Fibre Networks for the Square Kilometre Array (SKA)

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Contents

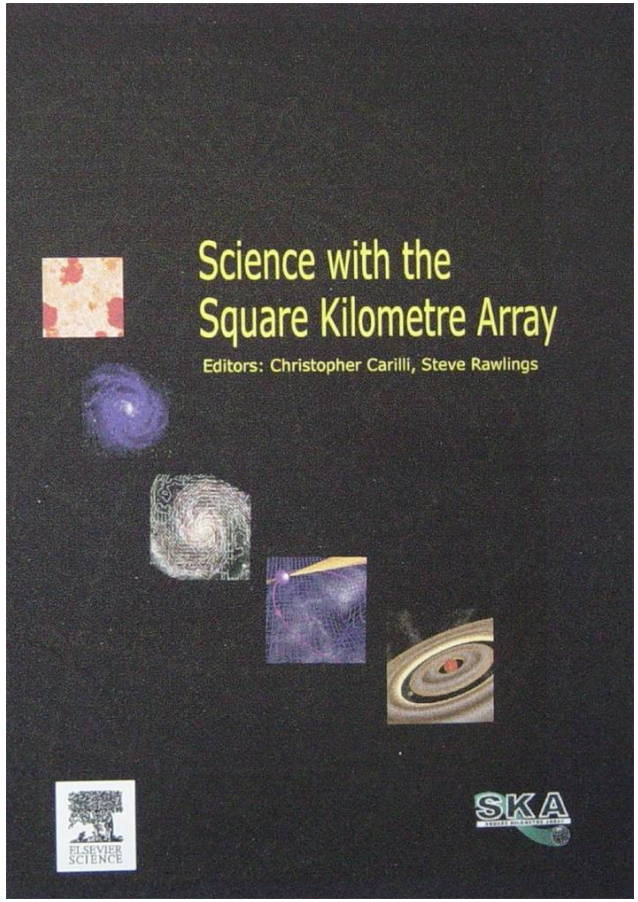
- SKA Description
  - Science the array will target
  - Characteristics of the array
  - Animation – Visualising the array
- Signal Transport and Networks for the SKA
- Challenges for the Signal Transport and Networks in the SKA

What is the SKA for?

Five Key Science Projects (KSPs)

1. **Probing the Dark Ages**
2. **Galaxy Evolution, Cosmology, & Dark Energy**
3. **The Origin & Evolution of Cosmic Magnetism**
4. **Strong Field Tests of Gravity Using Pulsars and Black Holes**
5. **The Cradle of Life/Astrobiology**

… plus The Exploration of the Unknown as an underlying philosophy for design of the instrument



4 prime characteristics

- **very large collecting area (km^2)** → sensitivity to detect and image hydrogen in the early universe
  - *sensitivity 40 x EVLA, 50 x LOFAR*
- **very-large-angle field of view** → fast surveying capability over the whole sky
  - *survey speed ~10000 x EVLA with FoV=1 sq. deg.*
- **wide frequency range required for the Science Reference Mission**
  - **low : 70-300 MHz**
  - **mid: 300 MHz-10 GHz**
- **large physical extent (3000+ km)** → capability for detailed imaging of compact objects and astrometry with milli-arcsec resolution


SKA
SQUARE KILOMETRE ARRAY
www.skatelescope.org

Signal Transport & Networks for the SKA

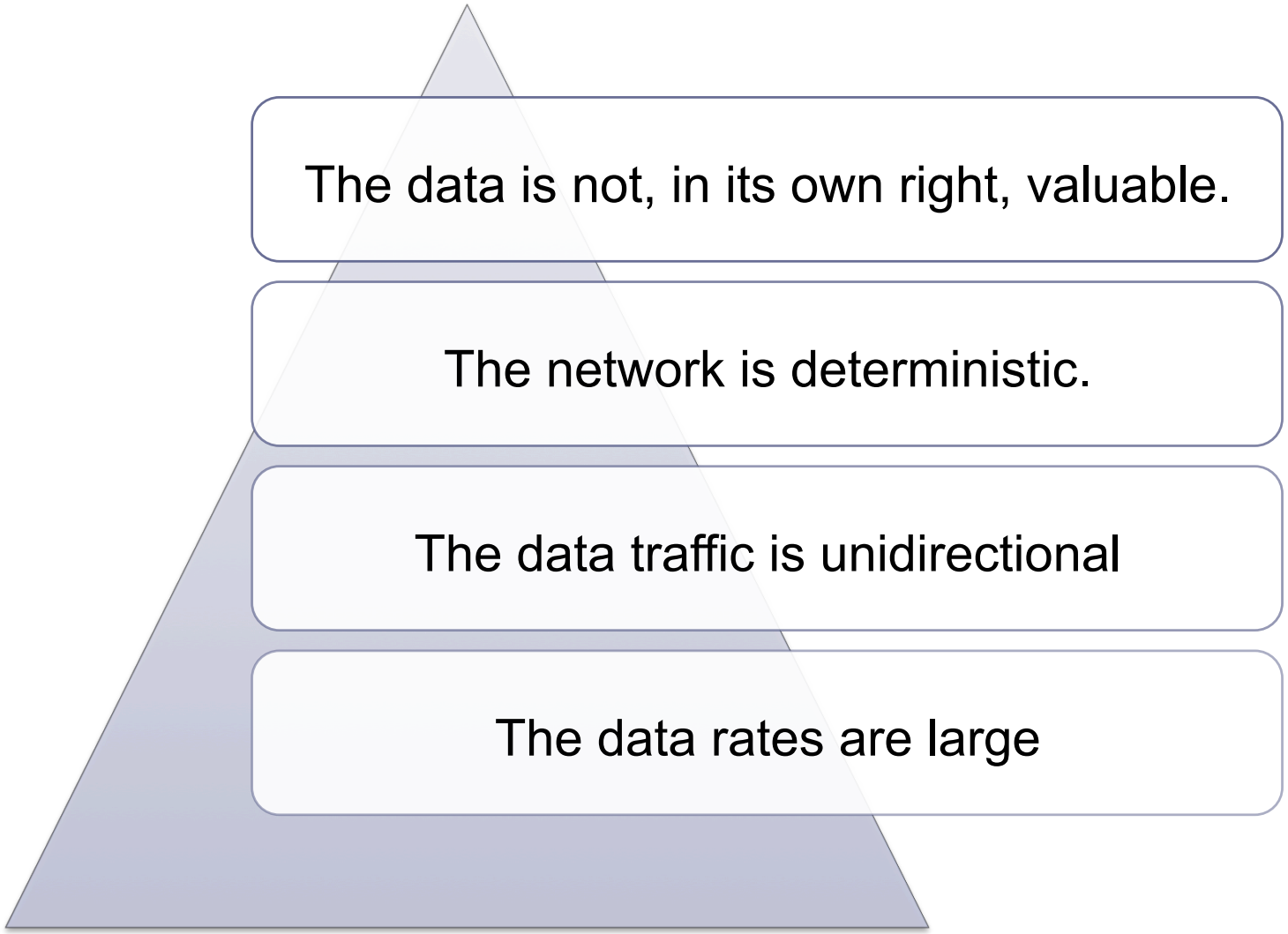
Data Network	• For transporting astronomical signals to a central processing facility (CPF)
Timing Network	• For the distribution of local oscillator signals for clocks and down converters.
A Monitor & Control Network (M&C)	• Including comms and required redundancy
Connections from the CPF to the outside world	• For the distribution of imaging data to regional centres
High Volume, High Speed Interconnects	• Not fully defined but significant data centre style interconnects will be required

Data Network – Local Analogue Links

- Local – limited range.
- With a bandwidth of upto 10 GHz
- Photonics links to reduce EMC
- No frequency conversion required
  - Removes requirement for LO distribution
- Require high degrees of linearity and stability to meet dynamic range imaging requirements (70 dB)

Data Networks characterised

SPDO

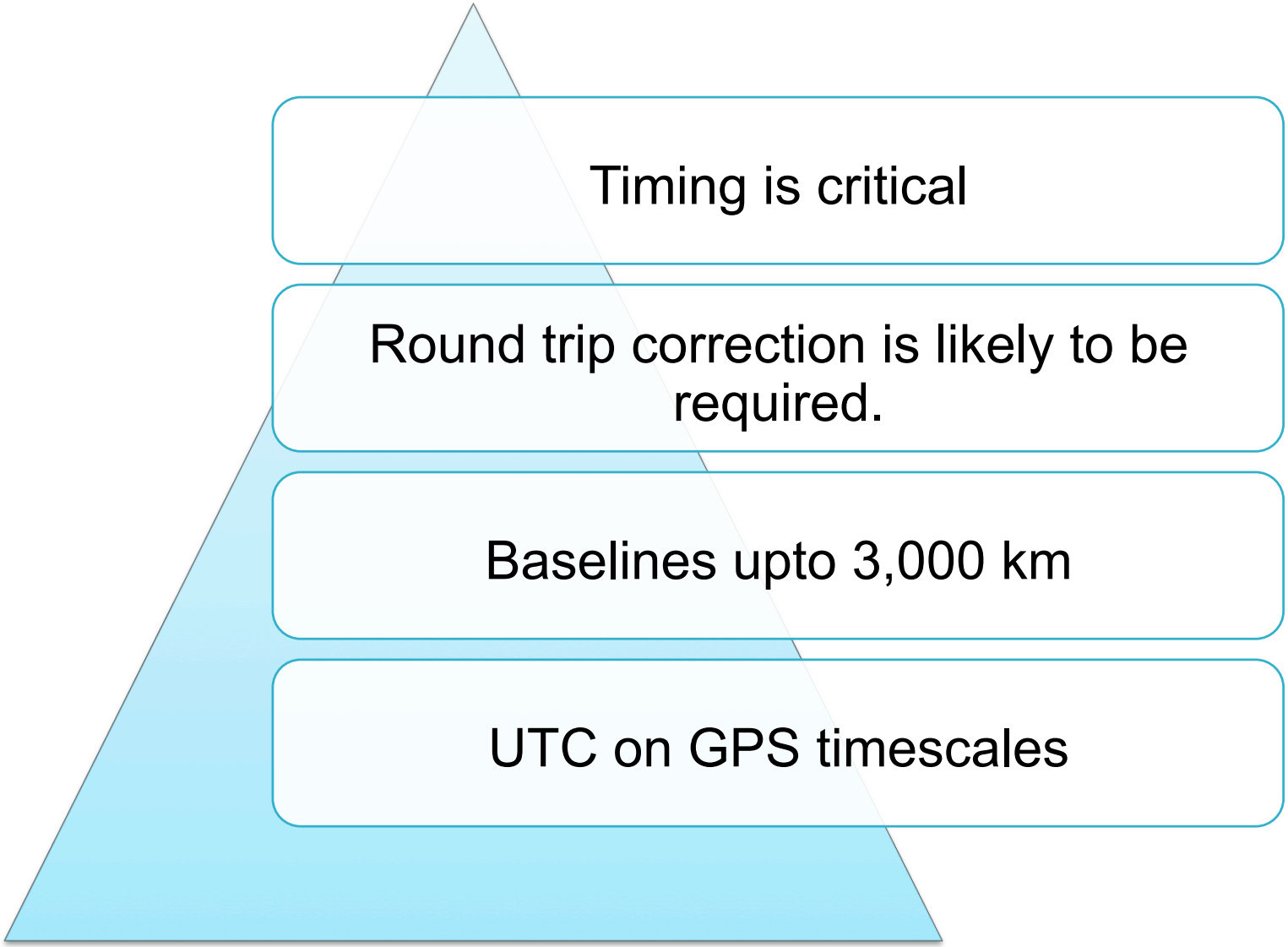


Data Network -Bit Rates

Representative Implementation	Number of stations or dishes	bit rate per station or dish (Gbits/s)*	Maximum baseline of transmission (km)
WBSPF *Phase 1* Phase 2	 *250* 3300	 *40 Gbps* 80 Gbps	 *100* 3000
PAFs Phase 2	 1000	 1840	 180
Sparse AA *Phase 1* Phase 2	 *50* 250	 *33440 (max)* 33440 (max)	 *100* 180
Dense AA	250	16800	180

Ref: * SKA System CoDR High Level Description Document (highly dependent on final design)

Timing Networks Characterised

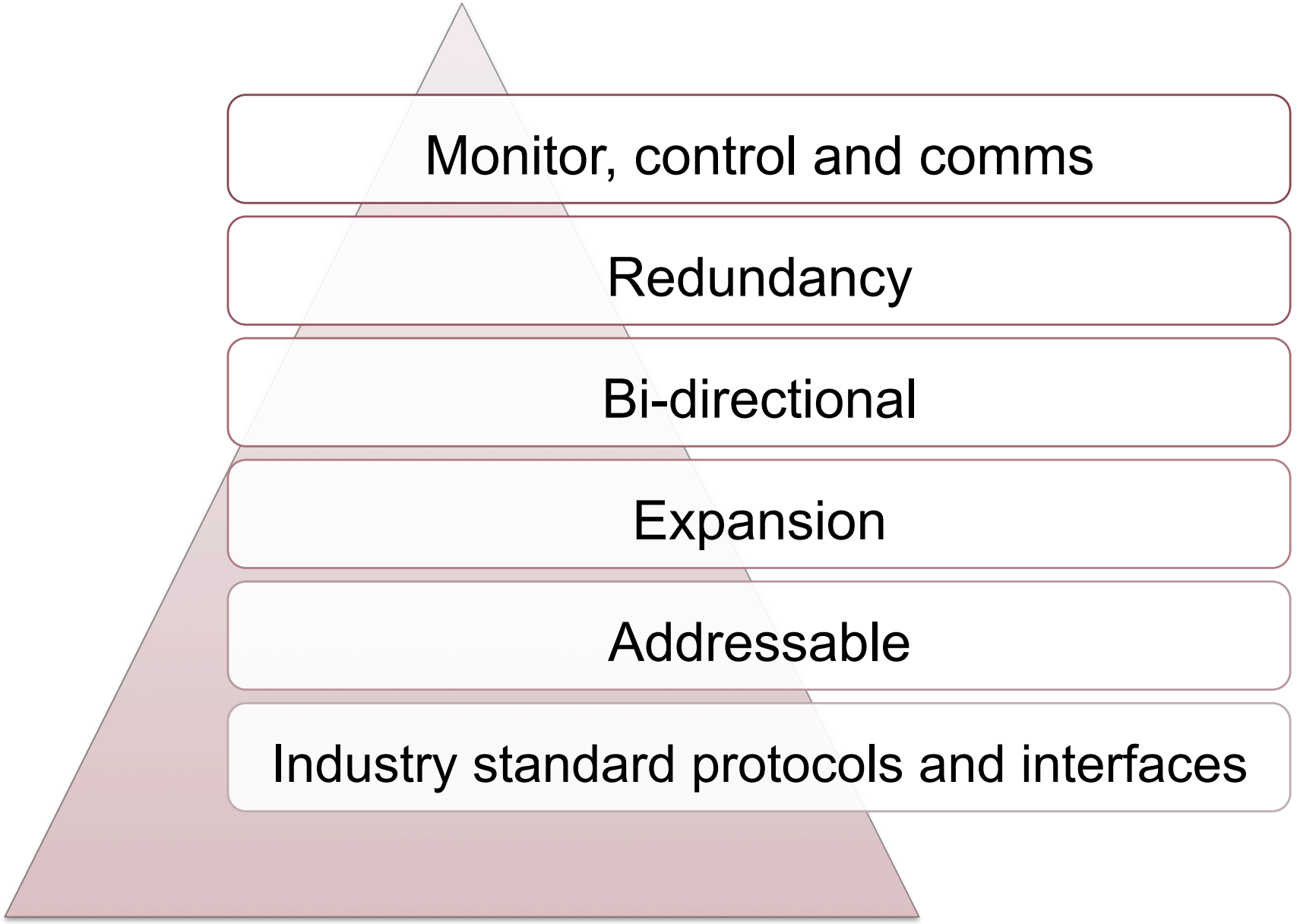


Preliminary Requirements

- Within 2 ps over a 1 second timescale
- 4 ps over timescales of 1 minute,
- 10 ps over a timescale of 10 minutes
- As stable as possible over long timescales

M&C Networks characterised

SPDO



Challenges for the SKA

- Large & complex instrument
- Significant system challenges in
  - Power Consumption
  - Cost
  - EMC

Desirable design targets to meet the SKA challenges

Thermal control solutions for semiconductor laser diodes with low power dissipation.

Higher bit rate capacities

- for constant or reduced power dissipation
- For lower costs

Increased use of optical technologies in signal processing to reduce the transitions between optical and electrical domains.

Possible components of interest

- Low Power TECs for lasers
- High bit rate, long wavelength VCSELs
- Optical backplanes
- Integrated ‘ receiver on a chip’ devices with RF (10 GHz) or IF (2 GHz) inputs and optical, digital outputs.

Conclusions

- SKA will make extensive use of photonic networks and devices.
- The design requirements are challenging, but exciting.
- They can be achieved using existing techniques.
- New and innovative techniques may allow more efficient use of resources.

Questions to mccool@skatelescope.org