Reticulation Distances,Quantities and Dimensions
PITF Oxford 2010

Dr. Adrian Tiplady, SKA South Africa
atiplady@ska.ac.za, +27 11 442 2434

SKA SOUTH AFRICA
SQUARE KILOMETRE ARRAY

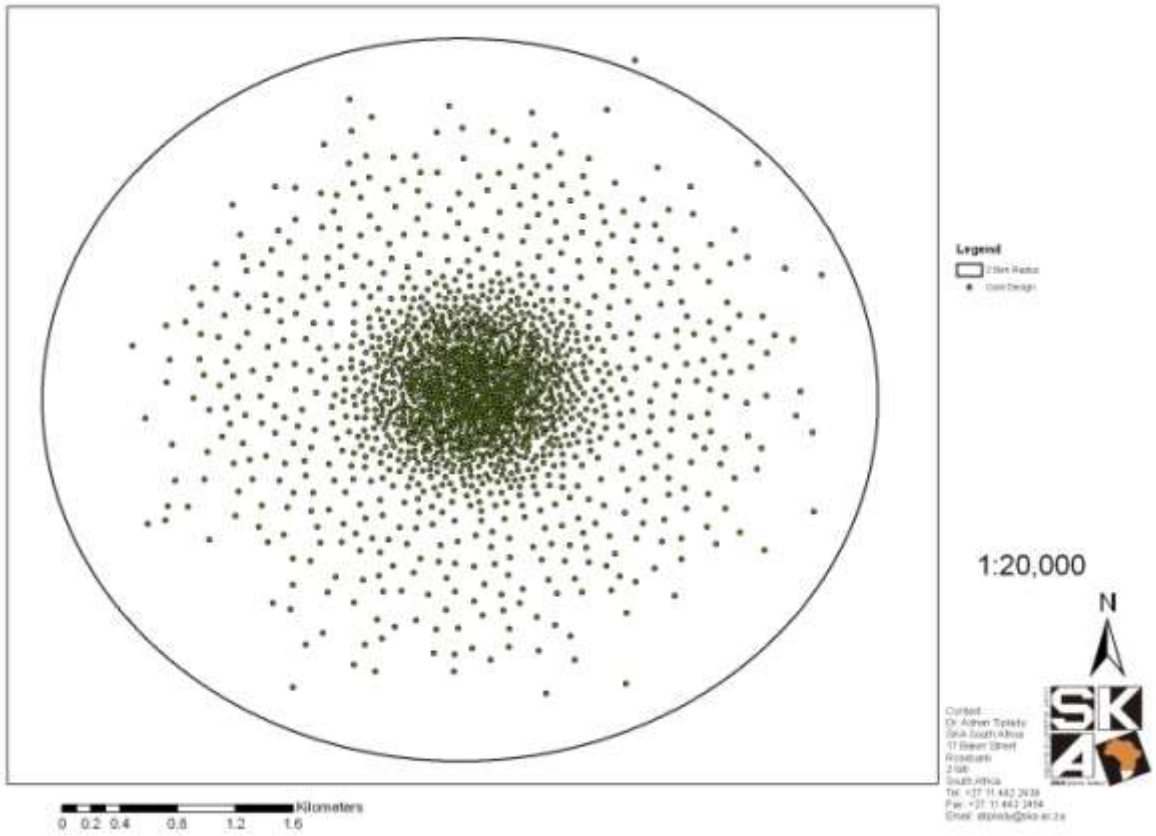
SKA
SQUARE KILOMETRE ARRAY

Scenario Building

- Operational modelling
  - See presentation of SKA 2010 Manchester
- Demand
  - Based on existing power modelling, with modification following onsite measurements of KAT-7
  - Based on operational requirement
  - 100 MVA
    - 7.5 MVA supplied to 1500 dishes/receivers
    - 175 kVA supplied to each remote station
    - 80 MVA to correlator (40 MVA) and post-processing computer (40 MVA)

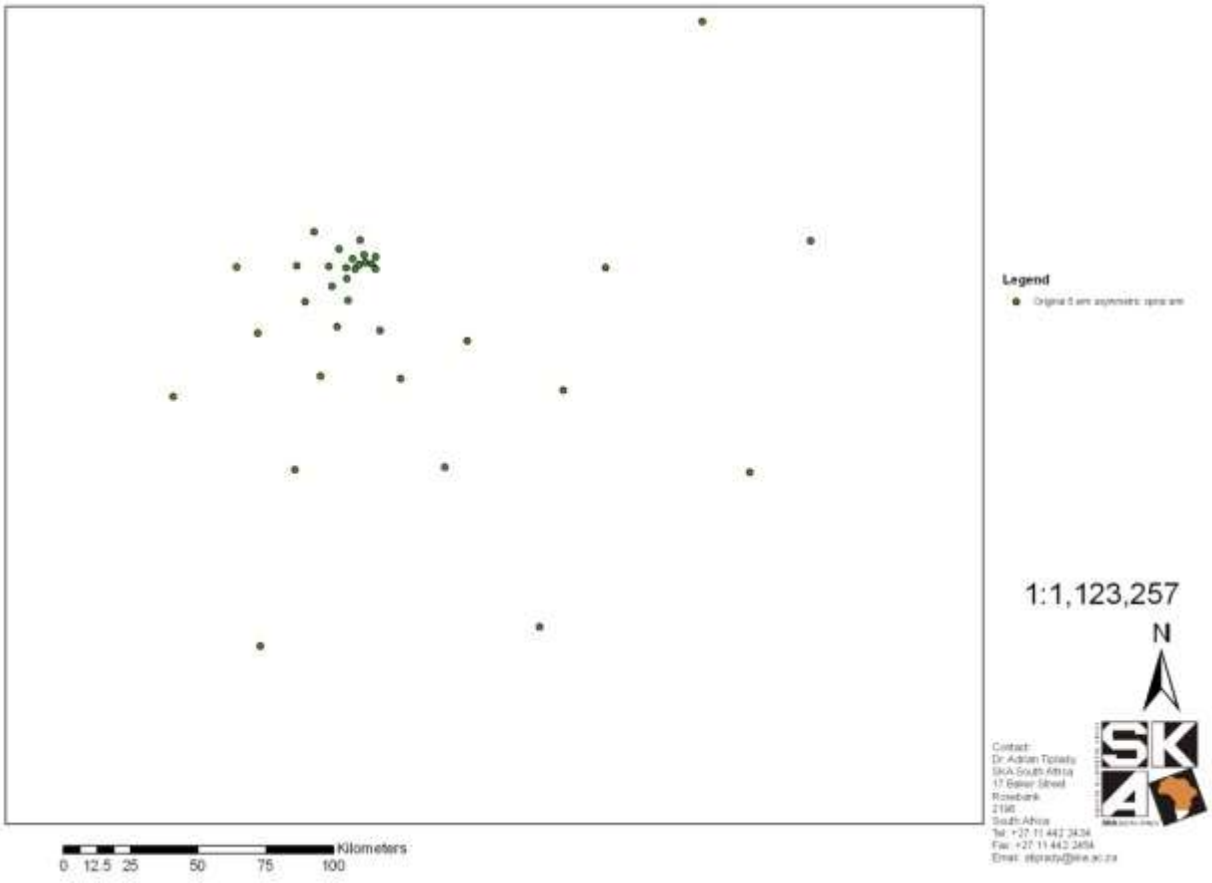
Scenario Building

- Core design – 1500 receivers



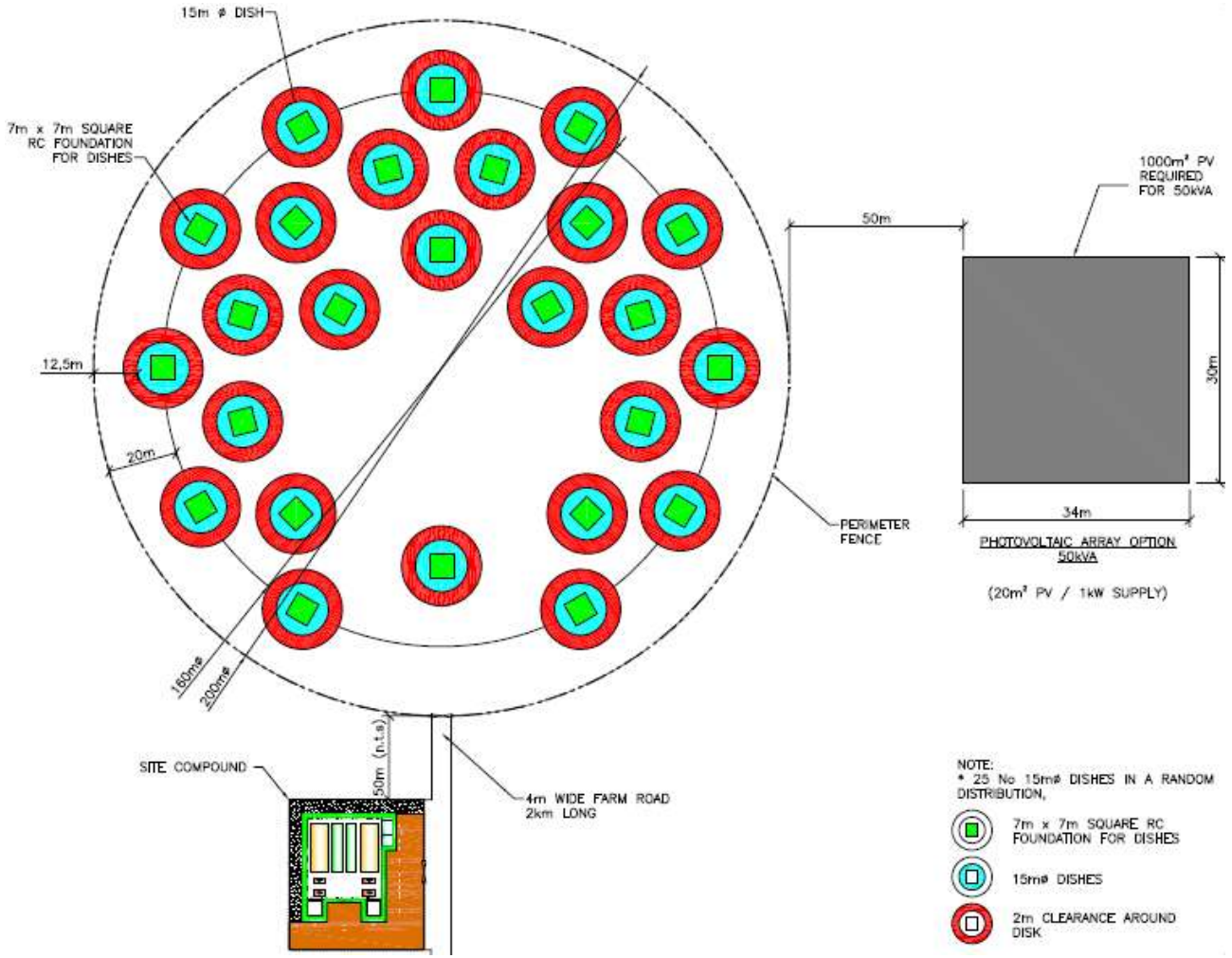
Scenario Building

- Design
  - Use of asymmetric structure produces results that are not significantly different from symmetric design



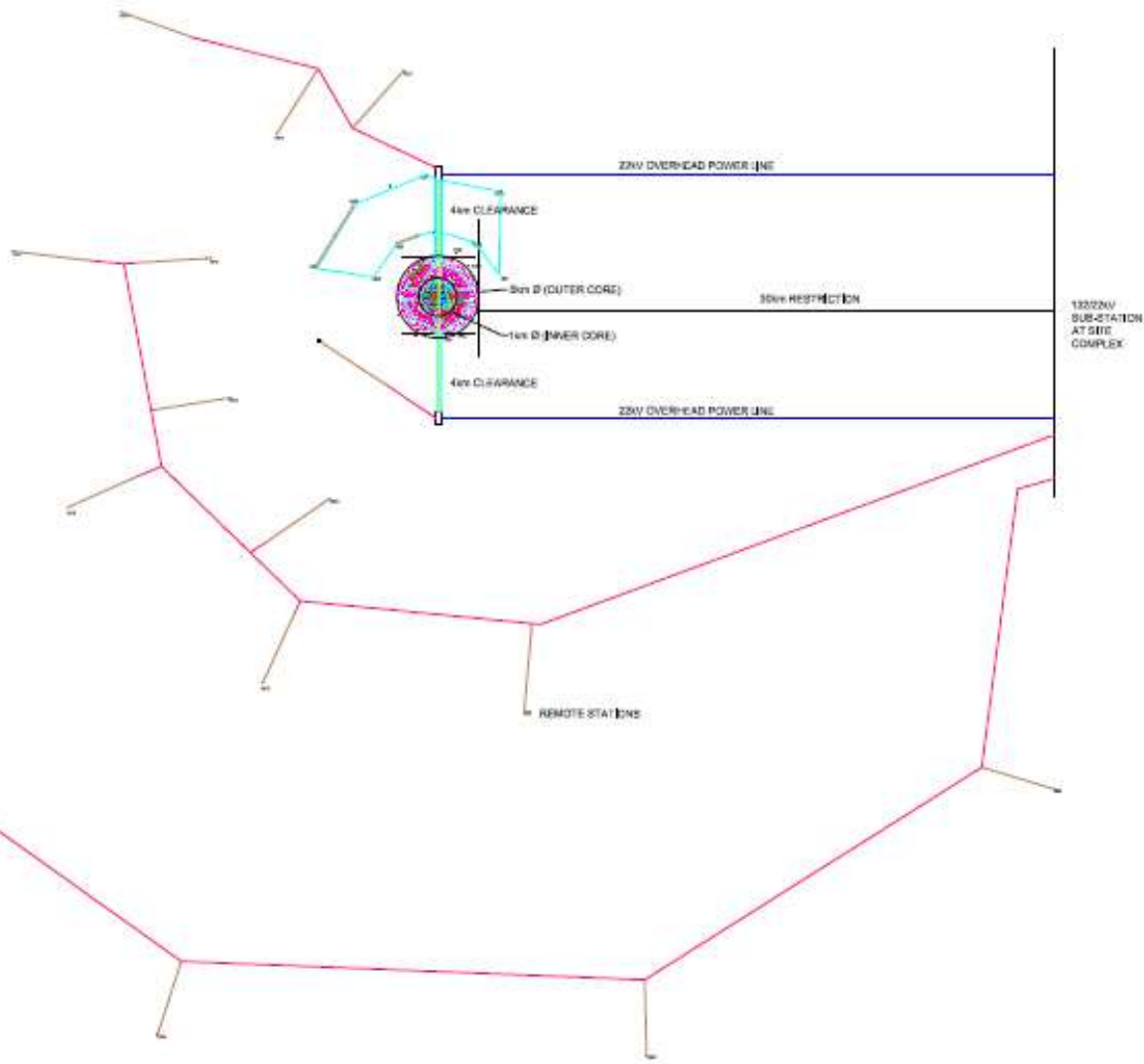
Scenario Building

- Design for remote station



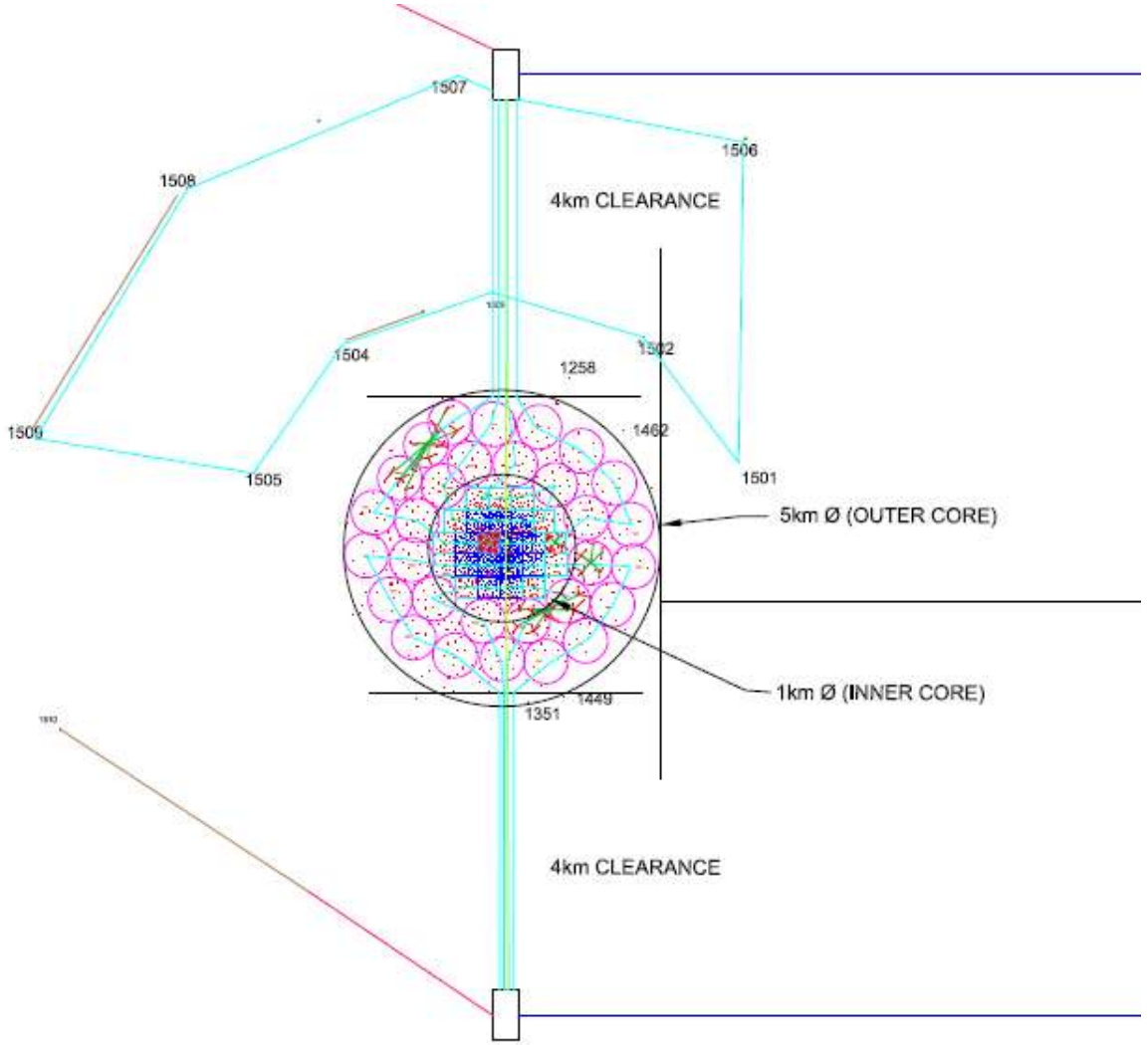
Solutions: Core

- Power room located up to 30km (variable) from core due to EMI and potential HV-MV infrastructure
- Feeder network to redundant switching stations into core
- Stations/dishes beyond core can be fed from core reticulation -> cost optimisation indicates routing not nec. along spiral arms

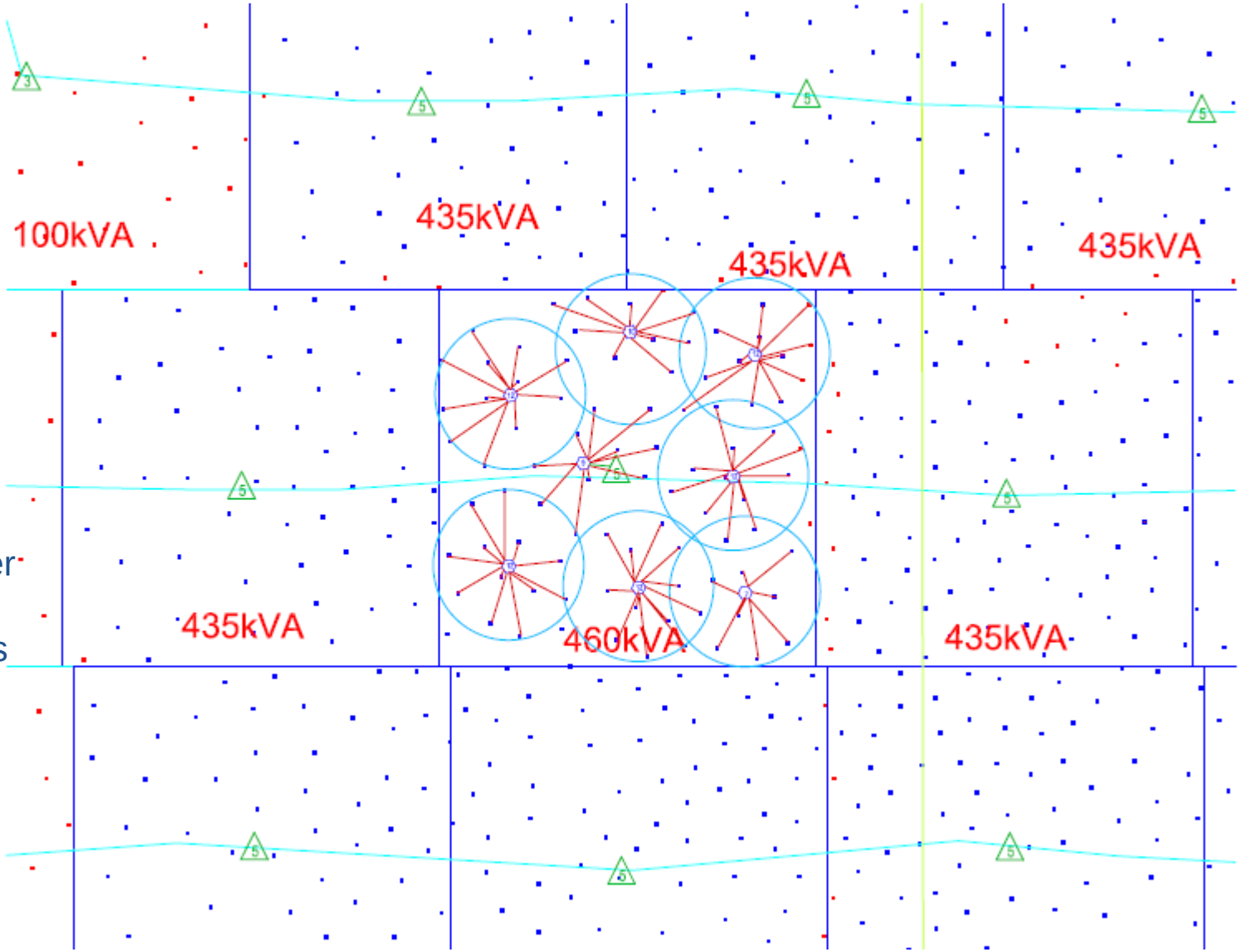


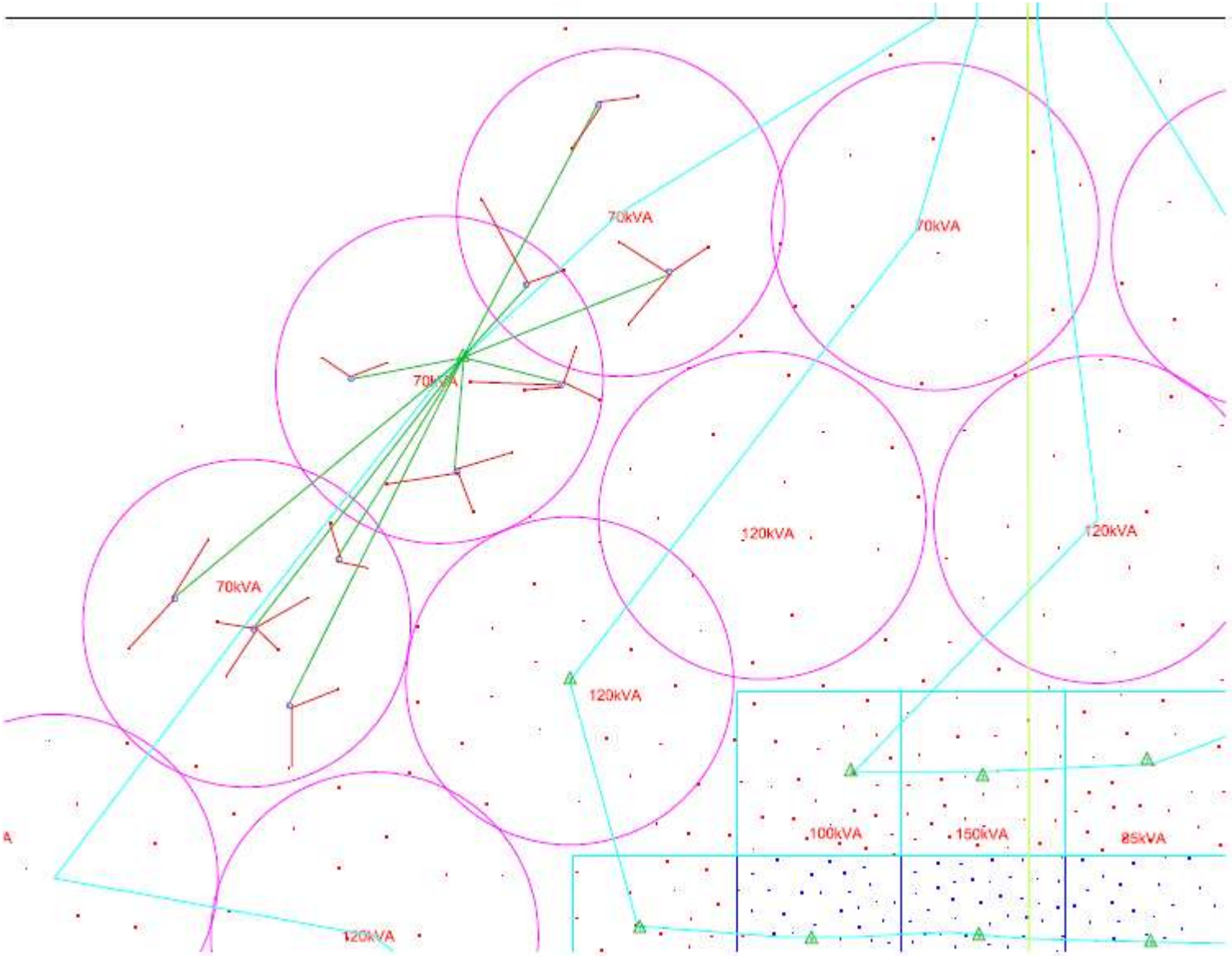
Solutions: Core

- 2 x fully redundant 22kV switching stations feeding single core



- Cell infrastructure required
  - power distribution
  - MV-LV power transport requirements
  - redundancy
  - Distributed UPS system




70kVA
70kVA
70kVA
70kVA
120kVA
120kVA
120kVA
100kVA
150kVA
85kVA
120kVA

Quantities for 1,500 dish core from 2x22kV Switching Stations

- Mini-substations
  - 9 x 500kV
  - 27 x 315kV
- Cabling and Reticulation
  - 22kV
    - 60,300m of 3C 120mm^2
    - 12,400m of 3C 185mm^2
  - LV (1,000V)
    - 93,134m of BCEW 6mm^2
    - 57,282m of BCEW 16mm^2
    - 93,134m of 4core 10mm^2
    - 57,282m of 4core 50mm^2
- Excavations for trenching
  - 51,000 m^3/161,000 m

Quantities for 1,500 dish core from 2x22kV Switching Stations

- Circuit breakers
  - 1,500 x 40A, 3 phase
  - 252 x 15kA, 3 phase
- UPS systems
  - 27 x 300 kVA (peak) for 15minutes
  - 9 x 400 kVA (peak) for 15 minutes
- Distribution kiosks
  - Circuit breakers
    - 3way, 6way, 9way, 12way [76,78,14,84]
  - Main distribution kiosk
    - 36
- 22kV Switching panels
  - 12 x supply-feeder breaker panel
  - 4 x supply incommer panel

Indicative Costing for 1,500 receiver core

- Bill of Quantities (up to and including 22kV switching stations)
  - Equipment
  - Cabling
  - Trenching
  - Installation
- 13 – 19 million euros
- Excludes
  - 132kV/22kV main substation
  - power room (80MVA)

Other Core Power Requirements

- 80 MVA power room
  - 40 x 2MVA external transformers
  - 9.5 to 10.5 million euros
- 80 MVA UPS backup
  - Rotary UPS with 15min backup load
  - 40.8 to 46.2 million euros
- Main power room reticulation
  - 0.3 to 0.6 million euros
- Main substation
  - 132kV/22kV substation
    - 6.5 to 9.2 million euros
  - 22kV feeder network to 22kV switching stations (26km overhead)
    - 0.8 million euros

Extension from Core to Outer Skirt

- 11 to 16 million euros

Quantities for Remote Stations

- Cabling and Reticulation
  - LV
    - 500m of BCEW 16mm^2 per station
    - 1,300m of 4C 16 mm^2 per station
    - 460m of 4C 50mm^2 per station
- Excavations
  - 500 m^3 per station
- Distribution kiosks
  - 4 x 9 way single phase per station

Indicative Costing per Remote Station

- Bill of Quantities
  - Trenching and excavation
  - Cabling
  - Equipment
  - Site establishment
- 45k euros per station
- Excludes bulk power supply
  - Grid connection (340k euro per connection)
  - Remote power generation
    - Diesel (4 (3) x 300kVA, battery banks)
      - 0.93 to 1.1 million euros
    - PV (4 (3) x 300kVA, battery banks, PV panels)
      - 2.6 to 2.8 million euros
    - Solar thermal
      - Not cost efficient for power requirements less than 1 MVA

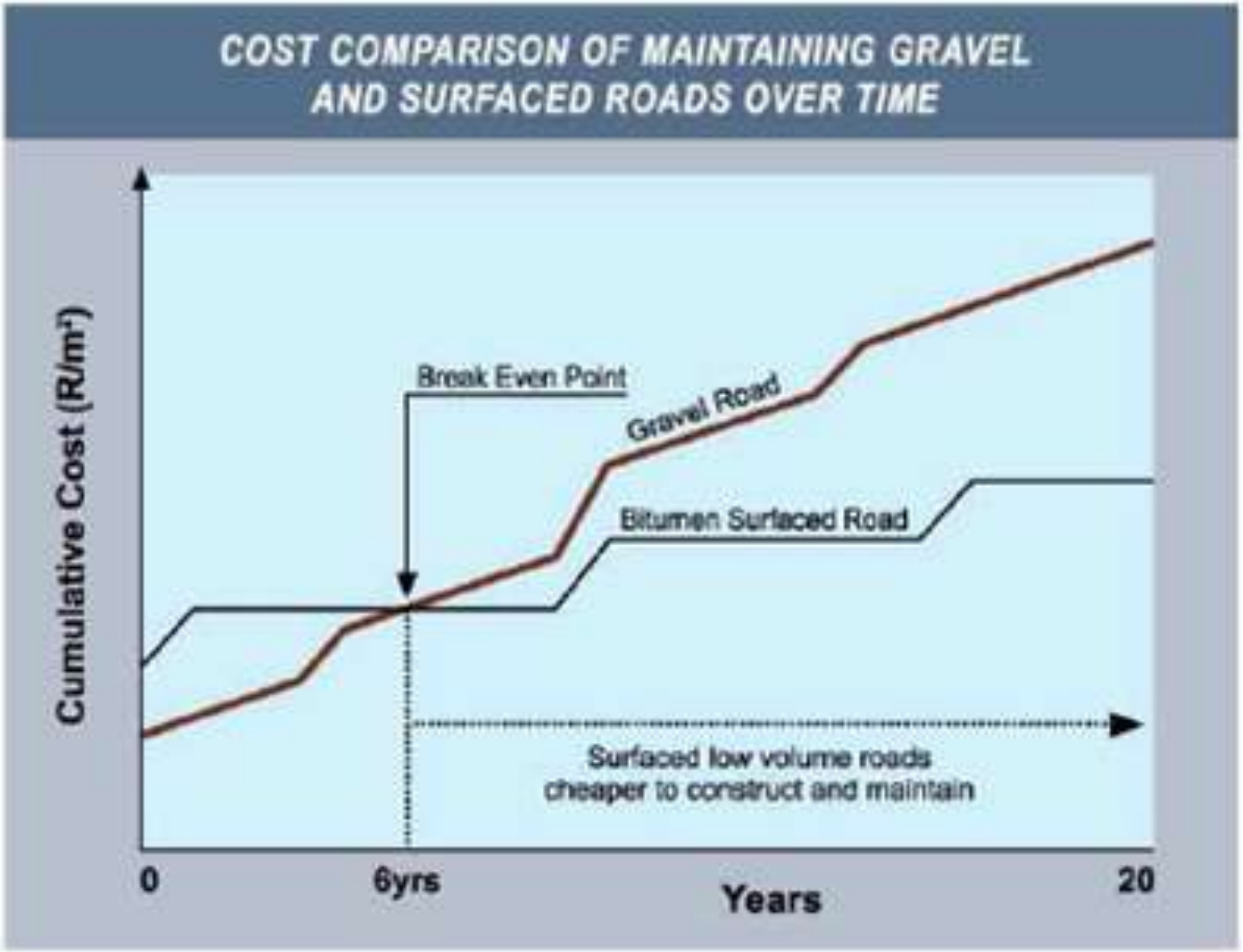
Implications

- Power reticulation to receivers is dominated by cell structure due to deployment of localised mini-substations and distributed UPS network – function drives form
- Power reticulation will therefore drive optic fibre routing with limited optimisation to the distance at which remote power generation becomes an option for remote stations
- To reduce SKA Phase 1 power infrastructure cost, build a clumpy core

Operational quantities

- Backup power
  - Options
    - Battery
      - Reasonable for short term loading
    - Diesel
      - For full operational loading, 16,000 litres of diesel per hour = 1 tanker per hour -> input to road requirements
      - Full backup power is not a cost effective option for SKA
  - Therefore, we require high availability of main supply, and remote station supply – high availability is ONLY possible through redundant power systems -> need to avoid high maintenance requirements systems
  - 1% unavailability = 1% complete data loss = 1.5 million euros operating cost

High Maintenance Requirements Impacts

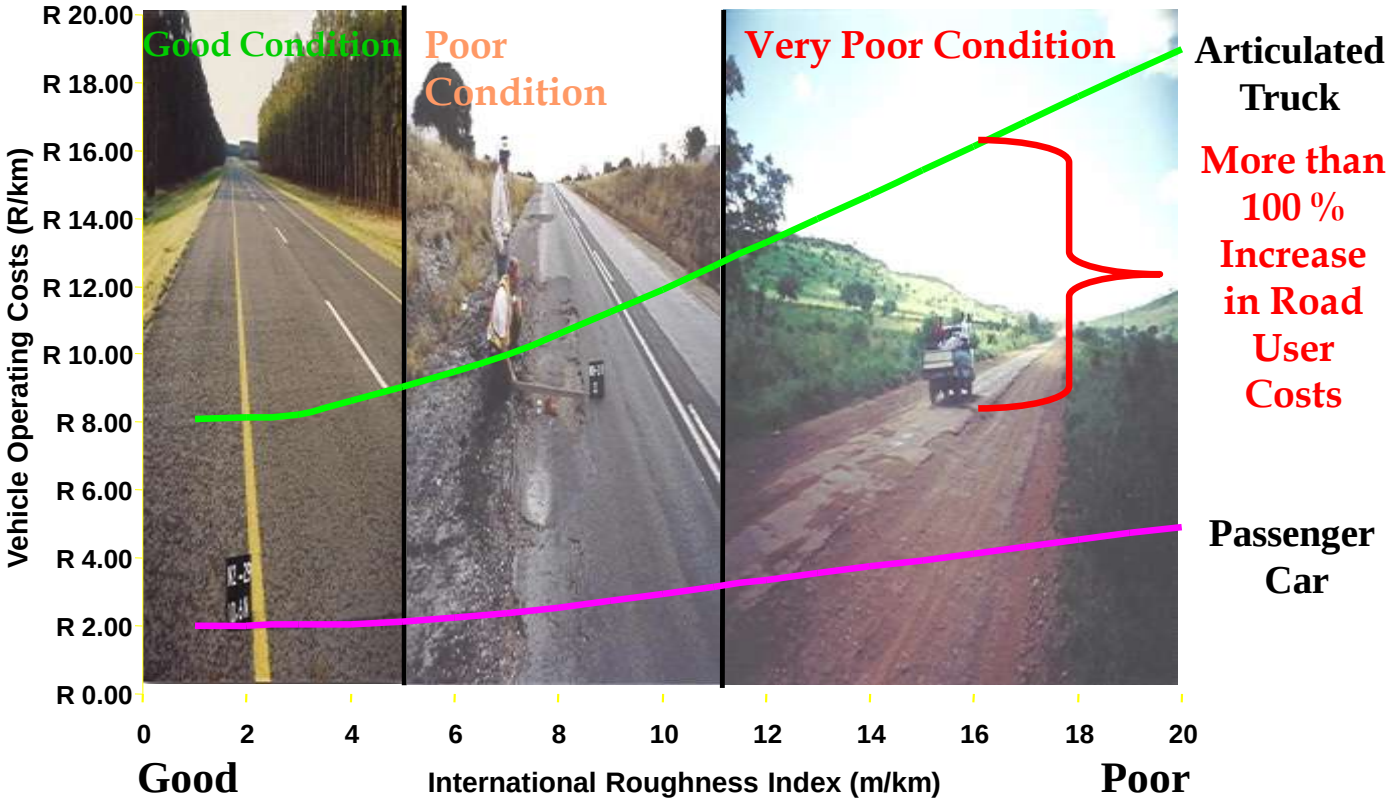


High Maintenance Requirements Impacts

Road Infrastructure (continued)

transport
Department:
Transport
REPUBLIC OF SOUTH AFRICA

Impact of maintenance delay on road user cost
(Over 90% of total transportation costs is road user costs)



Dr. Adrian Tiplady
SKA South Africa
atiplady@ska.ac.za
011 442 2434