MASUM 2022

MID Telescope Architecture & Design

Gerhard Swart

10 May 2022

Links to more information:

MID Telescope Information page

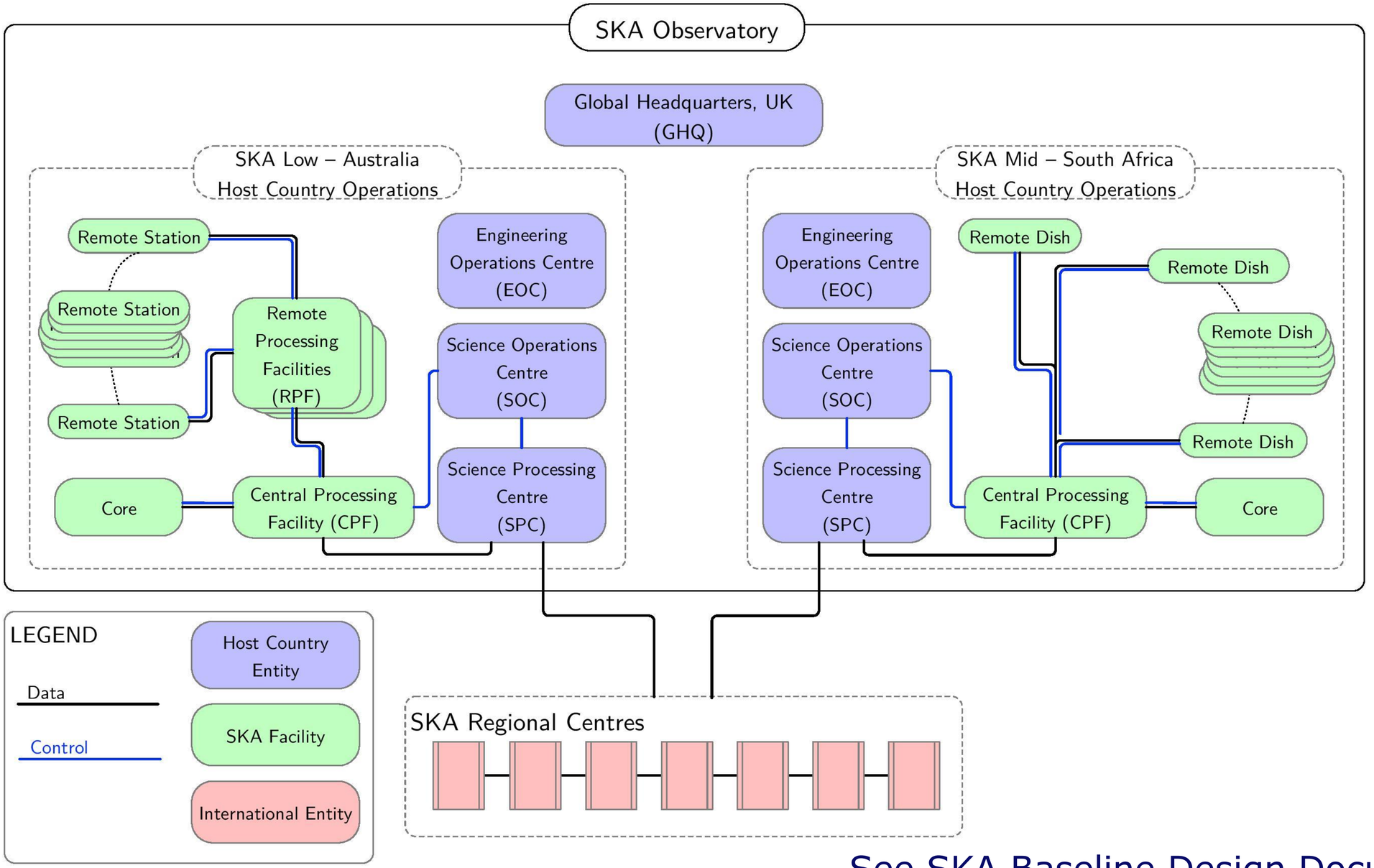
MID Architecture Overview

SKA Design Baseline Document

Architecture

https://www.designboom.com/architecture/frank-gehry-luma-arles-parc-des-ateliers-resource-building-france-08-09-2017
https://worldarchitecture.org/cdnimgfiles/extuploadc/txumht6nn1lumatoweradriandeweerd.jpg

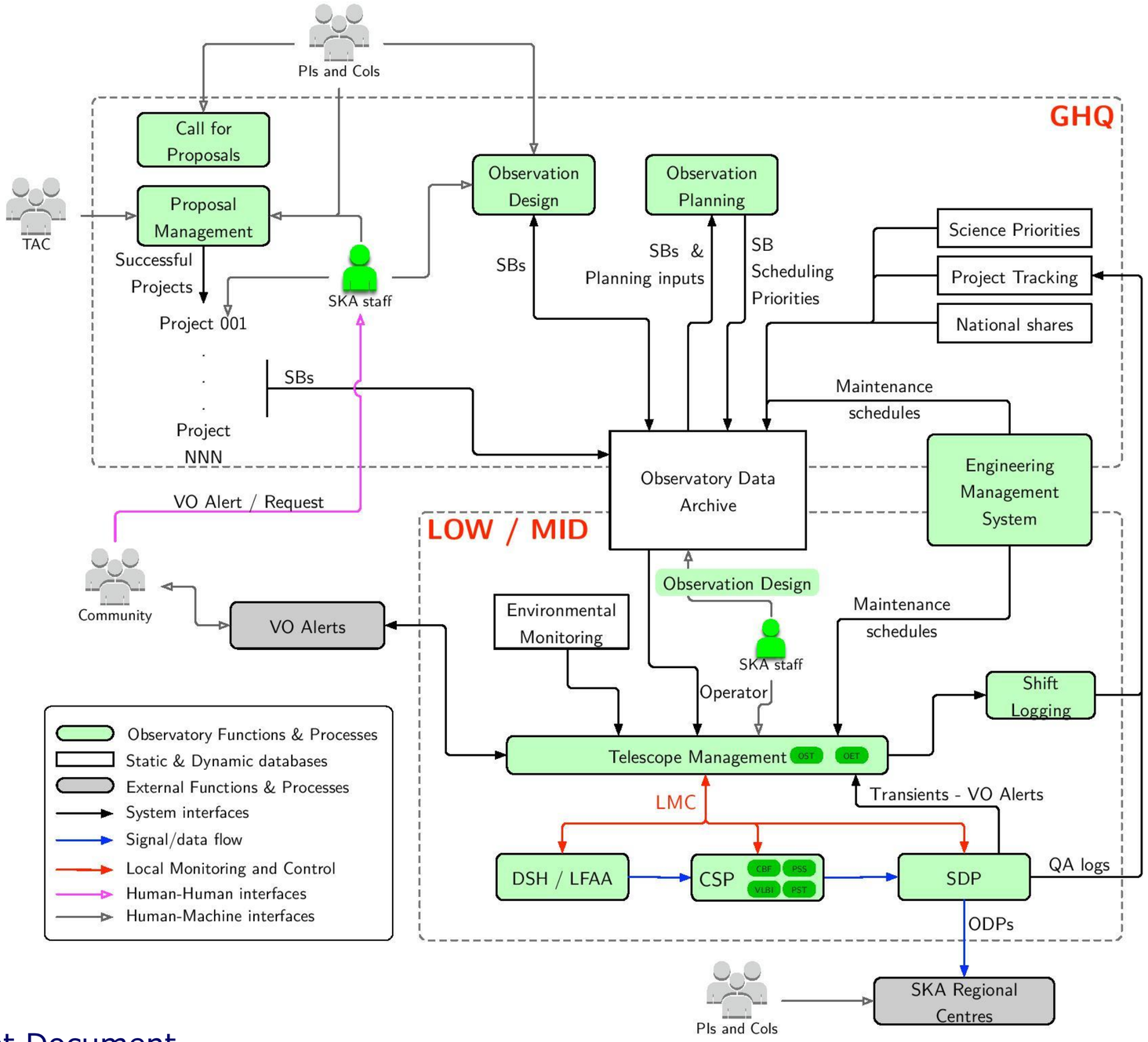
Observatory architecture



[See SKA Baseline Design Document (DBD)]

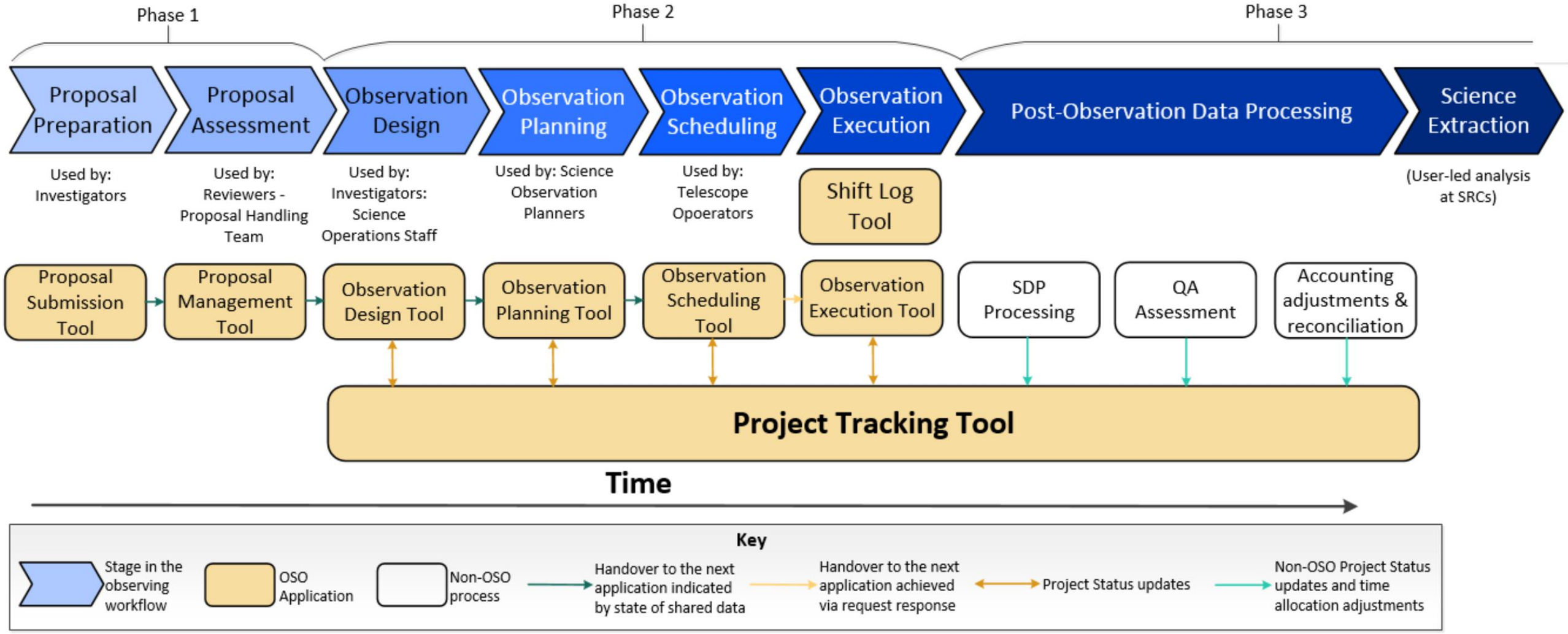
Observation design, planning & execution

- Proposal and observation tools at HQ and in-country
- Local science operation at SOC
- Maintenance ops at EOC
- Shared databases and tools



SKA-TEL-SKO-0000307 Operational Concept Document

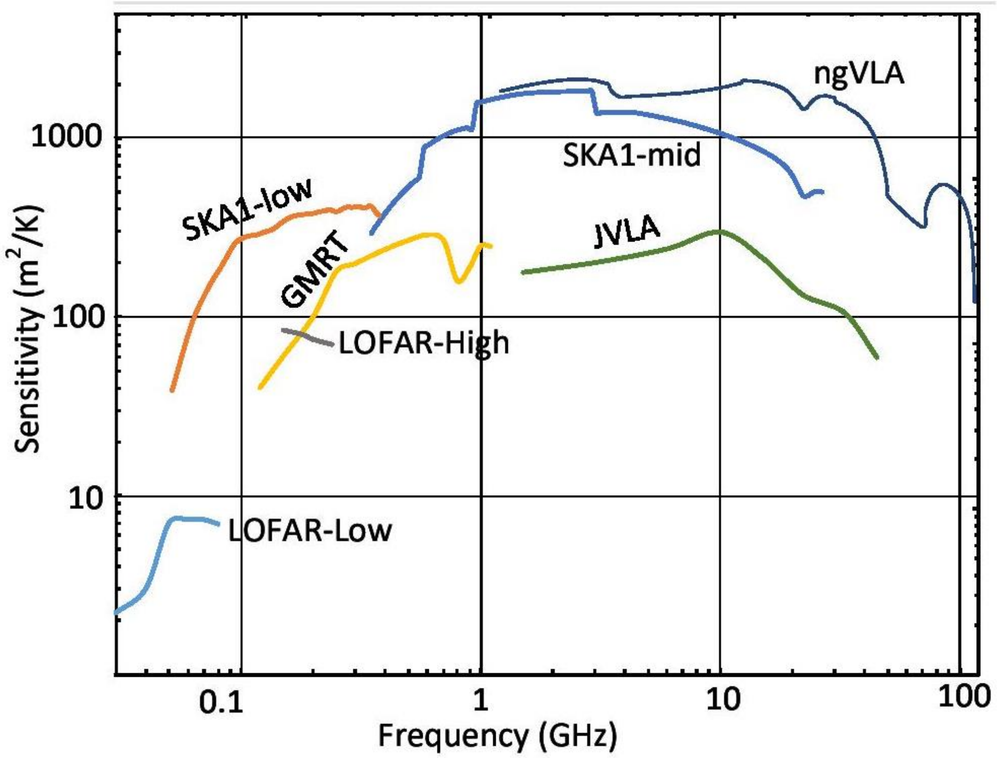
Globally distributed observing tools and process



[Link to OSO Confluence page]

Selected Mid features

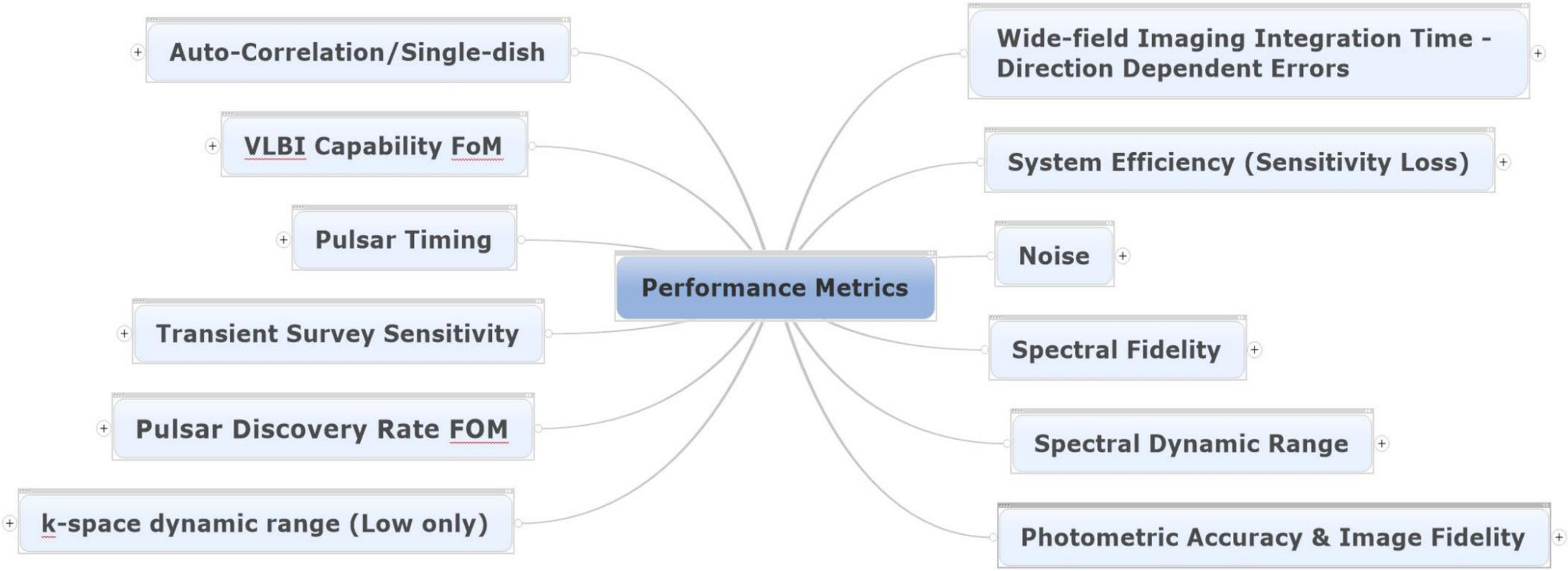
Imaging Sensitivity



- Modes:
  - Imaging (continuum and spectral)
  - Pulsar Search, Pulsar Timing
  - Flow through
  - Dynamic Spectrum
  - Transient Search
  - VLBI
- High time & spatial resolution
- Flexible Scheduling
- Commensal Observing
- 95% Operational Availability

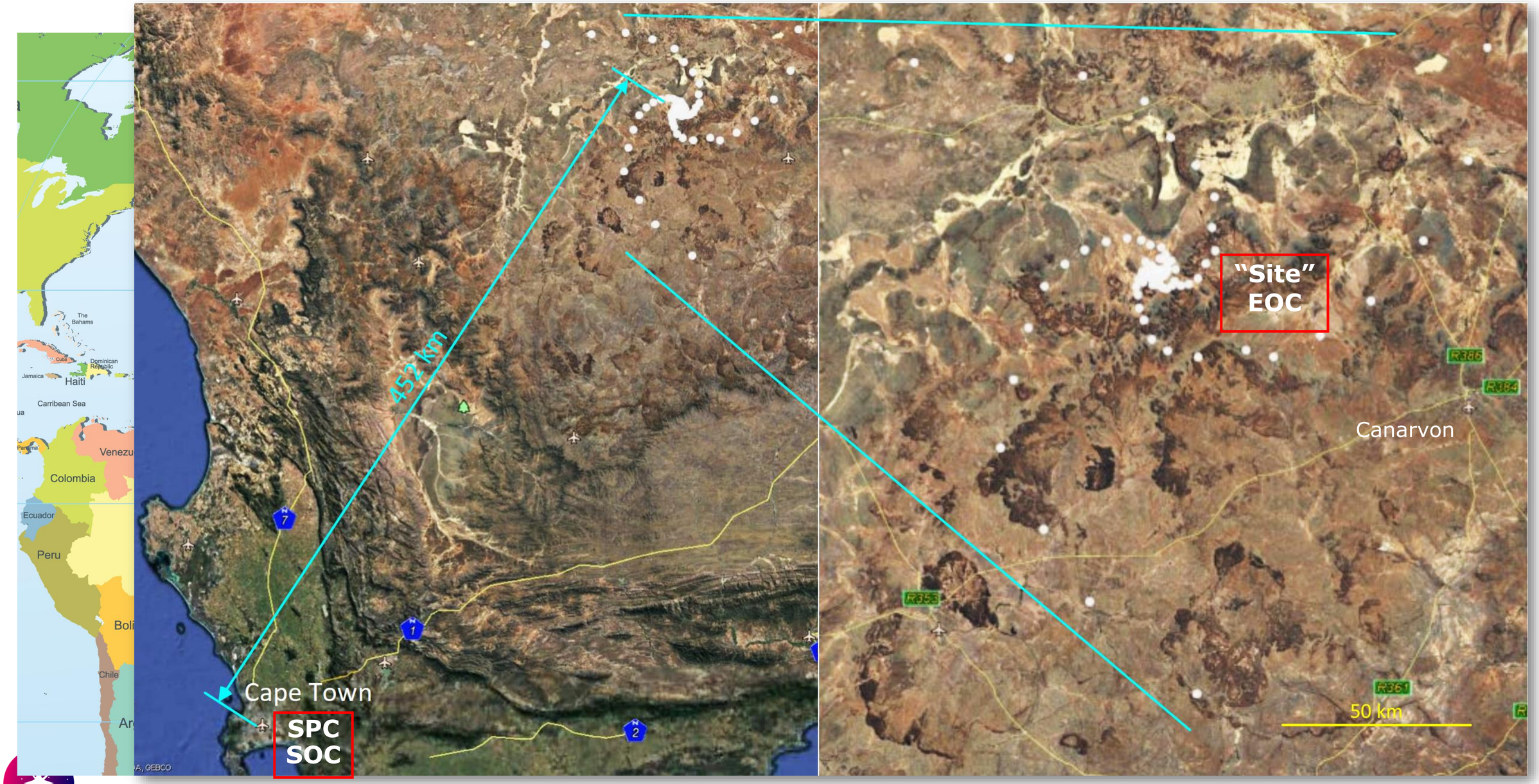
SKA-TEL-SKO-0000007 Level 0 Requirements
SKA-TEL-SKO-0000008 System Req. Spec.

Ongoing performance assessment & budgets



See SKA Baseline Design Document (DBD)

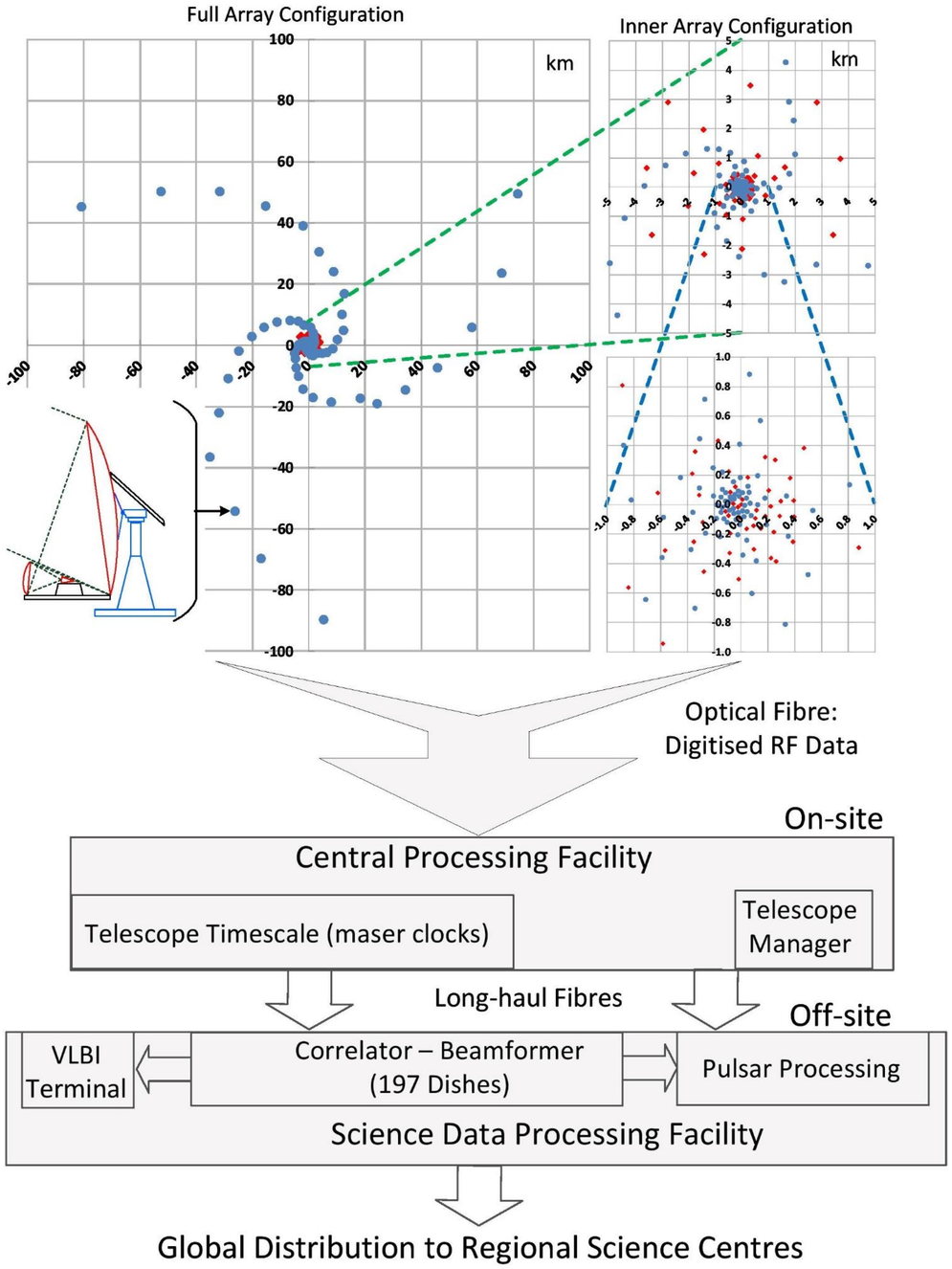
Mid Telescope Location



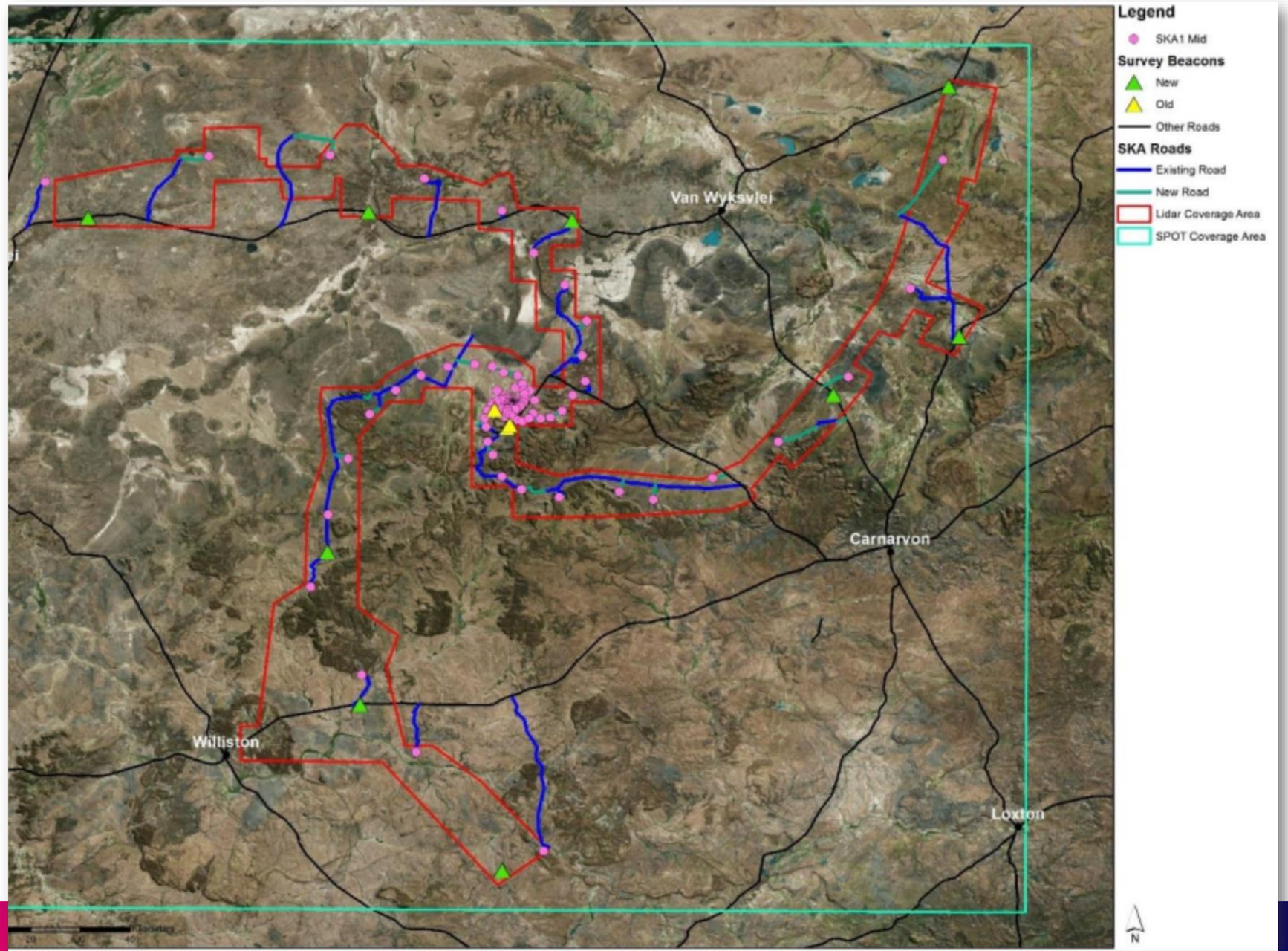
Array architecture

- Array layout to optimise resolution and sensitivity
- 150km longest baseline
- Incorporates MeerKAT Dishes
- 197 Dishes with 4 Rx Bands:
  - Band 1: 0.35 – 0.65 GHz
  - Band 2: 0.95 – 1.76 GHz
  - Band 5a: 4.6 – 8.5 GHz
  - Band 5b: 8.3 – 15.4 GHz

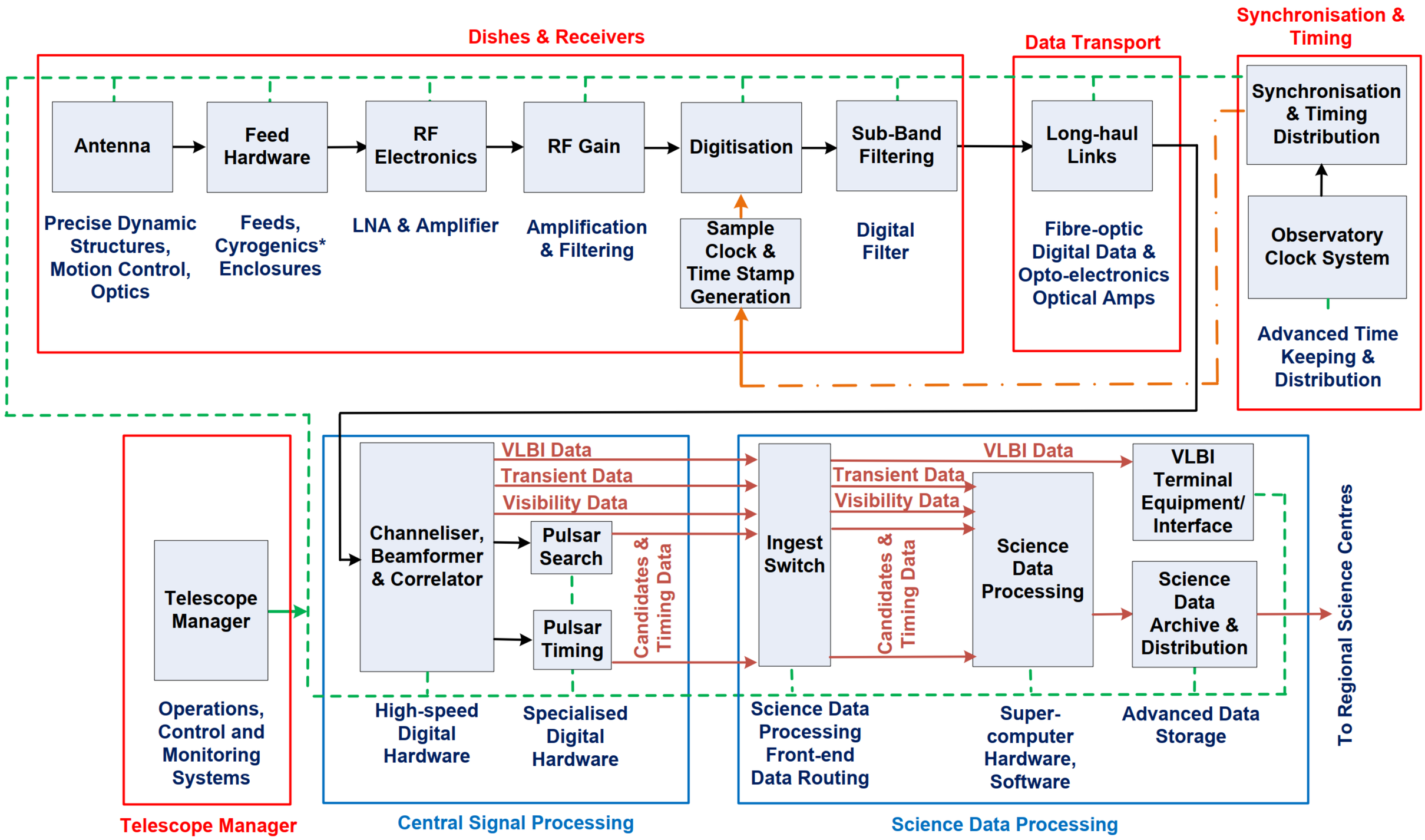
SKA-TEL-INSA-0000537 Mid Physical Configuration Coordinates



Mid Infrastructure



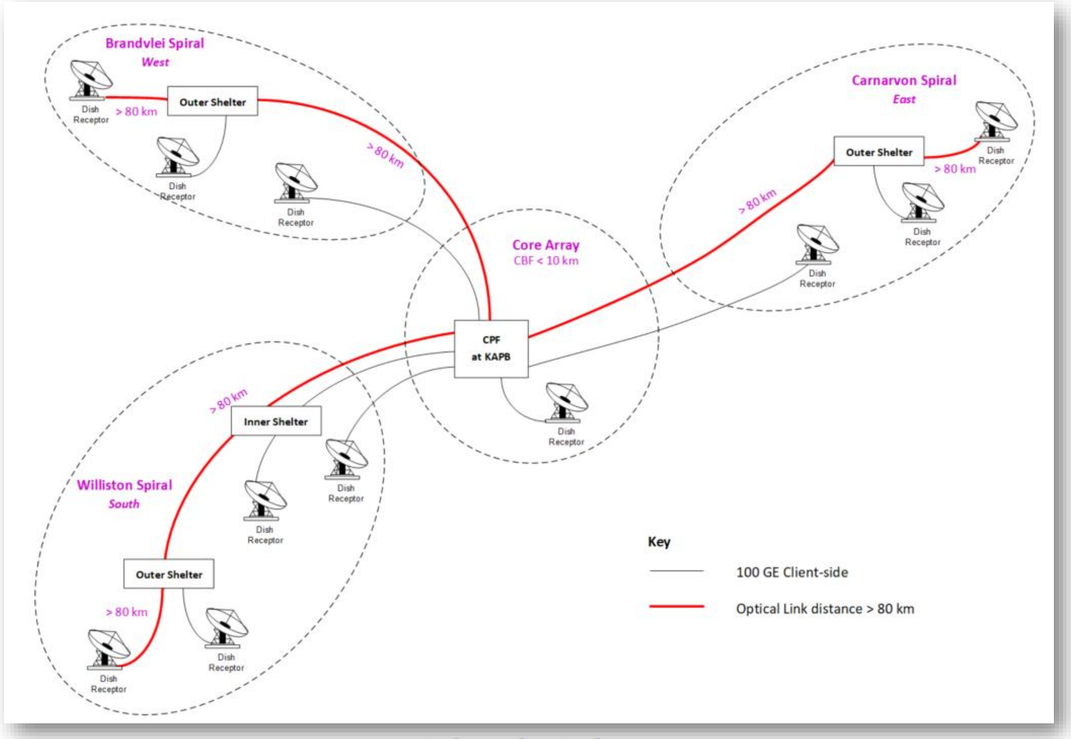
- Water
- Roads
- Power
- Fibre
- Buildings
- Cooling
- Dish Foundations

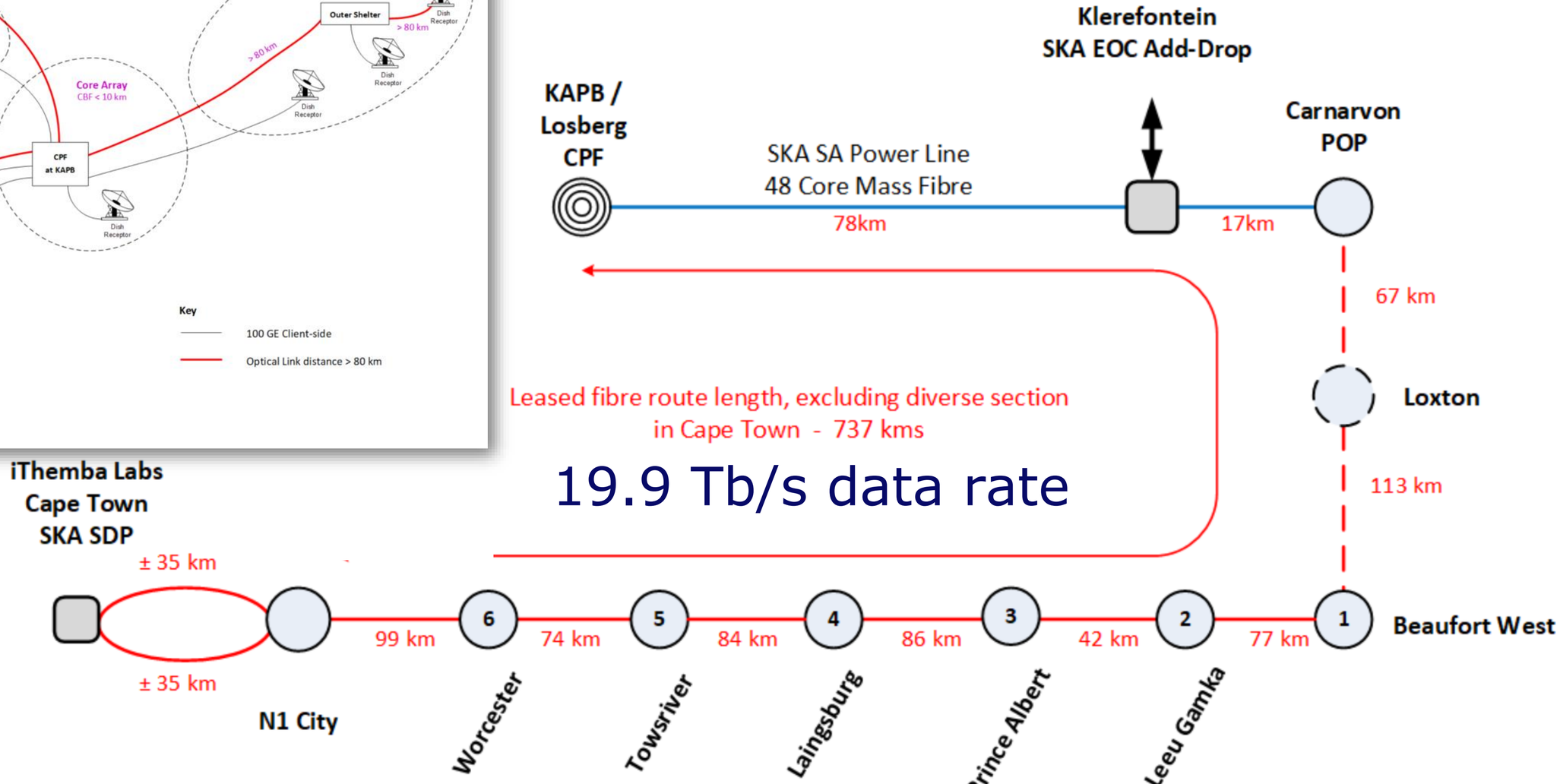

Dishes & Receivers
Data Transport
Synchronisation & Timing
Antenna
Feed Hardware
RF Electronics
RF Gain
Digitisation
Sub-Band Filtering
Long-haul Links
Synchronisation & Timing Distribution
Observatory Clock System
Precise Dynamic Structures, Motion Control, Optics
Feeds, Cyrogenics* Enclosures
LNA & Amplifier
Amplification & Filtering
Sample Clock & Time Stamp Generation
Digital Filter
Fibre-optic Digital Data & Opto-electronics Optical Amps
Advanced Time Keeping & Distribution
Telescope Manager
Operations, Control and Monitoring Systems
Channeliser, Beamformer & Correlator
Pulsar Search
Pulsar Timing
VLBI Data
Transient Data
Visibility Data
Candidates & Timing Data
High-speed Digital Hardware
Specialised Digital Hardware
Ingest Switch
Science Data Processing Front-end Data Routing
Science Data Processing
Super-computer Hardware, Software
VLBI Terminal Equipment/ Interface
Science Data Archive & Distribution
Advanced Data Storage
To Regional Science Centres
Telescope Manager
Central Signal Processing
Science Data Processing

Prototype Dish systems and subsystems

- 15m Offset Gregorian
- Cooled & uncooled Feeds
- Digitisation & timestamping
- Demanding pointing & stability

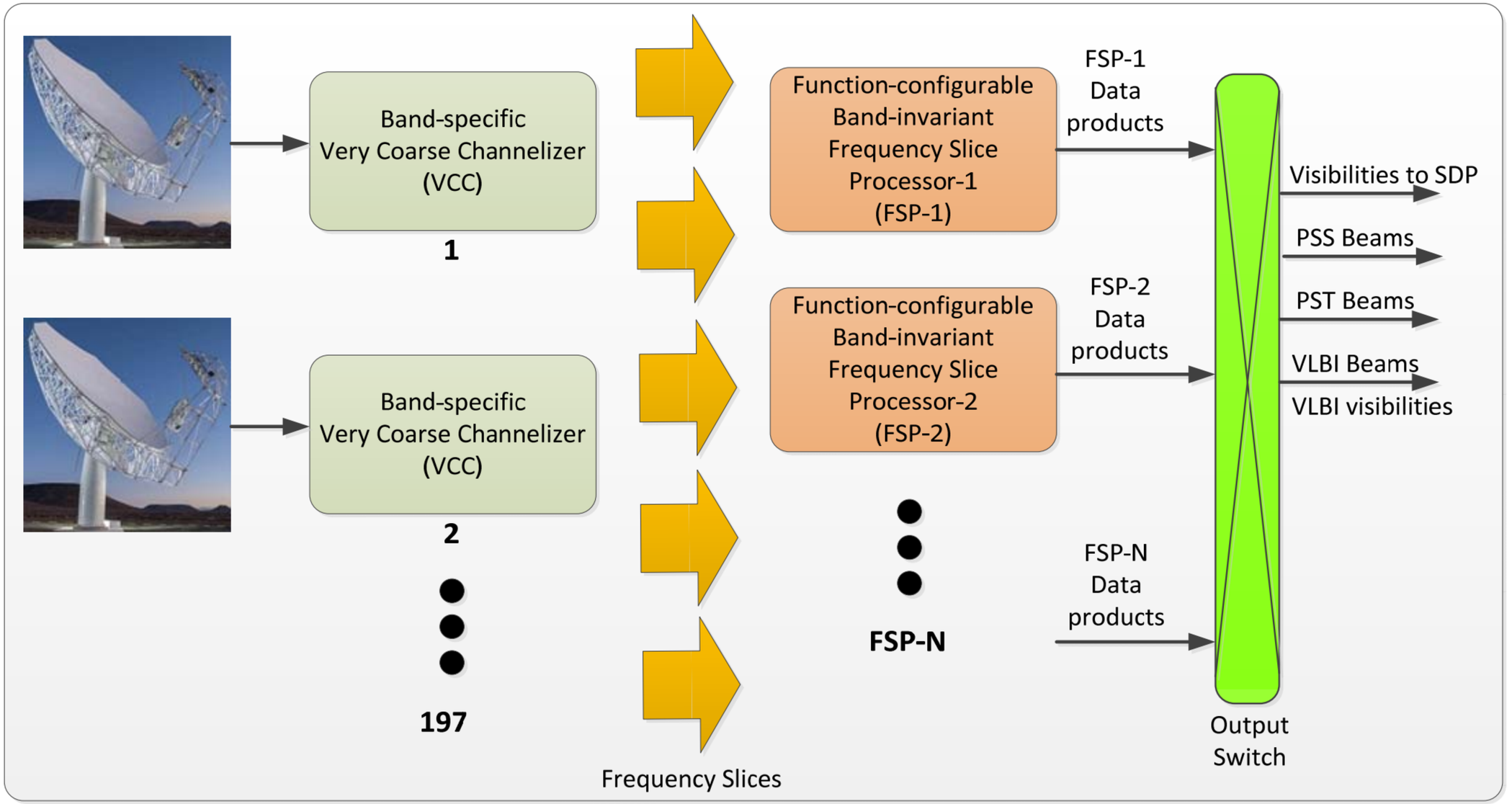
Network routes



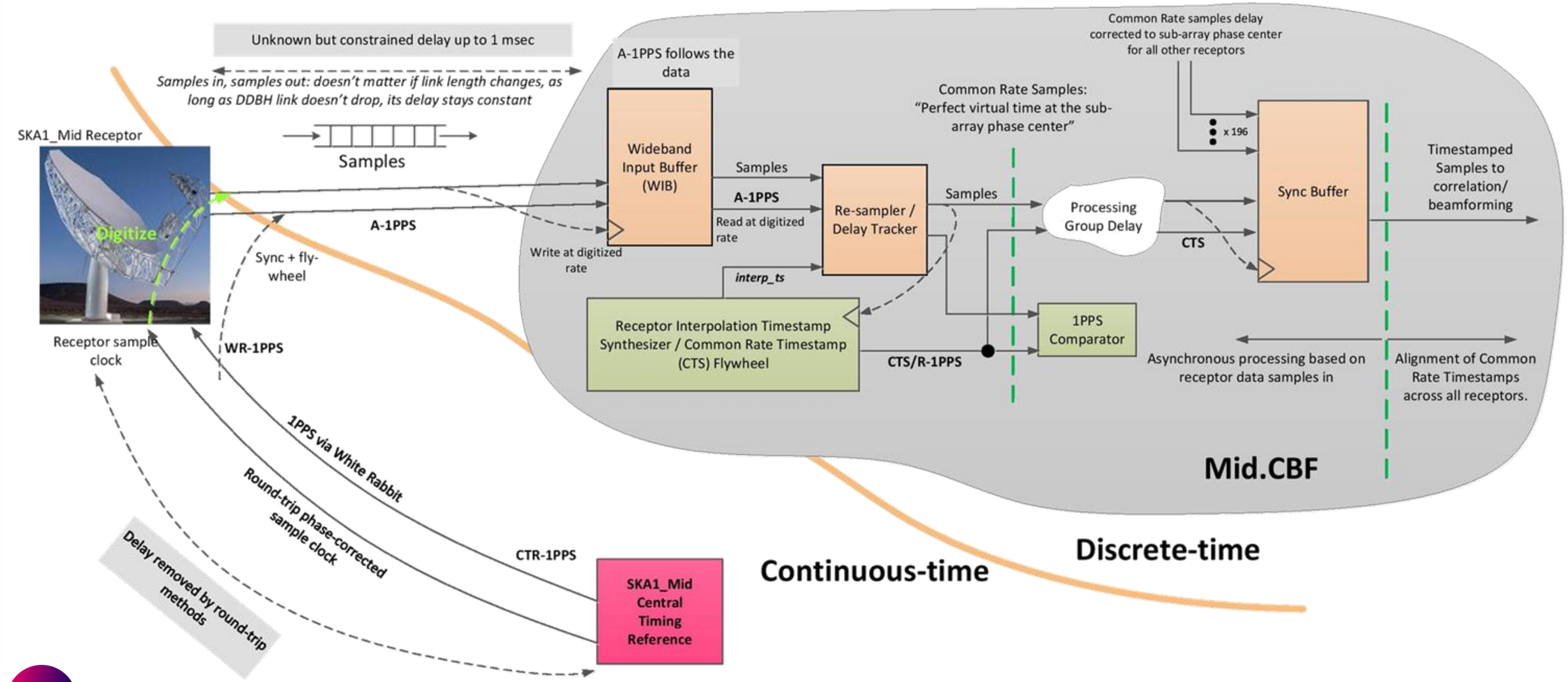


See: SKA-TEL-0001839 Science Network Re-Design for SKA1-Mid

Correlator Beamformer (CBF)



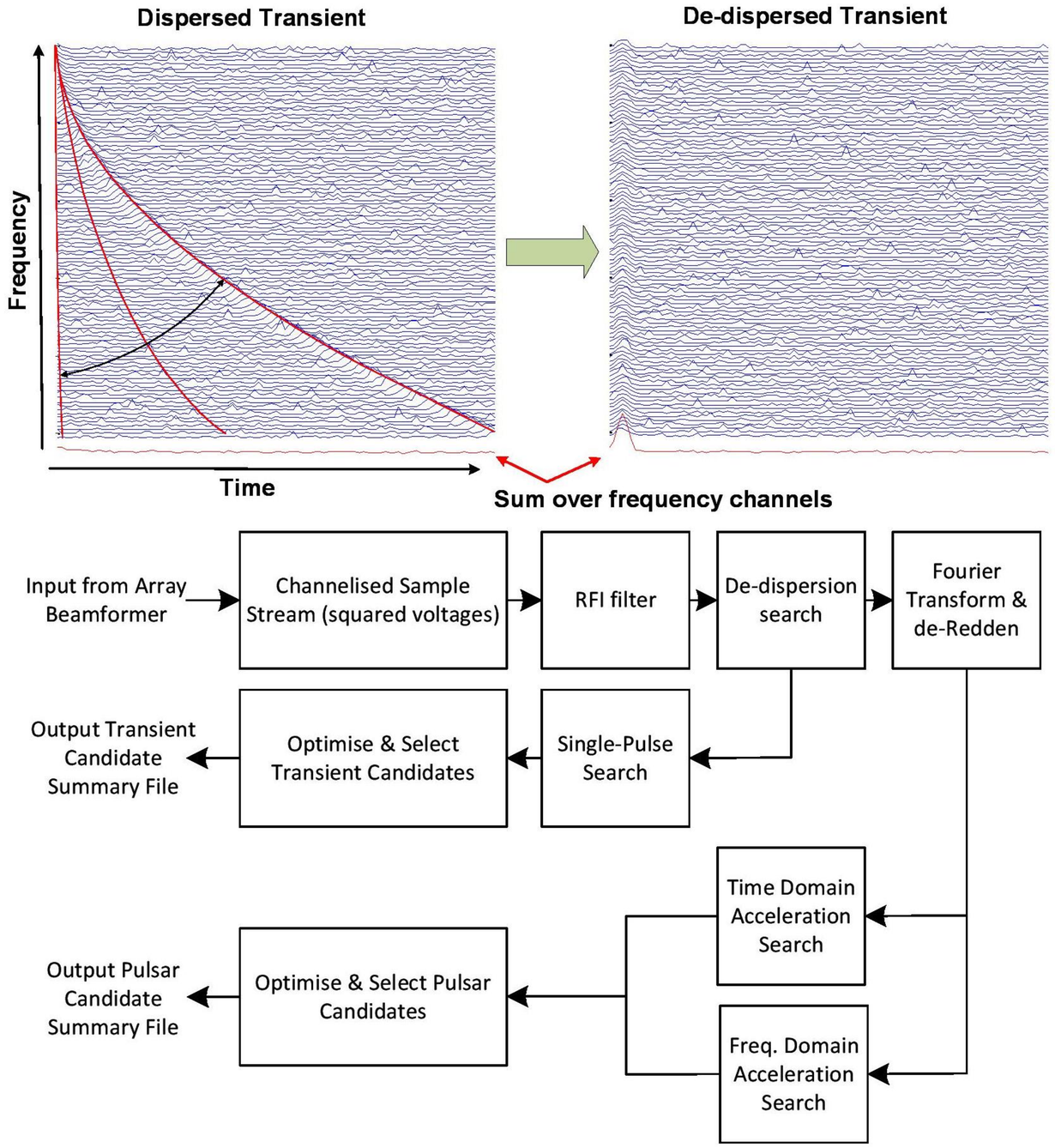
CBF is asynchronous (in Cape Town)



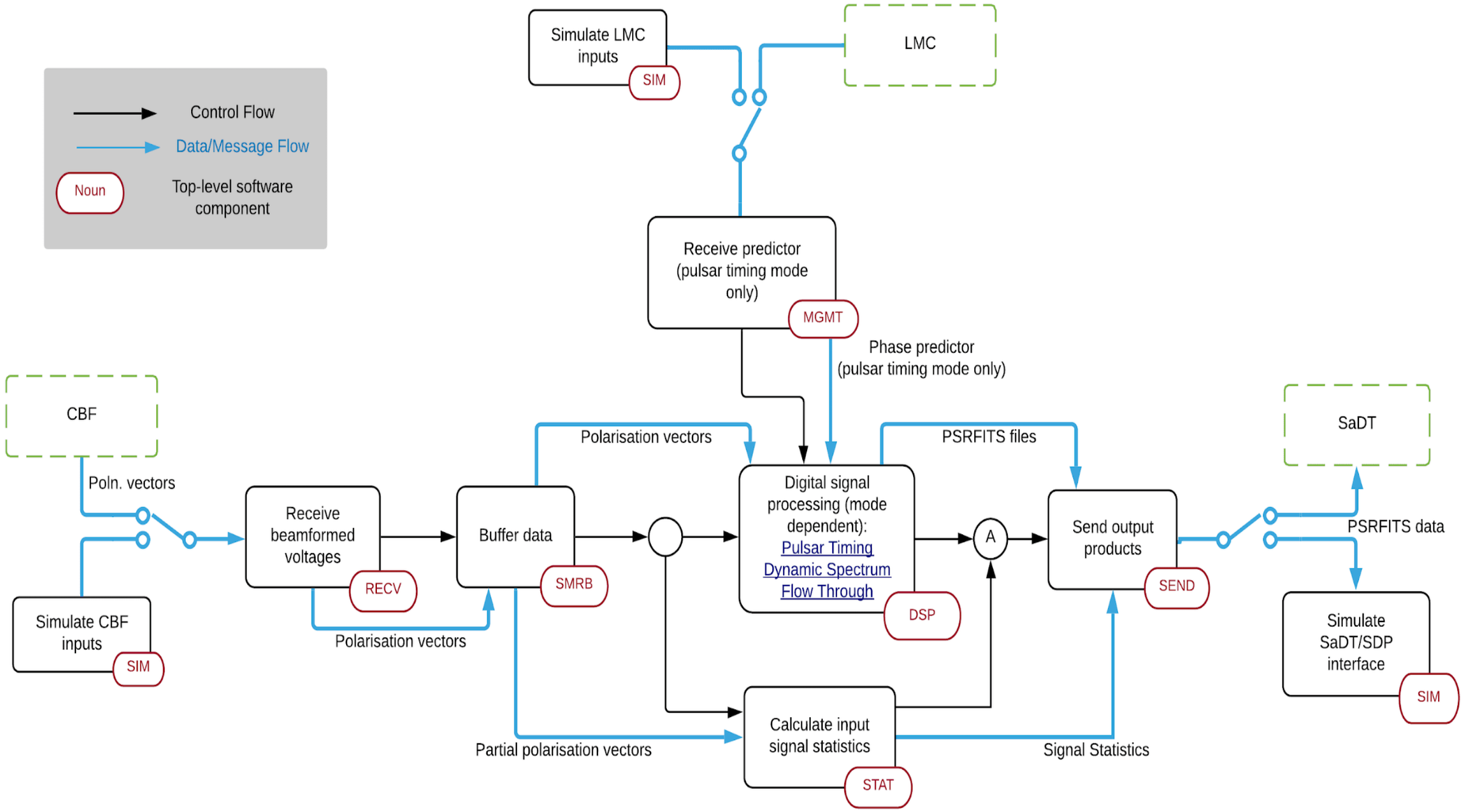
Pulsar Search (PSS)

- Uses beamformed data
- Separate, parallel processing
- RFI filtering
- Pulsar candidates sent to SDP

Link to Pulsar Search Confluence page



Pulsar Timing (PST)



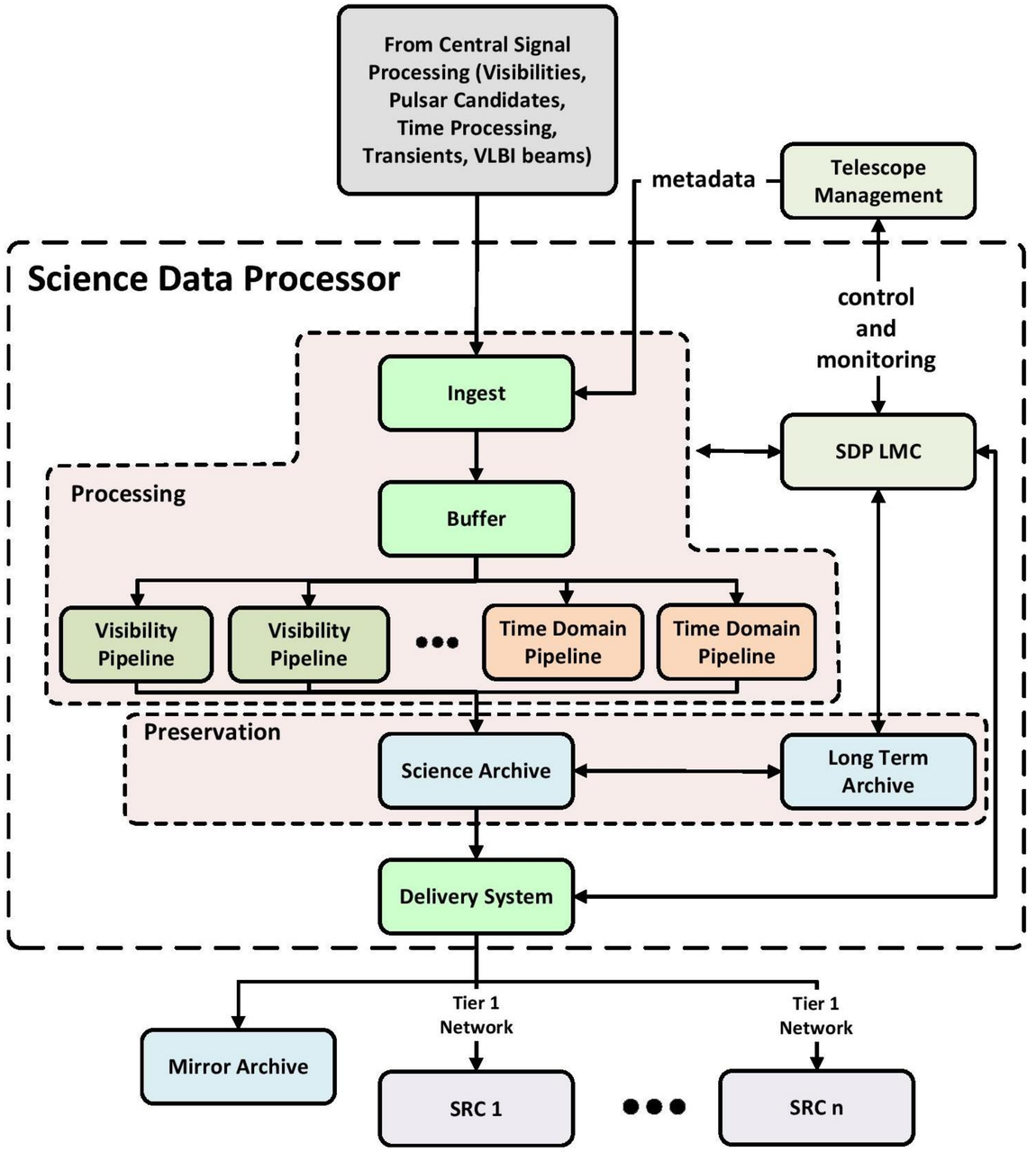
- Uses beamformed data
- Separate, parallel processing
- RFI filtering
- Pulsar times sent to SDP

Link to PST Confluence page

Science Data Processor

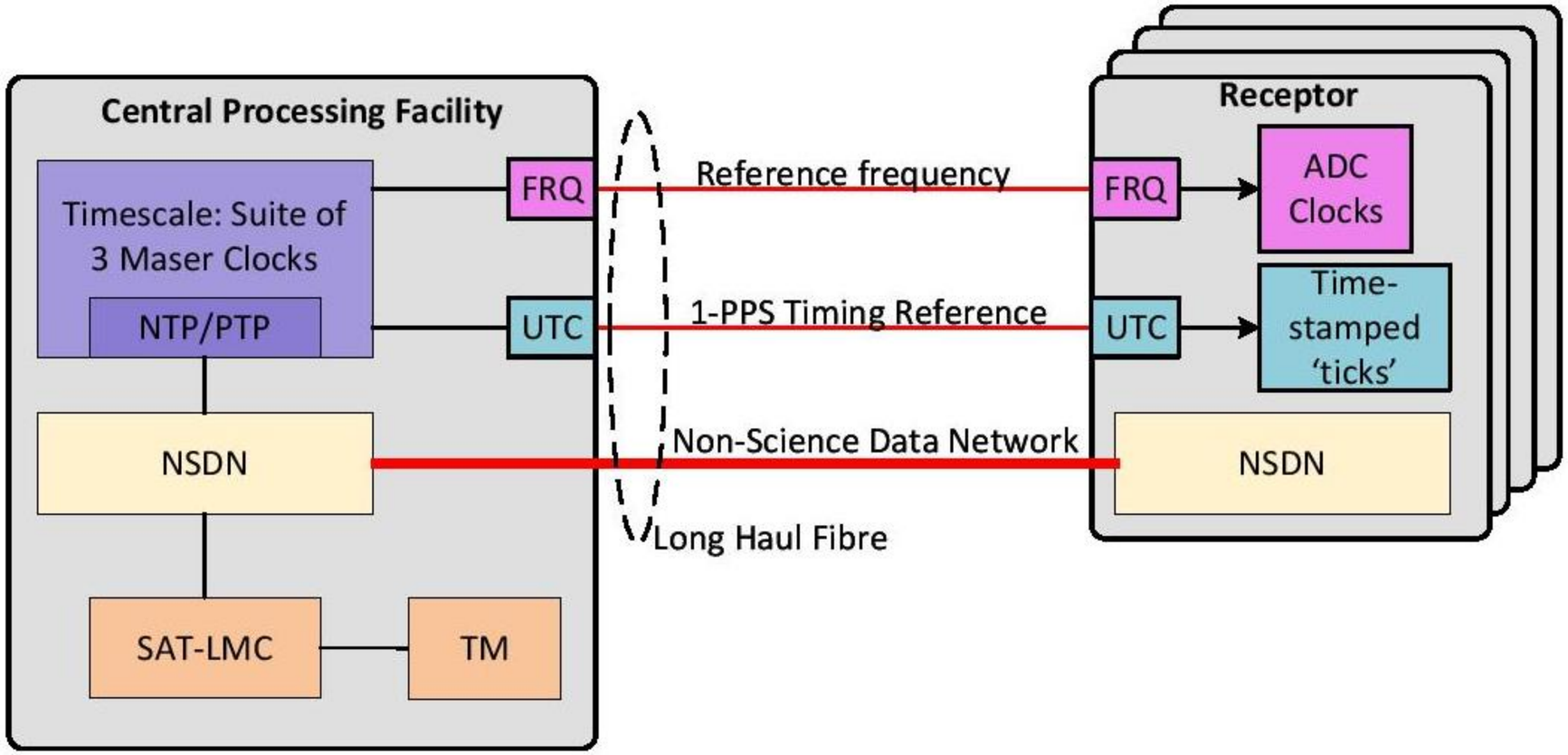
- Process data in real-time
- Under control of TMC
- Produces Observatory Data Products for users
- Computes calibration corrections for systems
- Quality assessment of data
- Archive delivered to SRCs

Link to SDP Confluence page



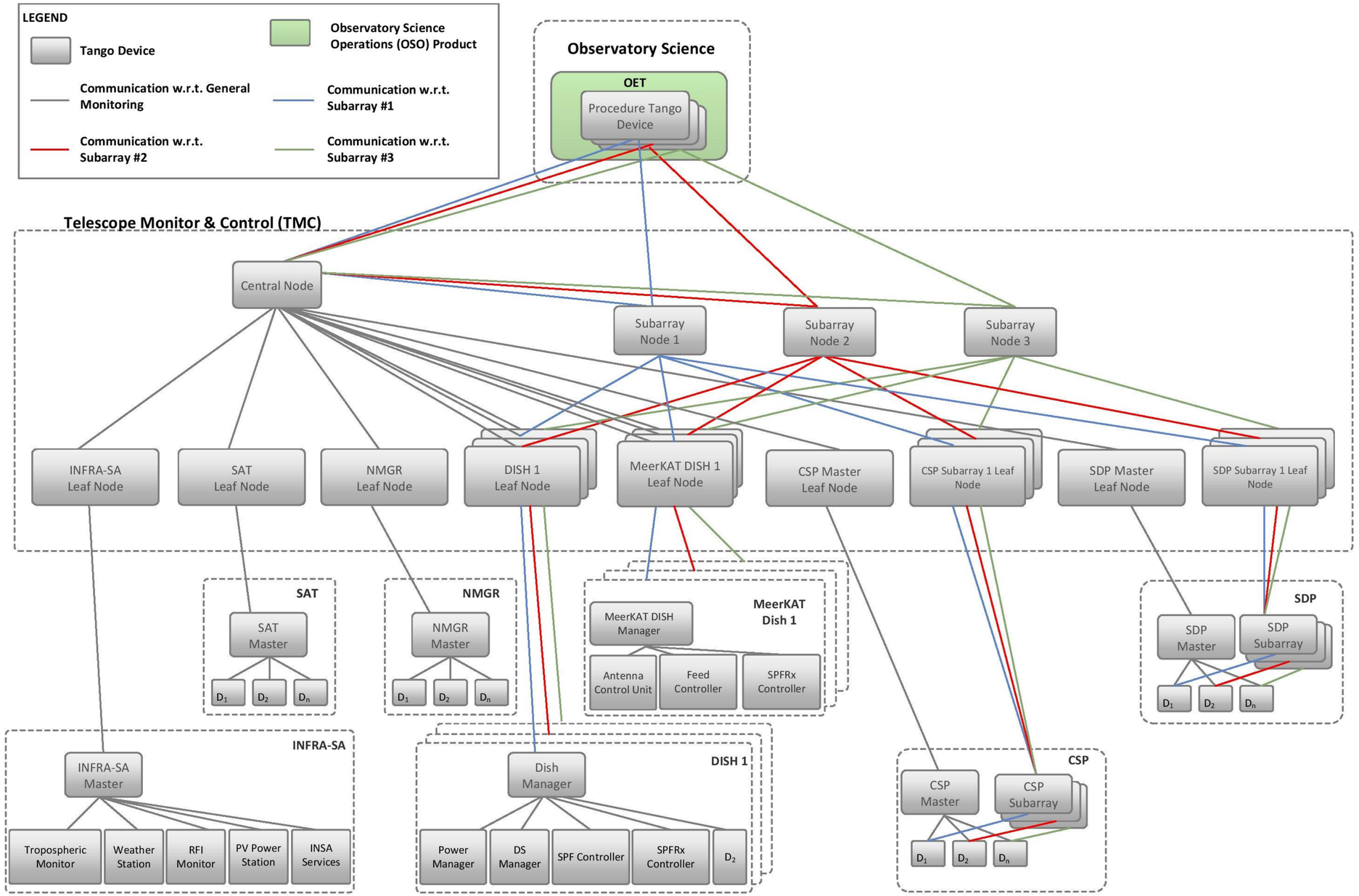
Synchronisation and Timing (SAT)

- Reference frequency to femto-second coherence
- Accurate time (ref. to UTC) with ns 10-year stability



Telescope Monitoring and Control

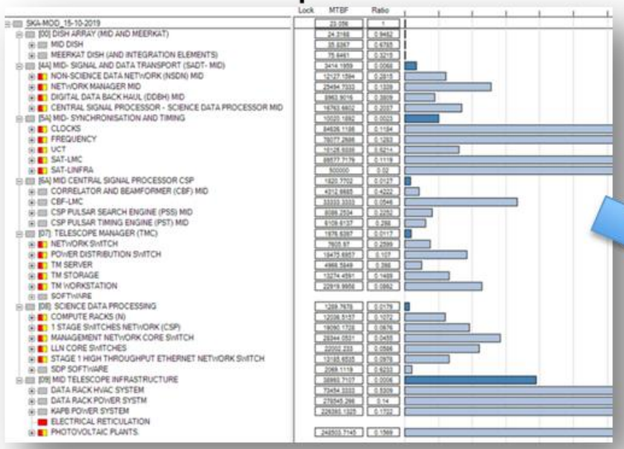
- TANGO
- Hierarchical
- Distributed
- Flexible
- LMC
- Logging



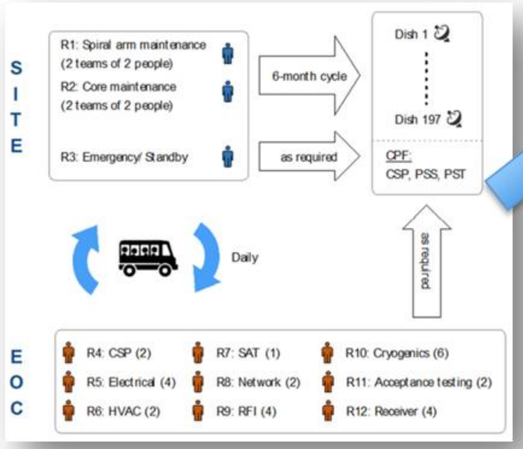
[Link to TMC Confluence page]

Achieving Reliability and Maintainability

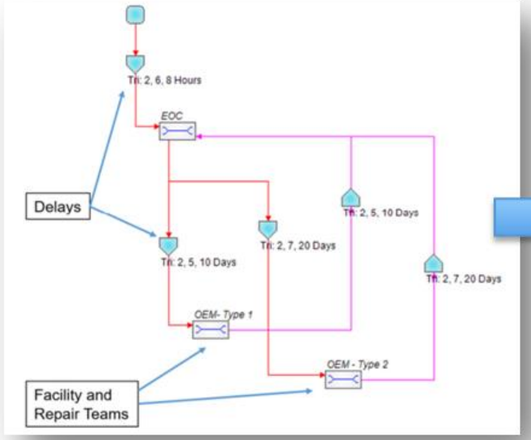
MTBF/MTTR per item



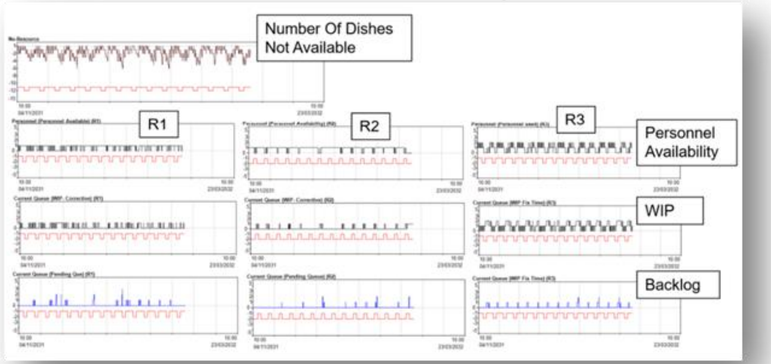
Maintenance Plans



Maintenance models



Operational Availability Estimate



[Link to Engineering Ops Confluence Page]

Thank you!
gerhard.swart@skao.int

We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.

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