The RFI Environment at the SKA/MeerKAT site

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MIDPREP/AAMID workshop 2016

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Overview

- Background
- Regulations and Protection
- Radio spectrum
- Future spectrum developments
- RFI monitoring plans
- RFI in relation to MFAA

Background

Instrumentation at the Karoo site:

- KAT7 (1200-1950MHz)
- MeerKAT (580MHz – S band)
- SKA1-Mid (350MHz – X band)
- HERA, succeeding PAPER (60?-200 MHz)

- *MFAA Demonstrator* (nom. 450-1450MHz)

The site is a unique radio astronomy reserve:
Quiet, big, yet well accessible.
But we cannot take access to the site for granted if we want to keep it quiet. Ultimate efforts from all users and visitors is expected to prevent interference.

Regulations and Protection

Regulations at the Karoo site

To establish long term protection the Astronomy Geographic Advantage Act was promulgated.

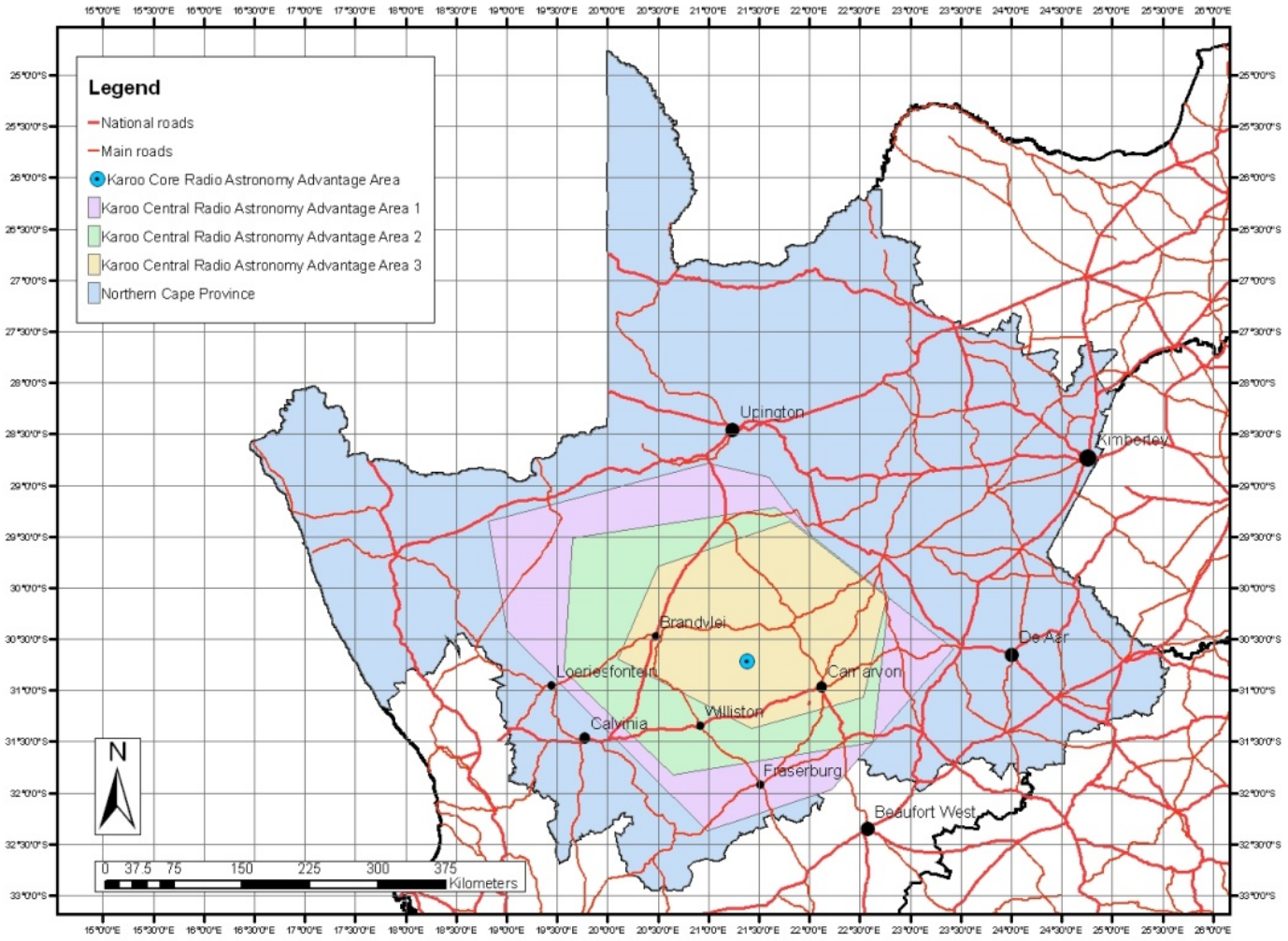
NOTICE OF INTENTION TO MAKE REGULATIONS ON THE PROTECTION OF THE KAROO CENTRAL ASTRONOMY ADVANTAGE AREAS IN TERMS OF THE ASTRONOMY GEOGRAPHIC ADVANTAGE ACT, 2007

REGULATIONS TO PROHIBIT AND RESTRICT THE USE OF CERTAIN RADIO FREQUENCY SPECTRUM AND CERTAIN ACTIVITIES IN THE KAROO CENTRAL ASTRONOMY ADVANTAGE AREAS DECLARED FOR RADIO ASTRONOMY PURPOSES.

Establishment of protection level standards, restriction of spectrum use and interference caused by certain activities.

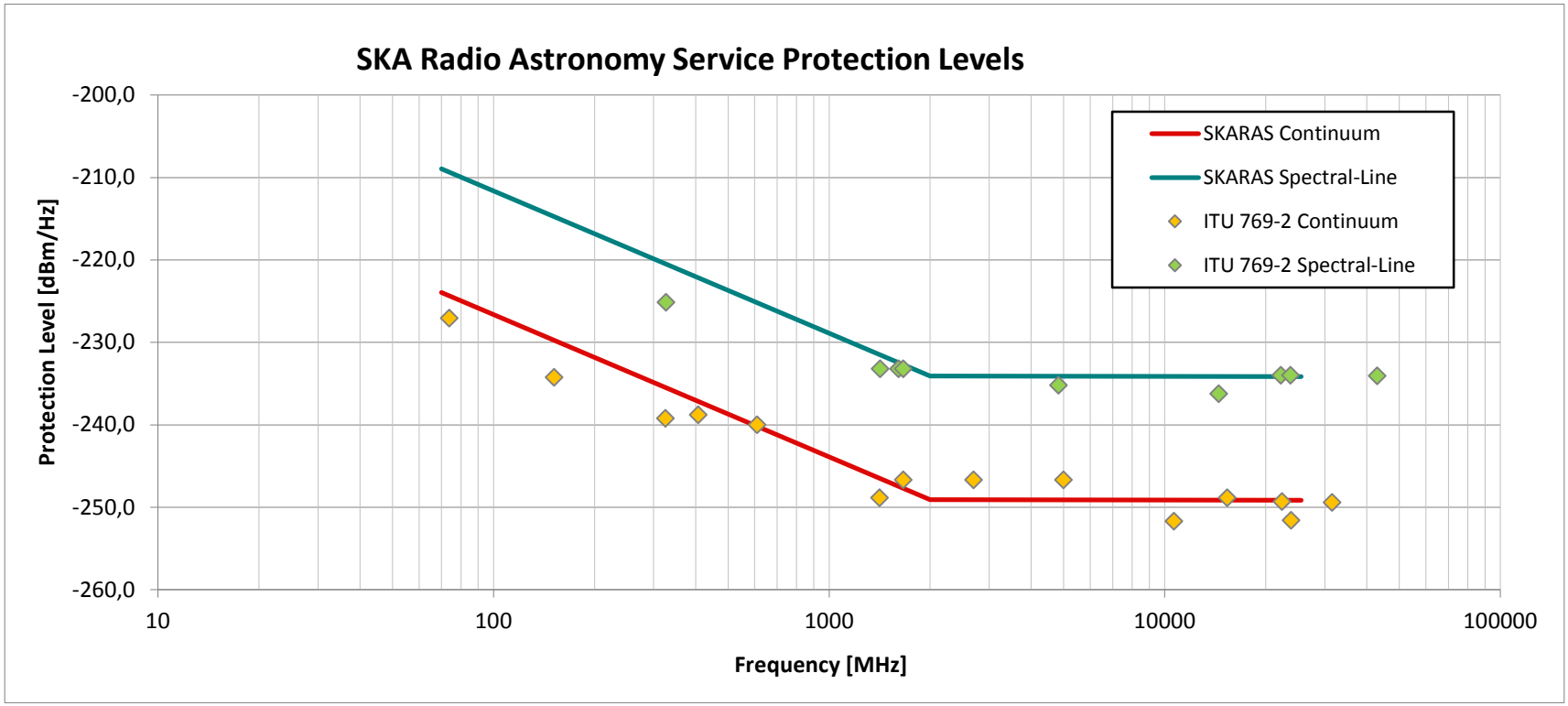
Regulations and Protection

Site is protected by the AGA: Astronomy Geographic Advantage Act



Regulations and Protection

Protection Levels as set by SKAO in: SKA EMI/EMC Standards and Procedures SKA-TEL-SKO-0000202. The levels were based on SA AGA SARAS levels.



Regulations and Protection

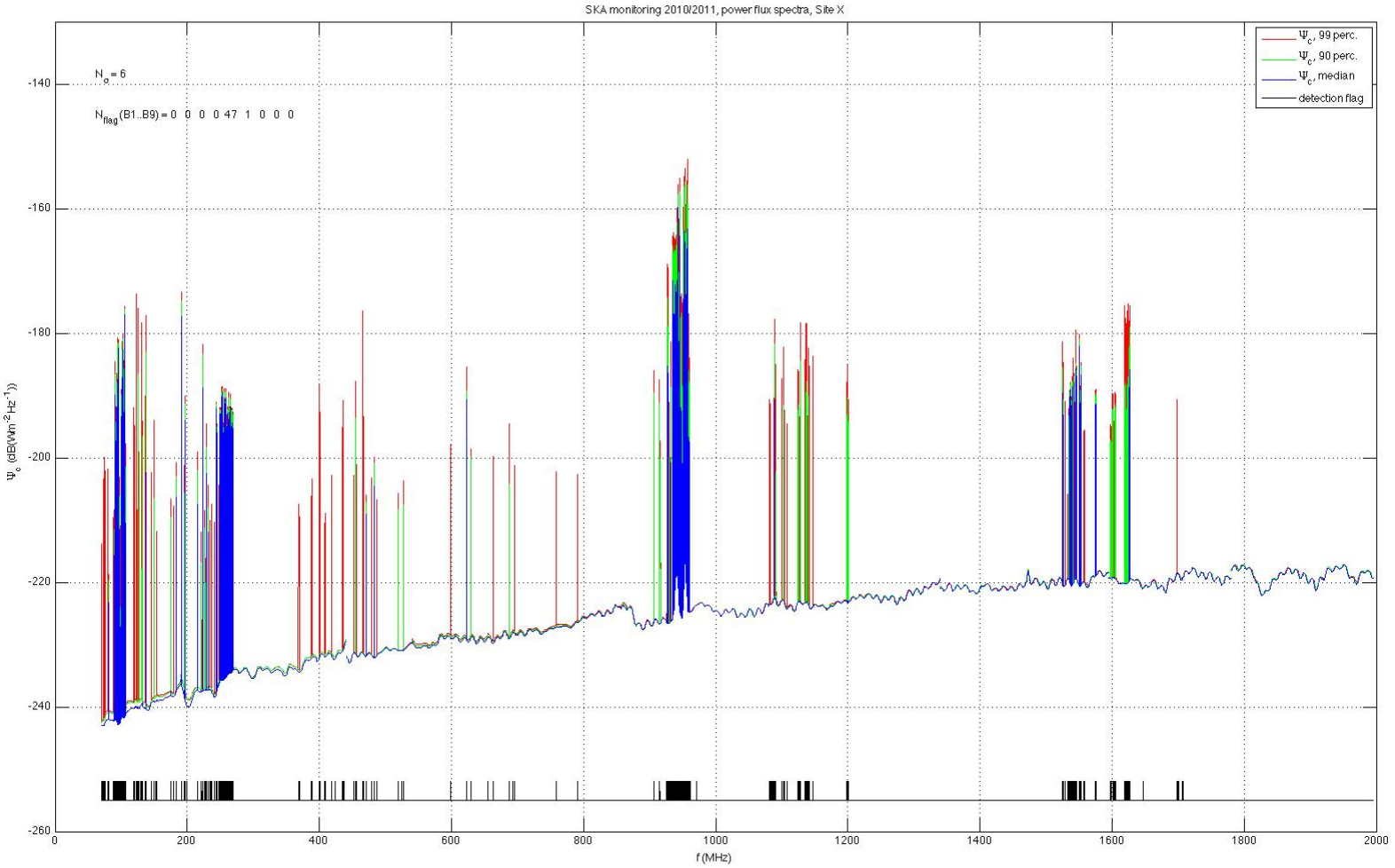
The protection levels apply primarily for interference generated from within the Core Astronomy Advantage Areas, including EMI and other self-generated interference.

Saturation Protection

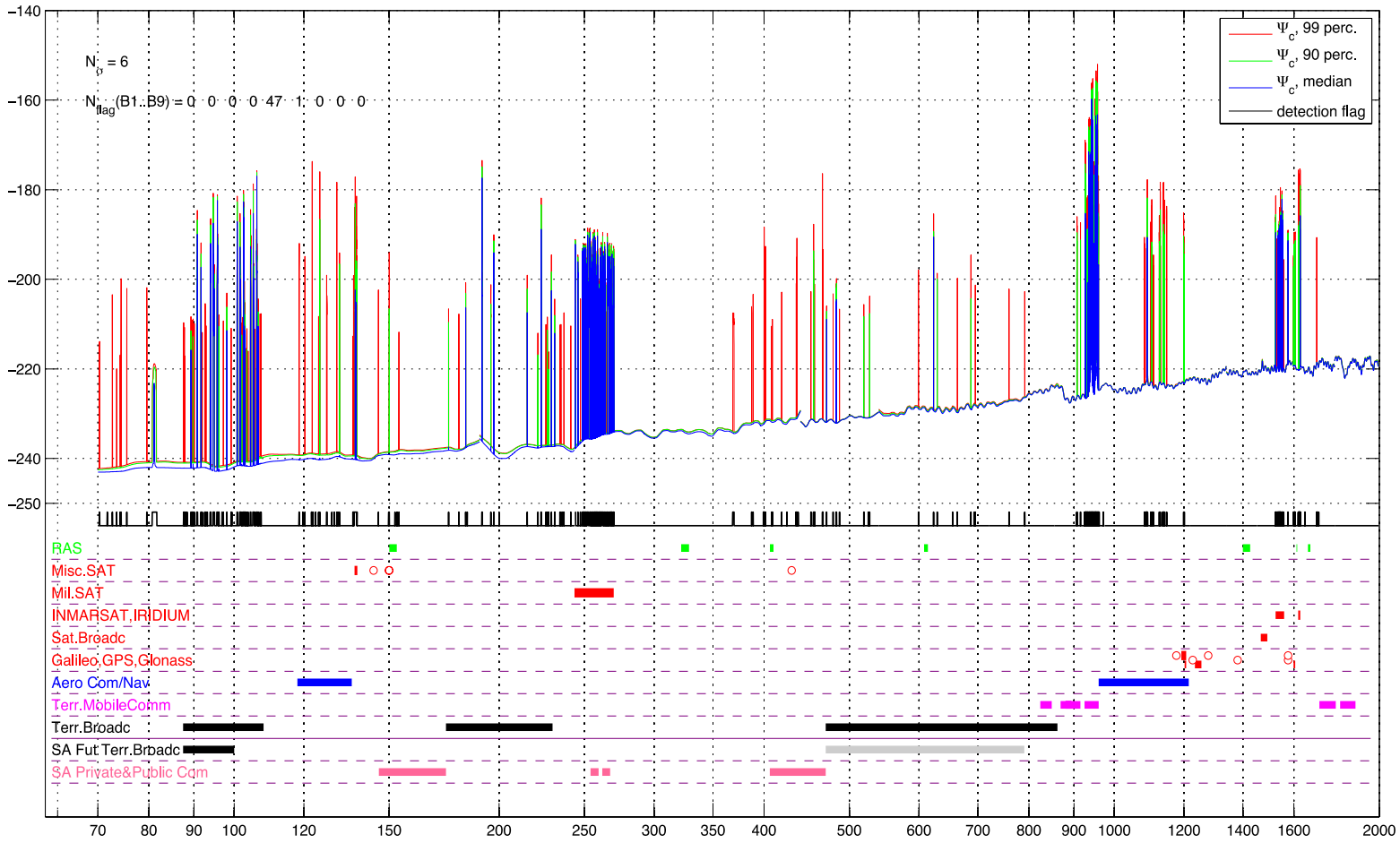
“saturation level” means a received power level of (minus) -100 dBm, or higher, for a radio frequency interference signal at which the saturation phenomenon occurs at a radio astronomy station or at a specified assessment point or points, or within a specified area;

This applies for any terrestrial service, so not for DME...

Radio Spectrum 2010



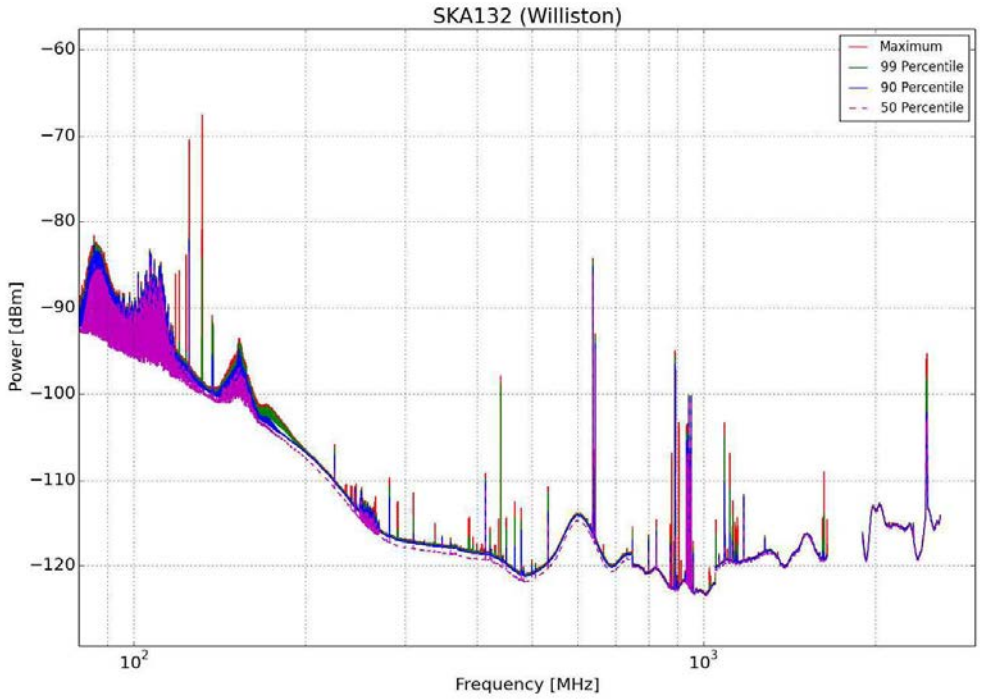
Radio Spectrum 2010



Radio Spectrum

So what does the radio spectrum at the core look like?

Currently not so good…



Future Site Spectrum Measures

A number of measures will (further) improve the interference environment:

General measures:

- Farms, some as far away from the core as 25km, will be bought and deactivated.
- Human presence at site to be minimised as soon as possible. Strict RFI/EMI policy that applies to personnel and visitors alike. Part of it will be an RFI/EMI induction.
- Temporary and construction-time facilities to be removed or made radio quiet.

Specific measures:

- GSM interference
- Broadcasting Digital Migration aspects
- Alternative communication methods

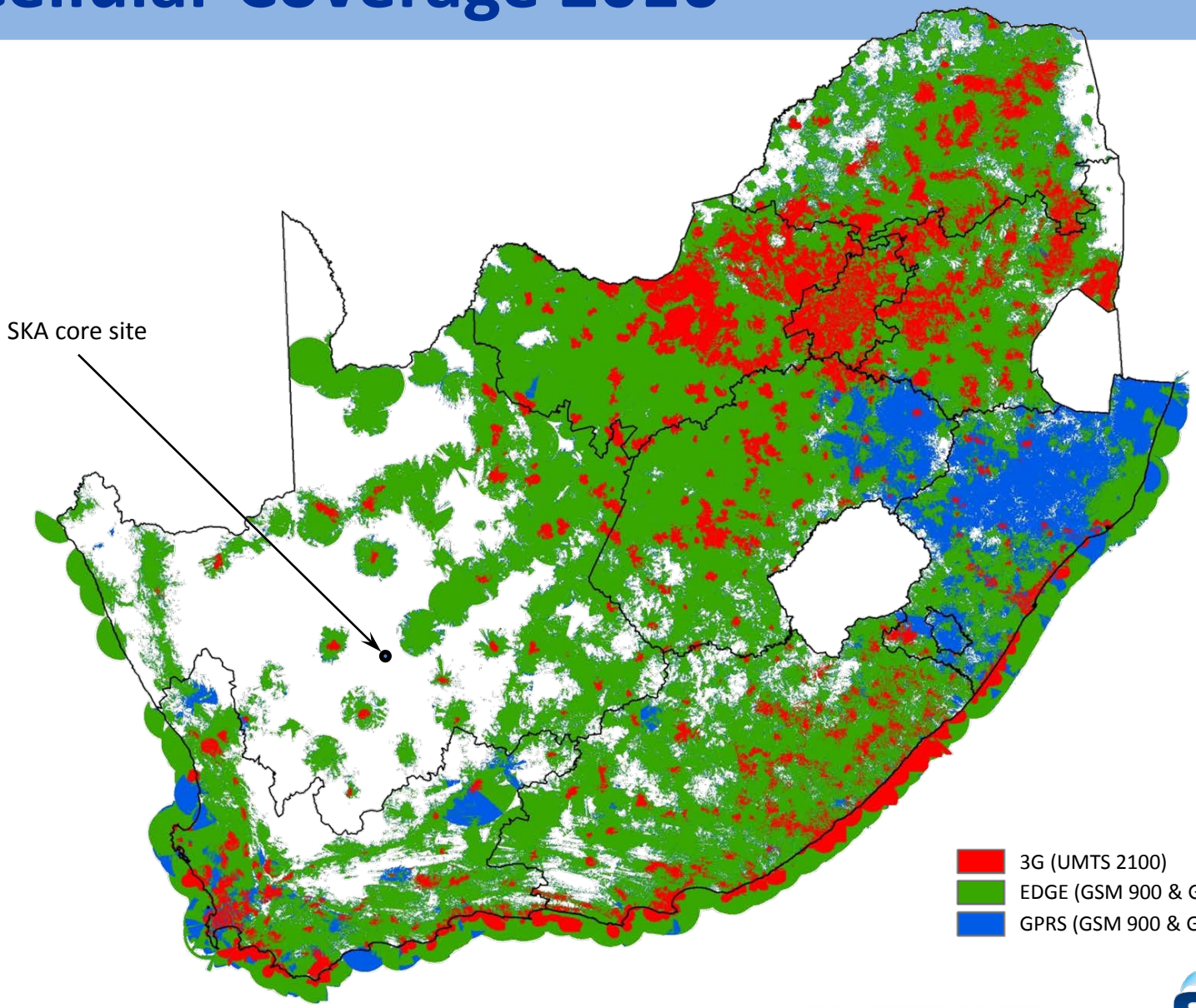
Future GSM

Telecommunications operators are bound by the rule that they cannot cause levels exceeding -100 dBm anywhere in the Karoo Central AAA's.

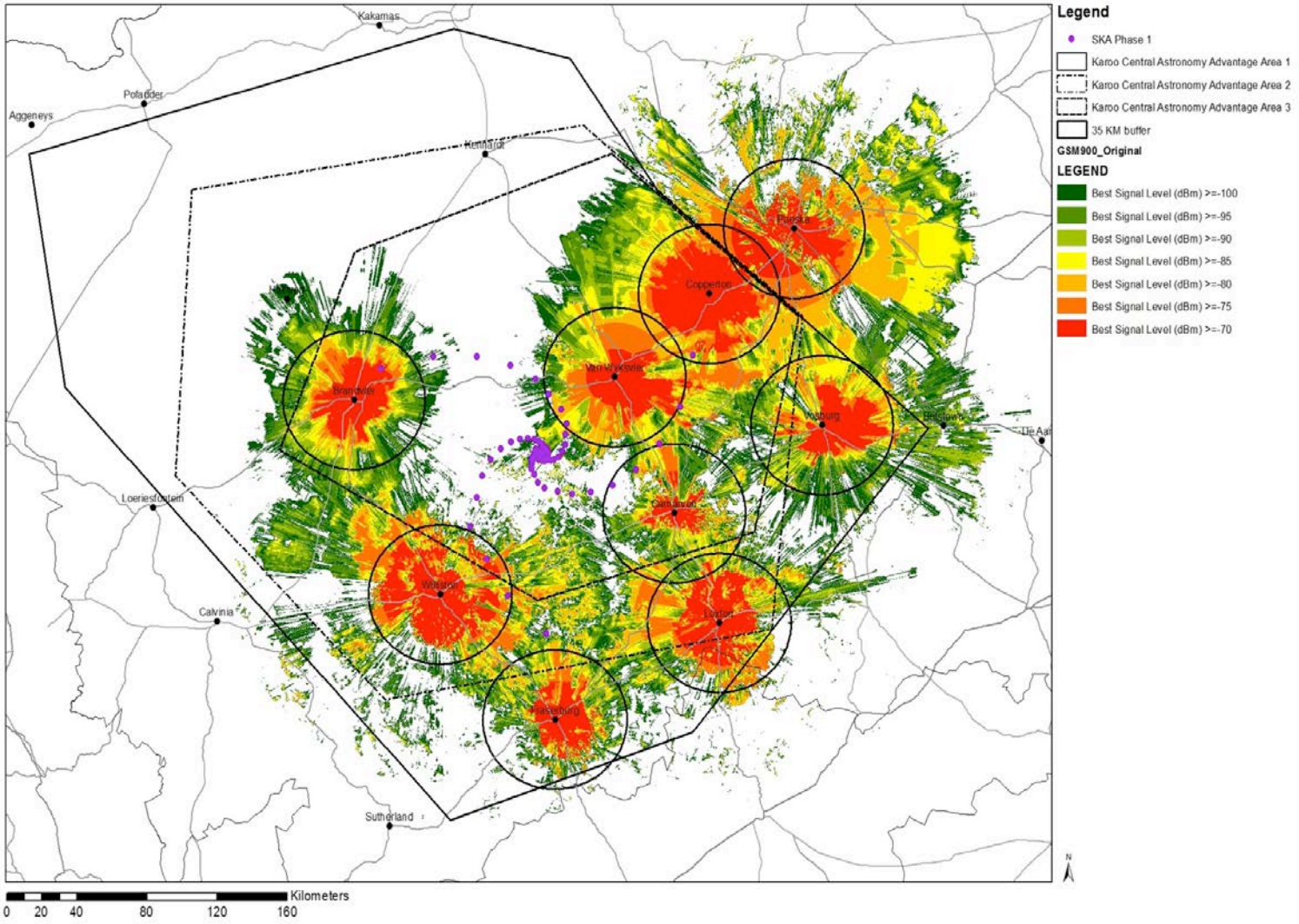
That means that they must use any of these measures, where needed:

1. Use special directional antennas on existing masts, change tilt,
2. Reduce transmitting power,
3. Build lower masts, reduce power and have more of these.

Cellular Coverage 2016



GSM Coverage 2016



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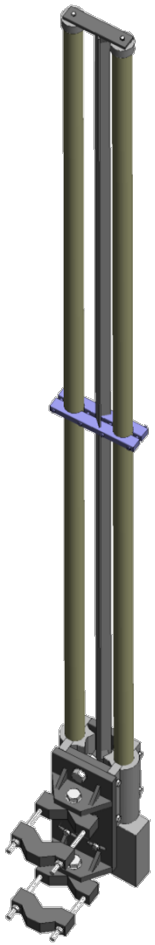
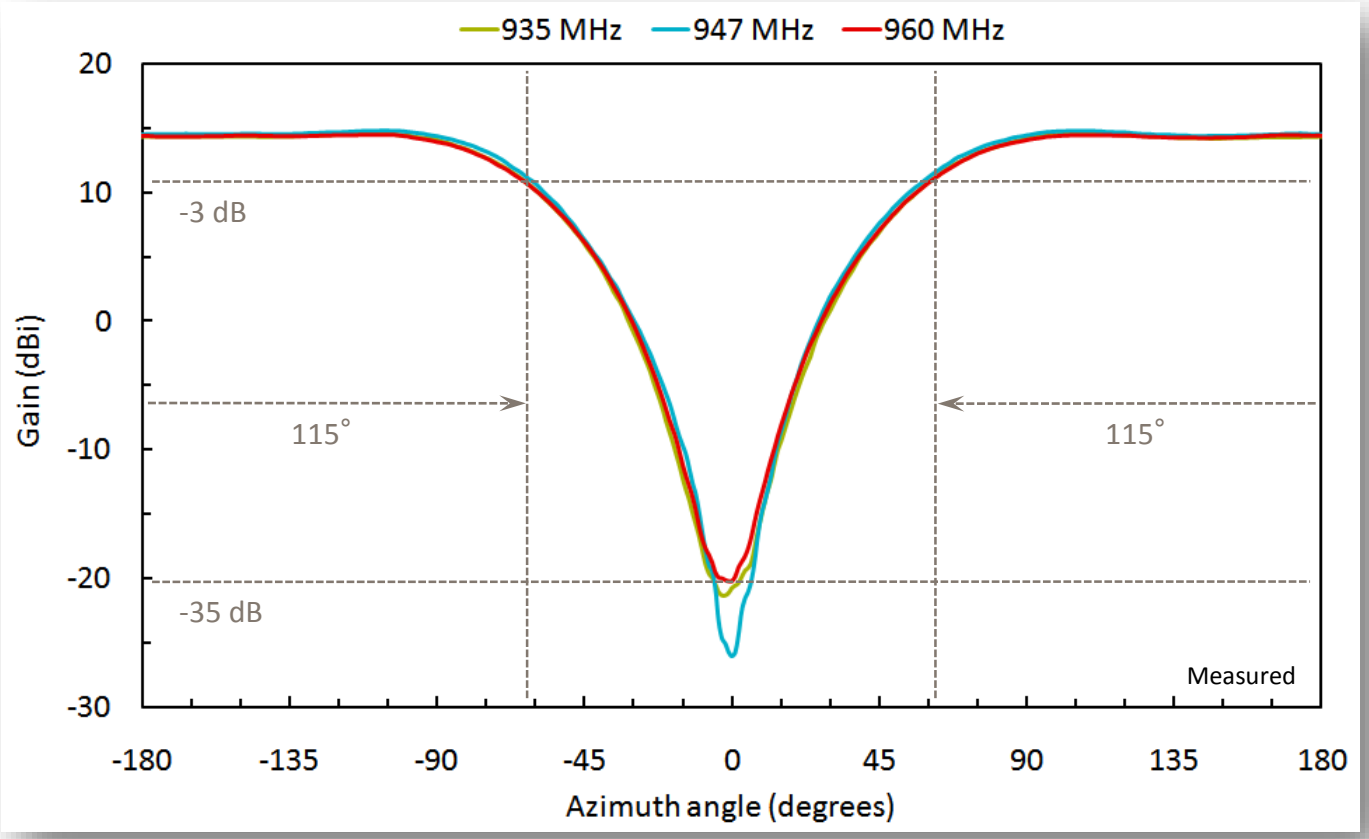
Null-Forming GPS Antenna

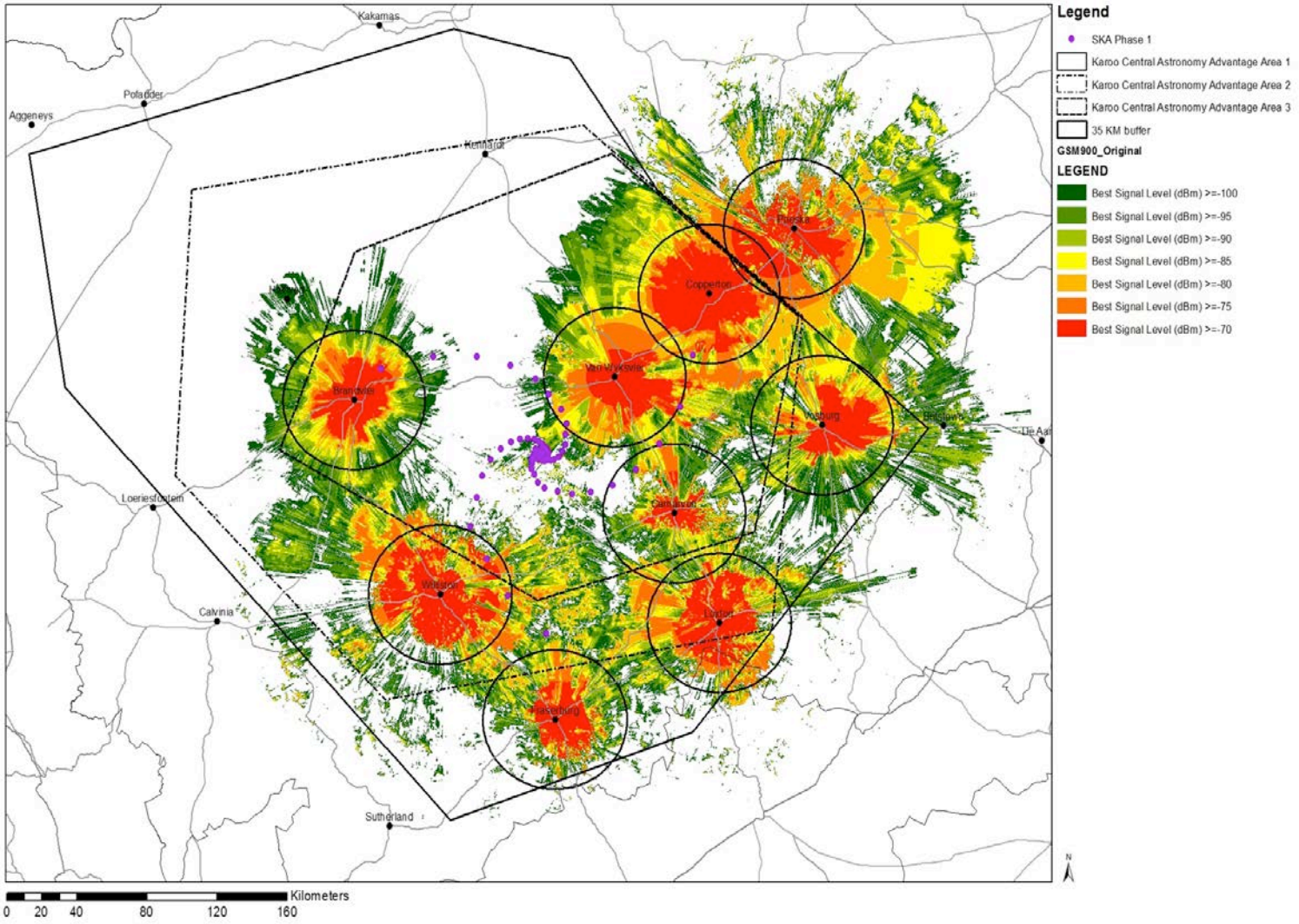
Radiation Pattern of Complete Assembly





- A null depth of about 35 to 40 dB is achieved.
- A half-power beamwidth of about 230° is achieved.

GSM Coverage 2016



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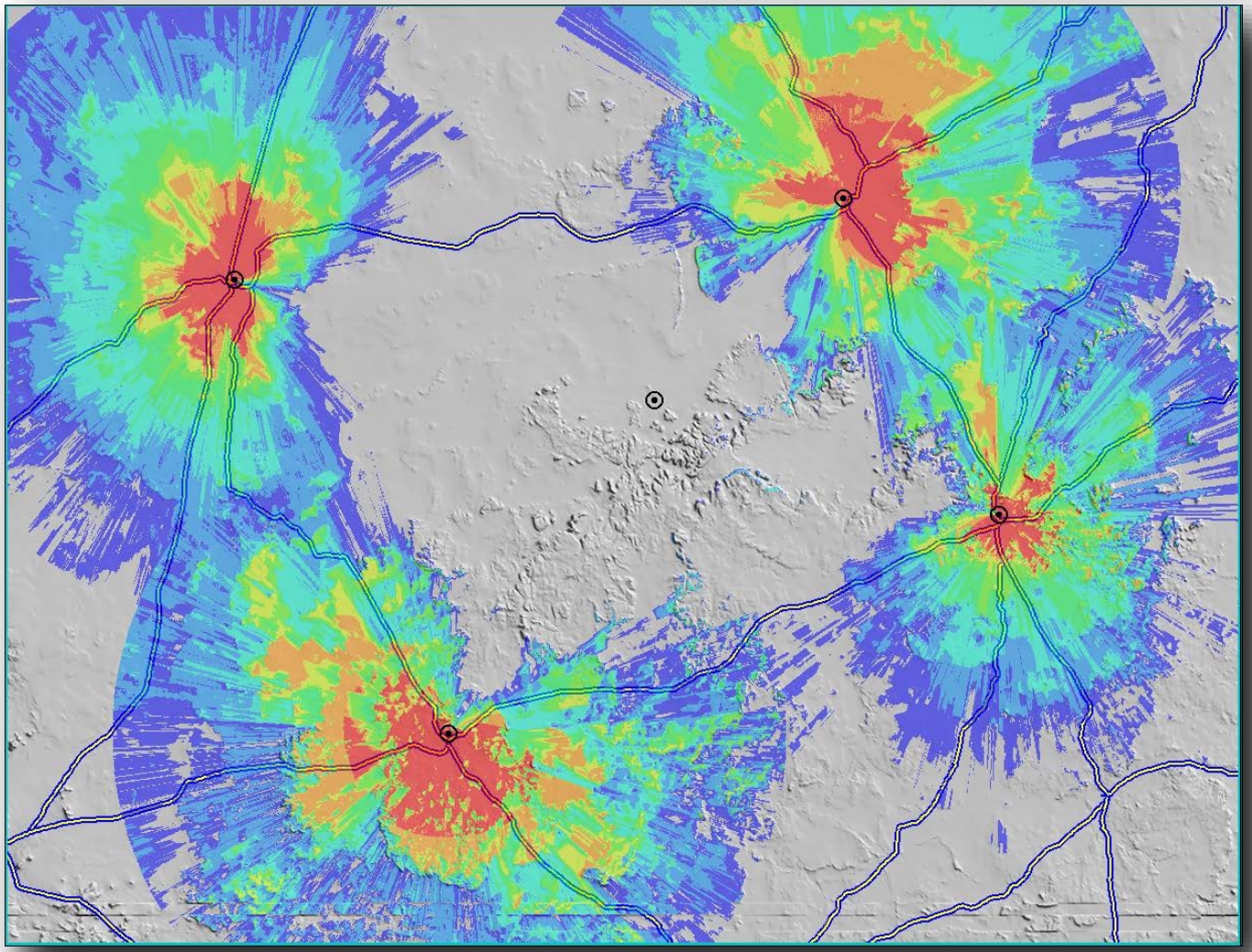
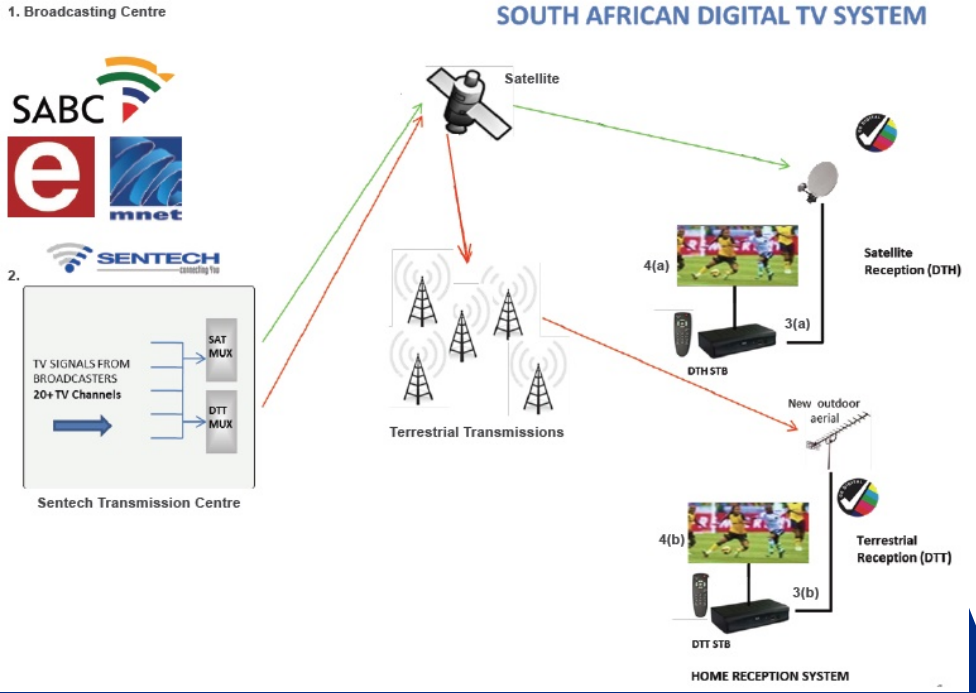
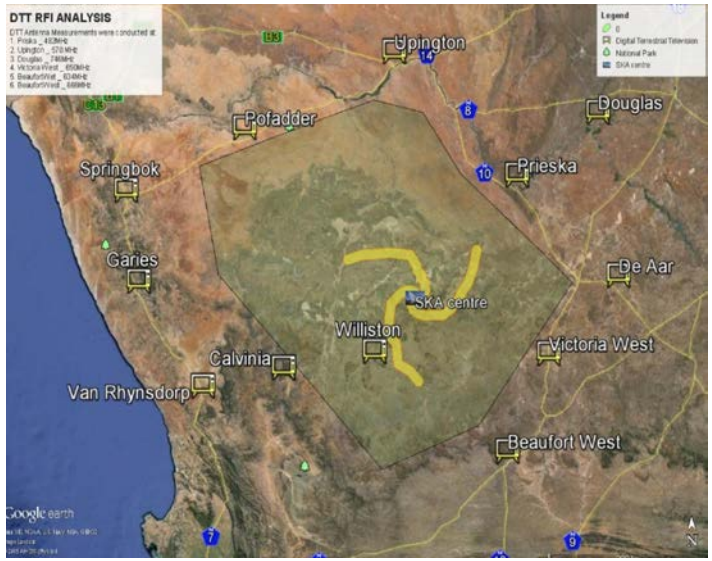


Future Site Spectrum Measures, DTT

Broadcasting Digital Migration aspects:

- Rollout of DTT (terrestrial) in Northern Province ongoing
- Analog TV transmissions will terminate
- DTT not exceed saturation and protection limits
- Investigations carried out at transmission masts in area on EIRP, antenna pattern and propagation towards individual SKA1 telescope positions





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Future Site Spectrum Measures

Alternative communications (1): SKA SA subsidises alternative communications for affected farmers in Karoo, for telephone comms and internet access.

Installations must comply with the applicable protection levels, for which additional shielding measures may be necessary. Tests on installations have been carried out and additional screening effectiveness has been assessed. Note: Local DECT and WiFi will be prohibited.

SKA CPE Configuration

Standard CPE

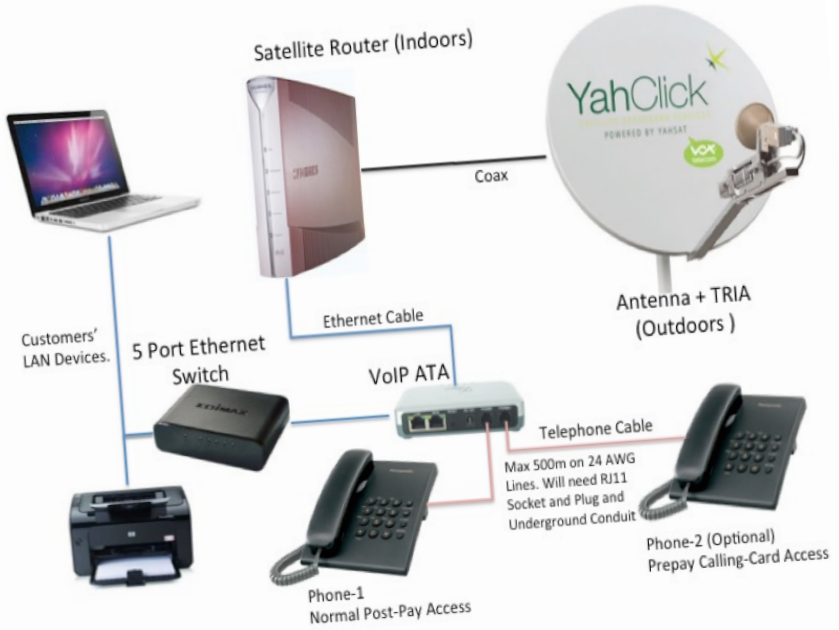
- Dish- 74/98cm
- Wall mount
- Router 9600/9800
- TxRx - 1W/2W
- Grandstream ATA
- 1 Panasonic Phone
- Standard Installation
- UPS

Subsidized by SKA

Service Plans

- 2Mbps Lite – 2GB
- 2Mbps Premium Lite

vox telecom



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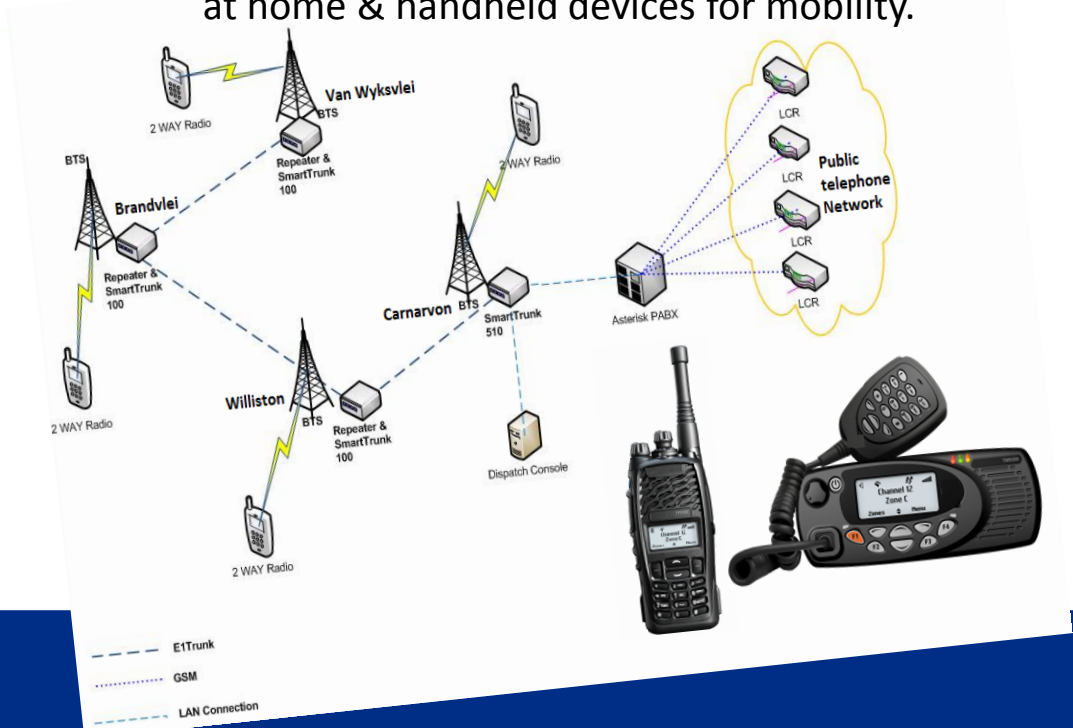
Future Site Spectrum Measures

Alternative communications (2): Trunk Radio

- SKA SA will publish an open tender during the first half of 2016 to appoint a single service provider to supply, installation and operation of the mobile trunk radio telecoms services.
- The preferred business structure is to have a single telecommunications service to provide good quality service to the local public, rural safety, emergency and municipality.
- Karoo communities will have access to mobile communication solution that has the following service : SMS, voice calls, intercom via mobile devices in vehicles, fixed unites at home & handheld devices for mobility.

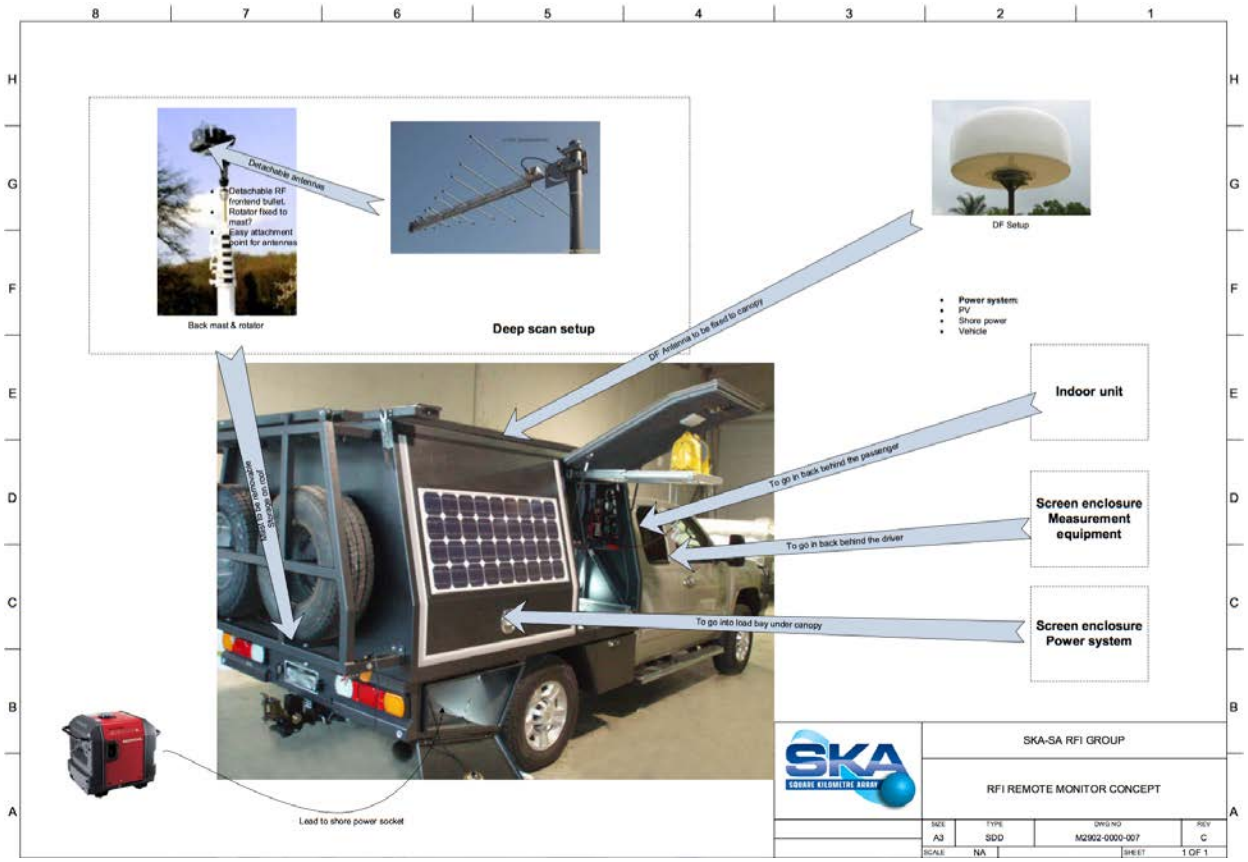


Currently specifications, such as frequency, under debate.

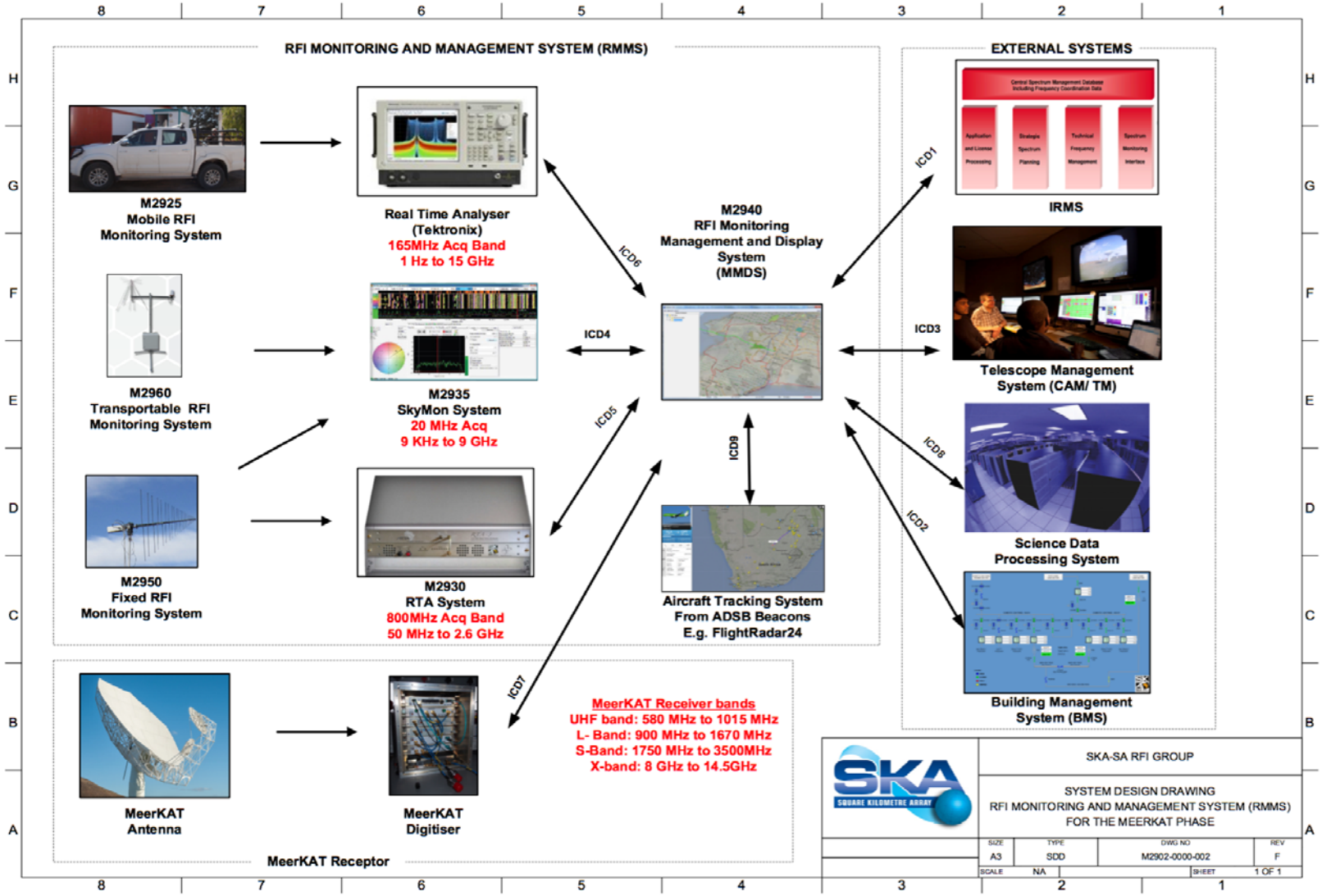
Future of existing 60-80MHz simplex radio in use at site is uncertain, in view of future HERA frequency coverage.

RFI Measurement Instrumentation

Measurement capability of RFI/EMI is important in order to monitor the environment at the site and to locate offending equipment.

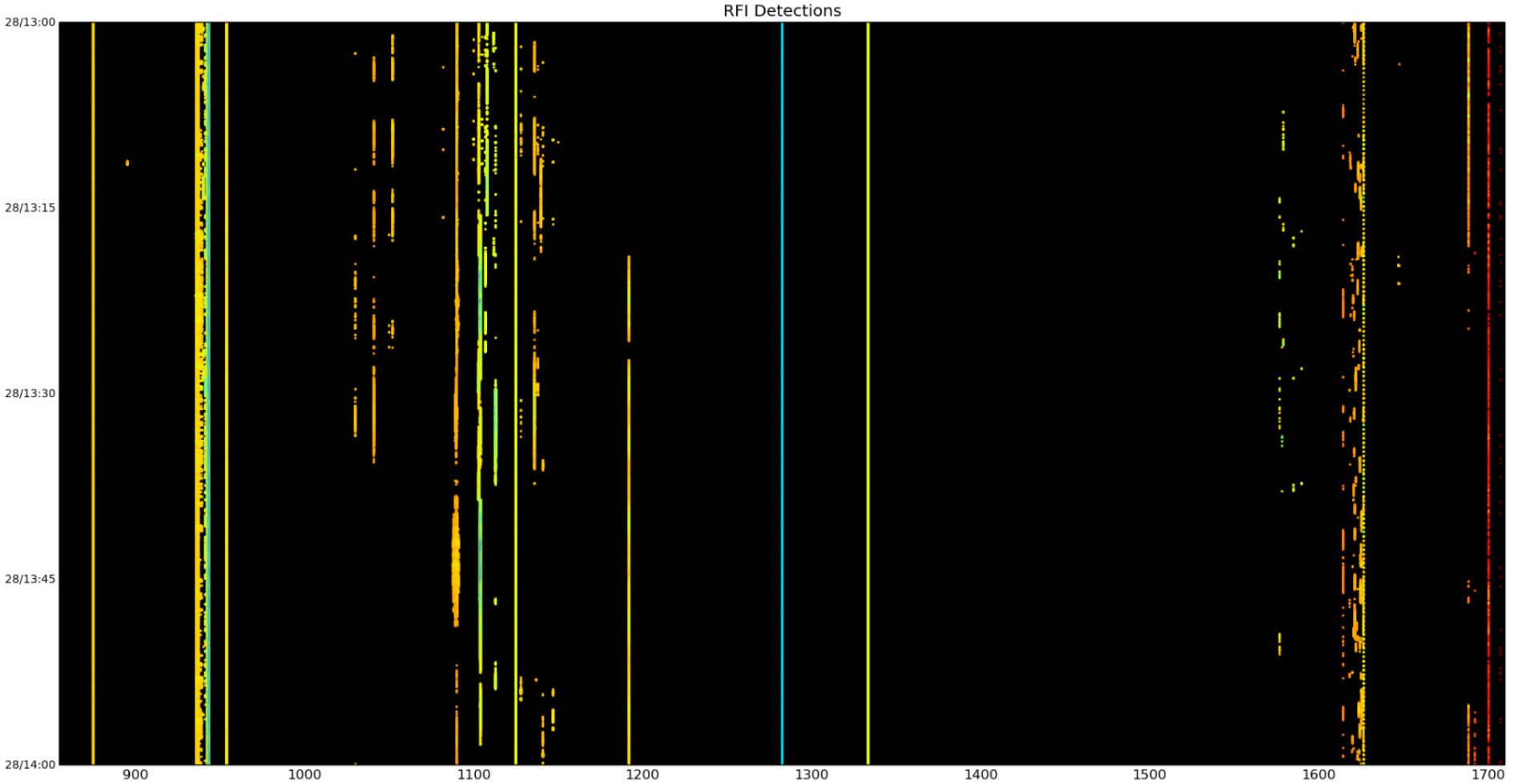


RFI Measurement Instrumentation



RFI Monitoring, current system

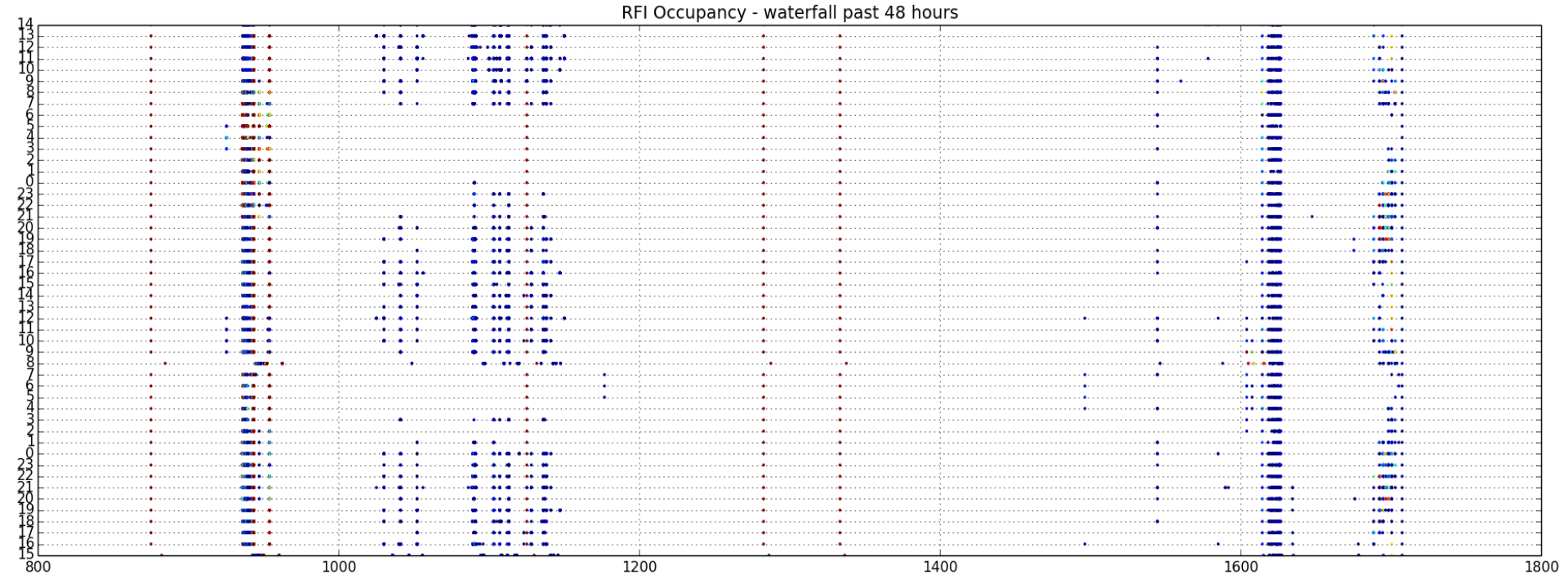
Occupancy statistics, L band



RFI Monitoring, current system

Occupancy statistics, L band

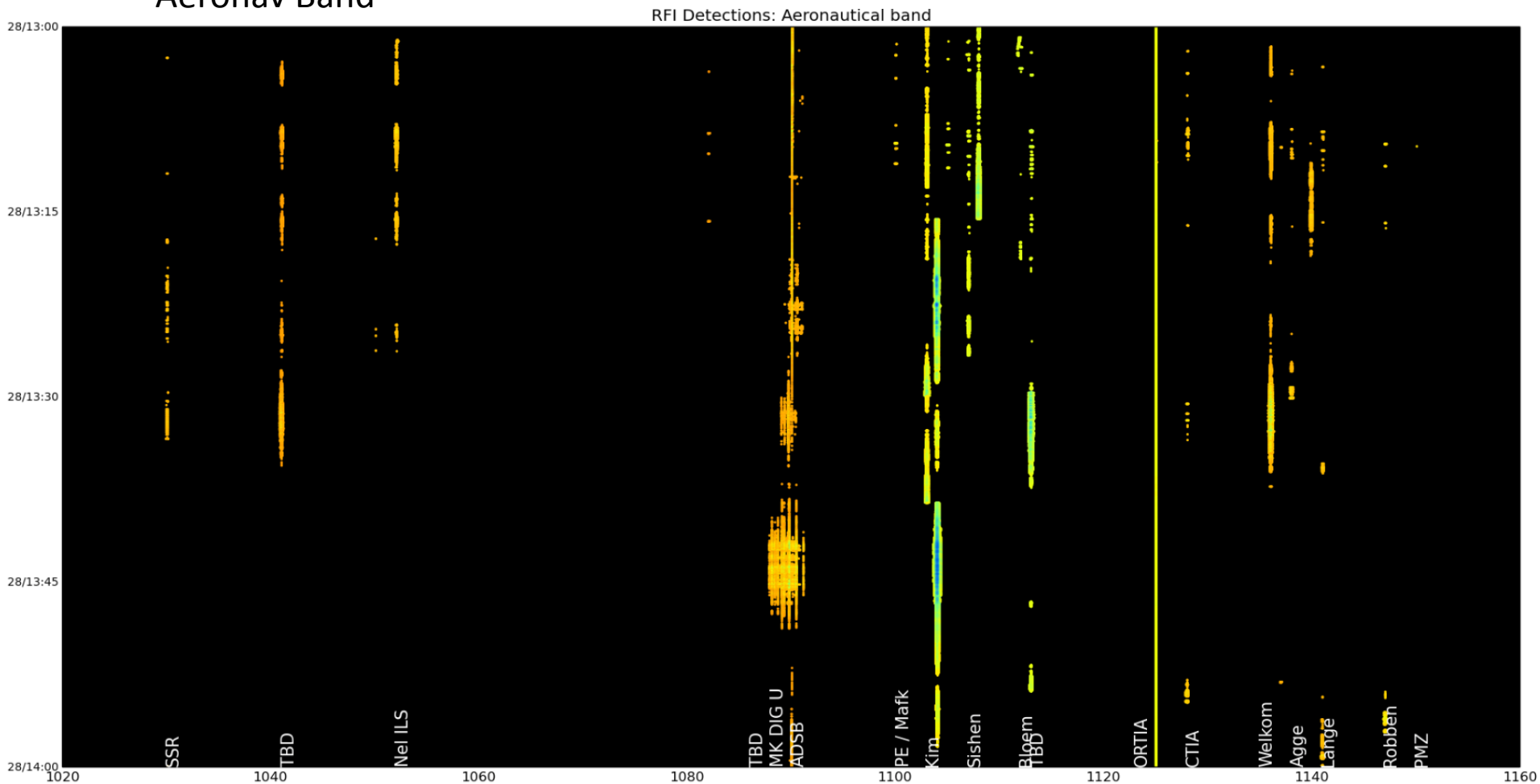
No DME and SSR during night hours



RFI Monitoring, current system

Occupancy statistics

Aeronav Band



RFI and MFAA

Primary sources of in-band interference:

- GSM – will change
- Aeronautical navigation, DME, SSR – daytime only
- Broadcasting – will change

Sources of relatively strong near-band interference:

- Iridium – ~1620 MHz
- Inmarsat – ~1550 MHz
- Aeronautical comms – 118-136 MHz
- FM – 80-105 MHz
- Local communication radios – 60-80 MHz

Two factors that affect susceptibility to RFI:

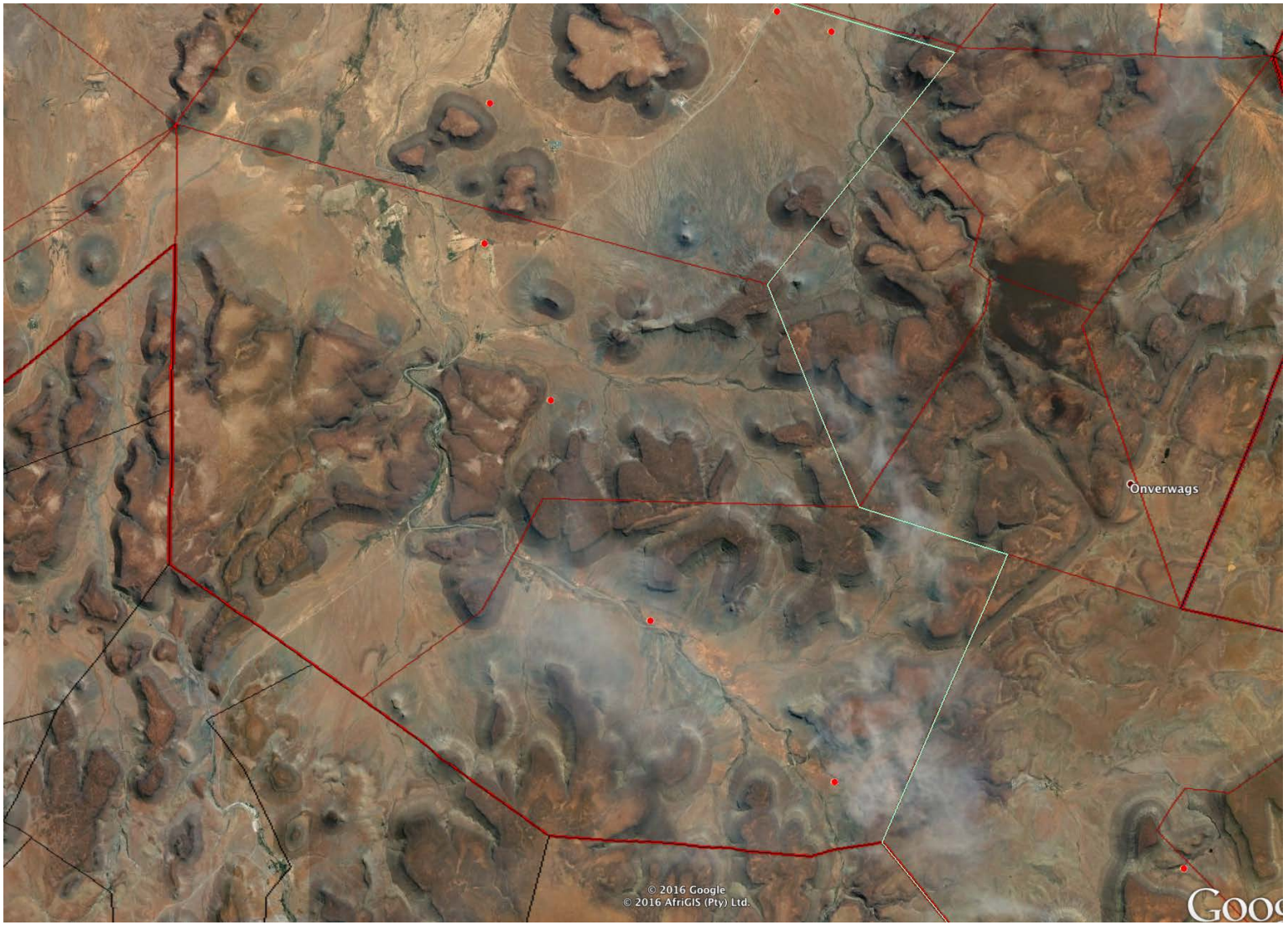
- Close to ground, ~1m
- Some sensitivity towards horizon affecting individual antenna elements, just like LOFAR, EMBRACE

RFI and MFAA, site

Depending on the extent of the demonstrator and the final required SKA2 AAMID core there are some opportunities that:

- Enjoy excellent terrain shielding that block terrestrial broadcasting and GSM,
- Minimise risk of interference from other activities at the site (works both ways)

SKA123 (K4)



SKA123 (K4)

RFI and MFAA

MFAA Demonstrator developments will be able to benefit from interference survey plans, to

- Further characterise environment for weak and (relatively) strong interference,
- Obtain time occupancy statistics at short time scales for strong RFI,
- At multiple locations, including candidates for the demonstrator.

Using real time spectrum analyser and lna.

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