

The Science Network within the Telescopes

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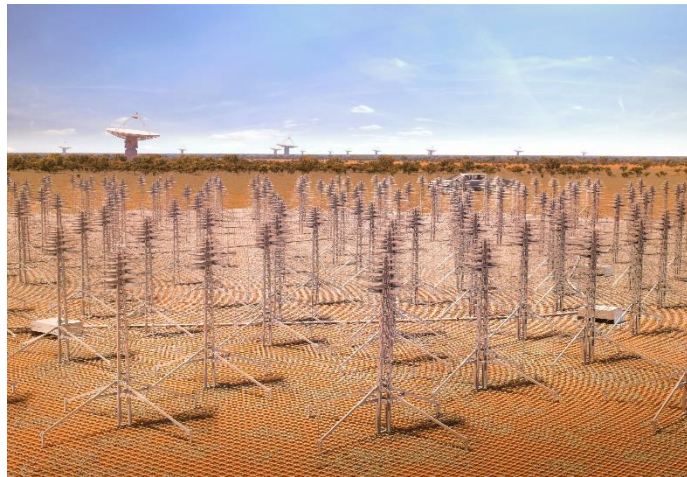
SKA The Square Kilometre Array: One Observatory Two Telescopes

- Australia
- Canada
- China
- France
- Germany
- India
- Japan
- Italy
- Netherlands
- Portugal
- South Africa
- South Korea
- Spain
- Sweden
- Switzerland
- UK



- SKA Observatory (SKAO), a new Inter-Governmental Organisation governed by a treaty, born on 4 February 2021.
- 7-8 year construction schedule. Cost ~€2B (2021 euros) for first 10 years.
- Start of Construction (T0) 1st July 2021.

SKA Phase 1 Two Telescopes – One Observatory



SKA1_Low 50 – 350 MHz
131,000 dipoles 512 stations of 256 antennas
65 km baselines at Murchison



SKA1_Mid 350 MHz – 14 GHz
64 MeerKAT dishes & 133 SKA1 dishes
120 km baselines at Karoo

SKA Uses 3 Networks for Signal and Data Transport

Data Network

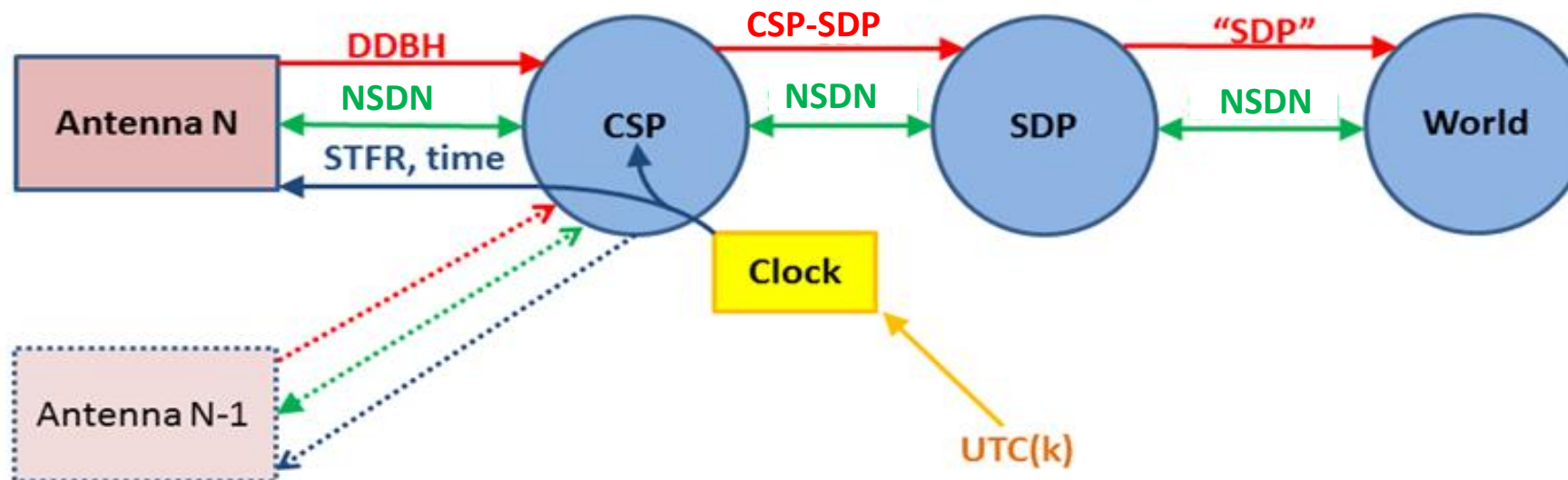
- DDBH
- CSP-SDP
- SDP to Regional Centres

Sync & Timing

- Maser clock ensemble
- Freq. & Phase nice photonics
- 1 ps accuracy, 10ns over 10 years
- UTC time White Rabbit

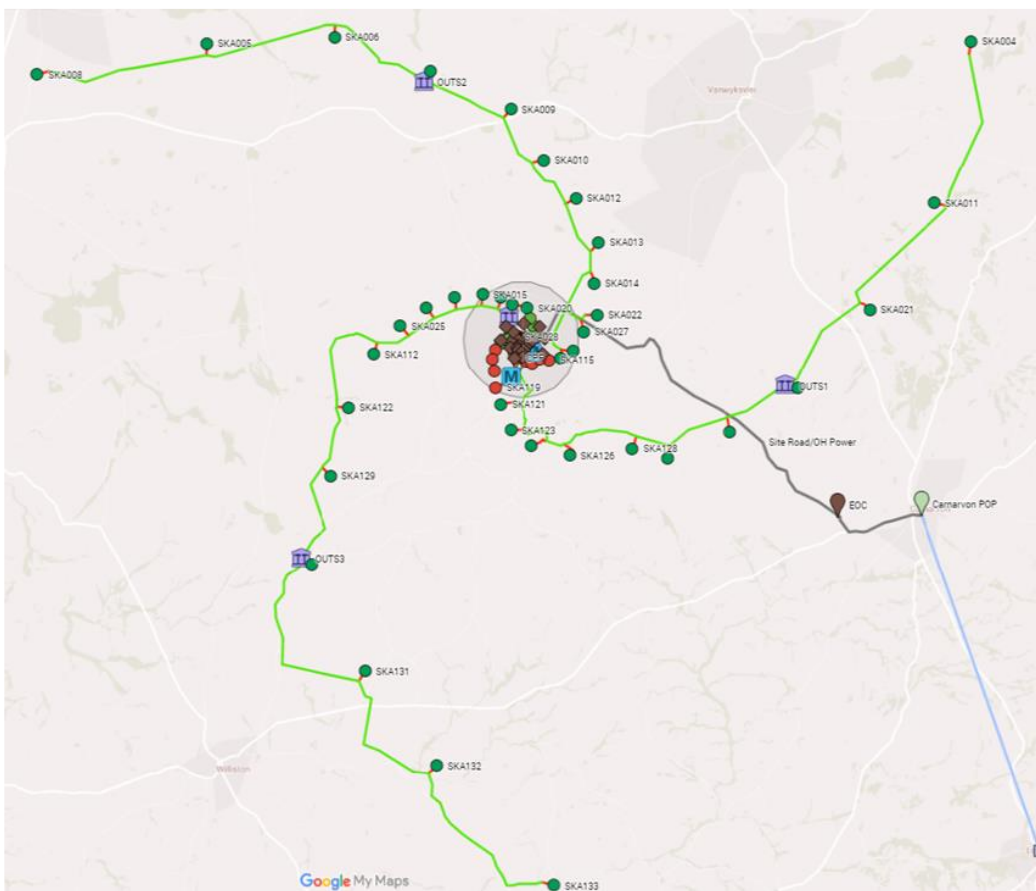
Non-Science Data

- Control & Monitor
- Alarms
- Internet, VoIP

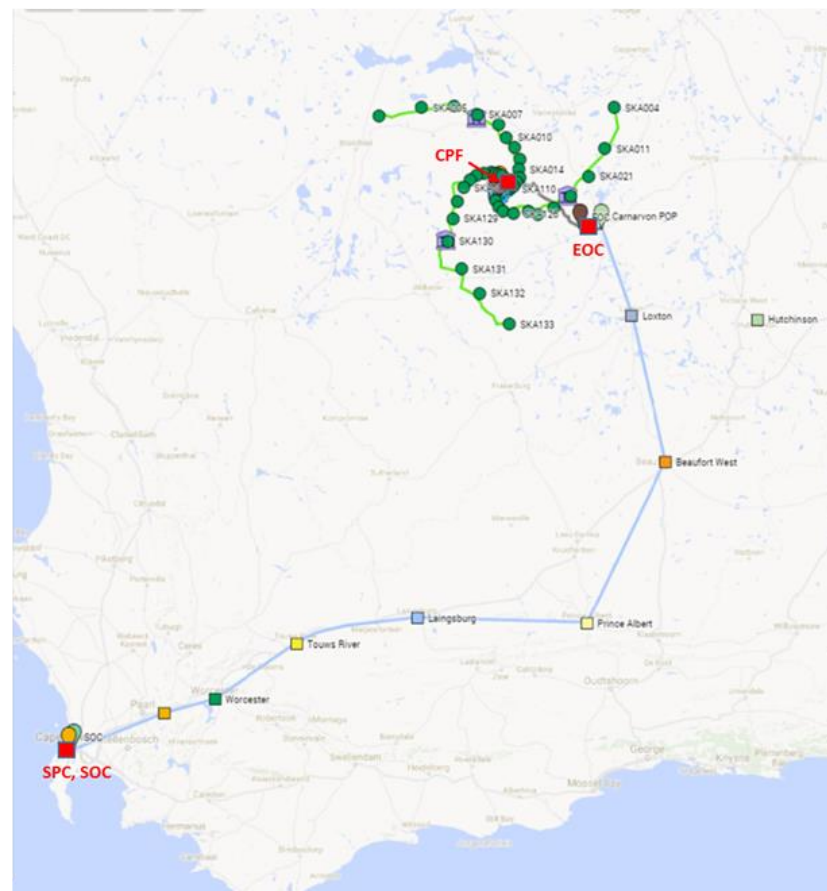


The Antenna Layout and the Physical Data Networks

SKA1-Low Australia
Telescope at Murchison, SDP at Perth

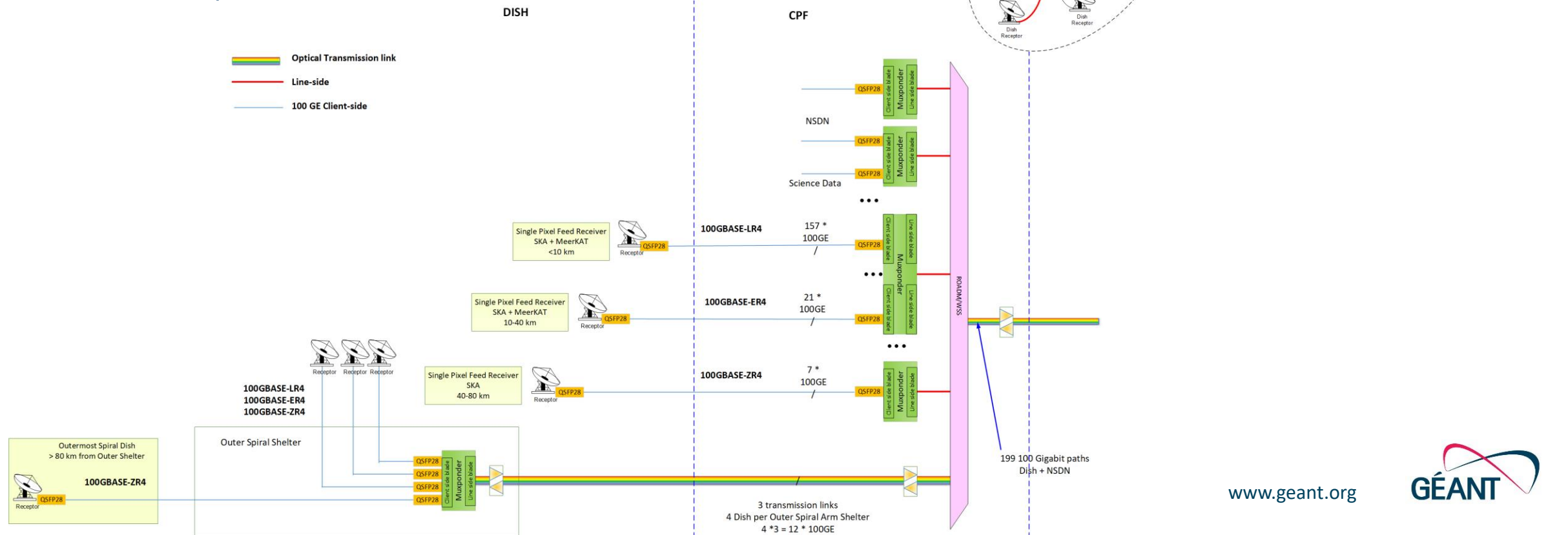


SKA1-Mid South Africa
Telescope in the Karoo, SDP at Cape Town

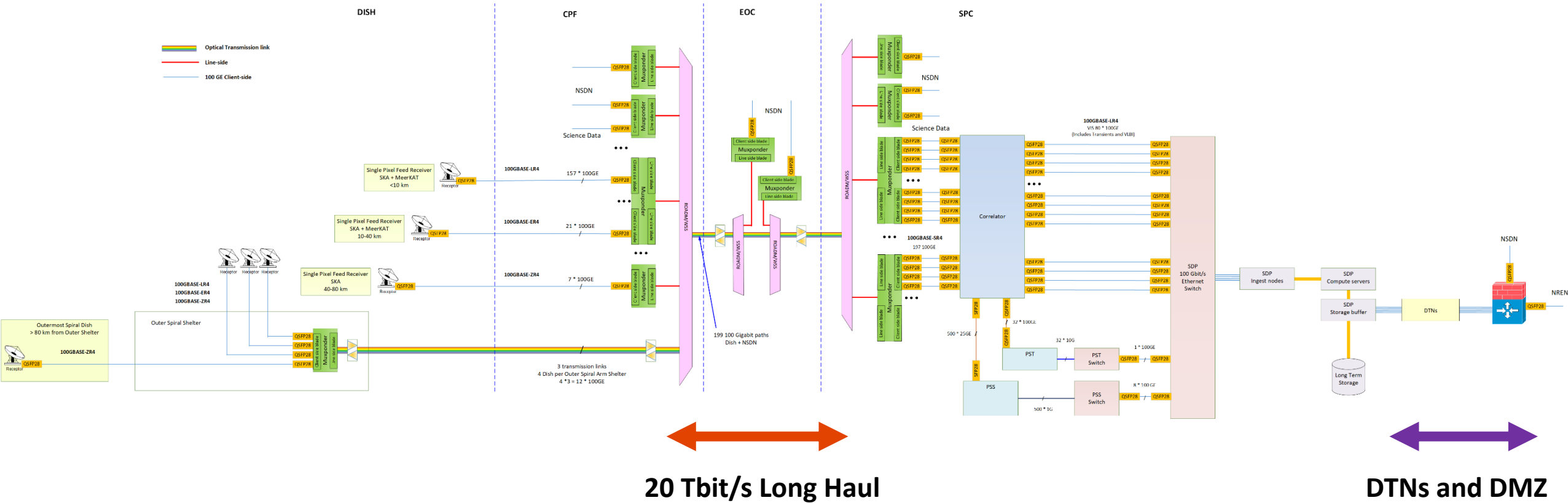


Connecting the Dishes for Long-Haul Transport

- The fibre plugs into the digitiser at the Single Pixel Feed Receiver
- 160 Dishes < 10km 100GBASE-LR4
- 23 Dishes 10-40 km 100GBASE-ER4
- 11 Dishes 40-80 km 100GBASE-ZR4
- 3 Outer Spiral Dishes 80-90 km 100GBASE-ZR4

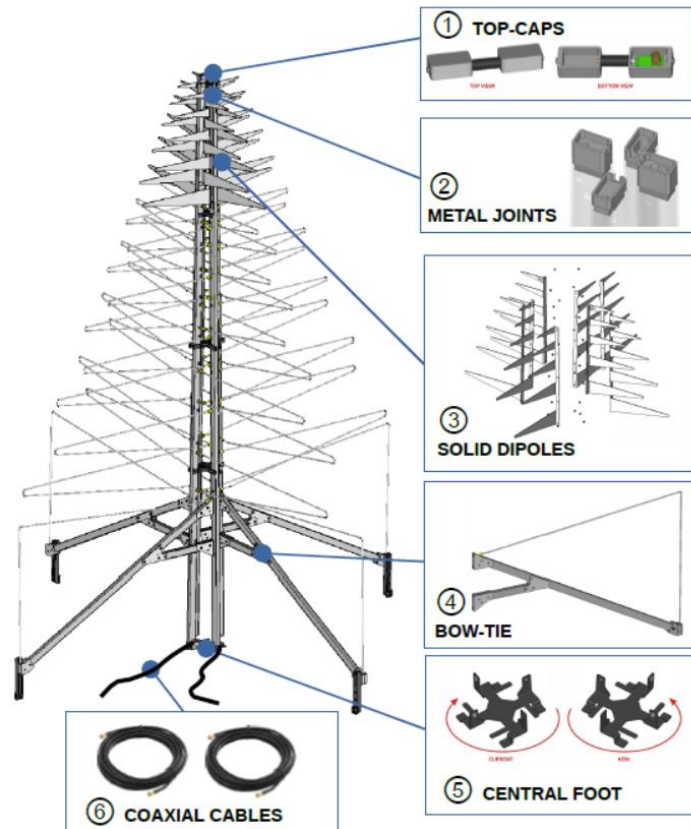


The Science Network in the SKA1-Mid Telescope

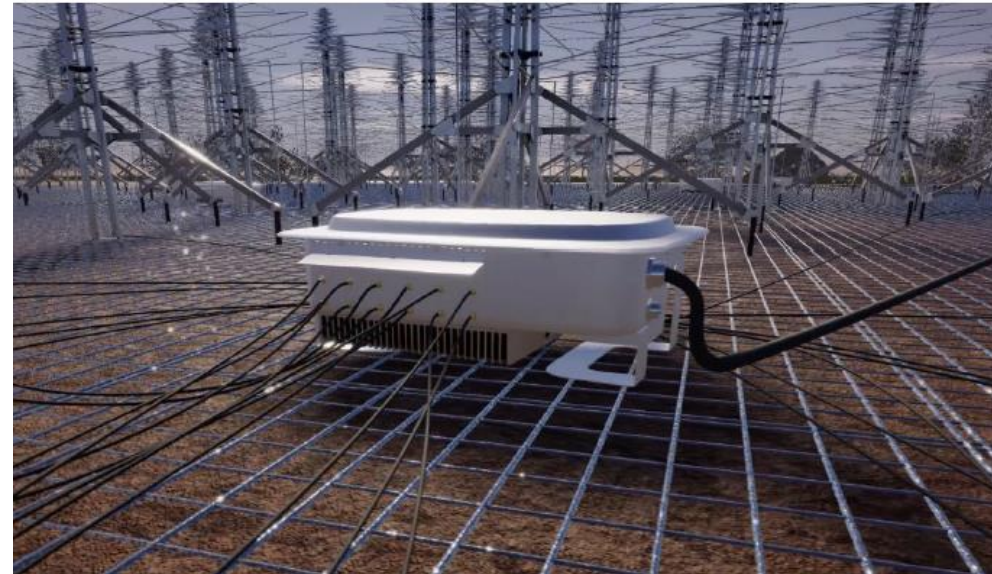


- Optical transport from the Karoo to Cape Town 737 km

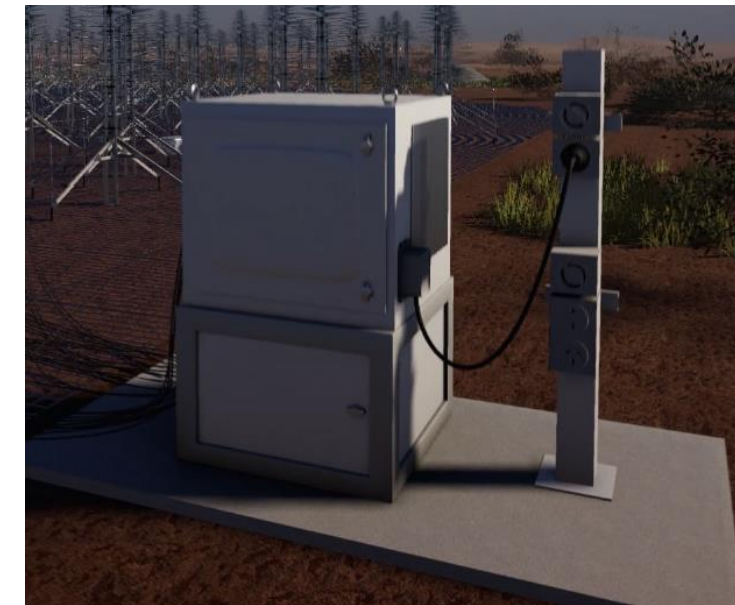
A SKA1-Low Station



256 Log periodic Dipoles

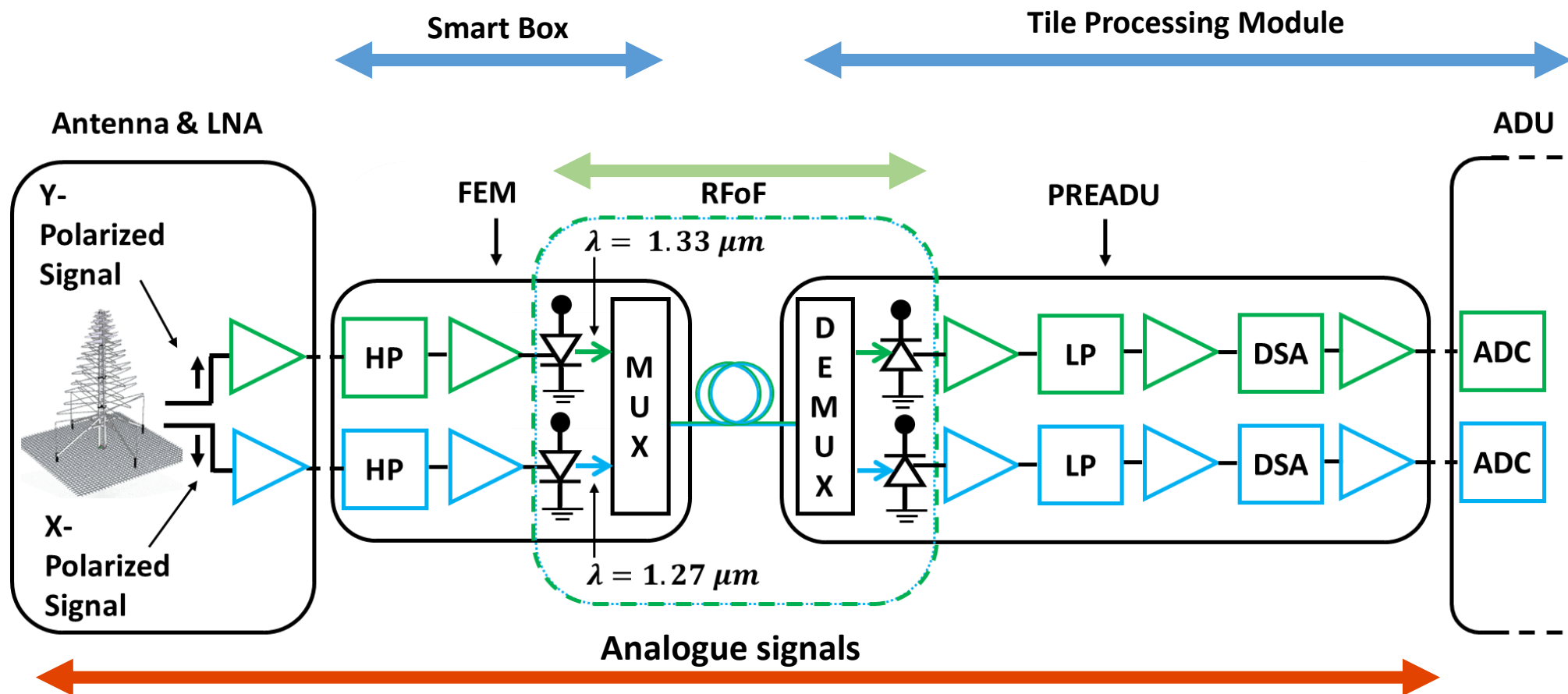


24 Smart Boxes
Coax to RFoF

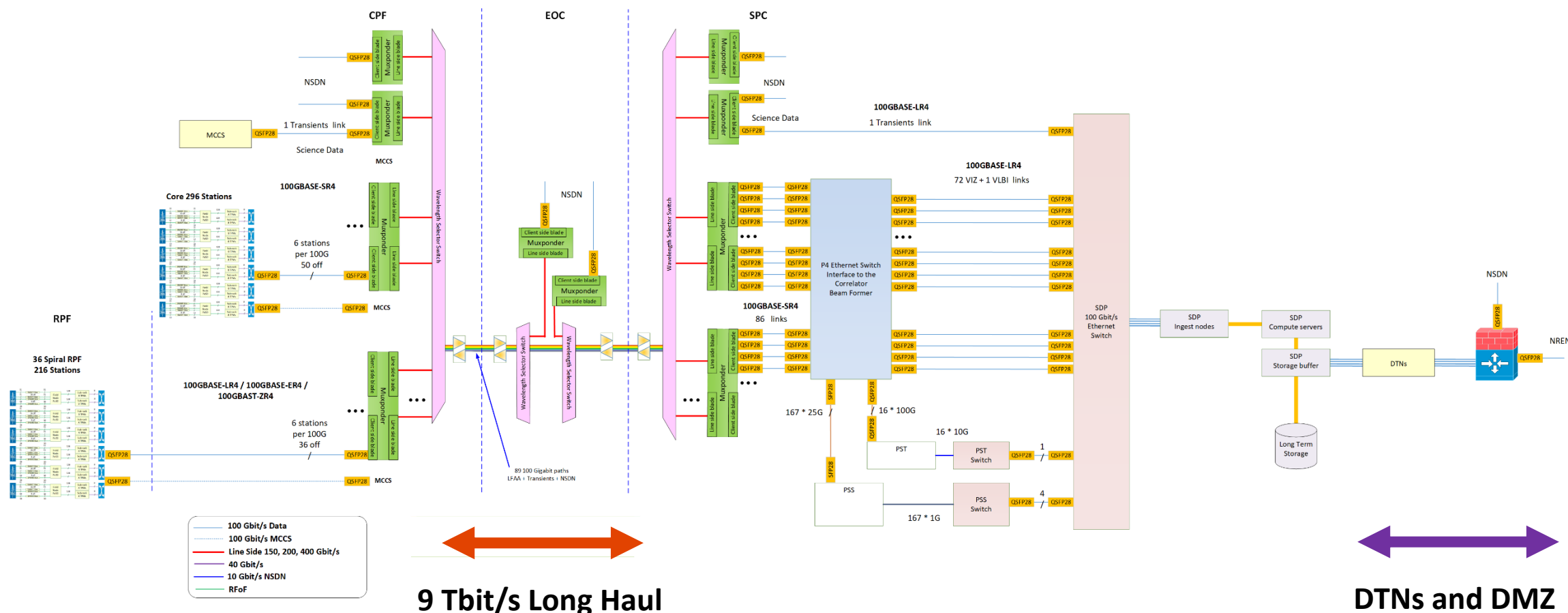


Field Node Distribution Hub
Power & Fibres

Connecting the Low Stations



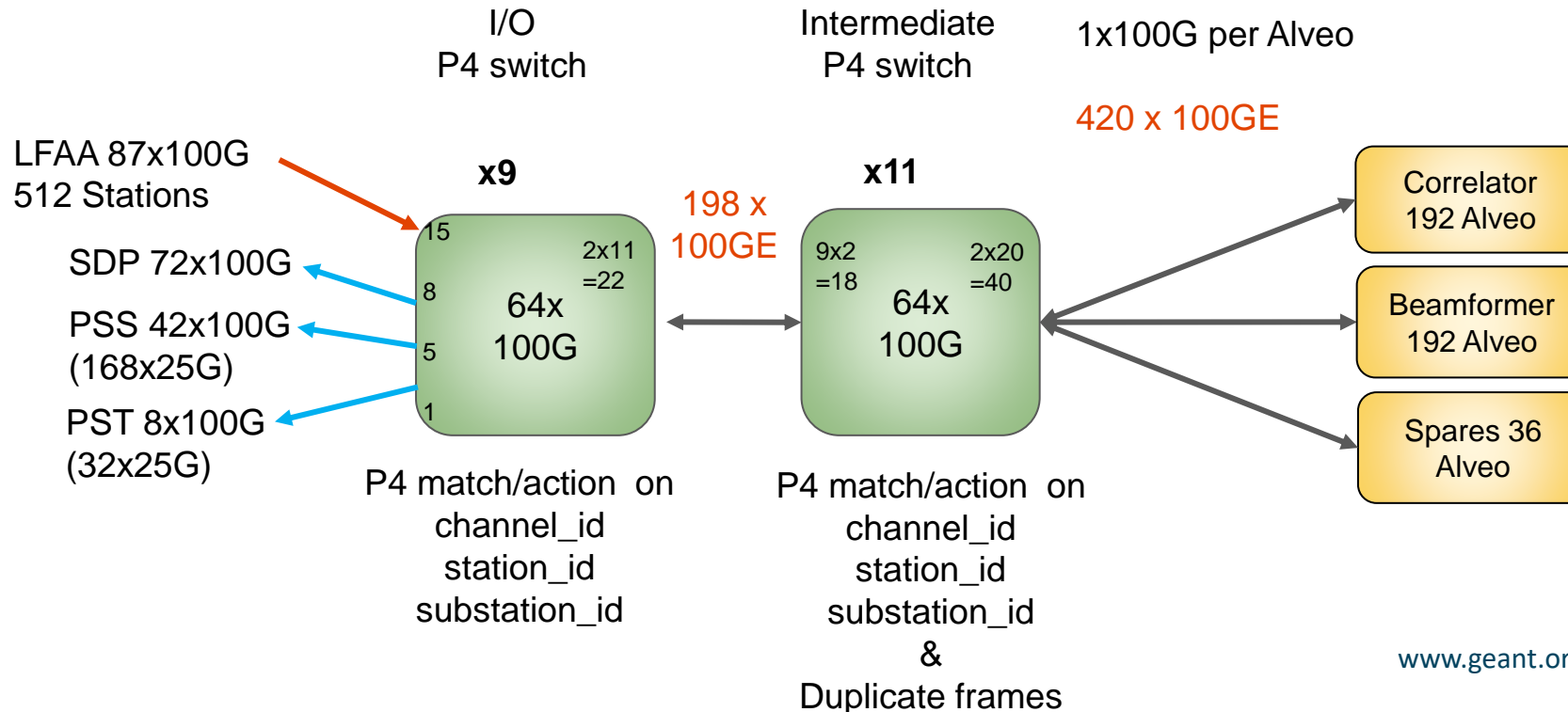
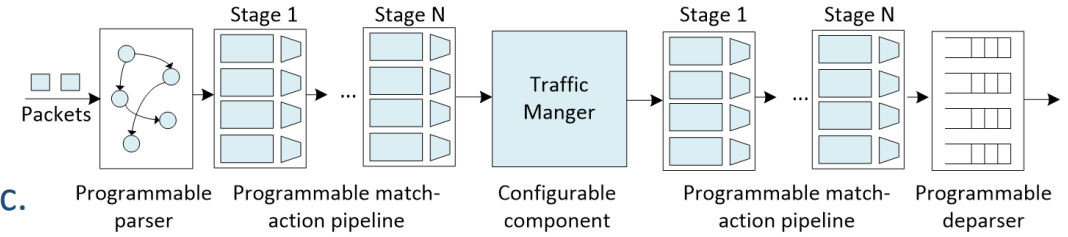
The Science Network in the SKA1-Low Telescope



- Optical transport from the MRO to Perth 820 km

Use of P4 in SKA1 Low

- P4 moves the data: 128 x 100Gbit/s input. 122 x 100 Gbit/s output.
- P4 looks after 1-way flows, ARP, IP addresses, PTP, network counters etc.
- P4 match-actions performed on meta data within the packets
- Alveo processes the data – different personalities Beamformer, Correlator, VIS, PSS, PST
- Each Alveo Server has 20 Xilinx Alveo cards Each with one 100 GE QSFP
- Two Alveo Servers per intermediate P4 switch



CSP – SDP Network **** need update**

- Long-haul: 8.1 Tbit/s over 820 km SKA1-Low 9.5 Tbit/s over 912 km SKA1-Mid
- Coherent 100GBASE-SR4 device → muxponders
- Line-side → DWDM WSS & amplifiers at CPF
- Line-side → DWDM WSS & Transponders at SPC
- 100GBASE-SR4 Transponder → Ethernet switch
- 25GBASE Ethernet switch → ingest node

Traffic Pattern:

Visibility, Transients 80* 100 Gigabit Bursts

VLBI 100 Gigabit continuous

Pulsar Search 740 * 1 Gig = 8 * 100 Gigabit Bursts

Pulsar Timing 1 * 100 Gigabit Bursts

Protocol:

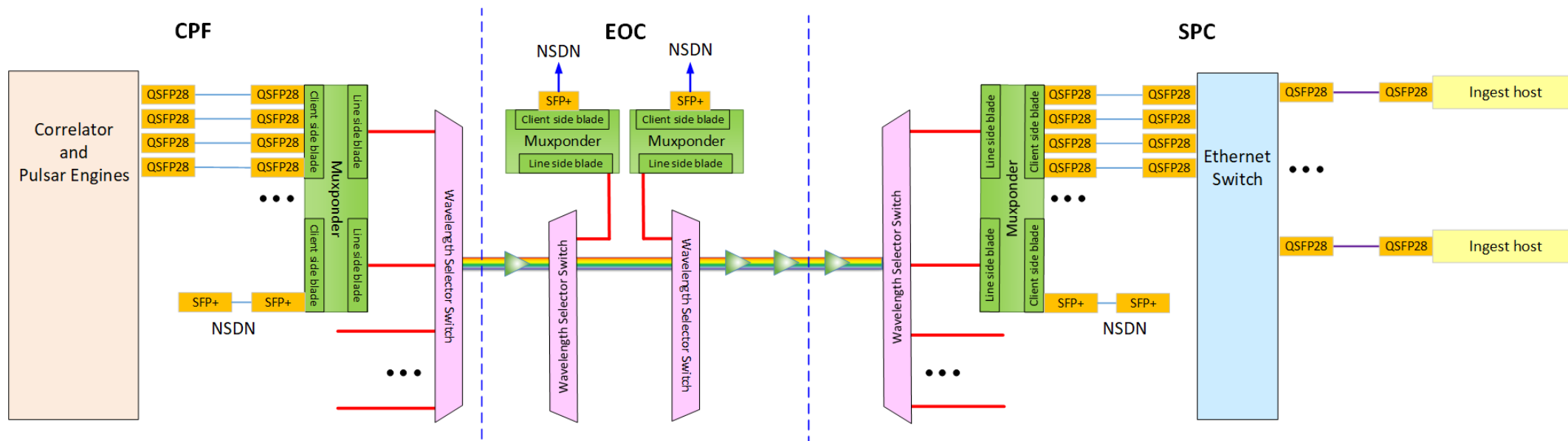
UDP/IP

UDP/IP

TCP/IP

TCP/IP

Design for peak rates



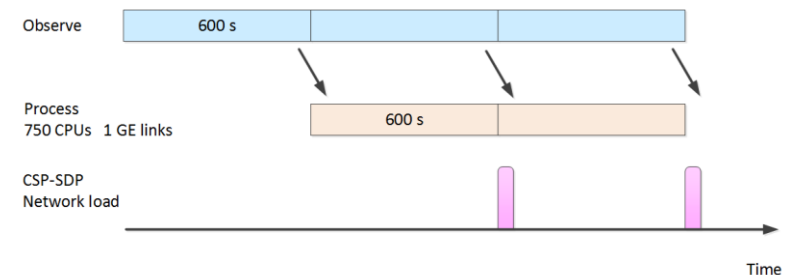
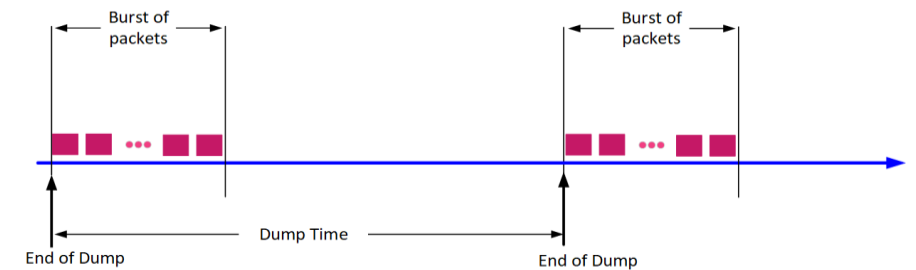
SKA Data Flows and Traffic Patterns

- **Digitiser to Correlator**

- Mid
 - Raw Ethernet frames Constant 100 Gigabit line rate. Don't need ARP
- Low
 - UDP/IP/Ethernet. Constant rate 6 stations 90 Gbit/s. Do need ARP

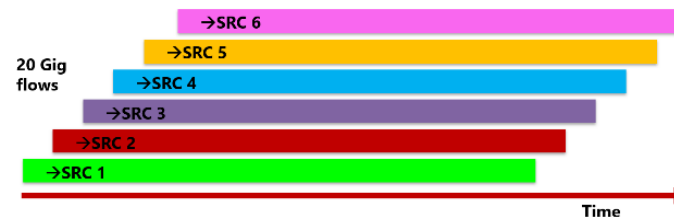
- **Correlator and Pulsar Engines to SDP**

- Visibilities
 - RDMA RoCE v2 UDP/IP/Ethernet.
 - 100 Gbit/s line rate bursts at the end of each integration time.
- Pulsars
 - TCP/IP/Ethernet. Data also in bursts – ensure no bottlenecks.

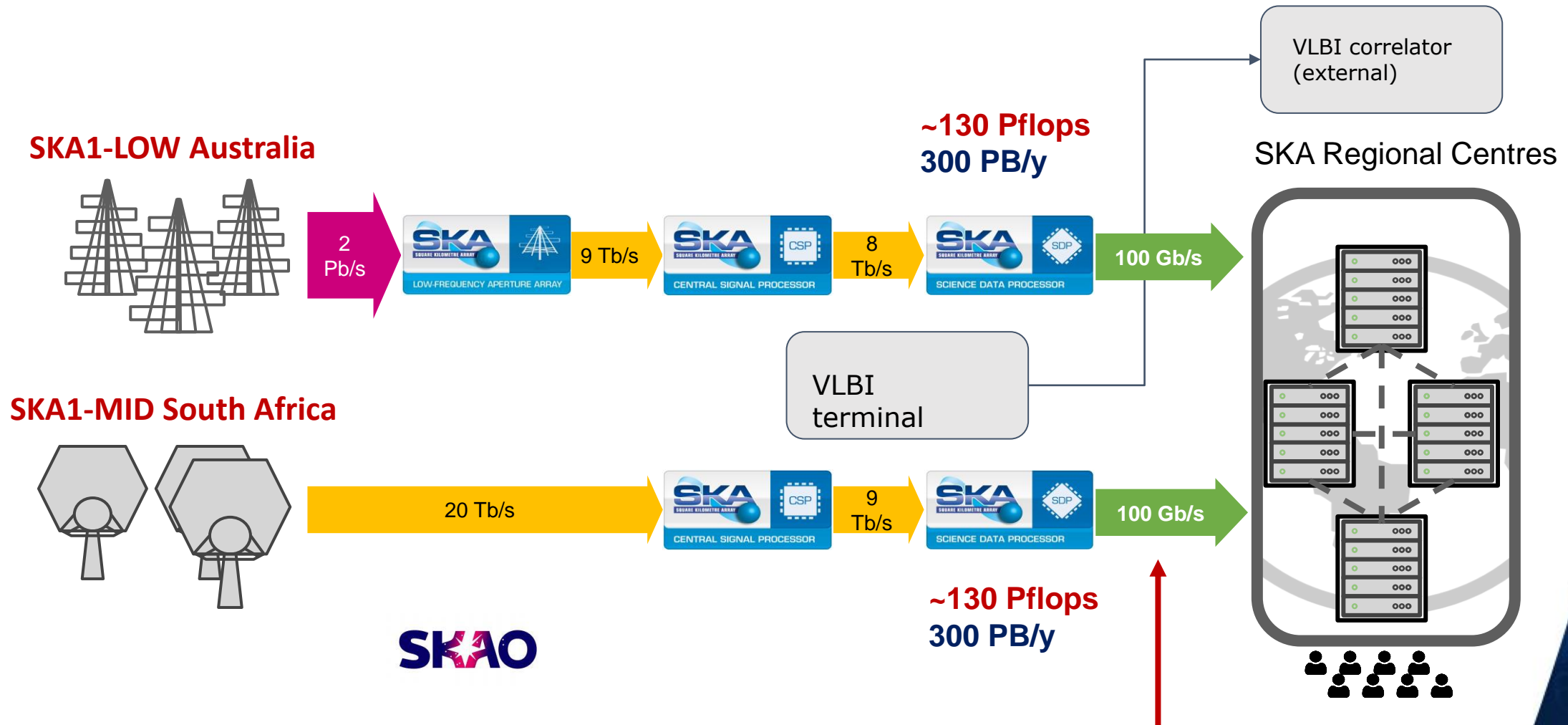


- **Global Transmission of Observatory Data Products**

- Push data from each telescope
- Multiple concurrent datasets
- Build on FTS https/TCP/IP



SKA Phase1 Data Flows



Observatory Data Products
pushed from SDP → SRC

