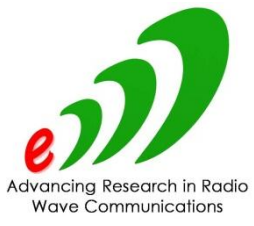


By  
*Chomora Mikeka, PhD*  
University of Malawi, Physics Dept., eCRG Coordinator  
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# The White Spaces Project in Malawi



Marconi  
Wireless Lab,  
ICTP



# Brief Statistics About Malawi

- Population pre-dominantly rural (85%)
- Less internet users but rapidly growing
  - 0.15% in 2000
  - 0.4% in 2005
  - 4.7% in 2009 (**UN-Data**)
- Very little broadband connectivity in rural areas
- ISPs refuse to connect to rural due to lack of business sense
- Telecom masts and towers do exist in rural Malawi for mobile phones (Site Finder Map soon to be developed)



<http://www.worldatlas.com/webimage/countrys/africa/mw.htm>

# Overview of the White Spaces Project in Malawi

---

1. Project Team
2. Collaborating Partners
3. Business Plan
4. TVWS Scan Setup
5. Results and Discussion
6. Mobile Application Platform for Health Care

# Malawi White Spaces Project Team

**Project Advisor**  
(Operations)  
Lloyd Momba

**Project Director**  
Chomora Mikeka

**Project Advisor**  
(R & D)  
Chris Kamlongera

**Administrative Officer**  
Ivy Fossa

**Assistant Director**  
(Operations)  
Jonathan Pinifolo

**Assistant Director**  
(R & D)  
Justice Mlatho

**Network Monitoring  
Manager**  
Dereck Kondwani

**Field Operations  
Manager**  
Patrick Musiyapo

**Finance Manager**  
Phillip Nakoma

**Economist**  
Linda Kambale

# Collaborating Partners

- **Physics Department, Chancellor College, University of Malawi**
- **Malawi Communications Regulatory Authority (MACRA)**
- **Marconi Wireless Lab, International Center for Theoretical Physics, Trieste, Italy**

# Malawi White Spaces Project Business Model (Partial..)

Malawi White Spaces Project Business Model  
Date: 18<sup>th</sup> June, 2013

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Malawi Communication Regulatory Authority (MACRA).	1. Developing of modules for the White Spaces measurement training.	1. Low cost infrastructure.	1. Virtual relationship with doctors for e-health application	1 Rural Secondary Schools
Physics Department of Chancellor College (UNIMA).	2. White Spaces preliminary measurements for pilot sites.	2. Providing low cost broadband connectivity using cheaper TV band license.	2. Provision of free internet services for education and health purposes	2 Rural health centers
Marconi Wireless lab, International Center for Theoretical Physics (ICTP)	3. Planning and fact finding mission with Marconi Wireless Lab staff.	3. Supports e-health and e-learning in rural areas with little or no connectivity.	3. Automated monitoring of network performance and bandwidth usage.	3. Leadership for Environment And Development (LEAD) Southern Africa
Rural education and health institutions.	4. Training on White Spaces measurements using the developed modules.	4. Provision of fast, reliable and non-line of site connectivity.	4. Self service by providing a platform for development of e-health and e-learning.	
	5. National wide field measurements for White Spaces and Private Mobile Radio (PMR) audit.	5. Efficiency use of spectrum.		
	6. Analysis of the captured data.			
	7. TV White Spaces spectrum allocation.			
	8. Deployment of radio equipment.			
	9. Link Monitoring (M & E)			
	10. Dissemination of results in Malawi (Stakeholders Meeting)			

# Pilot Phase Budget Elements

ESTIMATED WHITE SPACE PROJECT COSTS (PILOT PHASE – APRIL 2013 TO JUNE 2014)

S/N	ACTIVITY/ITEM	QTY	UNIT COST	TOTAL COST (MK)	TOTAL COST (USD)	TIME FRAME	STATUS
1	Developing of modules for the White Spaces measurement training.	1	836,000.00	836,000.00	2,090.00	April, 2013	Done
2	White Spaces preliminary measurements for pilot sites.	1	750,000.00	750,000.00	1,875.00	May, 2013	Done
3	Planning and fact finding mission with Marconi Wireless Lab Staff	1	1,177,000.00	1,177,000.00	2,942.50	June, 2013	Done
4	White Space/PMR Audit for new pilot phase sites	1	184,000.00	184,000.00	460.00	20 <sup>th</sup> – 21 <sup>st</sup> June, 2013	Not Done
5	Equipment (10 X Laptops , 2 X Desktop Computers and Printer)	1	4,310,000.00	4,310,000.00	10,775.00		
6	2X 1Mbps Broadband bandwidth	1	6,220,000.00	6,220,000.00	15,550.00		
7	Training on White Spaces measurements using the developed modules	1	11,874,000.00	11,874,000.00	29,685.00	22 <sup>nd</sup> - 26 <sup>th</sup> July, 2013	Not Done
8	National wide field measurements for White Spaces and Private Mobile Radio (PMR) audit.	1	4,393,536.00	4,393,536.00	10,983.84	17 <sup>th</sup> August, - 15 <sup>th</sup> September, 2013	Not Done
9	Analysis of the captured data	1	-	-	-	30 <sup>th</sup> September, 2013	Not Done
10	TV White Spaces spectrum allocation.	1	-	-	-	30 <sup>th</sup> August, 2013	Not Done
11	Deployment of radio equipment	1	10,608,000.00	10,608,000.00	26,520.00	16 <sup>th</sup> September, 2013	Not Done
12	Link Monitoring (M & E)	1	400,000.00	400,000.00	1,000.00	September 2013	Not Done

# Total Budget in USD for the Pilot Phase

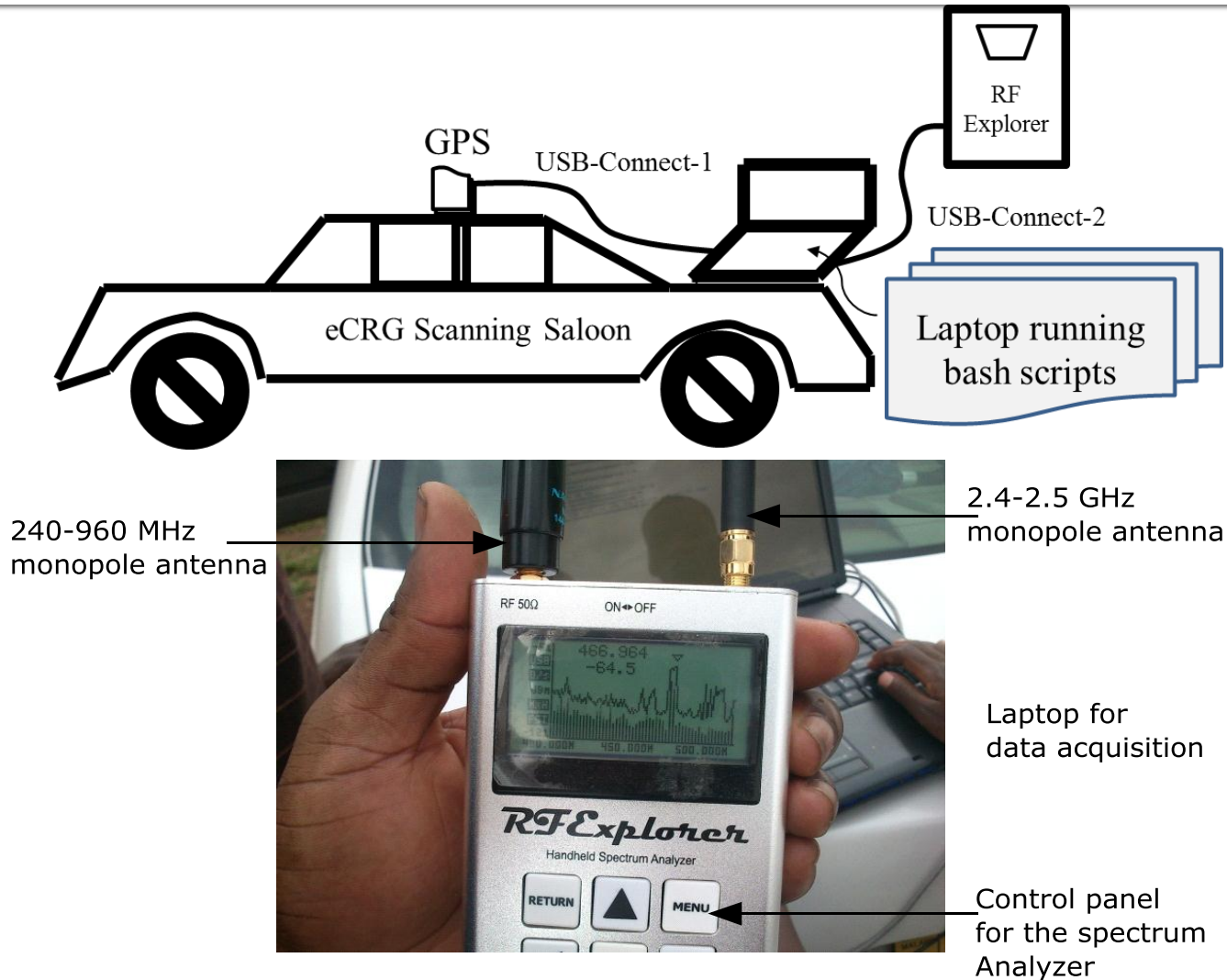
13	Dissemination of results in Malawi (Stakeholders Meeting)	1	924,000	924,000	2,310.00	June, 2014	Not Done
14	Project review meeting by project team	1	1,200,000.00	1,200,000.00	3,000.00	20 <sup>th</sup> June, 2013	Not Done
15	Publications of results	1	850,000.00	850,000.00	2,125.00	July, 2014	Not Done
TOTAL			44,126,572.00	44,126,572.00	110,316.43		

In MWK

In USD



# The White Spaces Scan Setup



# Cost-Effective RF Explorer

- Relatively cheap equipment - RF Explorer (can analyze 240 MHz – 960 MHz)



# GPS Position and Time Stamping

- GPS Receiver



- Laptop (running Linux bash scripts)

# The Scripts – Capturing Frequencies

```
[Chat with Kas <+26588176... Inbox (213) - martthodi238... Terminal - martin@localhos...  
Terminal - martin@localhost: ~/Documents/ecrg_code/changed/Zomba  
File Edit View Terminal Go Help  
#!/bin/bash  
  
count=1  
  
while :  
do  
  
# Measure Latitude  
  
latitude=$(gpspipe -w -n 5 | grep -m 1 TPV | cut -d, -f4,6-8,13 | cut -d, -f3)  
echo $latitude  
  
sleep 2  
  
# Measure Longitude  
  
longitude=$(gpspipe -w -n 5 | grep -m 1 TPV | cut -d, -f4,6-8,13 | cut -d, -f4)  
echo $longitude  
  
sleep 2  
  
# Measure Time  
  
dmeas=$(date)  
echo $dmeas  
  
sleep 2  
  
# Measure spectrum  
  
./rfexplorer /dev/ttyUSB0 024000000 0300000 050 120 $count  
mv $count data/200/$count.txt  
echo $latitude >> data/200/$count.txt  
echo $longitude >> data/200/$count.txt  
echo $dmeas >> data/200/$count.txt  
  
sleep 5  
  
./rfexplorer /dev/ttyUSB0 0300000 0400000 050 120 $count
```

1,1 Top

martin

```
[Chat with Kas <+26588176... Inbox (213) - martthodi238... Terminal - martin@localhost...
Terminal - martin@localhost: ~/Documents/ecrg_code/changed
File Edit View Terminal Go Help
#!/bin/bash
#####
#
# TO DO: convert data to .csv file
#
#####

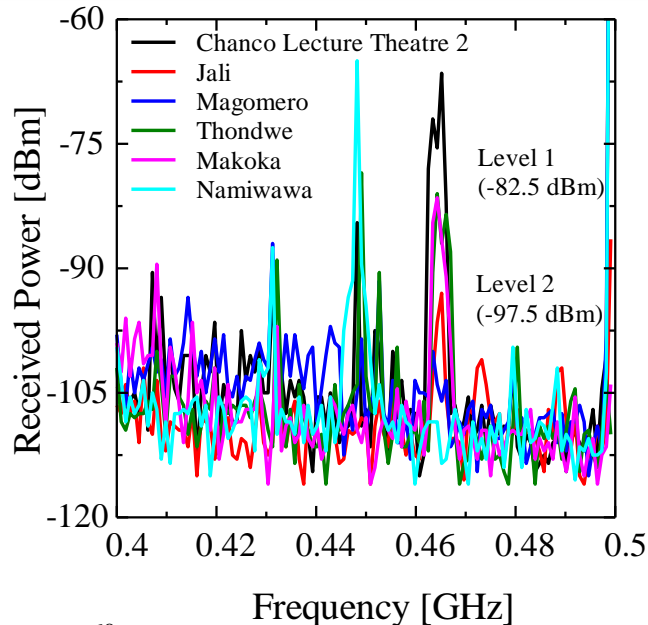
day="2012-09-12" #one part of the date (doesn't change)...will be concatenated with the time
work_dir=./400/cafe
cd $work_dir
category="400MHz-500MHz" #initialize to this and change accordingly...tricky one this one :)
count=1
number_files=$(ls | wc -l)
date=$(tail -1 $count.txt | cut -c11-18)
incident_date="$day $date"
lat=$(cat cafe.txt | grep lat | cut -c7-19)
lon=$(cat cafe.txt | grep lon | cut -c7-19)

while [ $count -lt $number_files ]
do
    lines=0
    cat $count.txt | while read LINE
    do
        let lines++
        max=113
        if [ $lines -lt $max ]
        then
            freq=$(echo $LINE | cut -c1-9)
            signal=$(echo $LINE | cut -c11-20)
            echo "\"$freq $signal\", \"$incident_date\", \"$category\", \"$lat\", \"$lon\"" >> testdata.csv
        fi
    done
    #echo $count
    let count++
done
#pwd
#echo $date
#echo $latitude
```

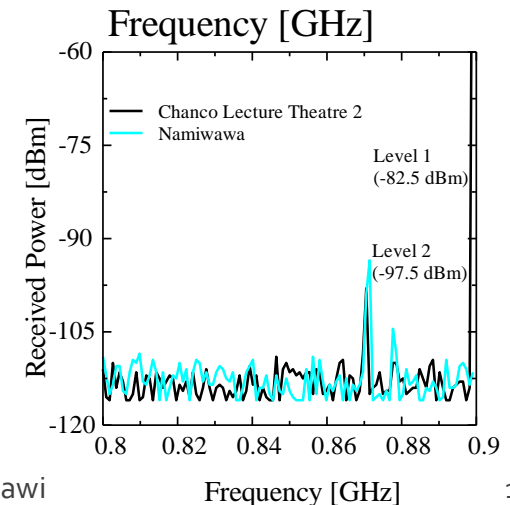
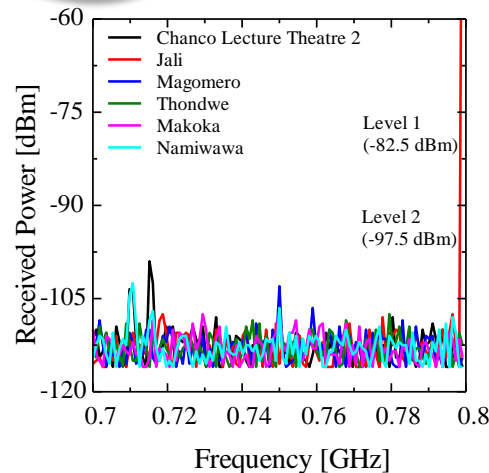
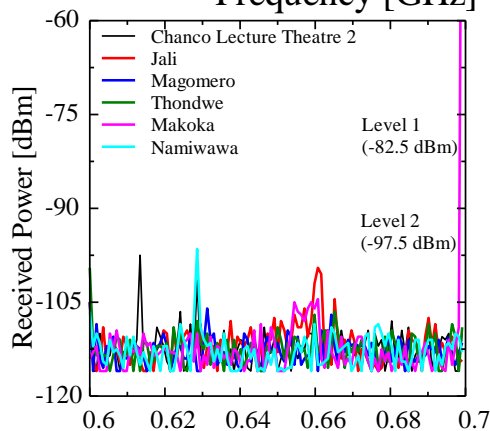
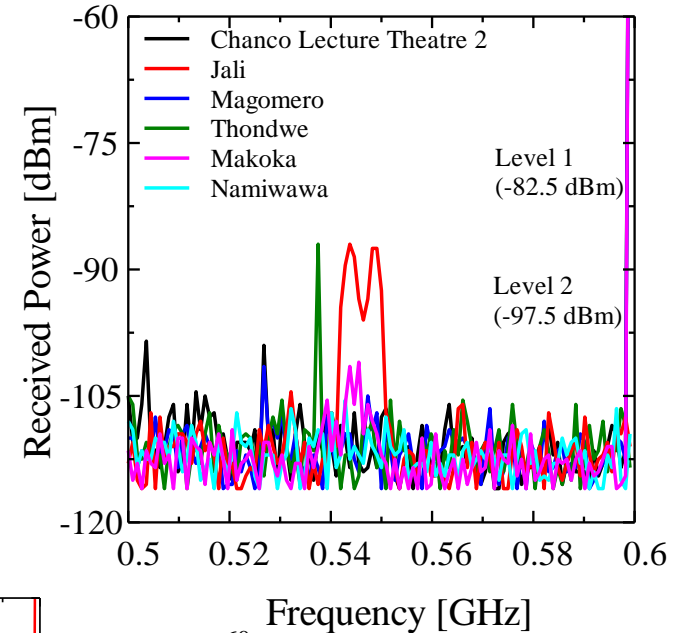
25,1-8 Top

martin

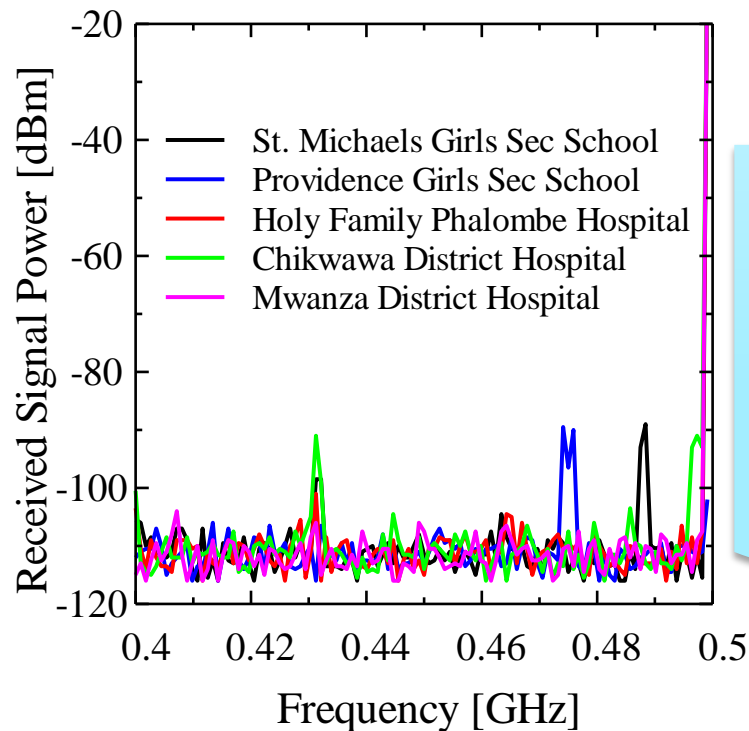
# Malawi City Preliminary Results: 400 - 800 MHz White Spaces Survey



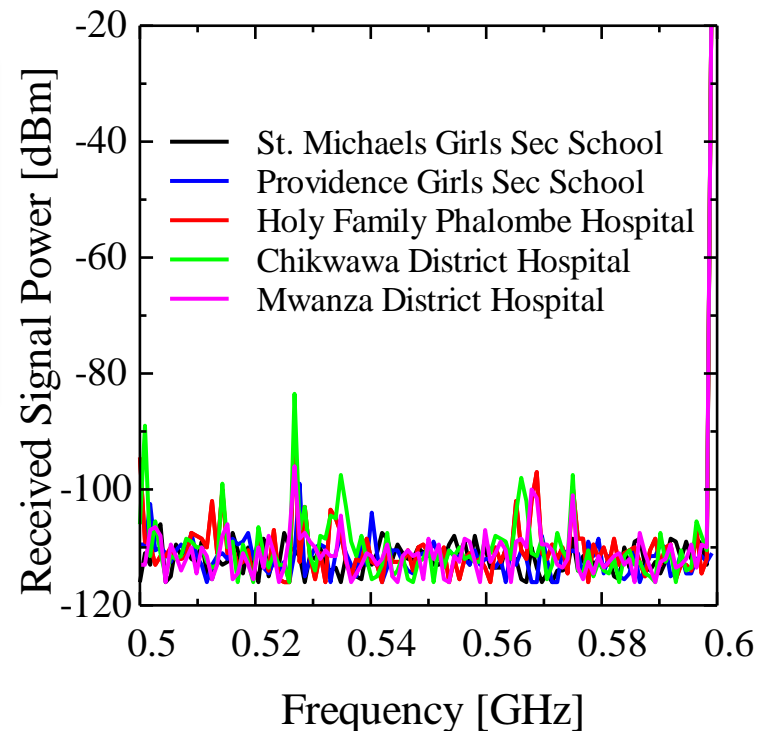
470 - 698 MHz  
is Available  
*Carlson Radio  
Compliant*



# Malawi Rural Preliminary Results: 400 - 600 MHz White Spaces Survey

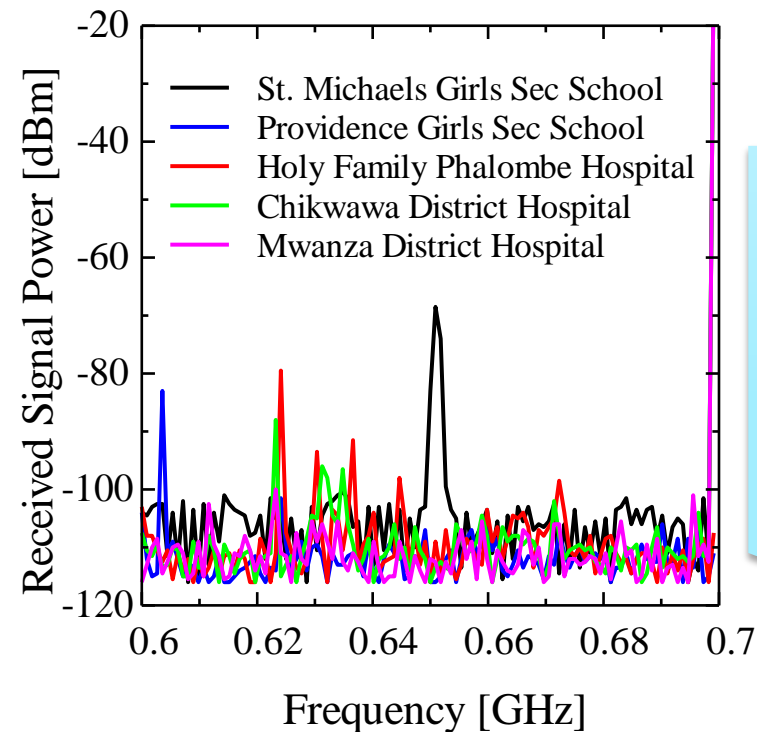


470 - 698 MHz  
is Available  
*Carlson Radio  
Compliant*

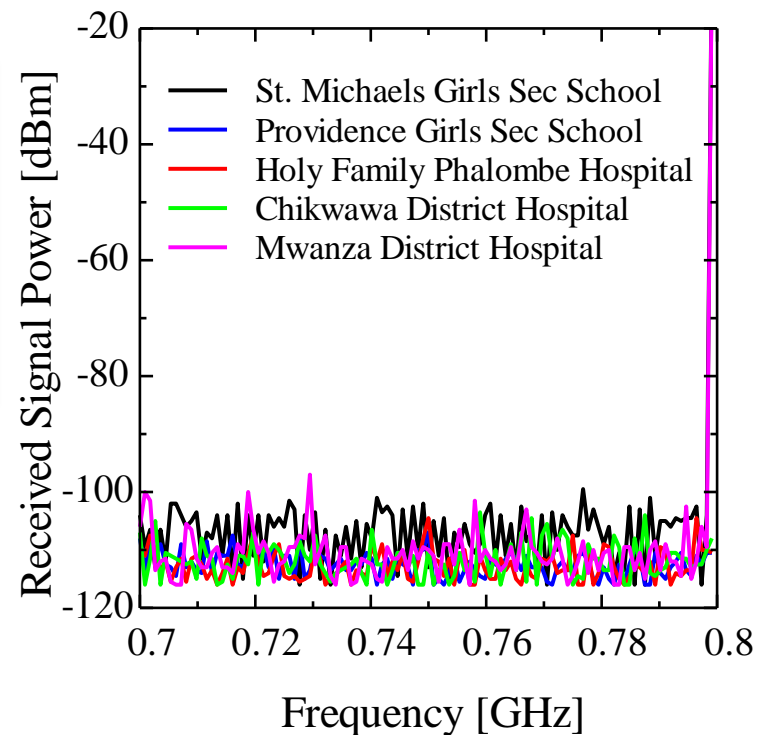




# Malawi Rural Preliminary Results: 600 - 800 MHz White Spaces Survey

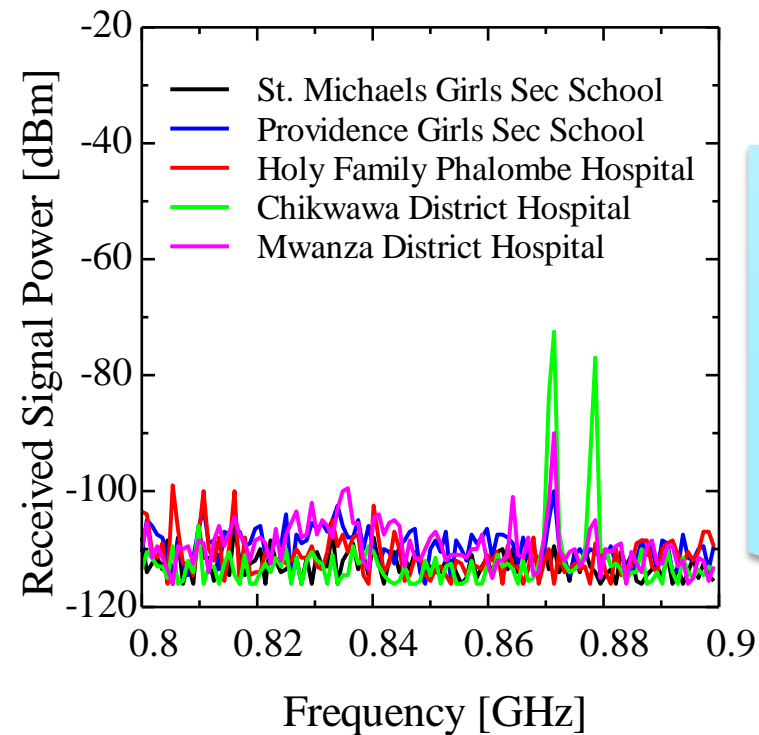


470 - 698 MHz  
is Available  
*Carlson Radio  
Compliant*

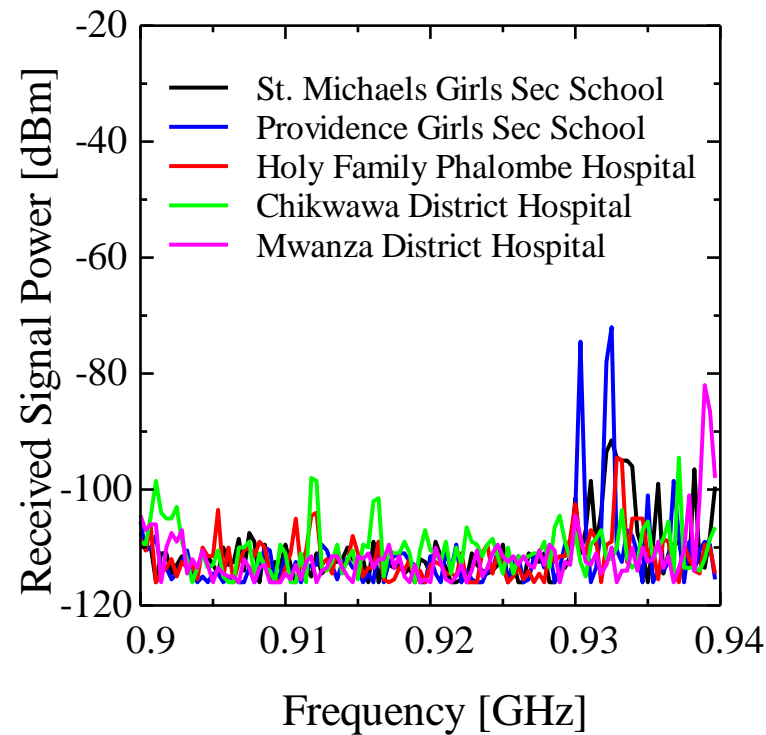




# Malawi Rural Preliminary Results: 800 - 940 MHz White Spaces Survey



470 - 698 MHz  
is Available  
*Carlson Radio  
Compliant*



# Need For White Spaces Technology *Towards Universal ICT Access in Malawi*

- Reaching out and connecting rural institutions
  - Health
  - Education

470 - 698 MHz is targeted by  
*Carlson Radio*

**Broadcasting band (320 MHz)**

**UHF band IV/V for broadcasting services**

**DD 1 (72 MHz)**

**Identified for IMT services**

**470 MHz**

**694 MHz**

**790 MHz**

**862MHz**

**Broadcasting band (224 MHz)**

**UHF band IV/V for broadcasting services**

**DD 2 (96 MHz)**

**Identified for IMT services subject to WRC-15 confirmation**

# e-Readiness Assessment and ICT-Compliance Test in Rural Malawi\_DS-1



Computer Room: Form IV Class



Dr. Mikeka and MACRA Team: TVWS Scan

**St. Michaels Girls Secondary School, Malindi in Mangochi**  
*Photo taken: May, 2013*

# e-Readiness Assessment and ICT-Compliance Test in Rural Malawi\_DS-2



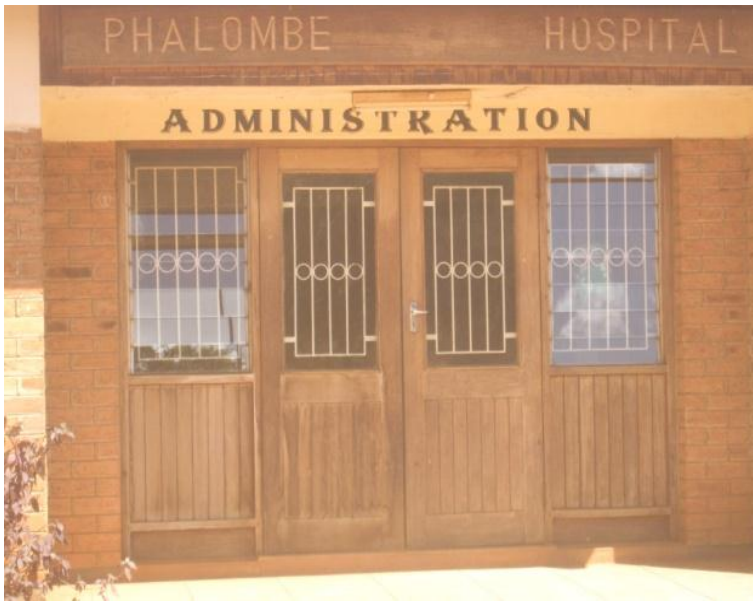
Gate: Providence Girls Sec., School Dr. Mikeka and MACRA Partner (Linda Kambale): Talking to ICT teacher in blue (Moleni) on LAN setup and sustainable ICT business model in readiness for TVWS broadband connection

**Providence Girls Secondary School, Chisitu in Mulanje**

*Photo taken: May, 2013*



# e-Readiness Assessment and ICT-Compliance Test in Rural Malawi\_DS-3



Rural Hospital Administration Block



MACRA Partner (Linda Kambale): An economist being turned into an RF/Telcom Engineer. She conducts TVWS Scan at the rural hospital

**Holy Family Hospital, Phalombe**

*Photo taken: May, 2013*

# e-Readiness Assessment and ICT-Compliance Test in Rural Malawi\_DS-4



Rural Hospital Wallmark



Chomora explains to Linda on spectrum analysis outside the HMIS building during TVWS Scan at the rural hospital

**Chikwawa District Hospital, Chikwawa**

*Photo taken: May, 2013*

# e-Readiness Assessment and ICT-Compliance Test in Rural Malawi\_DS-5



Rural Hospital Wallmark



Dr. Chomora Mikeka explains to the Hospital Administrator, Mr. Nkhonjera on the whole concept of TVWS

**Mwanza District Hospital, Mwanza**

*Photo taken: May, 2013*

# Economic Analysis: Business Sense of Current Connectivity to Rural Malawi (Expensive)

Effective time of using a dongle = 2hrs/day  
Total internet usage time per week = 10hrs  
Cost of using a dongle per week = K950 = US\$ 2.5  
Therefore monthly usage cost = (4\*US\$2.5) = US\$10  
Annual cost = (12\*US\$10) = **US\$120**

On the other hand

Normal time for internet usage = 12hrs/day  
Total internet usage per week = 60hrs/week  
Cost of using internet per week =  $\frac{60hrs}{10hrs} * US\$2.5$

= US\$15

Therefore monthly usage cost = (4\*US\$15) = US\$ 60  
Annual cost = (12\*US\$37.92) = **US\$720**

**Connectivity with ISP providers is very expensive about \$850 per 1Mbps per month (about \$10,200 per year) using fiber or broadband radio**

On the lower side, they spend about \$10 per month to connect a computers assuming 2 hour effective usage in a given day. For some, a Malawi Telecommunications Limited (MTL) Asynchronous Digital Subscriber Line (ADSL) is provided at \$30 a month. In some cases, users have to travel a distance of about 20Km just to have an Internet access.

**A concrete business model tailored to their specific situation and resources is required**



# Potential Mobile Application



<http://www.youtube.com/watch?v=fcbUP59MfeE>

- Mobile phone-based systems with IP are proposed to empower rural clinic settings for better health care
- If White Spaces Technology is harnessed, it is expected that more could:
  - {access health care,
  - {stay in life saving programs,
  - {benefit from emergency response to maternal health

Assuming LTE or TD-LTE based  
White Spaces Technology



\*Cognitive Radio enabled TD-LTE system that opportunistically accesses and utilizes the TV White Space spectrum.

Junfeng Xiao; Feng Ye; Tingjian Tian; Hu, R.Q., "CR Enabled TD-LTE within TV White Space: System Level Performance Analysis," *Global Telecommunications Conference (GLOBECOM 2011)*, 2011 IEEE , vol., no., pp.1,6, 5-9 Dec. 2011

# Continued....

The past slide presented some merits that would otherwise close the gap between health resources and communities by exploiting the white spaces technology

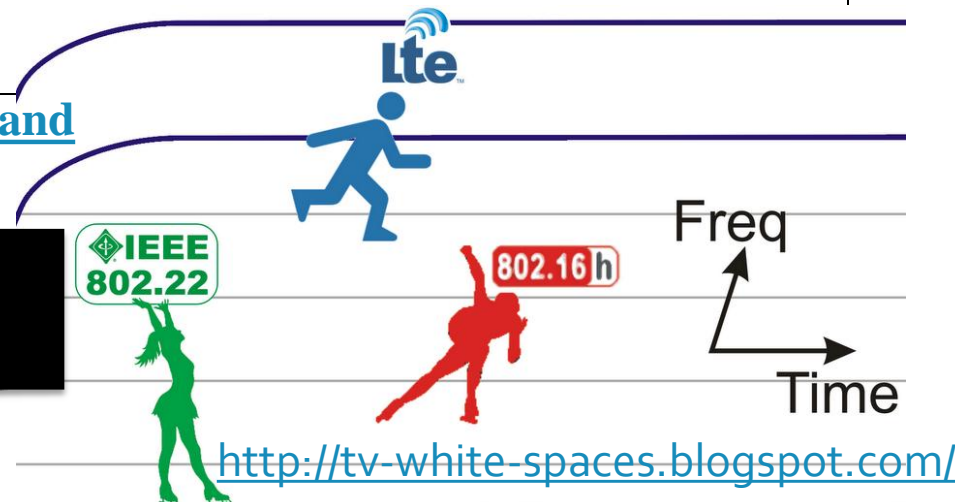
The **White Spaces Project in Malawi** aims at providing the necessary infrastructure in rural and undeserved places while ensuring:

- Low cost infrastructure deployment,
- Low cost broadband connectivity using cheaper TV band license and
- Efficient spectrum usage by using guard bands and dynamic channel shifting or polarization diversity incase of interference

**Sunday, June 17, 2012**

## What TV White Space might do for LTE and the cellular industry









We plan to partner with Medic Mobile and NEXLEAF:  
On ColdTrace sensor and other with interaction on computer, Smartphone, GSM Modem and Web Services



# Major Outputs

- Preliminary White Spaces Measurements Results:- In Rural and City Malawi, (400MHz to 960MHz), Presentation in Dakar, Senegal (May 30-31<sup>st</sup>, 2013)-Invited by Google, Microsoft and Ministry of Digital Economy, Senegal
- **June 18-22:** The NSRC is coordinating and sponsoring 5 days of direct engineering assistance at Copperbelt University in Kitwe, Zambia in cooperation with the Zambian Research and Education Network (ZAMREN), the UbuntuNet Alliance and engineers Ermanno Pietrosemoli, Marco Zennaro and Carlo Fonda of the Abdus Salam International Centre for Theoretical Physics (ICTP) and Sebastian Buettrich of NSRC.

# TVWS Modules I - III

MODULE I	MODULE II	MODULE III			
<div></div> <div>Familiarization of the handheld spectrum analyzer, portable GPS and Linux OS</div>	<div><pre>#!/bin/bash y=0 for x in \$( do</pre></div> <div>Bash scripts for simultaneous data acquisition from GPS and spectrum analyzer</div>	<div></div> <div>Ushahidi mapping platform for the received signal strength, spectrum occupancy on Google or GIS-like maps</div>			
<div>by</div> <div>Caspah Kamunda Panji Harawa</div>	<div>by</div> <div>Justice Mlatho (PhD) Martin Thodi</div>	<div>by</div> <div>Innocent Mghogho Chomora Mikeka (PhD)</div>			
<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>

eCRG May, 2013 Publications.

**\*Chance:** You can partner with us to produce a book on TVWS in Malawi

*Partner Role:* Book Editors, Financial Sponsor or Publisher

**Target Publication Date:** December, 2013, Rapid Publication

# TVWS Modules IV – Back Cover



## MODULE IV

Introduction of  
the capabilities  
of the Carlson's  
white spaces  
broadband radio  
for rural connect

*by*

Justice Mlatho (PhD)  
Chomora Mikeka (PhD)  
Annie Jere



<http://malawitech.com>

This edition first published May, 2013  
© 2013 e-Communications Research Group

The e-Communications Research Group (eCRG) was established on 11 May, 2012. It is under the Physics Department, in the Faculty of Science at Chancellor College, a constituent college of the University of Malawi. eCRG focuses on lower and upper layer aspects of mobile/wireless communications systems, right down to microwave circuit design.

The eCRG has evolved from the Wireless Research Group (WRG), a group that founded the Wireless internet in the University of Malawi since 2005 with support from the International Center for Theoretical Physics, ICTP, Trieste (Italy). The WRG also performed a national-wide IT in support of Agriculture e-Readiness Assessment in Malawi with support from the Wagen-gen University (Netherlands) and in collaboration with the Archway Technology Management and Kenya ICT Federation. The eCRG is a dynamic research group, drawing in talented researchers from the world over and reacting rapidly to the changing technological landscape. It aims at maintaining an exceptional reputation for high quality work.

This module series has been made possible through the collaboration between eCRG and the Malawi Communications Regulatory Authority (MACRA).

### Editorial Board

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**Executive Editor**  
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**Advertising**  
eCRG/MACRA

**Cover Design**  
Alexander Mtembenuzeni

**Strictly Confidential**

# What Happens Next?

## With Regulator Approval and Partnership

- Deploy wireless network – using Rural Connect White Space Broadband Radios (Carlson Wireless)
  - Pilot phase is planned for distances within 20 Km from BS
  - MACRA, the regulator is planning to allocate 4 Channels in the TV band (470 – 698 MHz) for White Spaces Technology deployment in Malawi based on study results

