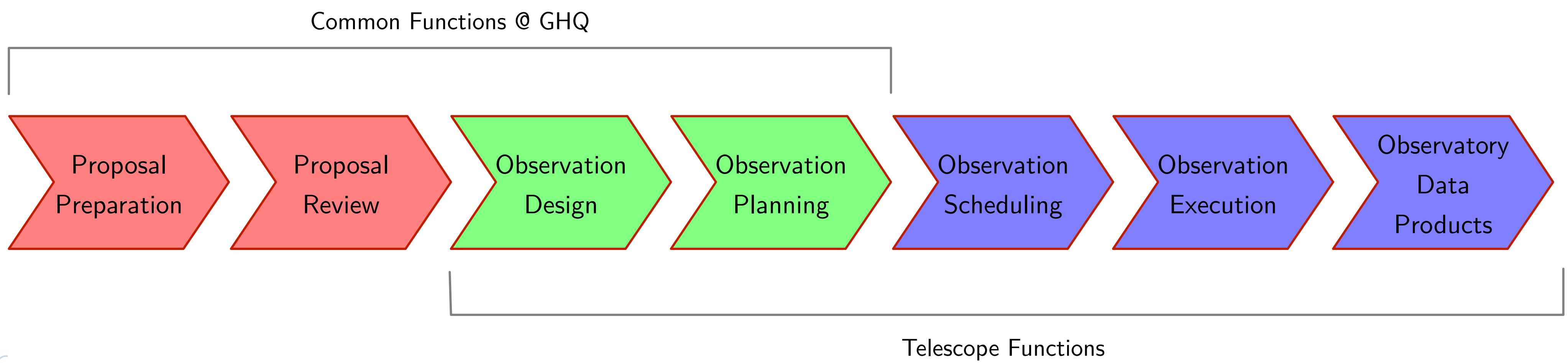
- data ⇒ different projects use the same data products for different science goals
- observing ⇒ different projects use the same signal/data for different data products
- multiplex ⇒ configure the telescope into subarrays

SKA Operational Model

The operational model is necessarily very distributed

Important to identify commonalities in operation of SKA1-Low and SKA1-Mid and truly make them Common

- avoid proliferation and bifurcation of code bases
- easier support model
- cost efficiencies



Operational Workflow

Phase 1 – proposal management

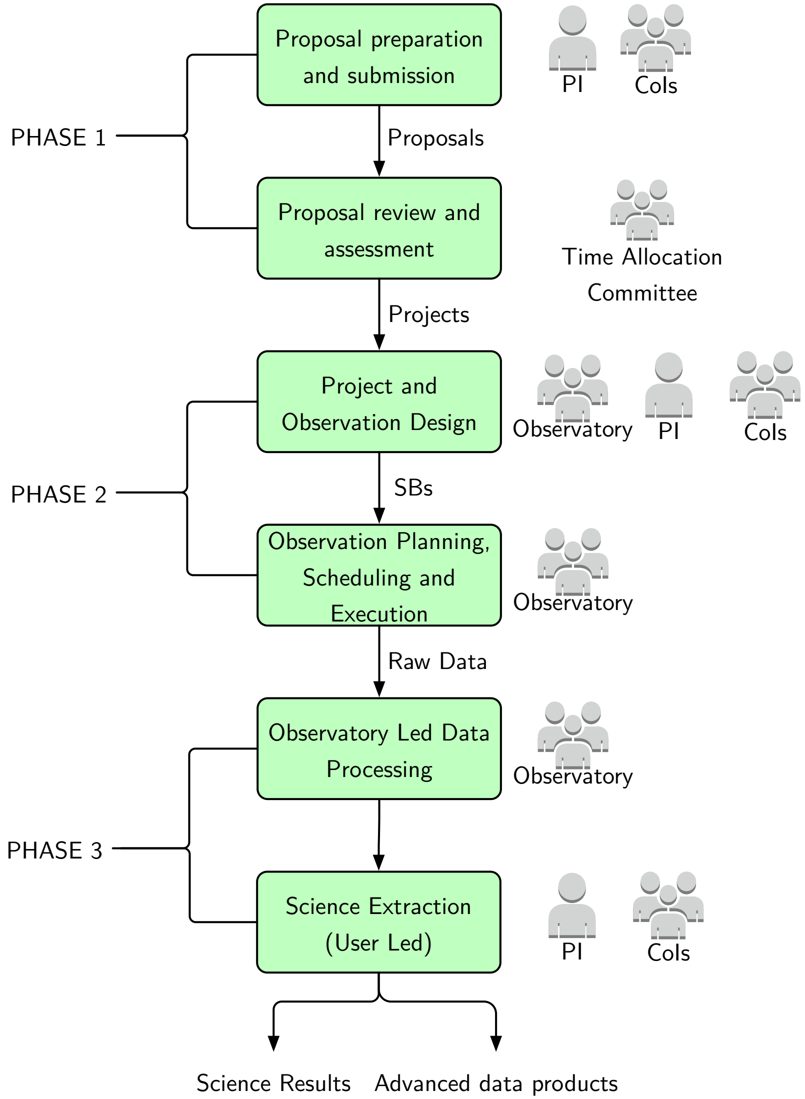
proposals ⟶ projects

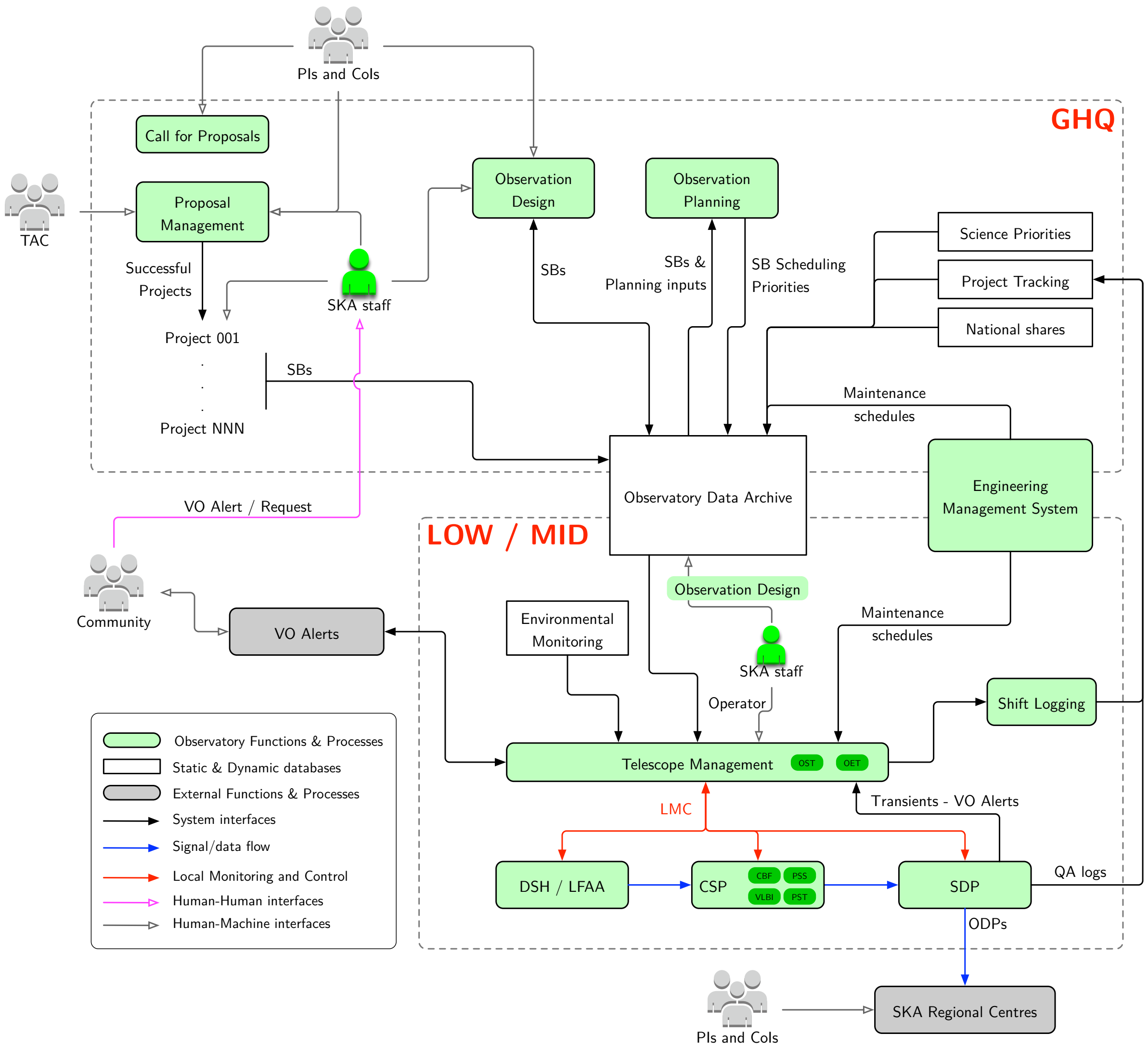
Phase 2 – observation execution

projects ⟶ data

Phase 3 – data processing

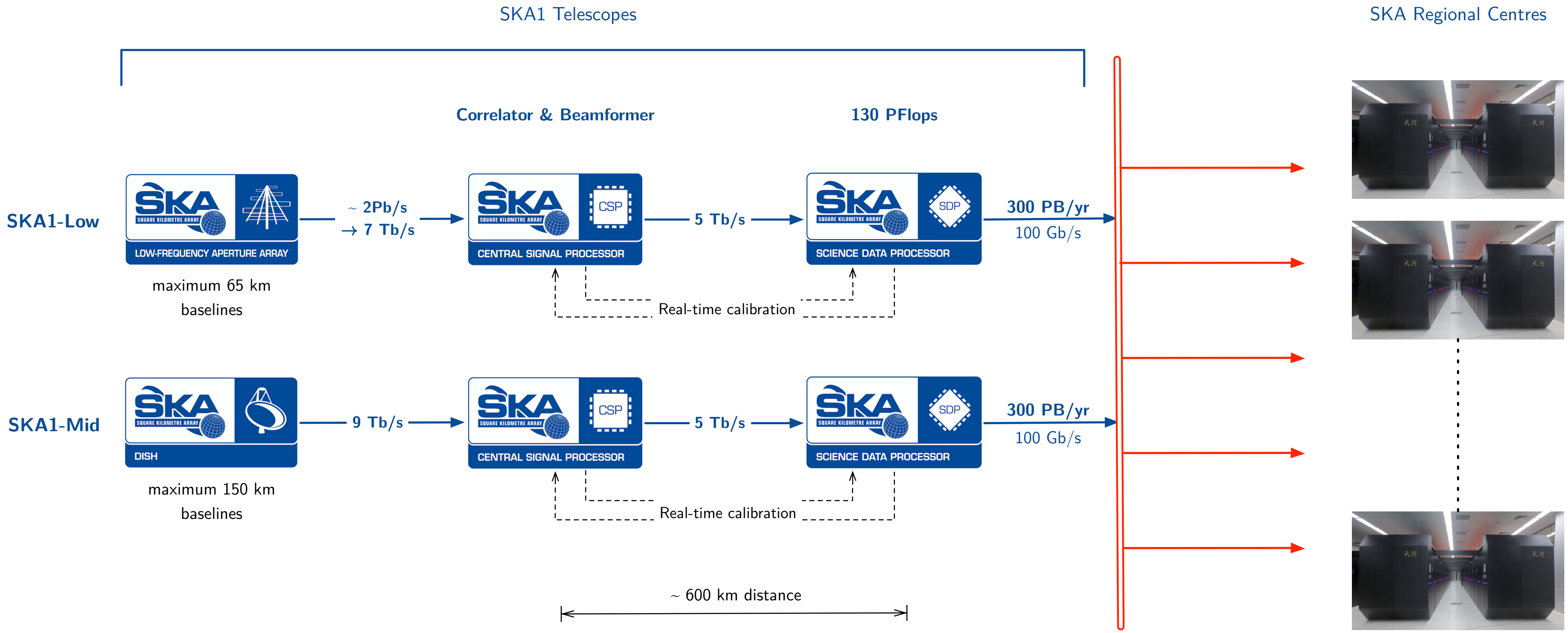
data ⟶ science





PIs and CoIs
GHQ
Call for Proposals
TAC
Proposal Management
Observation Design
Observation Planning
Science Priorities
Project Tracking
National shares
Successful Projects
SKA staff
SBs
SBs & Planning inputs
SB Scheduling Priorities
Project 001
Project NNN
Maintenance schedules
Observatory Data Archive
Engineering Management System
VO Alert / Request
LOW / MID
Community
VO Alerts
Environmental Monitoring
Observation Design
SKA staff
Operator
Shift Logging
Telescope Management
OST
OET
Transients - VO Alerts
LMC
DSH / LFAA
CSP
CBF
PSS
VLBI
PST
SDP
QA logs
ODPs
SKA Regional Centres
PIs and CoIs
Observatory Functions & Processes
Static & Dynamic databases
External Functions & Processes
System interfaces
Signal/data flow
Local Monitoring and Control
Human-Human interfaces
Human-Machine interfaces

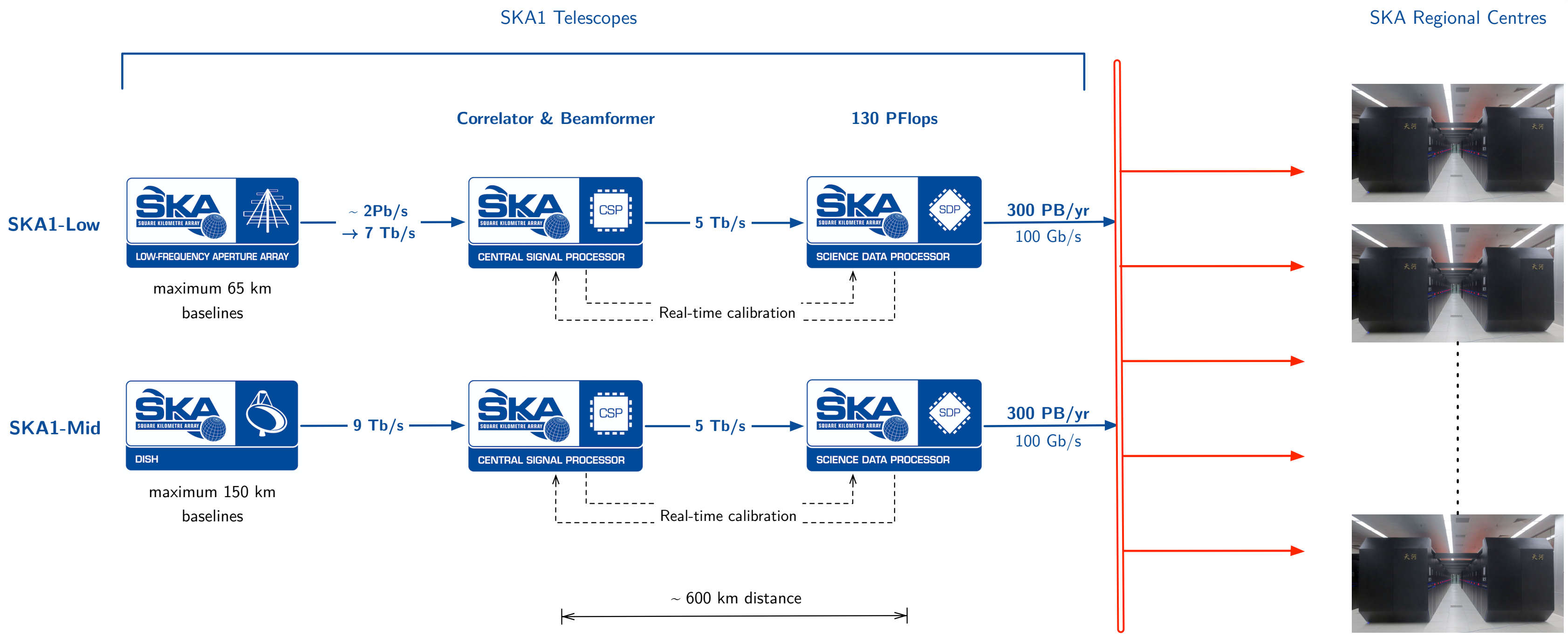
Data flow through the SKA



Managing the data flow is one of the greatest challenges for SKA

- scale and versatility ⇒ large data rate requiring robust signal transport and compute power

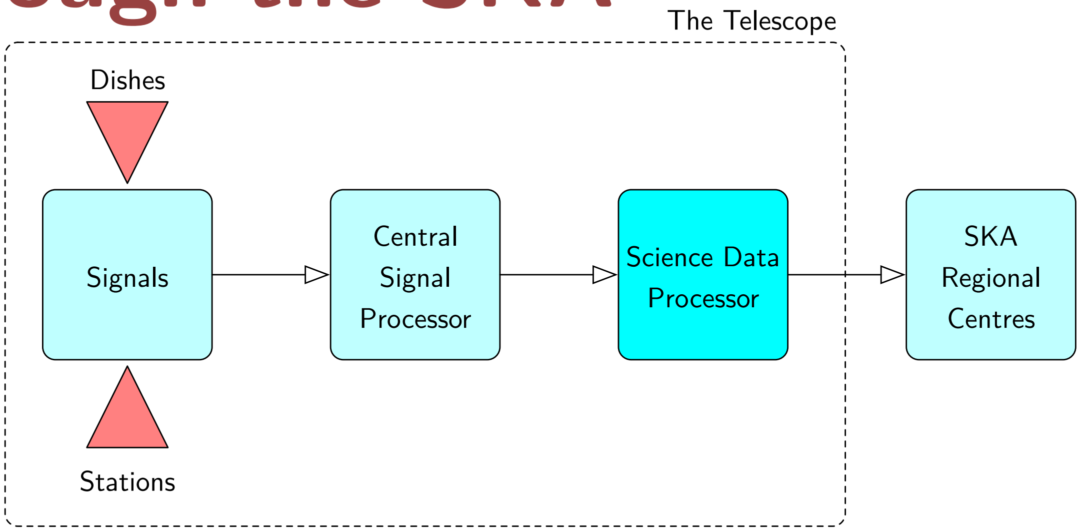
Data flow through the SKA



Managing the data flow is one of the greatest challenges for SKA

- data rate 0.5-1.0 TB/s from correlator ⇒ **45 - 85 PB of raw data per day per telescope**
- also limited by rate at which we can process data and deliver it to SRCs

Data flow through the SKA



If possible we would not consider the SDP as an integral part of the telescope

- data reduction should never interrupt or constrain data acquisition (except for on-line calibration!)

For planning the observing programme of the SKA, the SDP becomes a schedulable resource of the telescope

Data products

Catalogues	Transient Source Catalogue Science Data Product Catalogue
Imaging	Image Cubes Gridded Visibilities
Pulsars	Sieved Pulsar & Transient Candidates Pulsar Timing Solutions Dynamic Spectrum
Transient Buffer Data	
Calibrated Visibilities	
Science Data Model	LSM, Calibration Solutions, Telescope state data

Science Data Products

Observatory Data Products

- Observation-Level Data Products: calibrated data products generated by SDP workflows, based on data obtained from one or more Scheduling Block
- Project-Level Data Products: calibrated data products generated by combining several Observation-Level Data Products, delivering the requirements of the PI as outlined in their original proposal

Advanced Data Products

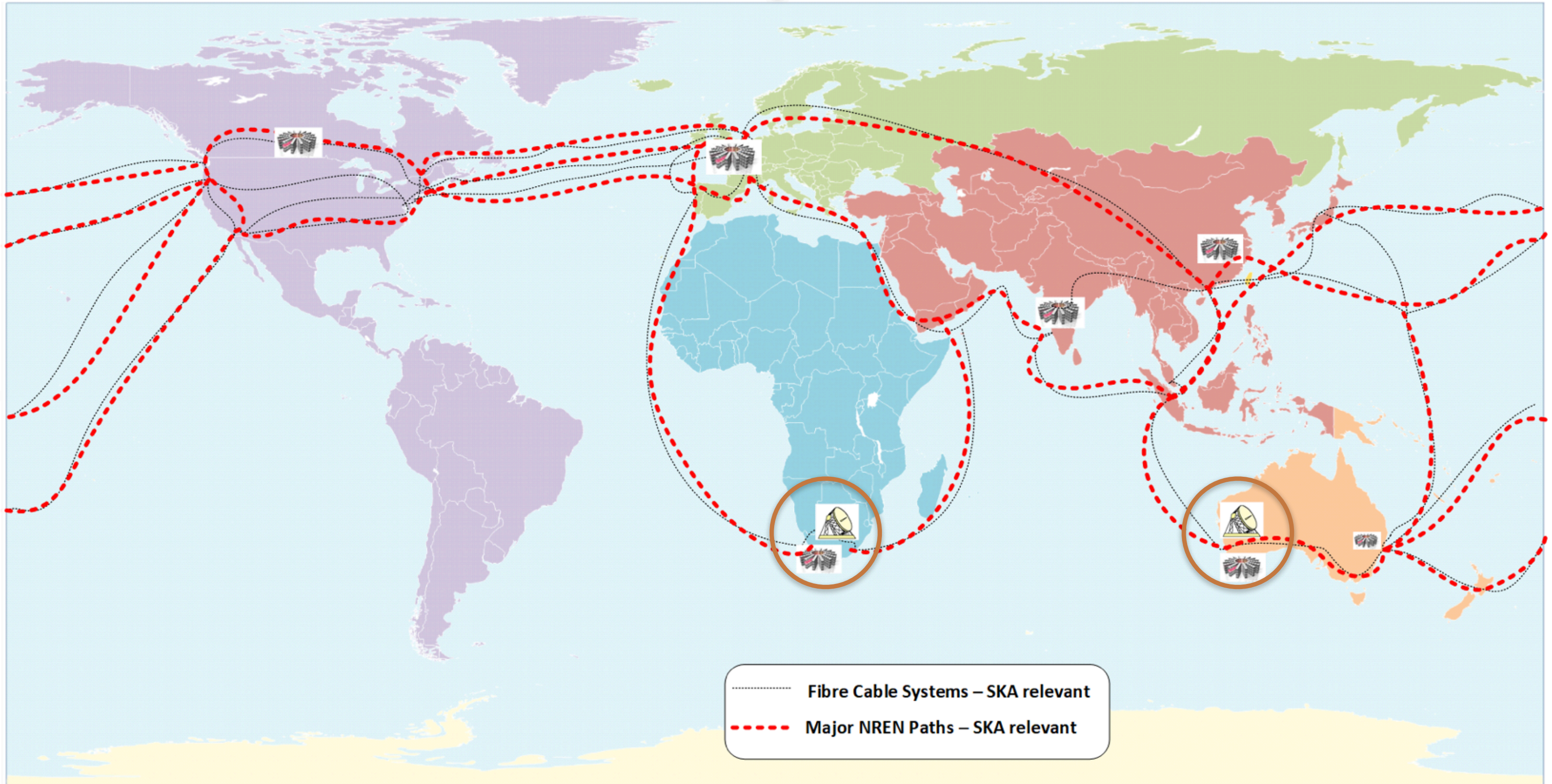
- Generated through the detailed analysis and modelling of Observatory Data Products
- Will require some level of interactive visualisation and examination of data, as well as comparison to data from other facilities (or SKA Projects)
- May require CPU intensive workflows for detailed modelling and analysis

ODPs are generated by the SKA Observatory

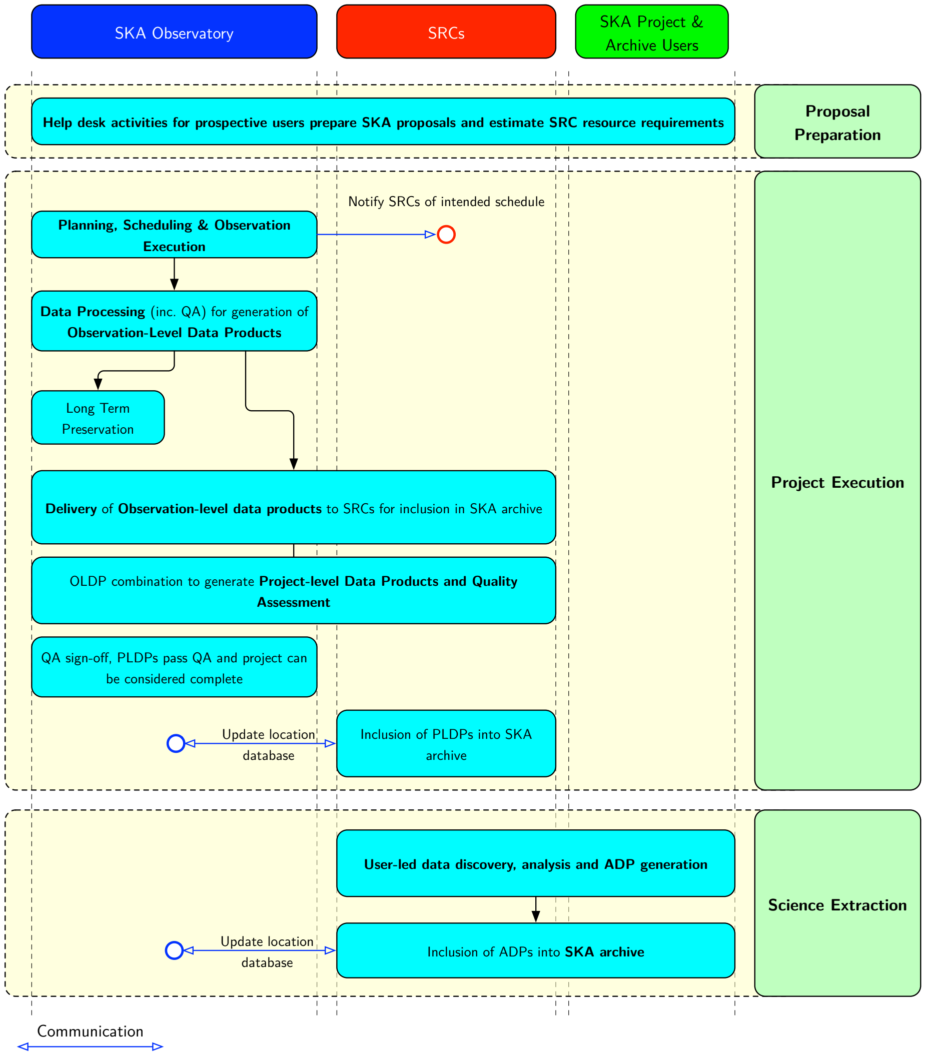
ADPs are generated by users at the SKA Regional Centres

Data flow from the SKA

Observatory Data Products flow from Science Data Processors in Perth and Cape Town to SRCs around the globe



Data flow from the SKA



Lifecycle of a project in going from initial proposal, to a project that is executed at the SKA telescope(s) through to science extraction at SKA Regional Centres.

The diagram shows an overview of the process and the responsibilities (sometimes shared) at each stage.

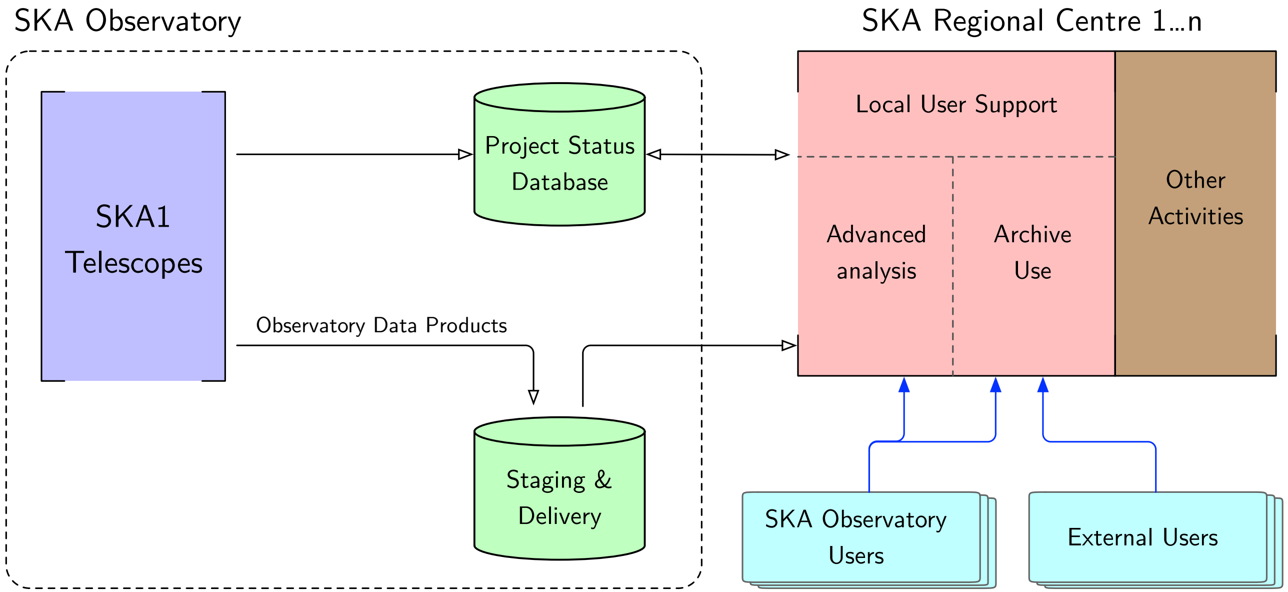
SKA Regional Centres

Three main factors that lead to a global collaborative model for SRCs

1. The observatory data products that emerge from the SDP will need visualisation, science analysis and modelling before publication
2. The data volumes are so large that direct delivery to end users is unfeasible
3. The community of scientists working on SKA science data will be geographically distributed

This global network will provide

- platform for collaborative science
- transparent and location agnostic interface for users
- access to project data
- place for software analysis, modelling, visualisation, algorithm development



SKA Regional Centres

Data Flow	Data Processing	Science Archive	User Support
Maintain the flow of data out of the Observatory and to the SKA community. Allows the science programme to proceed according to schedule	Provide compute resources to allow users to combine and analyse their Observatory Data Products	Provide data storage and tools to enable a SKA Science Archive and allow discovery science, perhaps from non-SKA users.	Provide support to users in these SRC activities.

SKA Regional Centres Steering Cmmttee

Design work in the regions is now moving to implementation

SRCSC was formed in May 2019 with membership from each SKA nation

- the members have the mandate to "...initiate work, commit resources, and to take decisions..."
- ambition to have proto-SRCs available during construction/commissioning of SKA

Australia	Peter Quinn (Chair)	Netherlands	Michiel van Haarlem (Vice-Chair)
Canada	Séverin Gaudet	Portugal	Domingos Barbosa
China	Tao An	South Africa	Simon Ratcliffe
France	Jean-Pierre Vilotte	Spain	Lourdes Verdes-Montenegro
Germany	Hans-Rainer Klöckner	Sweden	John Conway
India	Yogesh Wadadekar	UK	Anna Scaife
Italy	Andrea Possenti	SKA	Antonio Chrysostomou Rosie Bolton

Future reviews

Review timetable for further revisions of the Operations Plan remains unchanged

External review panel:

- Andreas Kaufer (ESO, Chair)
- Stuartt Corder (ALMA)
- Claire Chandler (NRAO)
- Doug Simons (CFHT)