Data Transport for SKA

URSI National Radio Science Meeting

6th January 2016

Keith Grainge, SADT Lead 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

- o 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)

Associate members

- CSIRO (Australia)
- IT (Portugal)
- SANREN (South Africa)



- SKA Africa (South Africa)
- Tsinghua University (China)
- NMMU (South Africa)
- UWA (Australia)
- University of Granada (Spain)
- AARNet (Australia)
- GEANT (UK)



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SADT summary



Science Data

- DDBH
- CSP-SDP
- SDP to world

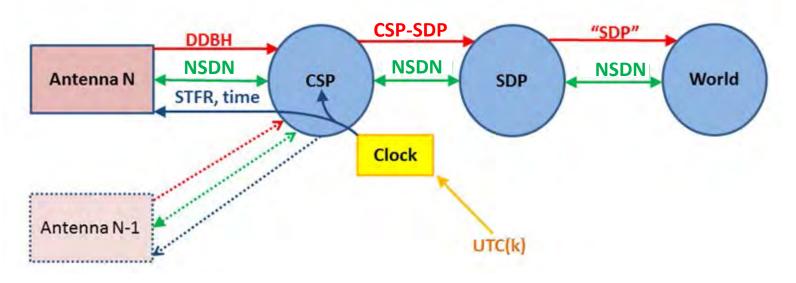
Sync & Timing

- Clock ensemble
- Freq. & Phase
- UTC time

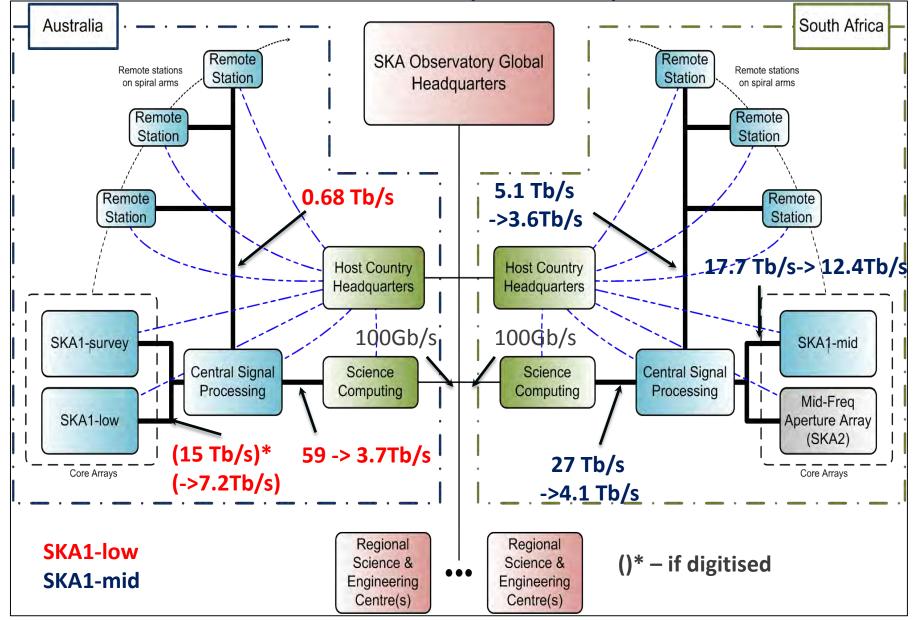
Non-Science Data

- Control & Monitor
- Alarms
- Internet, VoIP

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

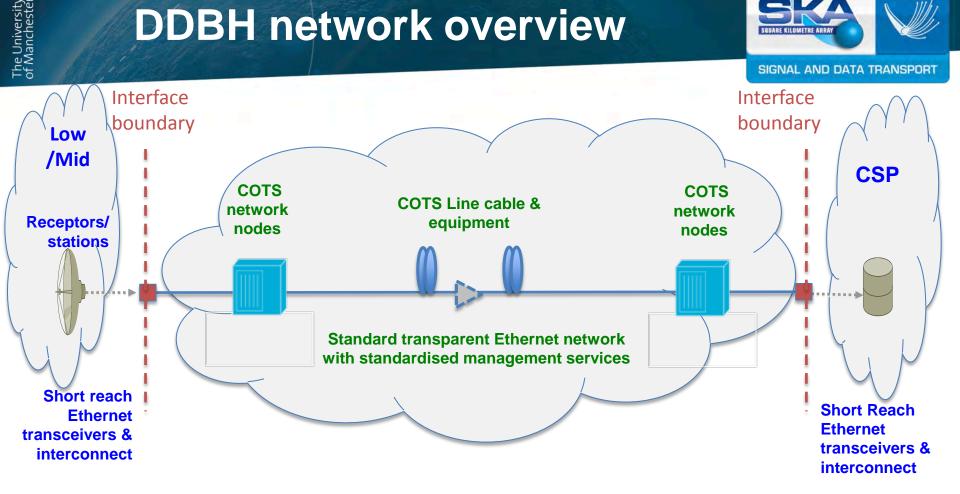


Post-RBS Data Transport Requirements



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

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DDBH COTS Cost estimation

SIGNAL AND DATA TRANSPORT

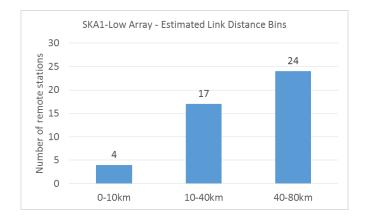
Fractional selling price drop per annum

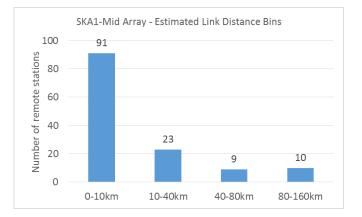


Cost / power function of :

 Year deployed (roll-out)
 Data capacity
 Cable distance

Estimates cable routed distance bins BDv2







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CSP-SDP Network Design



SIGNAL AND DATA TRANSPORT

Connector

SDP

• Carries the following on 10/100 Gigabit Ethernet channels from correlator to supercomputer facility:

Connector

CSP

Visibility Ο CSP-SDP TM TM SADT to specify Module SADT to specify Module SADT Responsible for: SADT.NSDN SADT.NSDN Pulsar Statistics such as Statistics such as \mathbf{O} SADT.NMGR SFP+@10Gbps or SADT.NMGR Transmit/Receive Power, Transmit/Receive Power. packet counts and errors packet counts and errors QSFP28 @ 100Gbps Modules, **Testing Tool Testing Tool** the connector driver is to the connector driver is to VLBI Patch \cap report to NM then TM report to NM then TM OSEP 28 OSEP 28 OSFP28 com SADT Network Manager NSDN \cap QSFP28 QSFP28 com QSFP28 QSFP28 com **DWDM Network Manager Software** QSFP28 QSFP28 QSFP28 com QSFP28 com [ransponder 123 Tbps QSFP28 **QSFP28** com QSFP28 com QSFP28 **CSP Devices** QSFP28 evic QSFP28 QSFP28 com QSFP28 com 7.8 Tbps QSFP28 QSFP28 QSFP28 com QSFP28 com QSFP28 com QSFP28 QSFP28 com QSFP28 0 S ransponde Transponder QSFP28 com QSFP28 com QSFP28 Amps every QSFP28 100 KM QSFP28 com QSFP28 com QSFP28 QSFP28 QSFP28 com QSFP28 com QSFP28 QSFP28 QSFP28 com **QSFP28** com QSFP28 QSFP28 Patch Patch NSDN xFPx Mod xFPx Mod xFPx com NSDN 241.1.2. Reciever Transmitter Modules Modules OSFP28 or SFPx QSFP28 or SFPx

Patch

OSFP28

or SFP Module

Xponder and DWDM

MUX

SADT CSP-SDP Responsibility

Patch

OSFP28

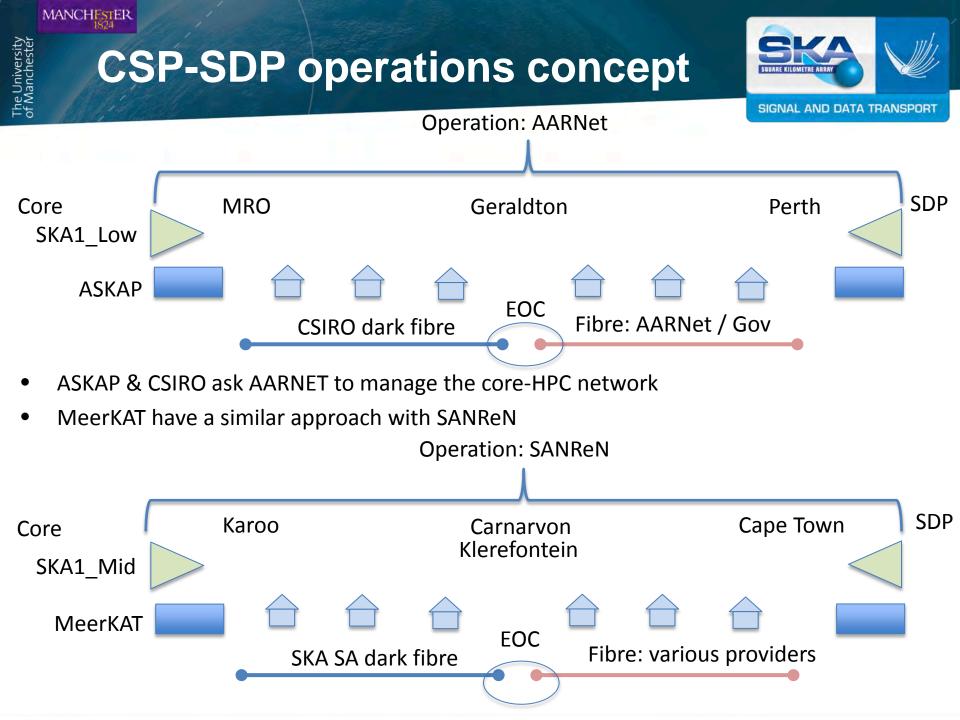
or SFP Module

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CSP Egress: Visibility Data



CSP Racks - -= Demarcation SaDT Racks 100GE Line side R **CSP** Devices . . . 100GE Line side N **CSP** Devices . . . 100GE Wavelength Selector Switch Line side MUD Line side Optical Transmission 400/1000 Gbit/s SADT DWDM **CSP** Devices TM Manager



CSP – Amplifier huts



SIGNAL AND DATA TRANSPORT



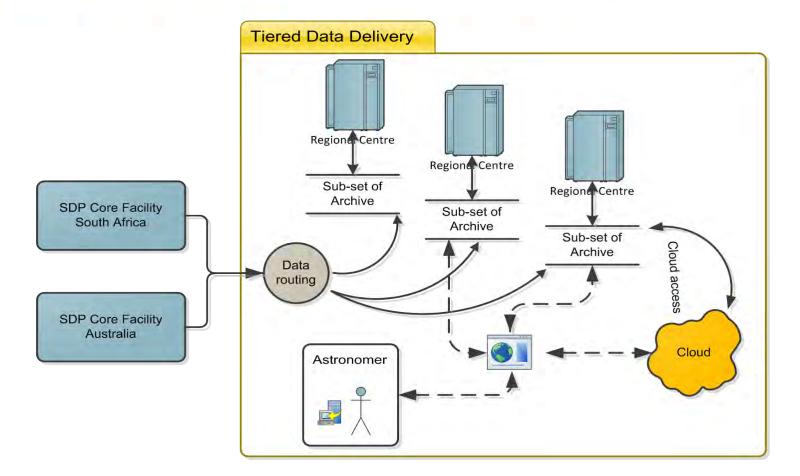
Solar powered CEV picture (left) and communications rack (right) installed at Geraldton (WA) (courtesy of S. Amy, CSIRO)

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

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Data Delivery to Astronomers

SUARE KILOMETRE ARRAY



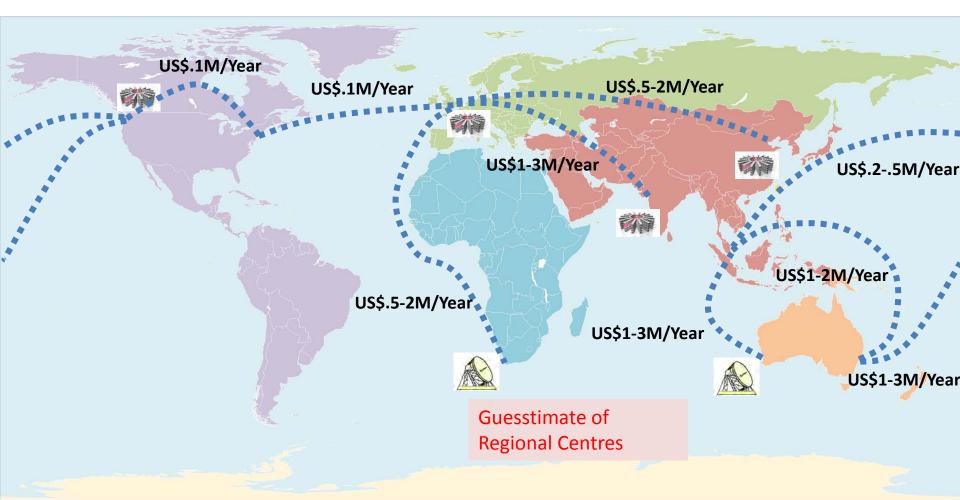
- 100 Gb/s reduced data to be distributed internationally
- Joint work by SADT and SDP



Estimated SDP to world costs



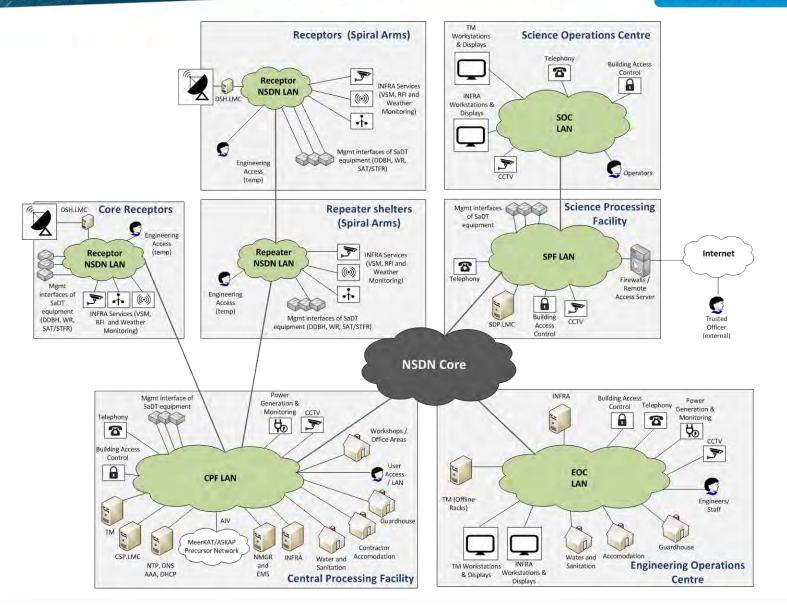
- 10 year IRU per 100Gbps circuit 2020-2030
- Guesstimate of Regional Centres locations



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Non Science Data Network

SUDARE KILOMETRE ARRAY



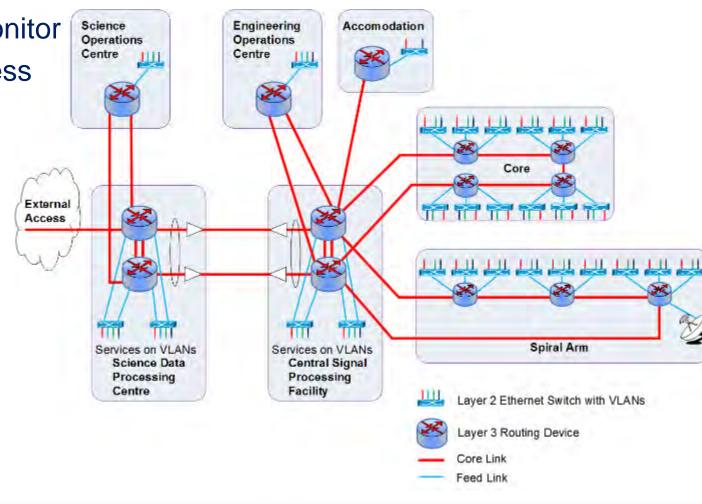


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Non Science Data Network



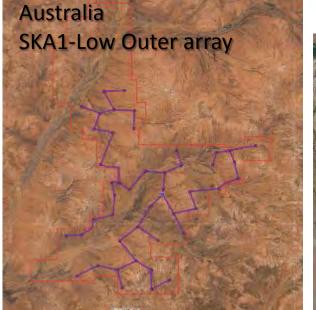
- A network infrastructure with resilience given the topology.
- The set of services include:
 - Control & Monitor
 - Internet access
 - o IP phones
 - o Security



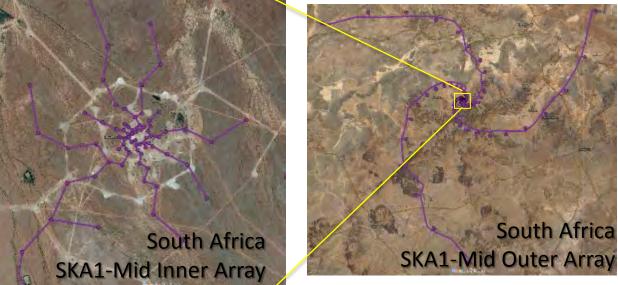
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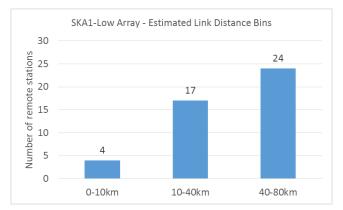
LINFRA - cable routing to CPF

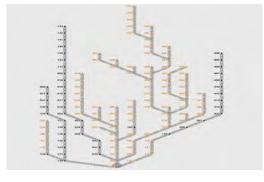


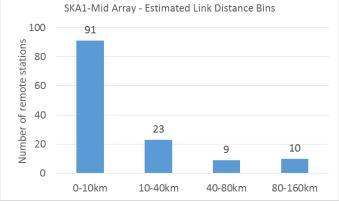


Cable route distance optimised examples









SKA1 MID Spiral Remote Station Fibre Options



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

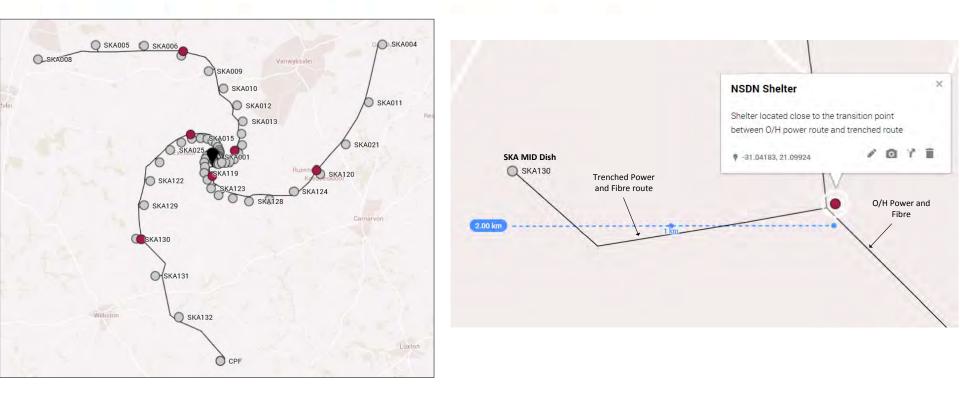
- Total fibre length 732 km
- Average length/spiral 244 km
- SADT trench req. 680 km
- Shared INFRA trench ± 52 km
- More costly option

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

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Network Architecture



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



Summary



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