

# 1st International Workshop on Open Research Infrastructures and Toolkits for 5G/6G R&D (OpenRIT 6G)

19-20 March 2024

Breakwater Lodge, Portsworld Rd, Victoria & Alfred Waterfront, Cape Town, 8001, South Africa

## Digital Health Research Infrastructures

*Generating evidence for the efficacy of Telemedicine systems in Africa: Can 5G/6G test bed infrastructures help?*

# Bessie Malila

- 15 years work experience in Telecommunications industry
  - Zimbabwe Internet Network Infrastructure
  - Rollout of Telecommunications Digitalization projects
  - First Public Data Network – Africom, Zimbabwe
  - Development of mmW radio devices, South Africa
- BSc in Electrical and Electronic Engineering, UZ
- MSc, PhD in Telecommunications Engineering, UCT
  - Mobile communication systems
  - 5G Small cell networks, mmW, SDR, Cognitive Radio
- Postdoc in Biomedical Engineering, UCT
  - Medical Imaging
  - Telemedicine and mHealth
- PI, Telemedicine and Connected Care Research group



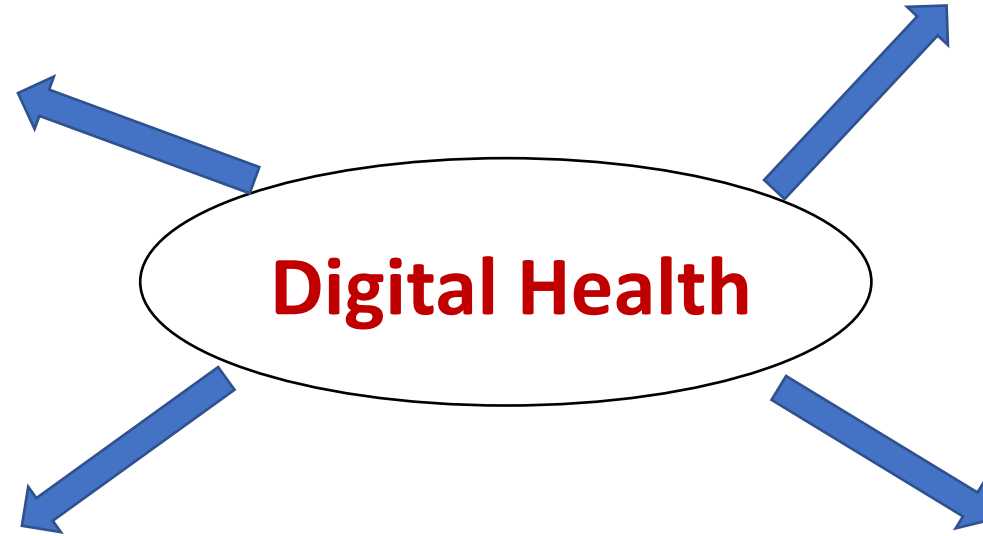
# mHealth



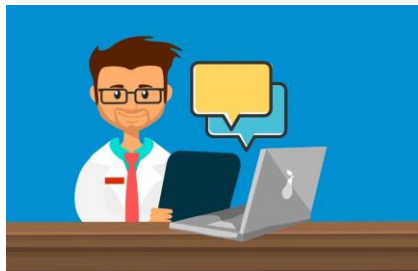
Capitalization of mobile devices and the complexities of mobile networks to support medical and public health practices (1G to 5G&Beyond)



Cost-effective and secure use of ICTs in support of health and health-related fields

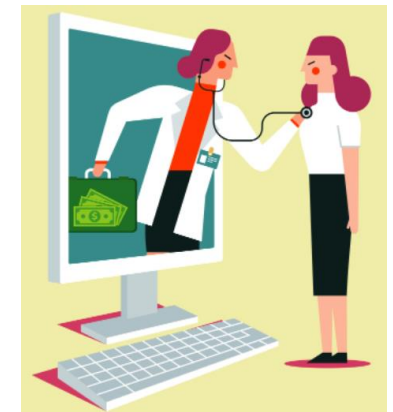


# Telehealth



Healthcare provided by healthcare professionals in general, e.g. nurses, pharmacists etc

# Telemedicine



Restricted to service delivery by physicians only

# The Project

## Aim

- To develop a secure and intelligent 5G digital health test bed infrastructure for evaluating and validating Telemedicine and mHealth applications
- Towards building evidence for the efficacy, safety and cost-effectiveness of Digital Health solutions



# What can 5G do for healthcare in Africa?

*5G digital healthcare platforms would enable disease screening, remote diagnoses, remote patient monitoring and remote training of healthcare staff, by linking healthcare facilities, patients and healthcare staff.*

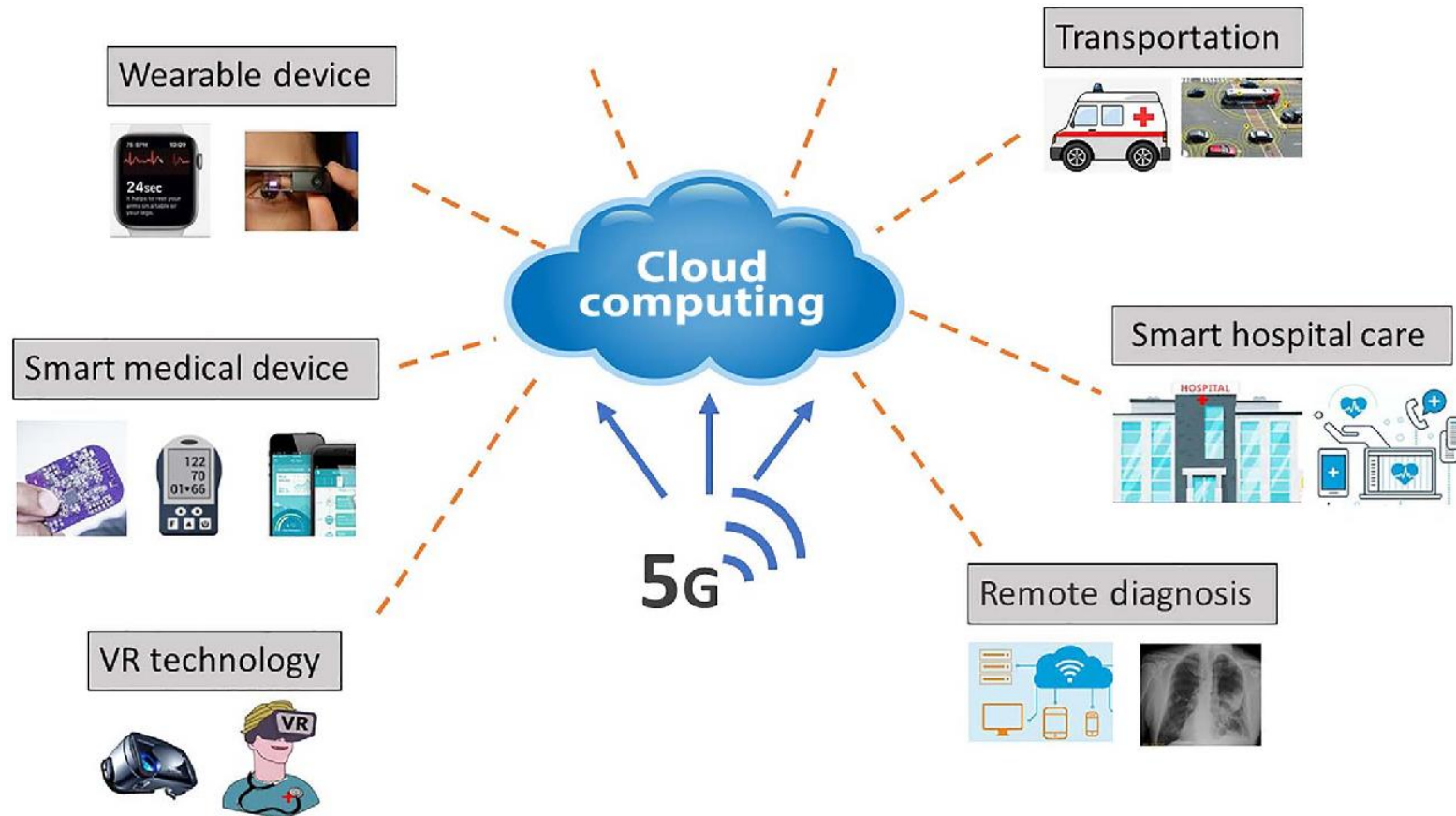
- Telesurgery
- Telemedicine
- mHealth
- Telenursing

Mwangama, J., Malila, B., Douglas, T. *et al.* What can 5G do for healthcare in Africa?. *Nat Electron* **3**, 7–9 (2020). <https://doi.org/10.1038/s41928-019-0362-7>

# 5G and the future of health

## 5G networks

Creating opportunities for intelligent, efficient, quality, scalable and sustainable models of care



Source: Li, D., 2019. 5G and intelligence medicine—how the next generation of wireless technology will reconstruct healthcare?. *Precision clinical medicine*, 2(4), pp.205-208.

# The Project

## Objectives

- Design and implement a 5G and beyond test bed infrastructure using open-source software and off the shelf radio devices
- Model 5G smart hospitals
- Model virtual clinic systems
- Develop and evaluate various Telemedicine and mHealth applications

# The Project

## **Motivation**

- Weak healthcare delivery systems and a high burden of disease in Africa
- Increasing mobile network coverage and performance
  - Opportunity to build scalable and sustainable digital models of care for strengthening African health systems
- **Project characteristics**
  - Multidisciplinary – Telecommunications Engineering, Biomedical Engineering, Medicine, Social Sciences
  - Local and international collaboration
  - Industry partners
  - Use of design thinking, solution co-creation and implementation sciences principles in solution design, development and testing



## Existing national/regional digital health test bed programs

- Australia digital health test bed program
  - 15 projects, 600,000AUD each
- Nordic Innovation Digital Health program
  - Regional initiative
  - 56 projects from 2016 onwards
- NHS Digit
  - 40 innovators, 51 digital health products, 8 teams, £24,9 million funding

# Key highlights

- Secured local funding for the project (+R1M)
- Secured international funding a 5-year international research grant (€479k) through an EU/AU funding implemented by the African Academy of Sciences
- Established Telemedicine Research Group
- Postgraduate students - 5 PhDs and 6 masters
- Implemented open-source NSA 5G test bed

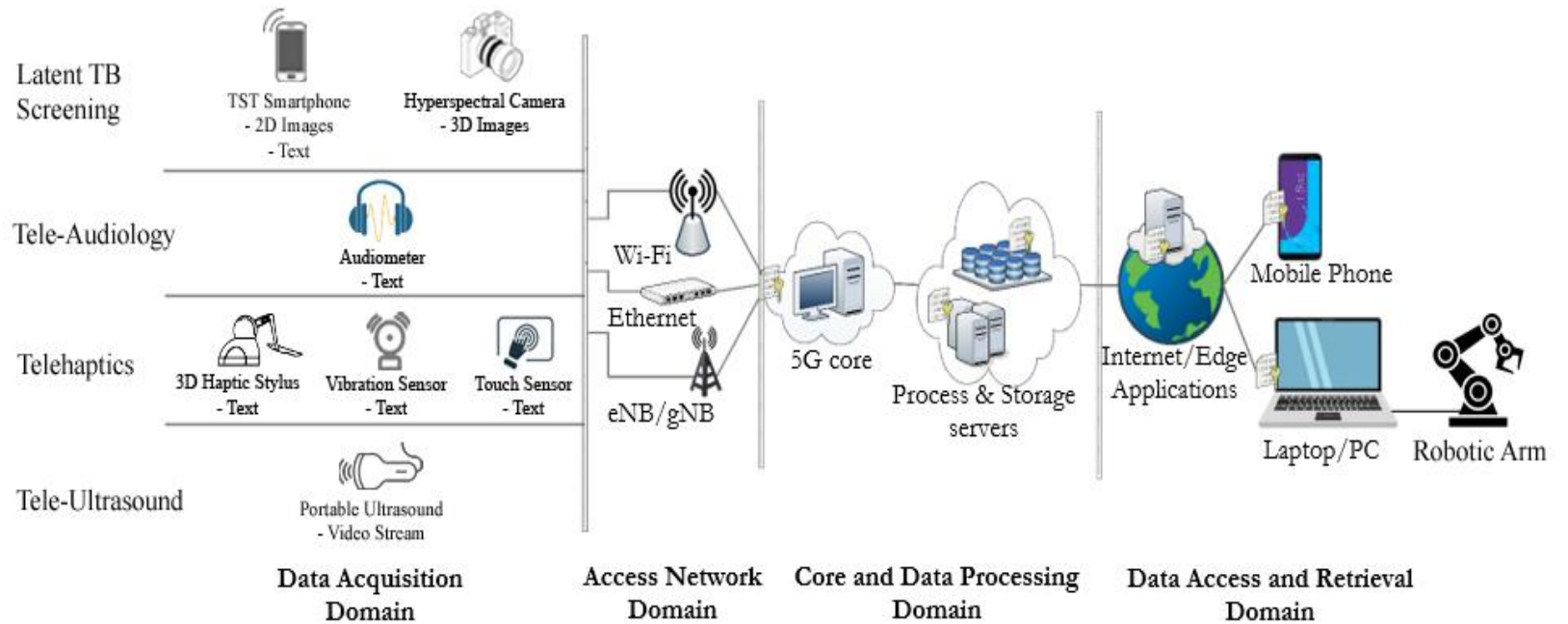
# Research Collaborations

- North-South collaborations
  - Oulu University in Finland
  - TU Berlin
- Worldwide Universities Network
  - Chinese University in Hong Kong,
  - Rochester University
  - University of Auckland, New Zealand
  - Maastricht University, Netherlands
  - University of Southampton, UK

# Research Collaborations

- South-South
  - Kenyatta University Nairobi, Kenya
  - Millenium University Malawi, Malawi
  - Carnegie Mellon University in Africa, Rwanda
- Local
  - UCT department of Electrical
  - UCT School of Medicine – several departments
    - Surgery
    - Psychiatry
  - University of Johannesburg

# Key Projects The test network



## RAN

- Baicells eNodeB, National Instruments SDR

## Core

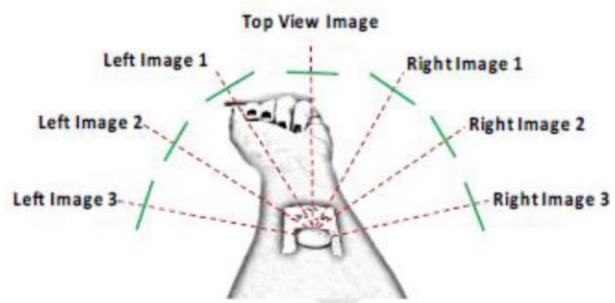
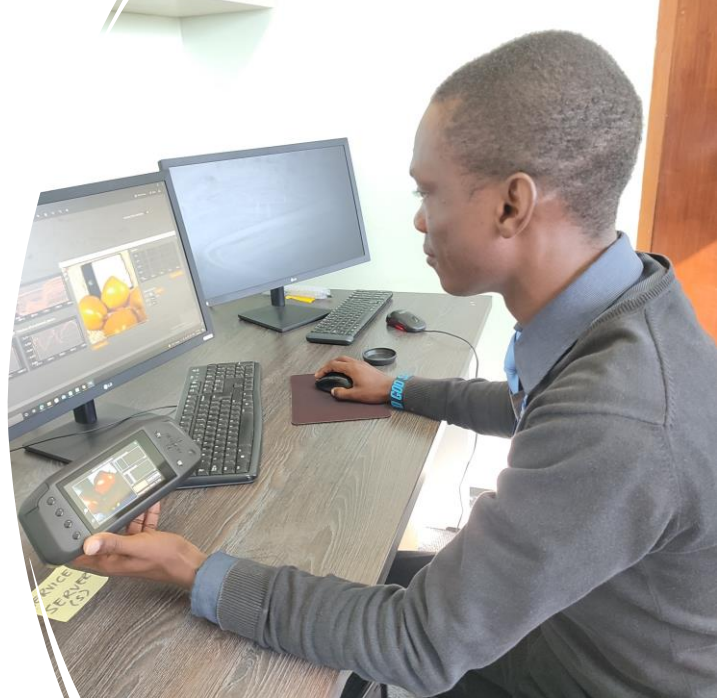
- srsEPC, OAI EPC, OPEN5GS



# Key projects

**Ajibola Oladokun - PhD in Biomedical Engineering**

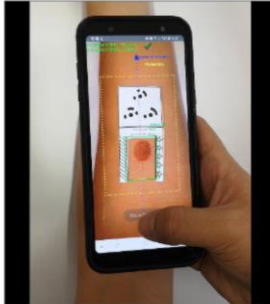
A Hyperspectral Imaging Approach for Quantitative Characterization of latent TB skin tests: Towards automated latent TB diagnosis.



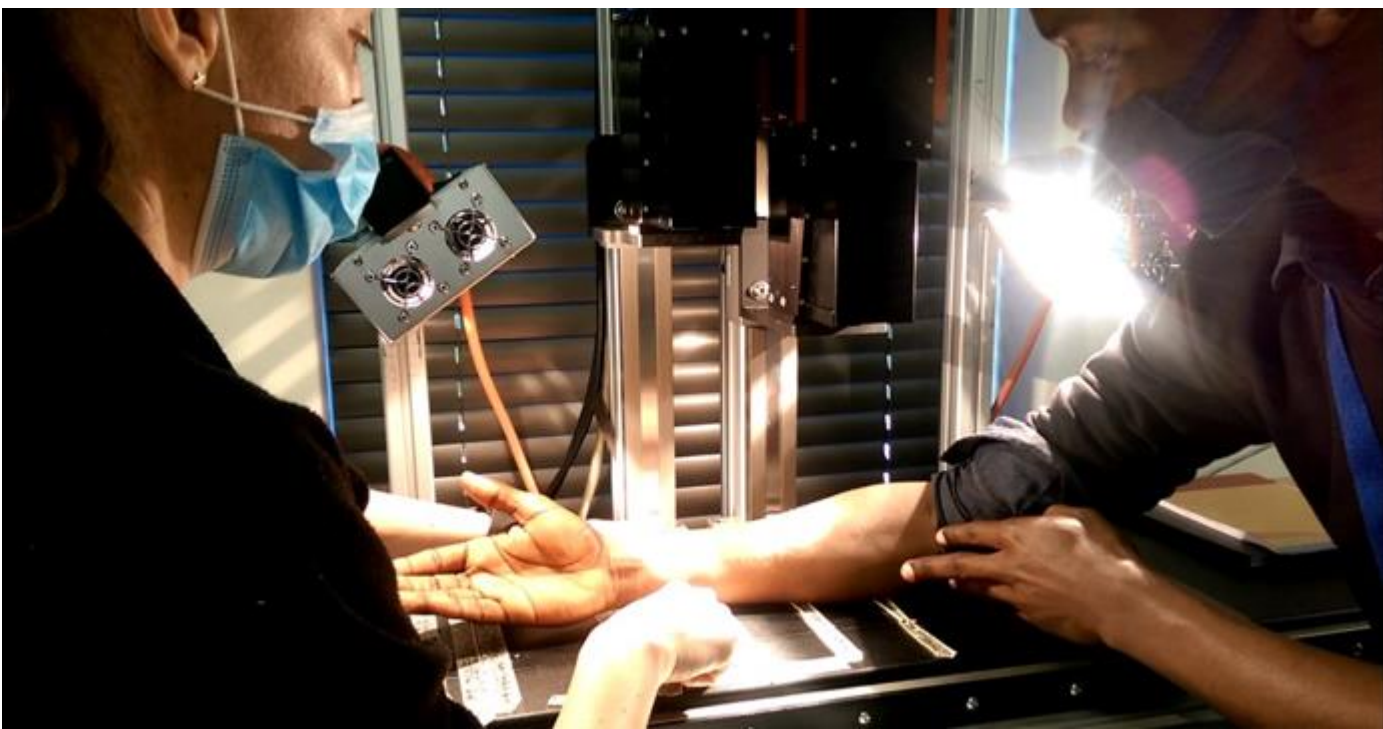
**TB Screening App**

← **IMAGE 1 - TOP** 📷

Video showing procedure



**Begin Taking Images**

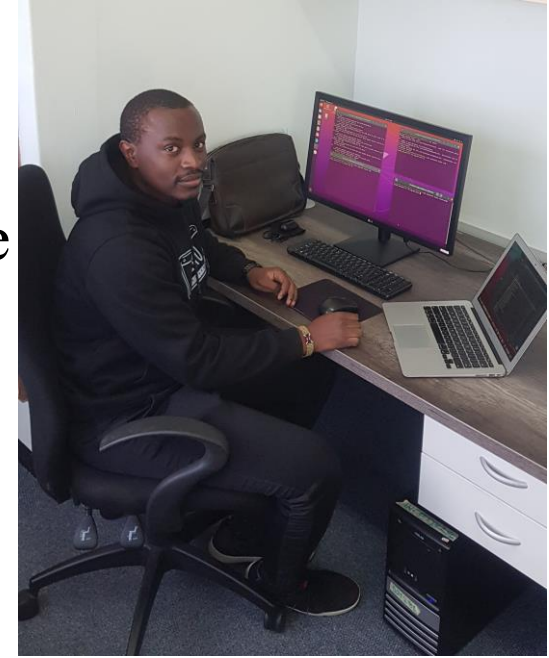
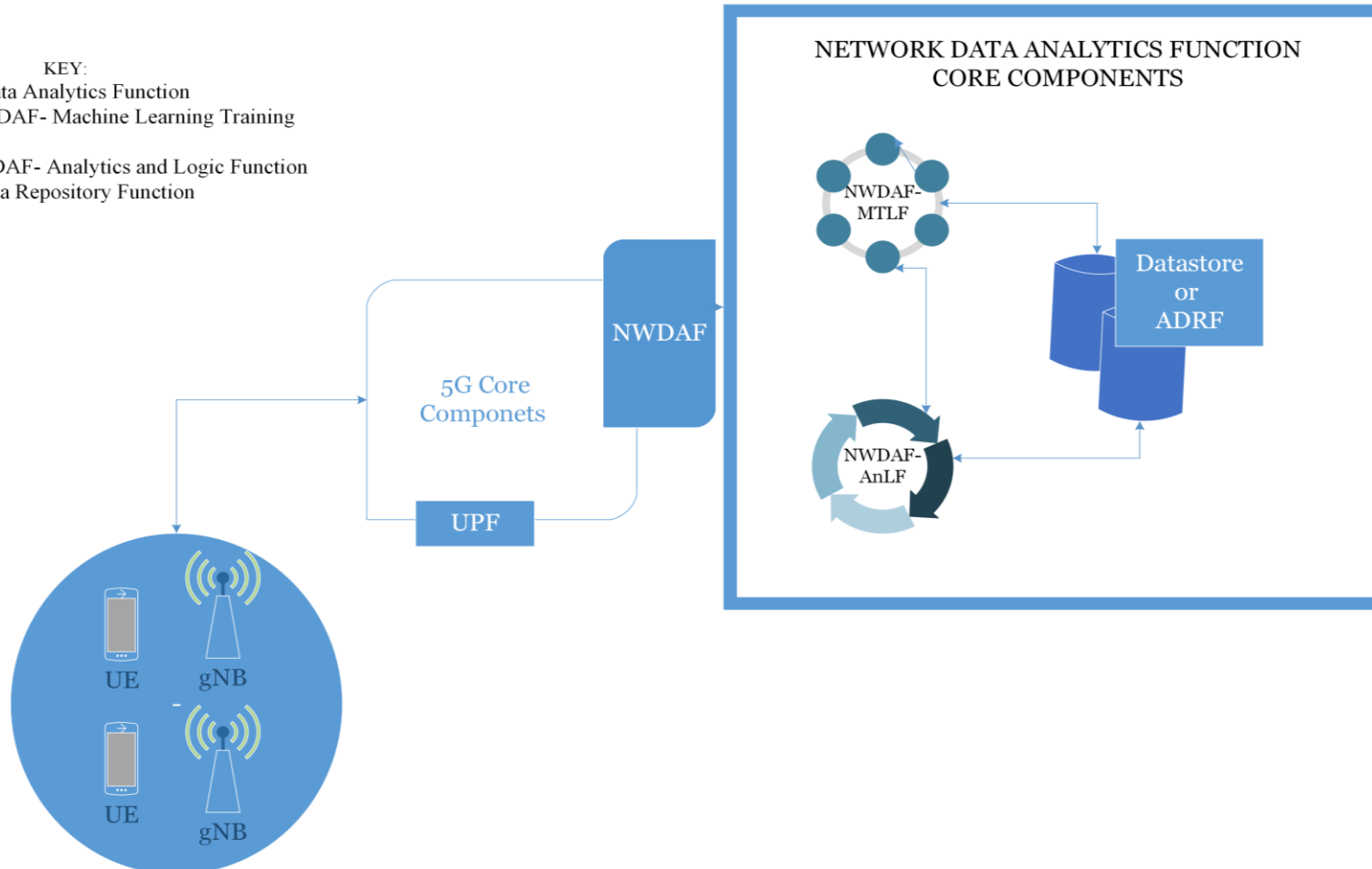


# Key projects

**Humphrey Otieno:** Machine Learning Clustering, Orchestration, and Management Models for End-to-End 5G Sub-Network Slices Instances: Case of Digital Health Applications in a Local 5G E-Health Slice.

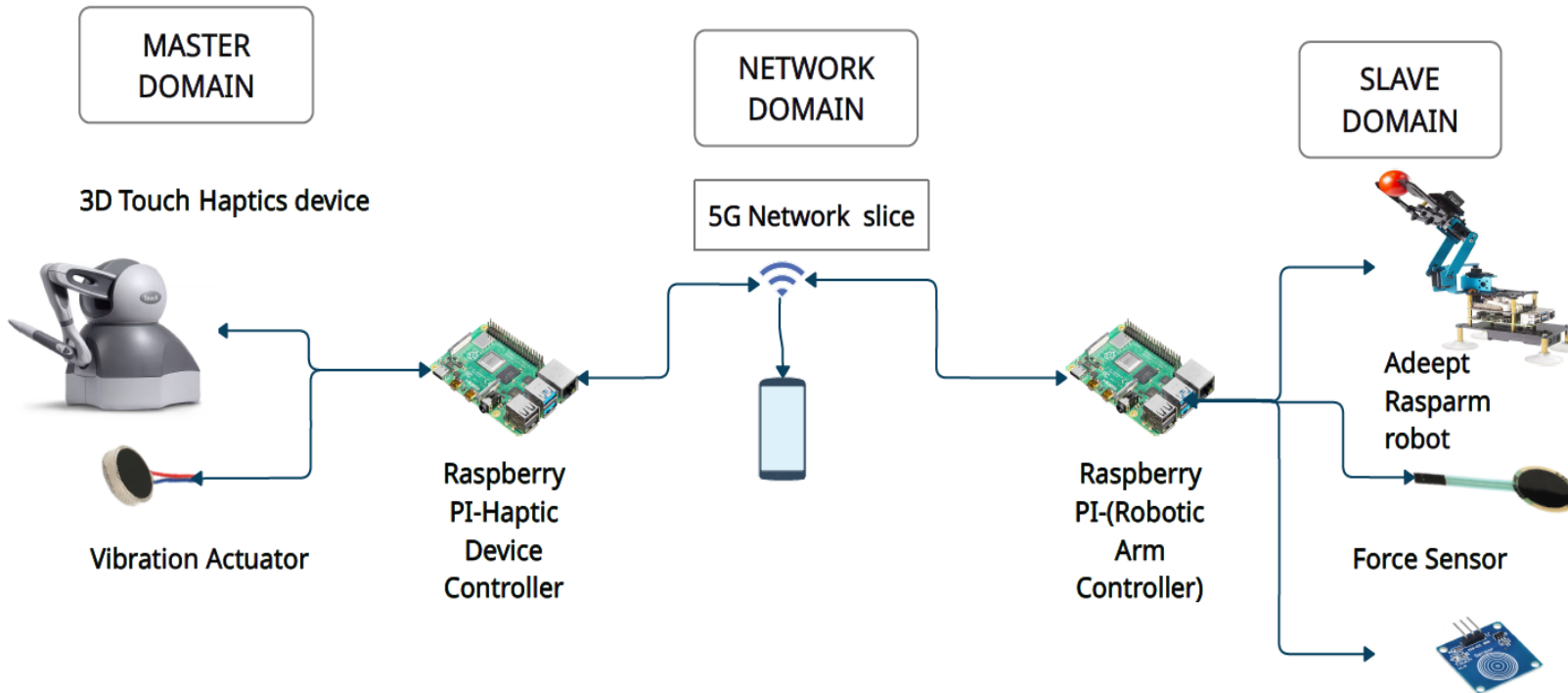
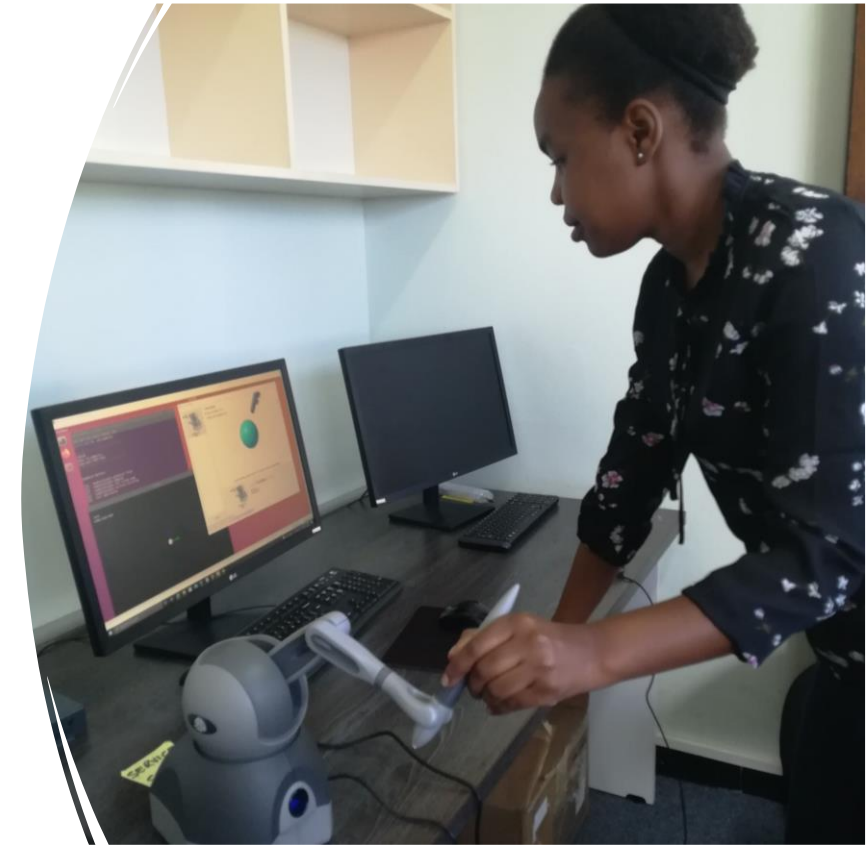
NETWORK DATA ANALYTICS FUNCTION COMPONENT IN THE 5G CORE NETWORK

KEY:  
NWDAF- Network Data Analytics Function  
NWDAF-MLTF- NWDAF- Machine Learning Training Function  
NWDAF-AnLF- NWDAF- Analytics and Logic Function  
ADRF- Analytical Data Repository Function



# Key Projects

**Maurine Chepkoech – MSc Electrical Engineering:**  
Telecommunications Engineering Implementation and Evaluation of a Tele haptics system over tactile 5G Internet: Towards low-cost 5G-powered Telerobotic surgery



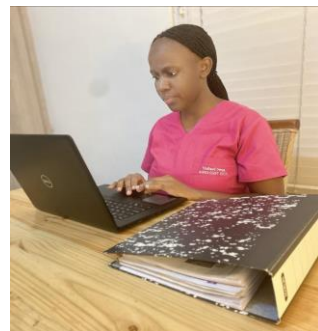


# Key Projects

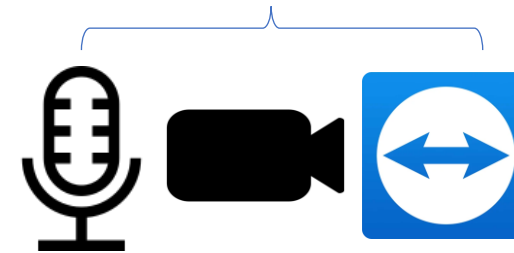
**Thidilweli Denga – MPhil Health Innovation** - Establishing the equivalence of tele-audiology and in-person audiology practice



Audiologist's with Webcam on laptop



5G Router

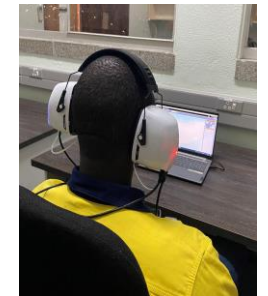


5G mobile network

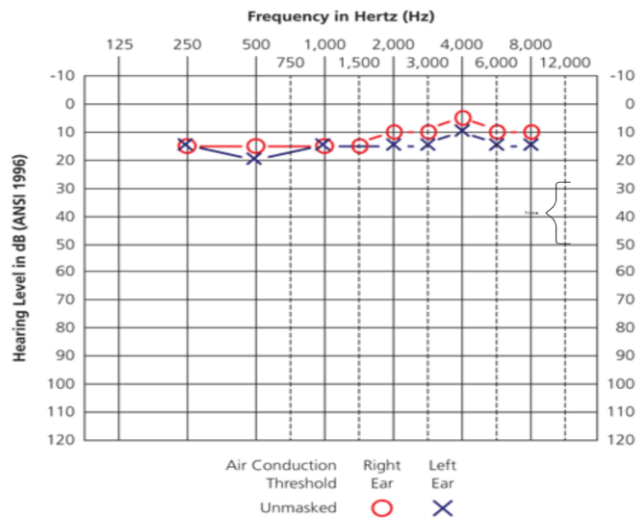
5G Router



Patient Site



Kuduwave Prime 5000 Audiometer + laptop with Webcam laptop



Screening results

# Key Projects

## Abby Blocker – MSc, PhD in Biomedical Engineering

Development and Evaluation of a virtual clinic for remote and rural communities in South Africa: The SKA project use case

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TytoCare Device with Exam Camera and Thermometer

Tongue depressor

Otoscope

Stethoscope





# Key Projects – Worldwide Universities Network



## Telemental health stakeholder workshop

Dr Sandra Jumbe (MU)  
[sjumbe@mu.ac.mw](mailto:sjumbe@mu.ac.mw)

Co-facilitators: Dr Bessie Malila, Gloria Chirwa, Joel Nyali



## Future Aspirations

- To create a 5G/6G real world test network infrastructure for testing digital health applications that can be used by innovators and researchers for validation of digital models of care
- To replicate the project across African Universities
- Contribute meaningfully to the training of Biomedical Engineers and Health professionals in the field of Digital Health



