



Attachment 1

Title: Satellite RFI Analysis and Prediction

Section A: Overview of the Research Project Proposal

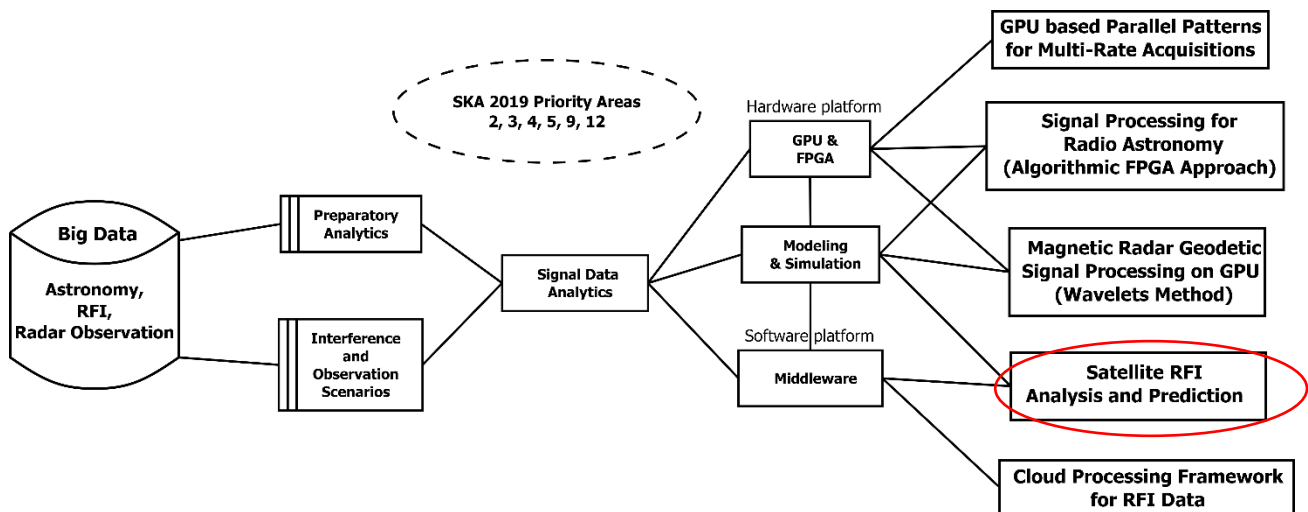
1. **Academic level of research project:** Masters
2. **Broad field of research:** Engineering
3. **Title of the research project:** Satellite RFI Analysis and Prediction
4. **Research project abstract/summary (max 250 words):**

Modelling and analysis of RFI due to satellites over South Africa in low earth and geostationary orbits will be studied.

Aspects of the research are:

- 1) correlation of models with ground measured RFI to identify and isolate the particular satellites
- 2) prediction of interference levels due to each satellite over the course of it's mission life considering orbital period, link budgets and on-board transmitters
- 3) Coupling space RFI analysis to existing spectrum management and RFI databases at SKA
- 4) Reproducing scenarios as identified at the RFI Work Group
- 5) Indication whether the ICASA guidelines on coordinated frequencies are conformed or violated
- 6) Assistance to SKA in selecting a quiet time slot for radio astronomy acquisitions.

This proposal arches to our bigger project view, shown below, in the skill development areas of FPGA/GPU hardware, instrumentation and data analytics that are related to the SKA requirements.



Section B: Supervisor Details

1. Primary supervisor's details

Title and full name: **Dr. Simon Winberg**

b. Name of South African or SKA Partner Country university at which the primary supervisor is a permanent academic staff member : **South Africa**

c. Email address and/or contact telephone number (please note that in the event this project is approved, these contact details will be made available to students awarded SARAQ postgraduate bursaries): **Email: Simon.Winberg@uct.ac.za Tel: +27 (0)21 650 2793**

d. Supervision of postgraduate students – please provide the details of all the previous and current postgraduate students supervised. Please provide the information in table format, as shown below.



Students current supervised and graduated

This section lists students currently supervised and graduated since 2013.

Doctoral Students (since 2013)

Name of student	Nationality	Date started Doctoral Degree (Month and Year)	Date completed / will complete Doctoral Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor
Mr Lerato Mohapi (graduated)	Lesotho	1-Feb-2014	18 October, 2017	A domain specific language for facilitating automatic parallelization and placement of SDR patterns into heterogeneous computing architectures	Michael Inggs (UCT)
Mr Danish Arif	Pakistan	24-Feb-2015	December 2019	Angle Independent Face Recognition for High Value Targets	
Mr John-Philip Taylor	South Africa	1-Mar-2015	December 2019	Alcha: Architectural Level Computational Hardware Abstraction: A New Programming Language for FPGA Projects	
Mr Lekhobola Tsoeunyane	Lesotho	15-Feb-2016	April/June 2019	Framework for integration of SDR applications using a DSL with SDF-AP dataflow models	Michael Inggs (UCT)
Mr Joseph Wamicha	Kenya	20-Feb-2017	December 2019	Investigation of a Low-Powered Mechatronic System to Enhance Power Generation of a PV Solar Array	
Mr Zeeshan Aleem	Pakistan	15-Feb-2016	December 2018	Development and Improvement in Control and Miscellaneous Aspects of Impedance Source Inverters and Converters	Moin Hanif (Dublin Institute of Technology)

ii. Masters Students

Name of student	Nationality	Date started Master's Degree (Month and Year)	Date completed / will complete Master's Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor
Mr Bradlee Wilson (graduated)	South Africa	Feb 2016	June 2018	Autonomous RGB-Depth Sensing 3D mapping robot	Daniel O'Hagan (UCT)



Ms Aphwe Hotele (graduated)	South Africa	Feb 2016	December 2017	Environmental Monitoring Predictor: A case study of the Meerkat Science Data Processor Imager	
Ms. Mpati Boleme (graduated)	Lesotho	Feb 2015	June 2016	Rhino streaming interface for Gnu Radio with performance testing case studies	
Mr Israel Tshililo (graduated)	South Africa	Feb 2015	December 2016	Parallelization of galaxy formation modelling algorithms	Catherine Cress (CHPC / UWC)
Mr Wesley New (graduated)	South Africa	Feb 2015	December 2016	Python Based FPGA Design-flow	Michael Inggs (UCT)
Mr Pius Mugagga (graduated)	Uganda	June 2013	December 2015	Human hearing augmentation device	
Mr Lekhobola Tsoeunyane (graduated)	Lesotho	Feb 2015	December 2015	RHINO SDR Blocks	Michael Inggs (UCT)
Ms Valerie Chiriseri (graduated)	Zimbabwe	Feb 2013	December 2014	RHINO API Cluster Control Management System	
Mr Shaun Katz (graduated)	South Africa	Feb 2012	June 2013	RadiO Modelling Environment (ROME)	
Mr Karthik Rajeswaran (graduated)	United Arab Emirates	Feb 2012	December 2013	Lossless compression of SKA Data Sets	
Mr Shaylin Chetty	South Africa	2018		A Heterogeneous System Architecture Based Image Processing Framework	
Mr Lindokuhle Biyas	South Africa	2017		SKA RFI Data Store and Remote Access Processing System	
Mr Josiah Shumba	Zimbabwe	2018		Cognitive Radio Wireless Sensor Network (CRWSN) Framework	
Mr Luckmore Magwa	Zimbabwe	2018		Spectrum Sensing to Characterising Interference	



				from Base Stations	
Mr Balone Ndaba	Lesotho	2016		OpenCL SDR Signal Steam Processing Framework for the Xeon Phi	
Mr Khobatha Setetemela	Lestho	2018		Evaluation of High Level Tool-Flows for Rapid Prototyping of Software-defined Radios on FPGAs	
Mr Mbongeni Bhebhe	Zimbabwe	2018		Characterizing Noise from Narrow Band Internet of Things (NBloT) for certain sensor nets	
Mr Yemeli Tasse	Cameroon	2017		Dynamic Signal Conditioning System for FPGA-based sampling systems	
Mr Bradley Kahn	South Africa	2016		Parameter control system for RHINO signal timing and sampling	
Mr Daniel Flowers	South Africa	2017		Stacked Denoising Autoencoder For Self-Organizing Maps	

2. Co-supervisor / Research Supervisor’s details

- a. Dr. Syed Muhammad Yaseen Zaidi
- b. University of Cape Town
- c. yaseen.zaidi@ieee.org / 021 650 2792
- d. Supervision

The following students were supervised/co-supervised during co-supervisor’s tenure at the Cape Peninsula University of Technology.



ii. Masters Students

Primary Supervisor

Name of student	Nationality	Date started Masters (Month and Year)	Date completed / will complete Master's Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor
Caleb Hillier	South Africa	March, 2017	-	A System on Chip (SoC) based Error Detection And Correction (EDAC) Implementation for Nanosatellites	Robert van Zyl

Co-supervisor

Name of student	Nationality	Date started Masters (Month and Year)	Date completed / will complete Master's Degree (Month and Year)	Title of Research Project / Thesis	Primary Supervisor
Kanyisa Sipho Mtshemla (graduated)	South Africa	January, 2015	September, 2017	Mission design of a CubeSat constellation for in-situ monitoring applications	Robert van Zyl

Research Supervisor

Name of student	Nationality	Date started Masters (Month and Year)	Date completed / will complete Master's Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor
Inge Chleo Pearce	South Africa	January, 2015	September, 2017	Magnetic Hardware In-The-Loop Simulator for a Nanosatellite	Robert van Zyl, Gerard Orjubins
Joel Biyoghe	Democratic Republic of Congo	January, 2015	-	Implementation of Quadrature Phase Shift Keying (QPSK) Modulation in FPGA for High Data Rate Nanosat Missions	Robert van Zyl, Yves Blanchard



Lilie Nally Leopold	Namibia	January, 2014	-	Design and Implementation of a C-Band Downconverter Receiver	Robert van Zyl, Francois Visser
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Students significantly helped in part selection, developing a focused proposal, test and measurements, publications and in thesis review:

Name of student	Nationality	Date started Masters (Month and Year)	Date completed / will complete Master's Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor
Lusanda Mdibi	South Africa	February, 2016	November, 2018	A Land based HF Transmitter for Ionospheric Propagation Studies Using SuperDARN Radars	Robert van Zyl, Mike Kosch (SANSA Hermanus)
Verena K. Naftali	Namibia	February, 2016	November, 2018	Implementation of Reverberation Chamber for Electromagnetic Compatibility Measurements	Robert van Zyl, Gerard Orjubin
Pamela Mvouezolo	Democratic Republic of Congo	July, 2015	-	On Improvement of the Reverberation Chambers with Two Stirrers	Robert van Zyl, Gerard Orjubin

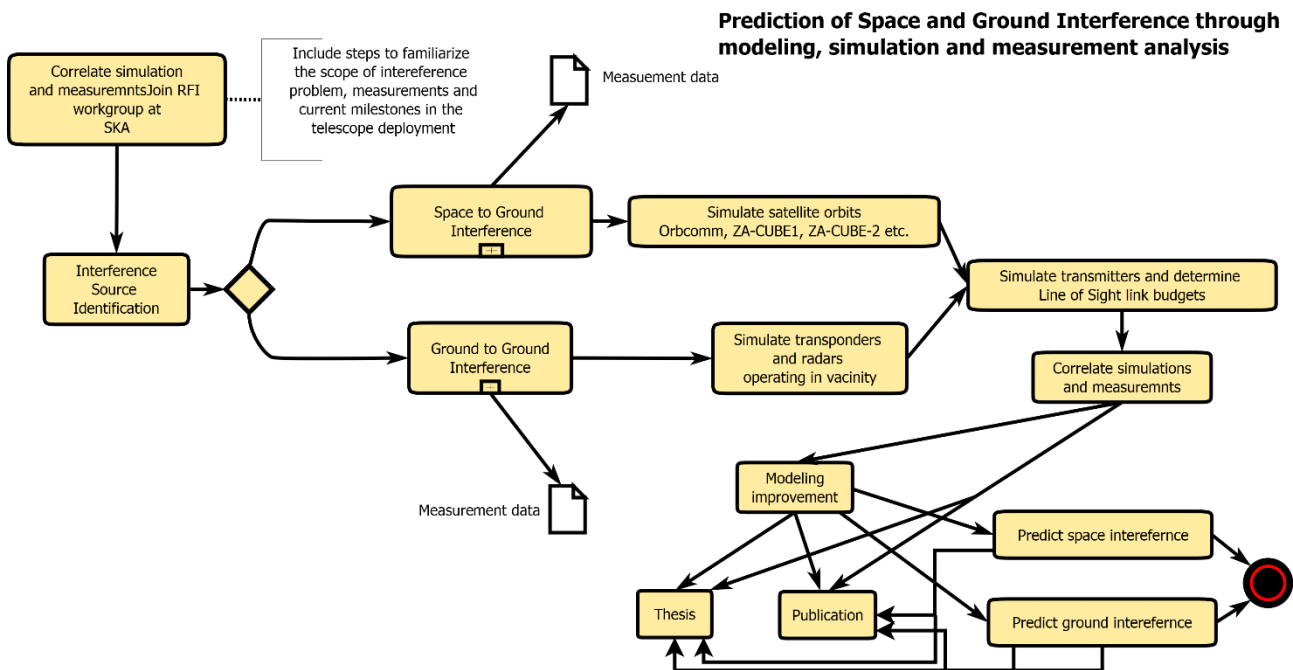
Section C: Full Research Project Proposal

1. Scientific Merit: Recent discussions at the RFI Work Group at SKA Pinelands, of which the supervisors are members, led to the problem of correctly identifying the RFI due to Orbcomm satellites in the RFI dataset. The space to earth interference to the sensitive SKA equipment is not just a one satellite problem, rather, this type of interference if received during live experiments, can ruin the measurements and radio astronomy acquisitions.
2. Feasibility: ZA-CUBE-2 CubeSat class satellite is due launch soon. It carries UHF, VHF/Automatic Identification Signal (AIS), S-band and a powerful 10W X-band payload that would operate at just 600 km away from earth. Even though these subsystems might conform to ICASA licensed frequency bins and power levels, their reception might still be detrimental to SKA acquisitions due to very low noise floor requirement and faintly discernible observations that are inherent to radio astronomy. Furthermore, under auspices of Operation Phakisa (<http://www.operationphakisa.gov.za/Pages/Home.aspx>), after tech demo of ZA-CUBE-2, the government of South Africa aims to build and launch in constellation, nine (9) copies of ZA-CUBE-2 for a full maritime domain awareness coverage to watch over the coastal waters. ZA-CUBE-1 launched in 2013 has malfunctioned just as SumbandilaSat whose transmitters are still active. Recently, Planet Labs, Inc has established a ground station in Cape Town to monitor their constellation of 88 earth imaging satellites passing over southern Atlantic. The EO sat is



under development at SpaceTeq. The space to earth interference is expected to exacerbate with the growing number of satellites orbiting over South Africa.

This project, therefore, aims to look at the RFI problem due to space communication. Both Low Earth Orbiting and Geostationary satellites will be considered to chalk out a profile of communication signals coming through space, their power levels and with what duration they repeat and for how many years. The student will be required to calculate dynamic link budgets after orbital simulations for each of the transmitters and pinpoint expected reception at the geolocated SKA sites as well as other sensitive equipment in the landmass. The primary tool utilized will be the System Tool Kit available at UCT. The Radio Frequency Interference Database of STK contains data on communications assets (receivers and transmitters) attached to satellites with given Satellite Catalog / NORAD numbers. The Secondary Two Line Element Database supplies ephemeris data for the satellites in question. Further customization or proprietary databases in addition to those supplied with STK Communications can be added. Potential victims and interferers to the scenario will be simulated. The detail of the project is shown in figure below.



3. Link to SARA0 priority areas: This project ties to area 5 i.e., systems for RFI detection and data analysis/interrogation/visualization. With the orbit simulations we would be able to predict the repetition of orbital passes and possibly how de-rating of on-board communications subsystems could degrade the signal power over the mission life. This information will help scheduling of astronomy experiments so area 12 is also touched.
4. Student profile: MSc/MEng degree in electronics or electrical engineering from ECSA recognized university or equivalent. Background (coursework, thesis /project, internship or job experience) in communications will be highly useful along with good analytical and problem solving skills. Graduates of UCT MPhil Space Science, Cape Peninsula University of Technology/F'SATI MEng/MSc Electronic Systems Engineering (space stream) and Stellenbosch University MEng Space Engineering would also be suitable.



Section D: Signatures

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Primary supervisor

Tuesday, 30 October 2018