Data Transport for SKA

URSI National Radio Science Meeting

6th January 2016

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University of Manchester

Talk Overview

- SADT Consortium
- Scope of SADT
- Digital Data Back Haul
- Non-Science Data
- Architecture
- Infrastructure
- Costs

SADT Consortium

- Lead institute: University of Manchester
  - Leader: Keith Grainge
  - Project Manager: Jill Hammond
  - System Engineer: Robert Gabrielcyzk
  - Project Engineer (SADT): Richard Oberland
  - Element specialist (SAT): Simon Garrington
  - SAT Architect: Paul Boven (JIVE)

Full members

- NPL (UK)
- NCRA (India)
- JIVE (Netherlands)
- SKA Africa (South Africa)
- Tsinghua University (China)
- NMMU (South Africa)
- UWA (Australia)

Associate members

- CSIRO (Australia)
- IT (Portugal)
- SANREN (South Africa)
- University of Granada (Spain)
- AARNet (Australia)
- GEANT (UK)

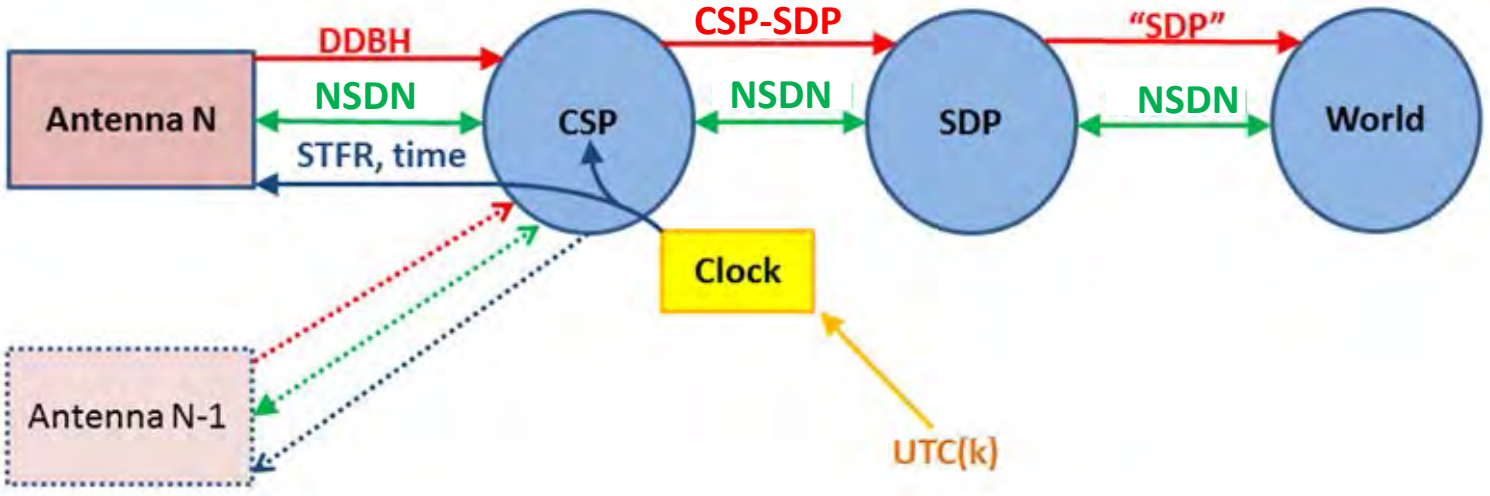
SADT summary

Science Data
- DDBH
- CSP-SDP
- SDP to world

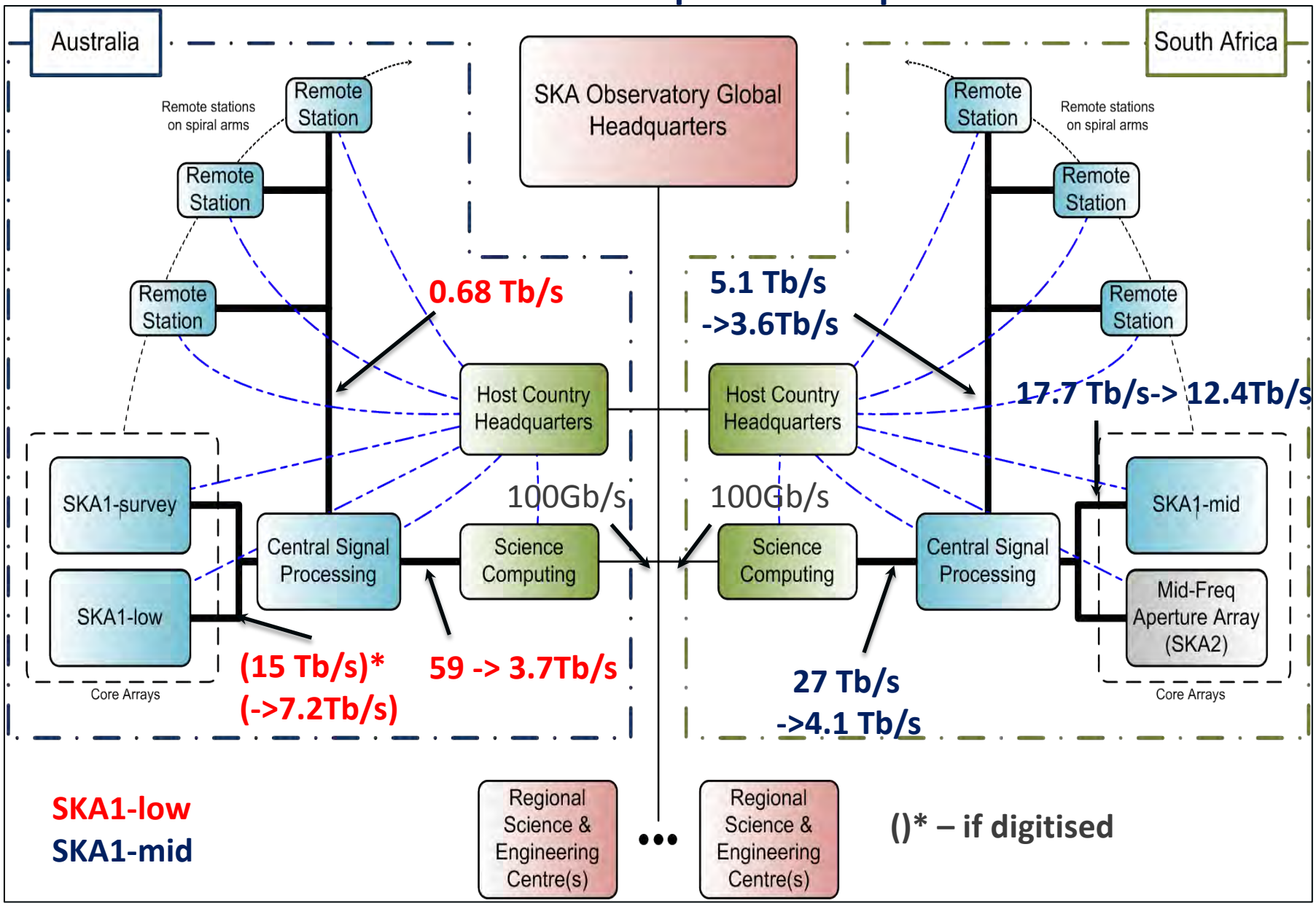
Sync & Timing
- Clock ensemble
- Freq. & Phase
- UTC time

Non-Science Data
- Control & Monitor
- Alarms
- Internet, VoIP

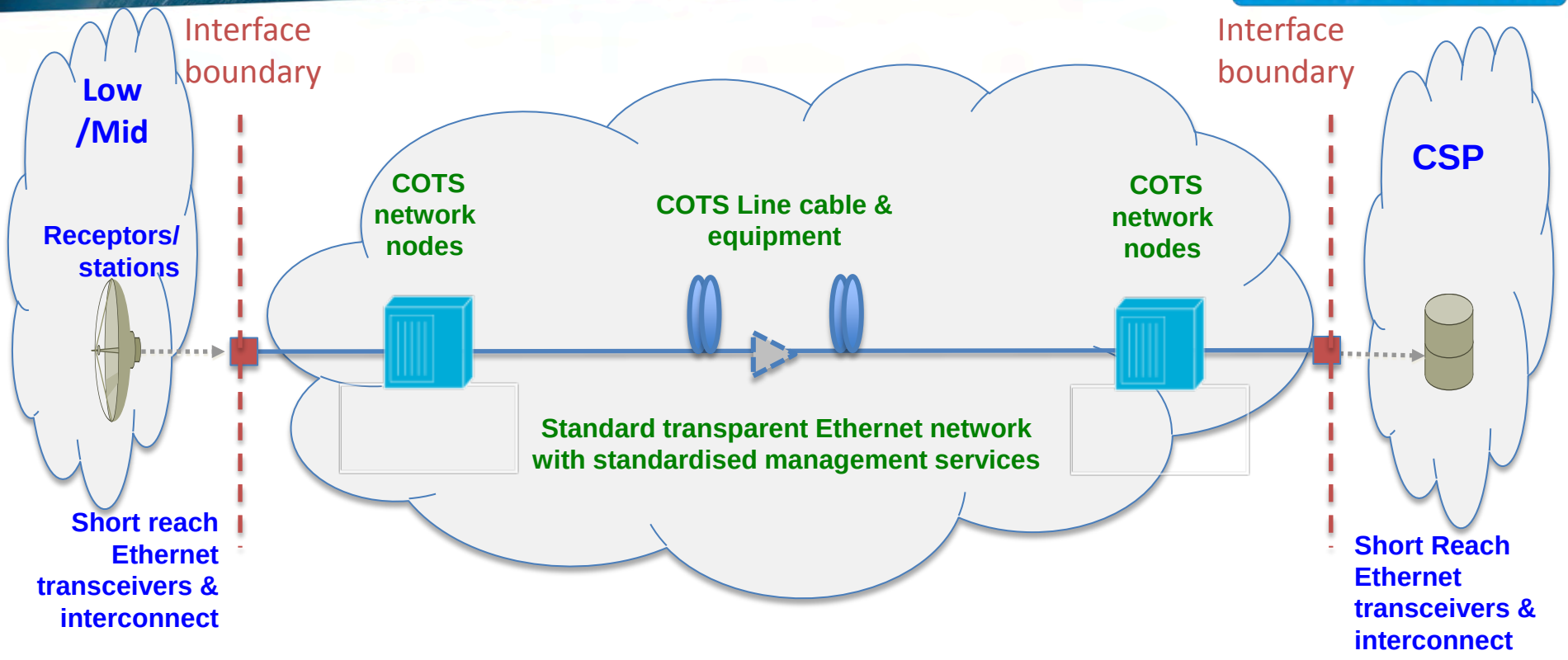
"Spanning" Tasks: Network Architecture; Network Manager; Local Infrastructure



Post-RBS Data Transport Requirements



DDBH network overview

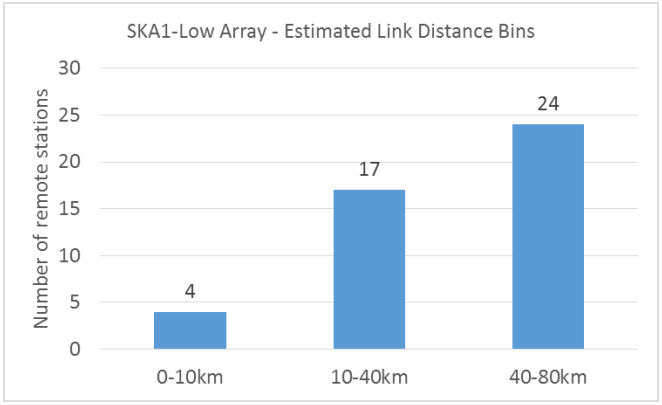


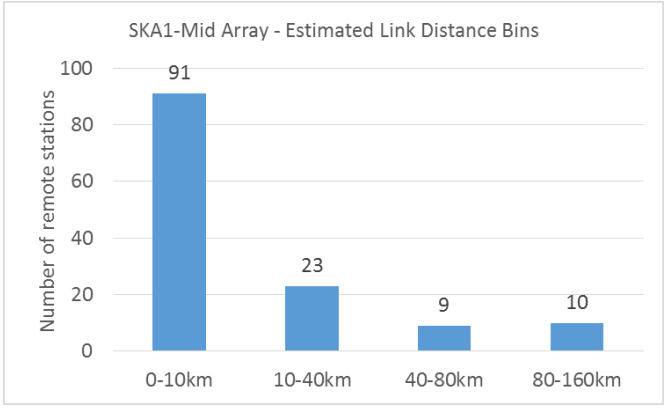
- Fully managed COTS solution – vendor agnostic design
- SKA-Mid; 133 dish antennas, 1x100GE transport lanes
  - Passive spans with LR4/ER4 grey optics or amplified/regen spans with DD/Coherent DWDM
- SKA-Low; 45 remote beam formed stations, 2 x 10GE transport lanes
  - Passive spans with LR/ER/ZR grey optics

DDBH COTS Cost estimation

Fractional selling price drop per annum

Estimates cable routed distance bins BDv2

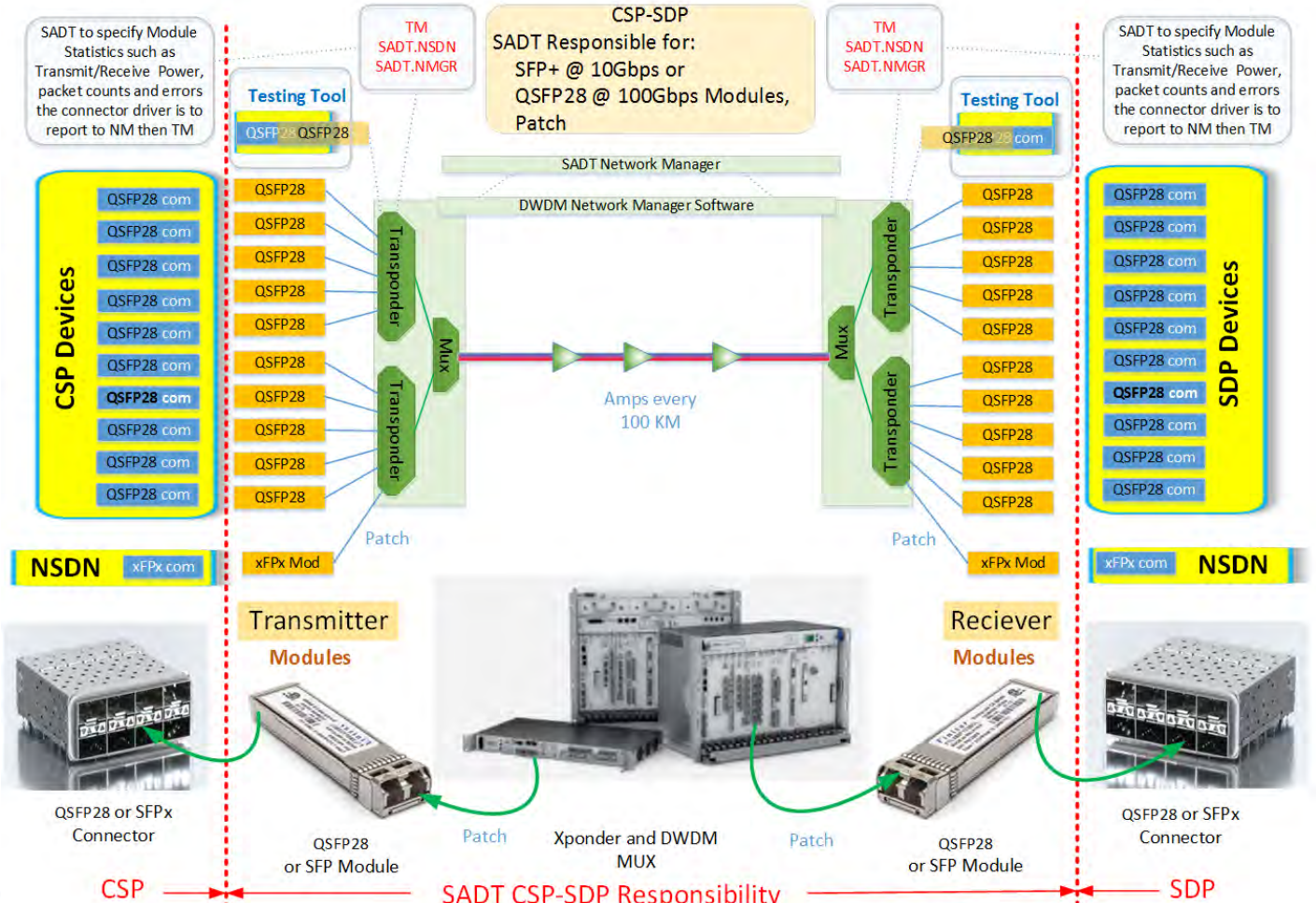




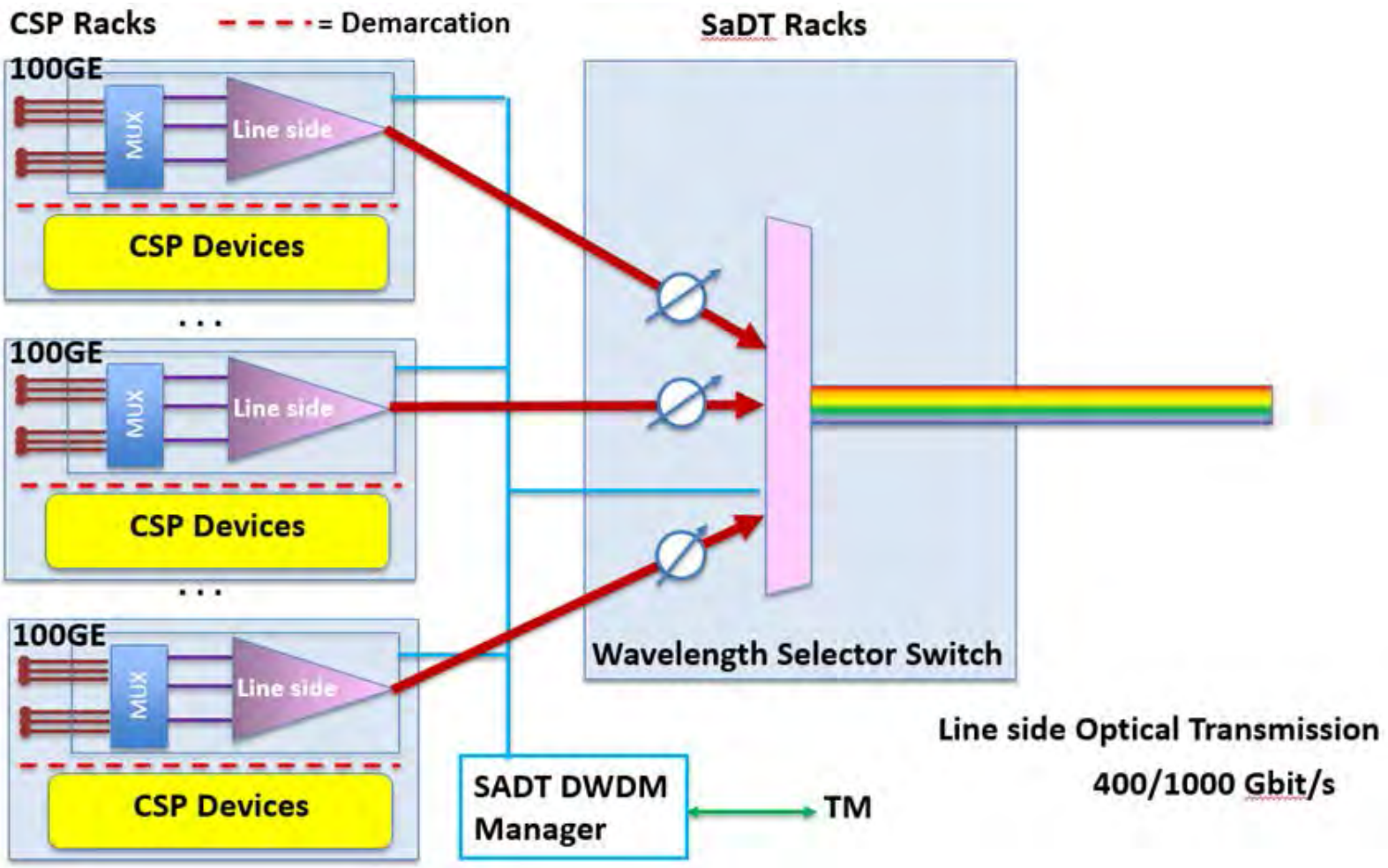
- Cost / power function of :
  - Year deployed (roll-out)
  - Data capacity
  - Cable distance

CSP-SDP Network Design

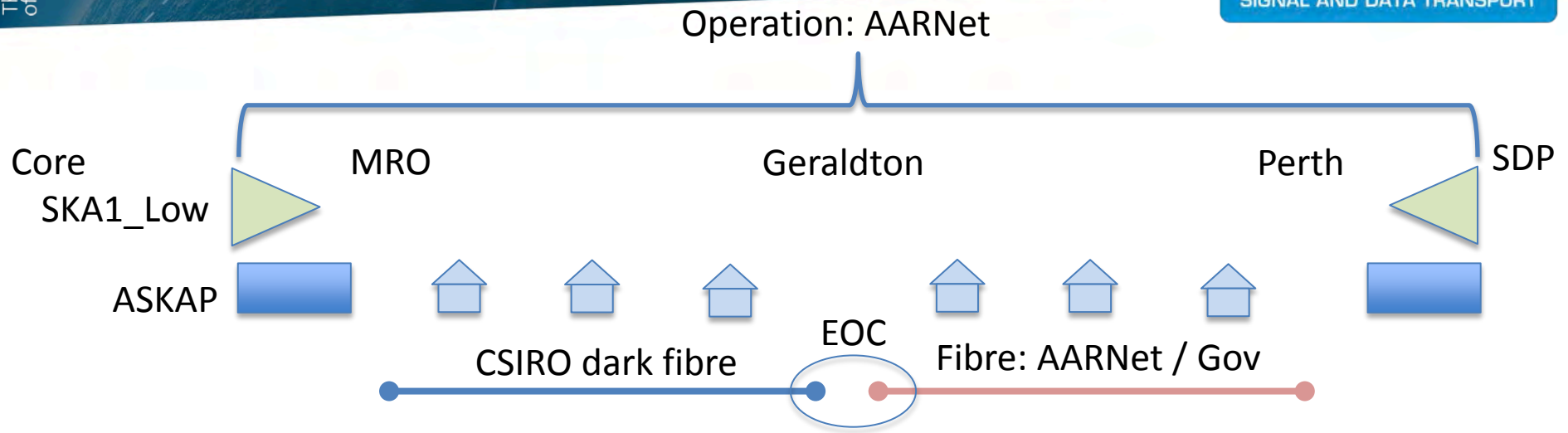
- Carries the following on 10/100 Gigabit Ethernet channels from correlator to supercomputer facility:
  - Visibility
  - Pulsar
  - VLBI
  - NSDN
- ~~123 Tbps~~
- 7.8 Tbps



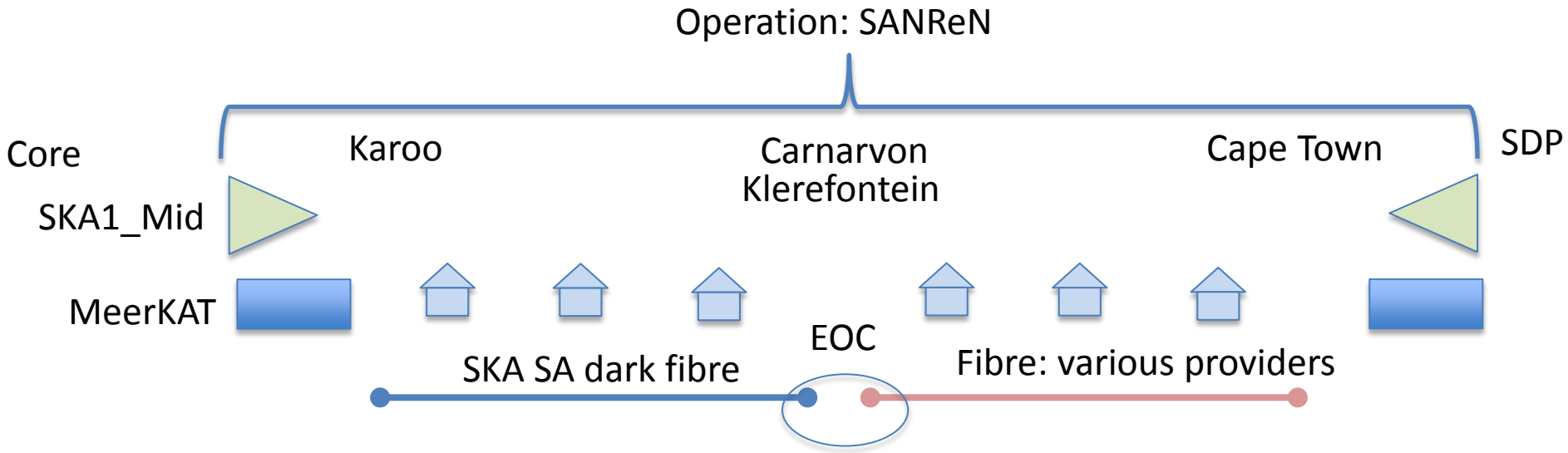
CSP Egress: Visibility Data



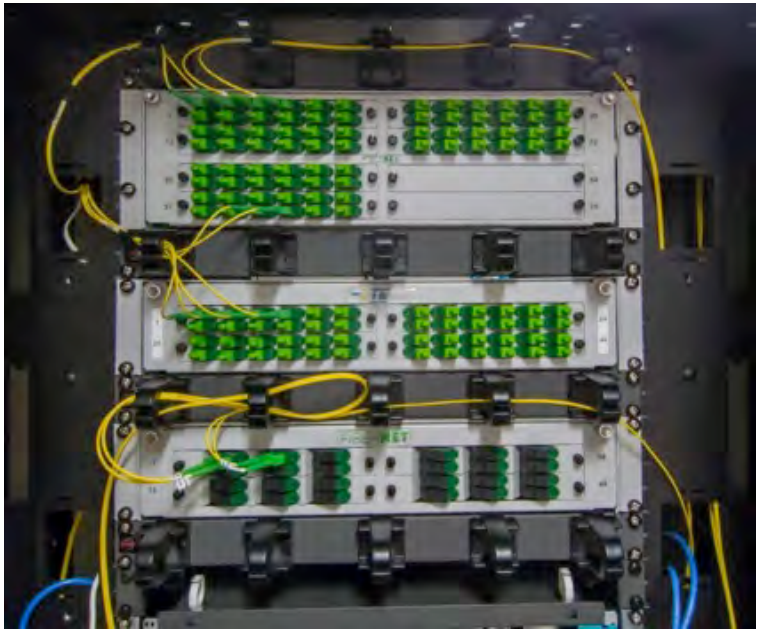
CSP-SDP operations concept



- ASKAP & CSIRO ask AARNET to manage the core-HPC network
- MeerKAT have a similar approach with SANReN



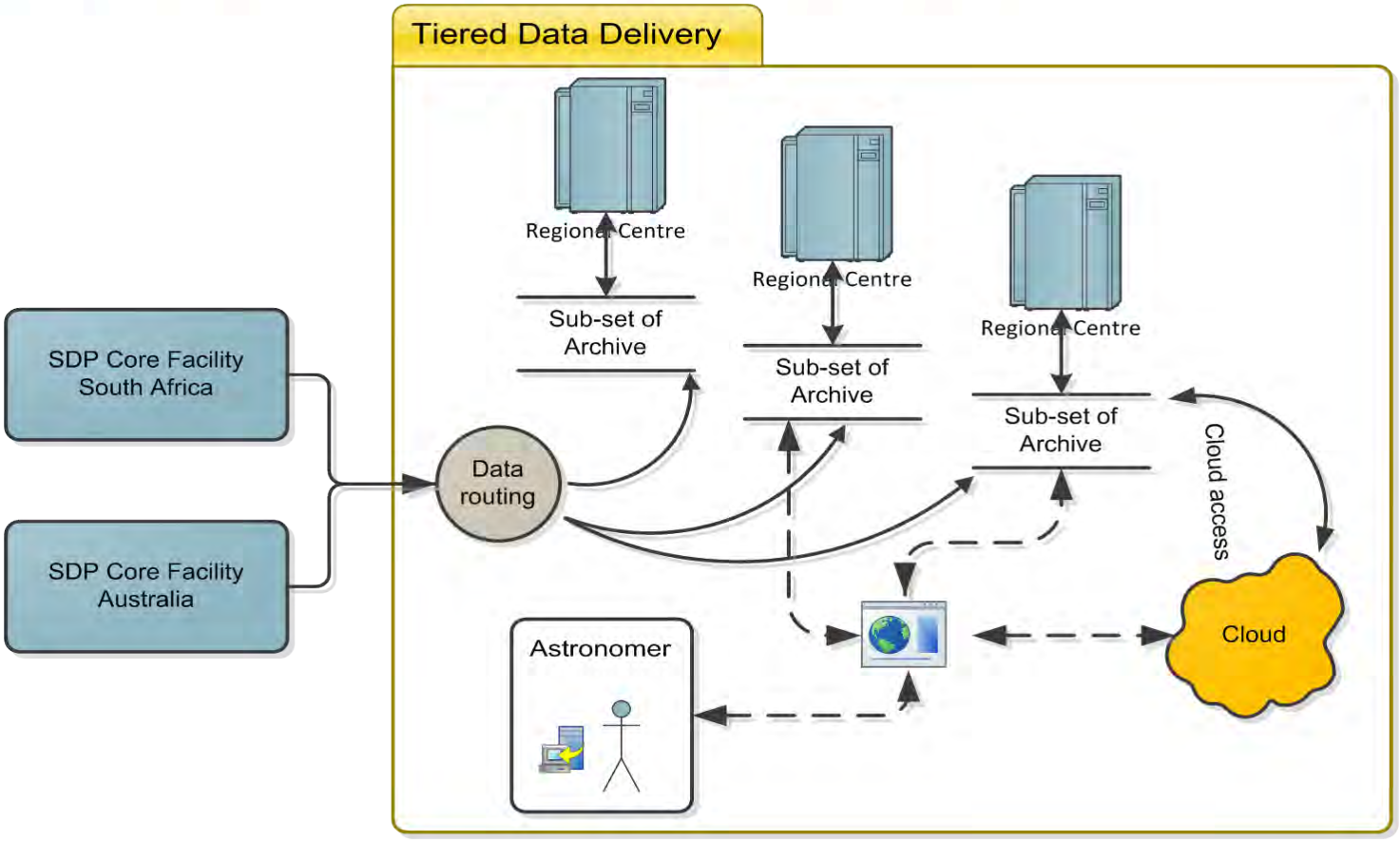
CSP – Amplifier huts



Solar powered CEV picture (left) and communications rack (right) installed at Geraldton (WA) (courtesy of S. Amy, CSIRO)

- No regeneration required for 820/900 km
- Do need amplifier huts every ~100 km

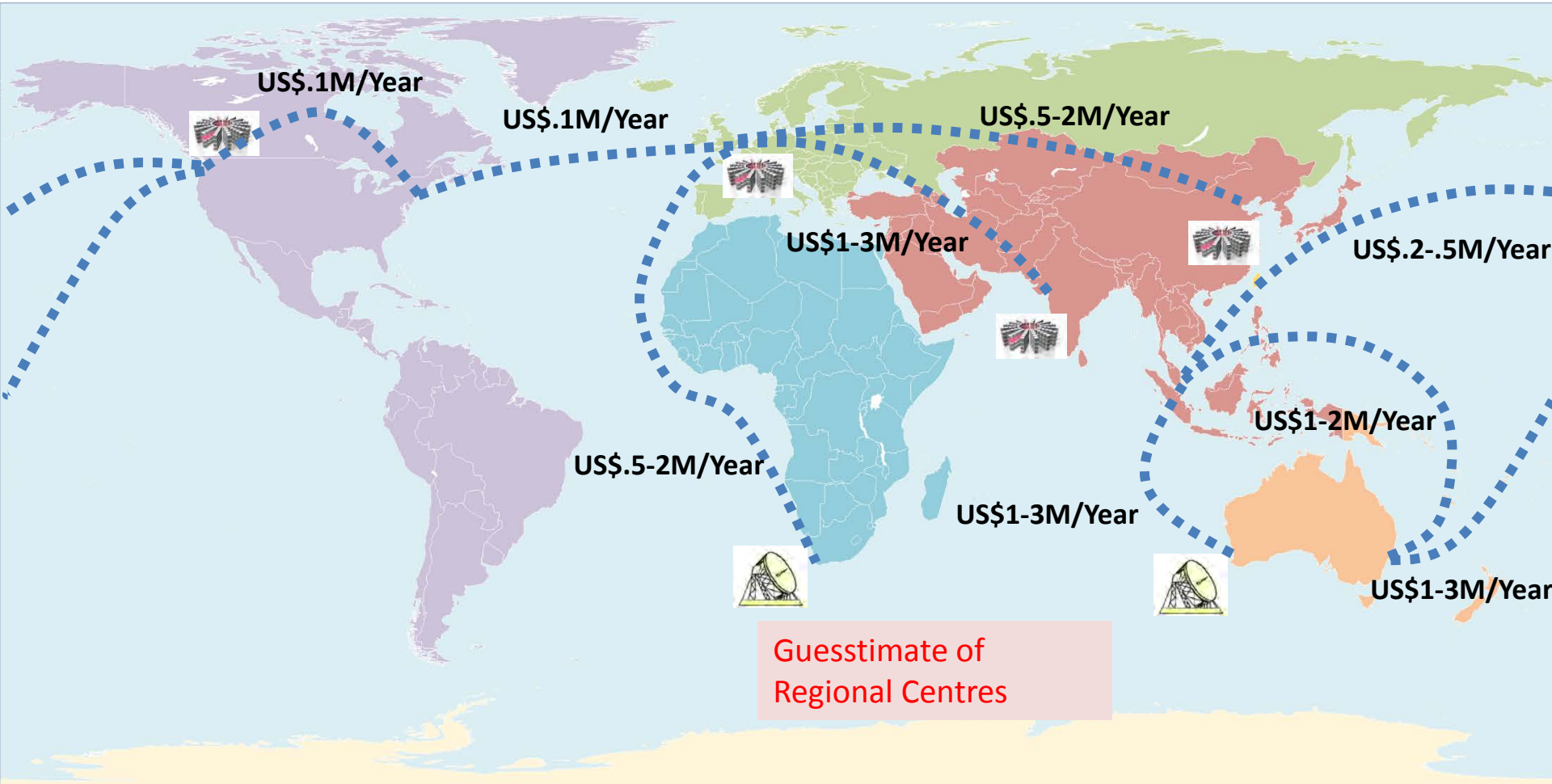
Data Delivery to Astronomers



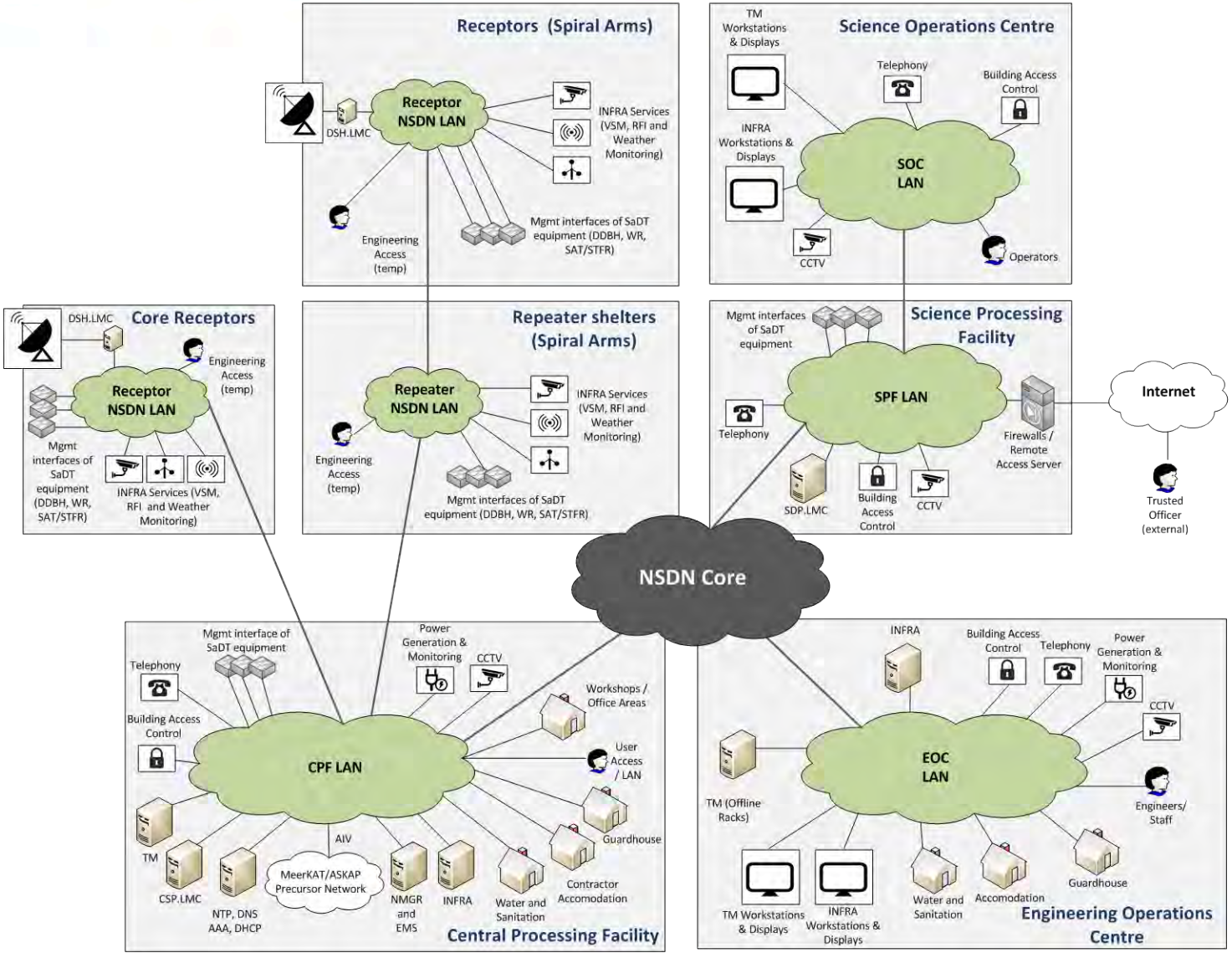
- 100 Gb/s reduced data to be distributed internationally
- Joint work by SADT and SDP

Estimated SDP to world costs

- 10 year IRU per 100Gbps circuit 2020-2030
- Guesstimate of Regional Centres locations

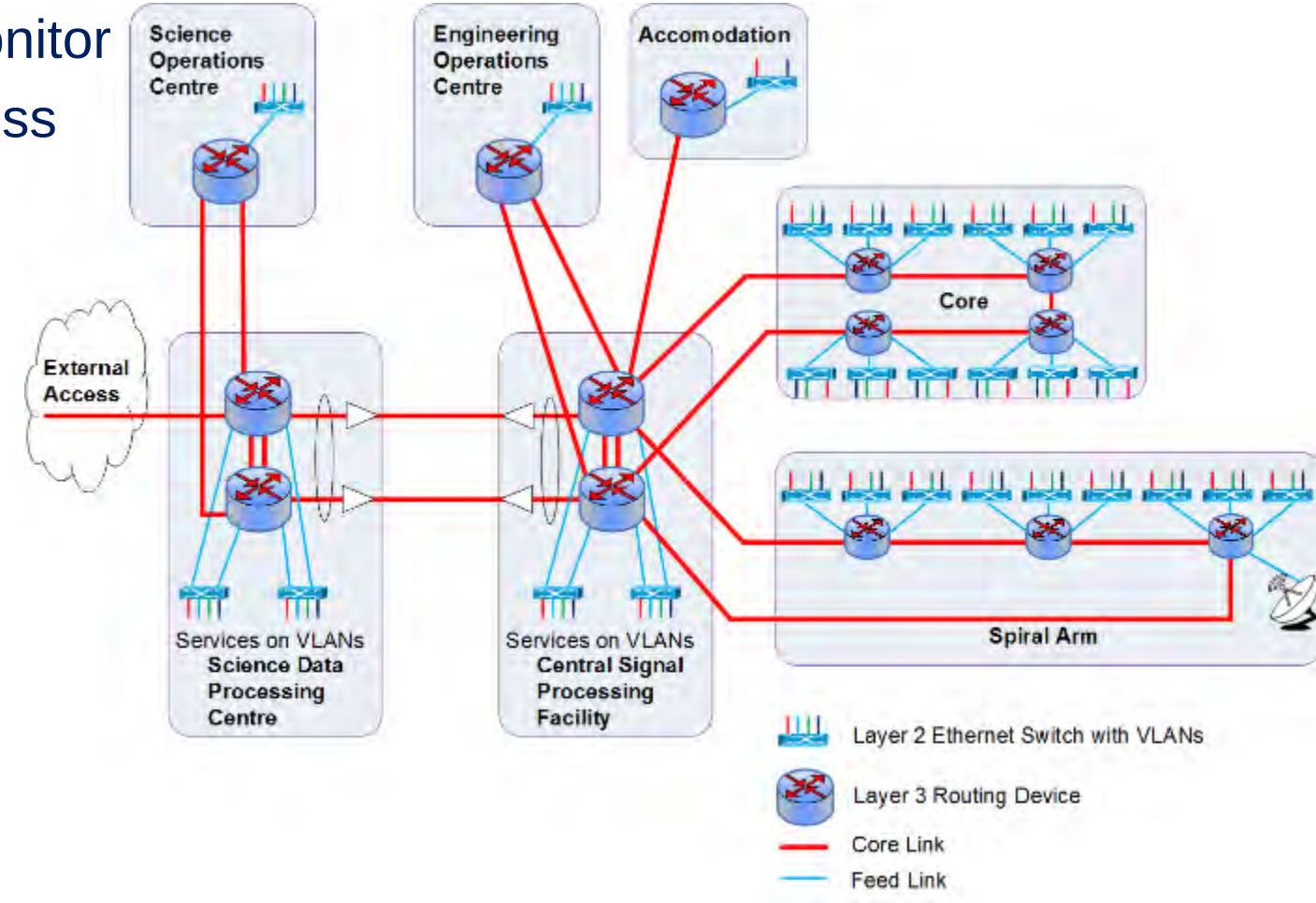


Non Science Data Network



Non Science Data Network

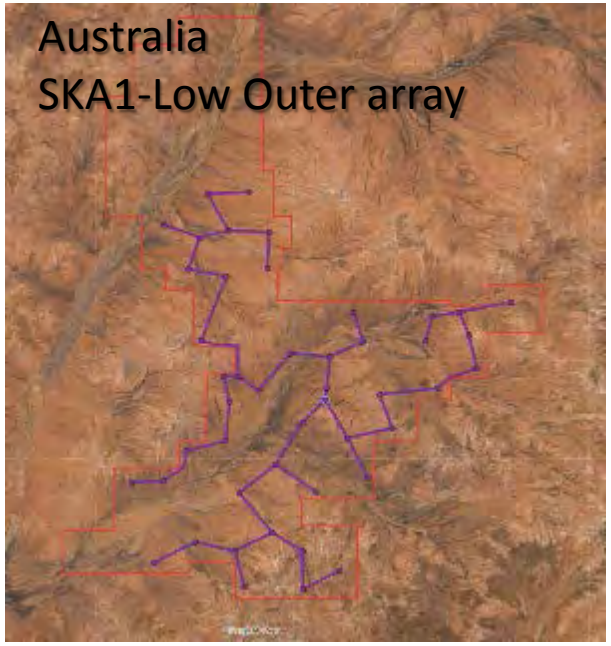
- A network infrastructure with resilience – given the topology.
- The set of services include:
  - Control & Monitor
  - Internet access
  - IP phones
  - Security

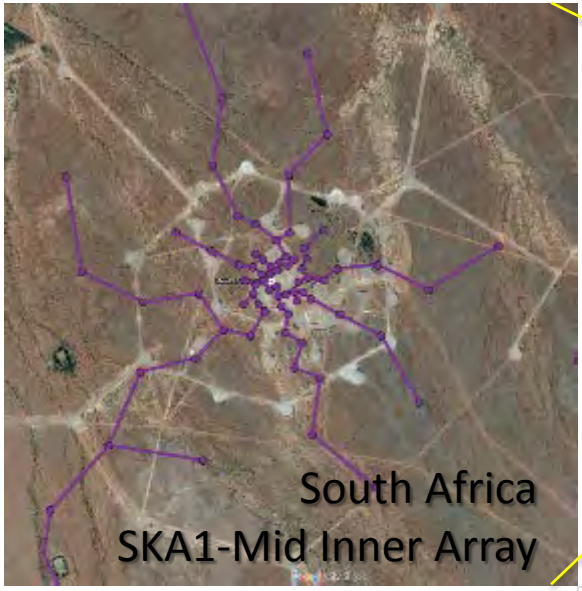


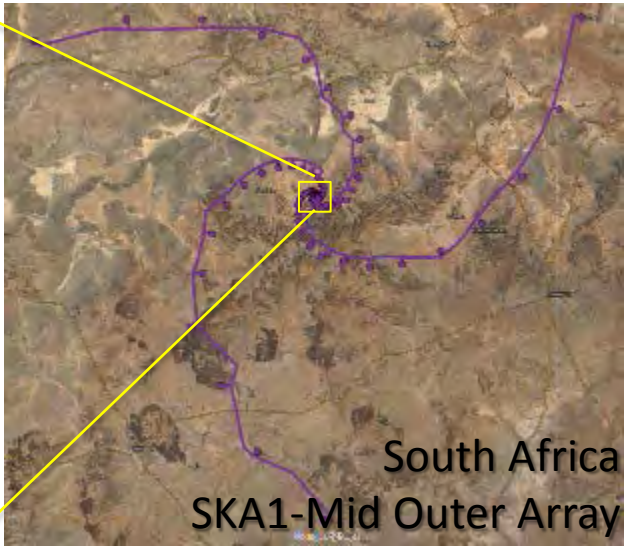
LINFRA - cable routing to CPF

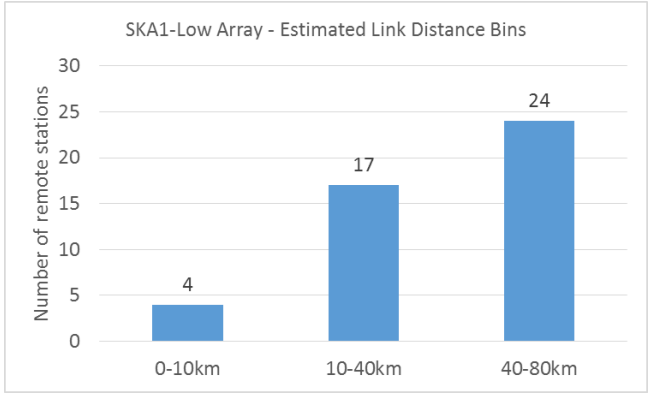
SIGNAL AND DATA TRANSPORT

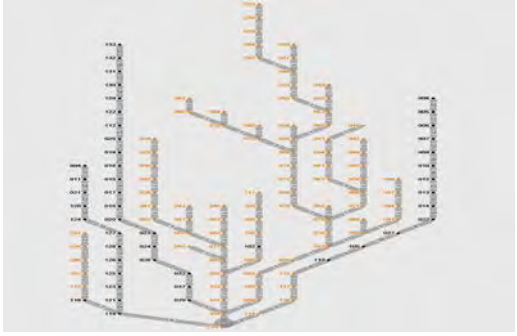
Cable route distance optimised examples

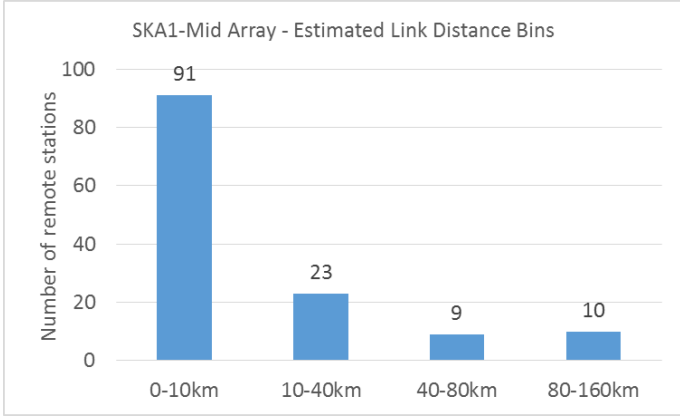












SKA1 MID Spiral Remote Station Fibre Options

SIGNAL AND DATA TRANSPORT

Overhead Fibre on Powerline

- Total Fibre Length – 453 km
- Average length/spiral – 151 km
- SADT trench req. - 0 km
- Shared INFRA trench - ± 214 km
- Could save around €10 Million (full powerline implementation costs to be assessed)

Pros / Cons:

- Fibre exposed to temperature changes / weather conditions
- Lower fibre losses - require 2 repeater shelters per line
- On same servitude as powerline – no additional legal wayleave costs
- Easier maintenance access – same as per current Long Haul fibre access to site

Buried Duct Fibre

- Total fibre length – 732 km
- Average length/spiral – 244 km
- SADT trench req. – 680 km
- Shared INFRA trench - ± 52 km
- More costly option

Pros / Cons:

- High fibre stability / not exposed to daily temperature and wind/vibration effects
- Lower risk of physical damage?
- Fibre loss require 3 repeater shelters per spiral
- Minimal fibre effect on SAT / STFR Timing systems

Network Architecture

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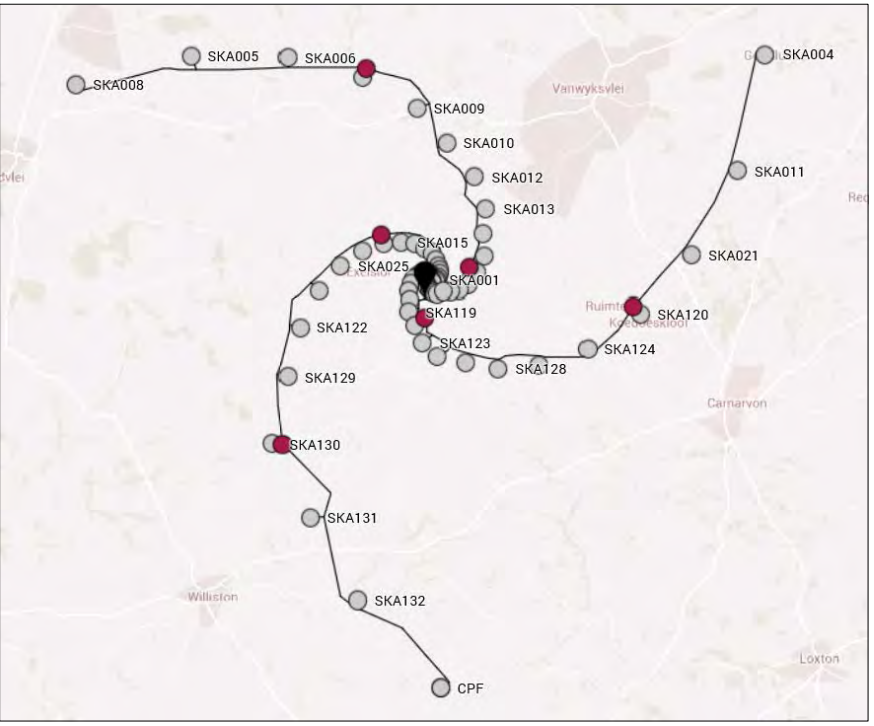

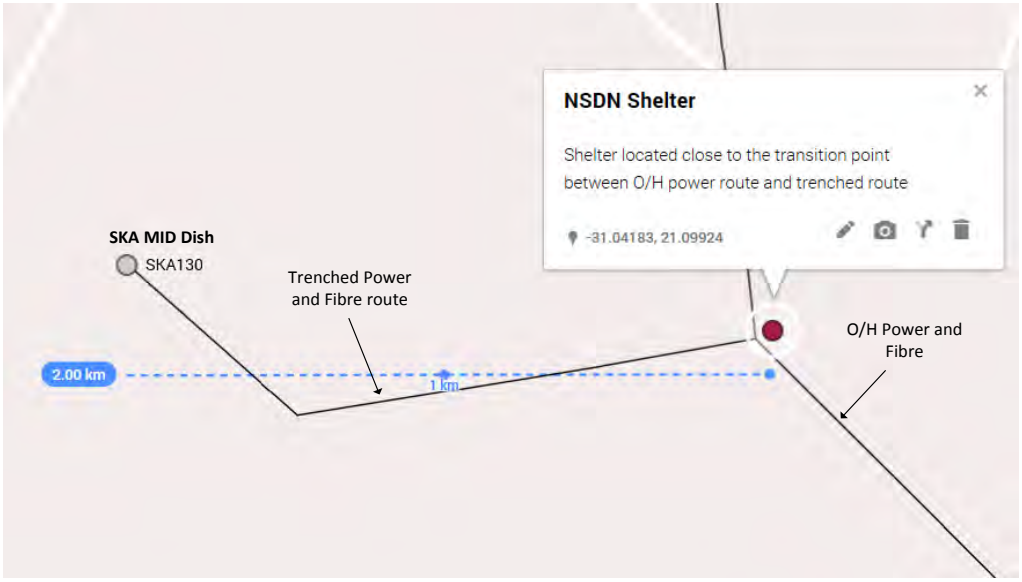

- Reach of optics ~ 80km
- Amplify or regenerate DDBH, NSDN, STFR, WR
- Dedicated shelters along spiral arms

Summary

- Many different challenges for SKA data transport
  - Volume
  - Distance
  - Topology
  - Combined architecture
  - Services
  - Security
- Now affordable with largely COTS