# Interconnecting Communities in a Radio-Silence Protected Region

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# Background: The Square Kilometre Array Telescope



- The Square Kilometre Array astronomical telescope project is one of the biggest scientific projects internationally
- Consists of two parts: Low Frequency array in Australia (50 to 350 MHz) High Frequency array in SA and in Africa (300 MHz to 25 GHz)
- Observations intended to enhance our understanding of the laws of physics active in the universe, such as:
  - The state of the early universe
  - Dark energy
  - Dark matter
- It currently consists of 73 telescopes at a site 80 km from Carnarvon
- Site chosen due to relatively low RF noise levels
- It is a telescope array, based on VLBI (Very Long Baseline Interferometry)
- Total footprint app. 220 x 220 km
- The number of telescopes is scheduled to be expanded to 199 (Has commenced)

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### **SKA Telescope extent**

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# **Threats to Astronomy: 1. Visual**

### Ito a new telescope being constructed in Chile:

(Scientific American Feb 2023) achieve its goals if the sky fills with bogus stars. New swarms of satellite constellations, such as SpaceX's Starlink, threaten to outshine the real celestial objects that capture astronomers' interest—and that humans have admired and pondered for all of history.'

At present.... and now more

than 5,400 satellites orbit Earth at any given time.

Half of which is from SpaceX - Starlink.....

"This is a deeper cultural question. Should Elon Musk control what people see in the night sky?" —Meg Schwamb Queen's University Belfast



### **Huge problem already**





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mits filed with the world's two leading telecommunications agencies—the U.S. Federal Communications Commission and the International Telecommunication Union (ITU)—a combined 431,713 satellites in 16 constellations are planned to launch in the coming years.



According to per-

# **Threat No. 2: Radio Frequency Interference (RFI)**

Emitted by a huge variety of sources, e.g.:

- Mobile communications
- Fixed radio transmissions
- Satellite communications
- Vehicles
- Electric fences
- Tools and household equipment
- Computer equipment
- Many more...

### Problem:

• Astronomical observations are obscured at the frequency bands where the emissions occur, ie. rendering the telescope partially blind in the non-visual spectrum





### **RFI limits**

- The threshold limits applicable in the area are the South African Radio Astronomy Services Protection Levels (SARAS)
- The SARAS levels are a direct implementation of ITU recommendation 769.2 (ITU-R RA769.2) and define an interference level applicable to the most sensitive areas of the SKA site
- The telescope receivers are helium cooled to app. 10K and extremely sensitive Put into perspective: 90 dB better than your typical cellphone, ie. factor 10<sup>8</sup> or, the signal from a phone on the moon can be received
- Protection against RFI ito observation and scientific integrity, is critical



### Impact on communities and inhabitants in the KCAAA (1)

- Regulations from December 2018, restrict usage of the radio frequency spectrum in the KCAAA
- Telecomms operators in the area require a permit from the Astronomy Management Authority (AMA) to continue operating
- The practical- and social requirements of the population are to a great extent irreconcilable with the scientific objectives
- The engagement processes with the community, have not always been clear and consistent, both ways (Assaf report 2021)
- Typical findings:

"We have been here first and for decades"

"You said we shall not be worse off than before and now?"

"What has come of the promise to do something about the jackals in your area? Scientists are not always good at PR !

## Impact (2)

- 1. Probably most problematic and unpopular: Mobile phone coverage has been drastically reduced and limited to towns
- 2. Local private data networks severely restricted
- 3. Personal safety and emergency concerns
- 4. Business and financial impact
- 5. General social consequences ito reduced, or eliminated personal contact
- 6. General negative sentiments towards the project among many inhabitants
- 7. Rural inhabitants are the worst affected(App 600 farms in the area of which +- 60% are permanently occupied)



### Mobile coverage before:





### After:



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### Mobile phone impact

A phone used 20 km from the core telescopes will render observations totally useless





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### What can be done?

# **1. Satellite data access to fixed locations:**

Subsidised service by SARAO – Not very expensive, but still unaffordable by many and it does not provide mobile access

2. Terrestrial connections via SKA fibre infrastructure where feasible (The yellow routes)





**3.** Terrestrial network via microwave links

- Design critical to ensure RFI compliance
- Still no mobile solution



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### 4. Local LTE (4G) picocell where situation allows



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### **Typical network configuration**



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### **Problem:**

- Most of the above are expensive solutions due to low user density and consist of fixed infrastructure with limited local mobile footprint, eg. WiFi
- Clearly no simple quick fix

### **Priority requirement:**

Mobile personal point to point voice communications for:

- 1. Emergency
- 2. Business operations
- 3. General personal communications



### **Compromise solution:**

- To provide a facility at least enabling emergency- and personal communications
- Study undertaken to determine the most feasible solution, ito practicality and telescope RFI compatibility
- Digital Mobile Radio (DMR) VHF Low Band network found to be the most feasible, ito coverage and RFI compliance
- Operational frequency in the 40 MHz band
- Very much a GSM type system, providing seamless roaming between repeater sites
- Phase 1 (under construction) consists of 7 IP connected repeaters and a network management centre (NMC) at Klerefontein
- Narrow band system, so no practical data connectivity as such, but access to the general telephony infrastructure (fixed and mobile) is possible
- 24 Hour NMC planned at Klerefontein for emergencies
- Phase 2 will add another 6 to 7 repeater sites Faculty of Eng: Expo 2023



### Phase 1 network design for community & SKA use:



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### VHF Low Band 40 MHz coverage prediction: Phase 1





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#### VHF Low Band 40 MHz coverage prediction: Phase 2



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### What about mobile satellite connectivity?

• Yes, it is probably coming:

### "SpaceX Wants You to Connect Your Smartphone Directly to Starlink" BUT....

### **"AT&T Asks FCC to Block T-Mobile From Expanding Network With SpaceX Satellites"** "AT&T says it doesn't want possible interference with its own cell service." **AND...**

"Other companies are working to offer space-based mobile broadband, including Texasbased AST SpaceMobile, which recently launched a test satellite with a huge array of antennas"

(cnet Dec 2022)

- Technically not simple, due to mobile phone power and antenna constraints
- Not without a new set of problems for astronomers



# **Summary**

- Fantastic project with some non-scientific spin-off to the area
- However, there is a cost for the inhabitants ito inconvenience, financials, safety, socially and dealing with emergencies
- Whereas we keep migrating towards an ever increasing connected world, they cannot All of the above are caused by restrictions on communication options Efficient communications are vital towards growth in modern societies
- Satellite internet access helps, but is fixed (at present at least)
- The lack of mobile connectivity is probably the major concern

So how do we connect communities in a radio-silence protected region? We can only do it to some extent and with restrictions



# Thank you!

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