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The White Spaces Project in Malawi

Advancing Research in Radio Wave Communications

Marconi Wireless Lab, ICTP

UNIVERSITY OF MALAWI

MACRA
Promoting Universal ICT Access

Brief Statistics About Malawi

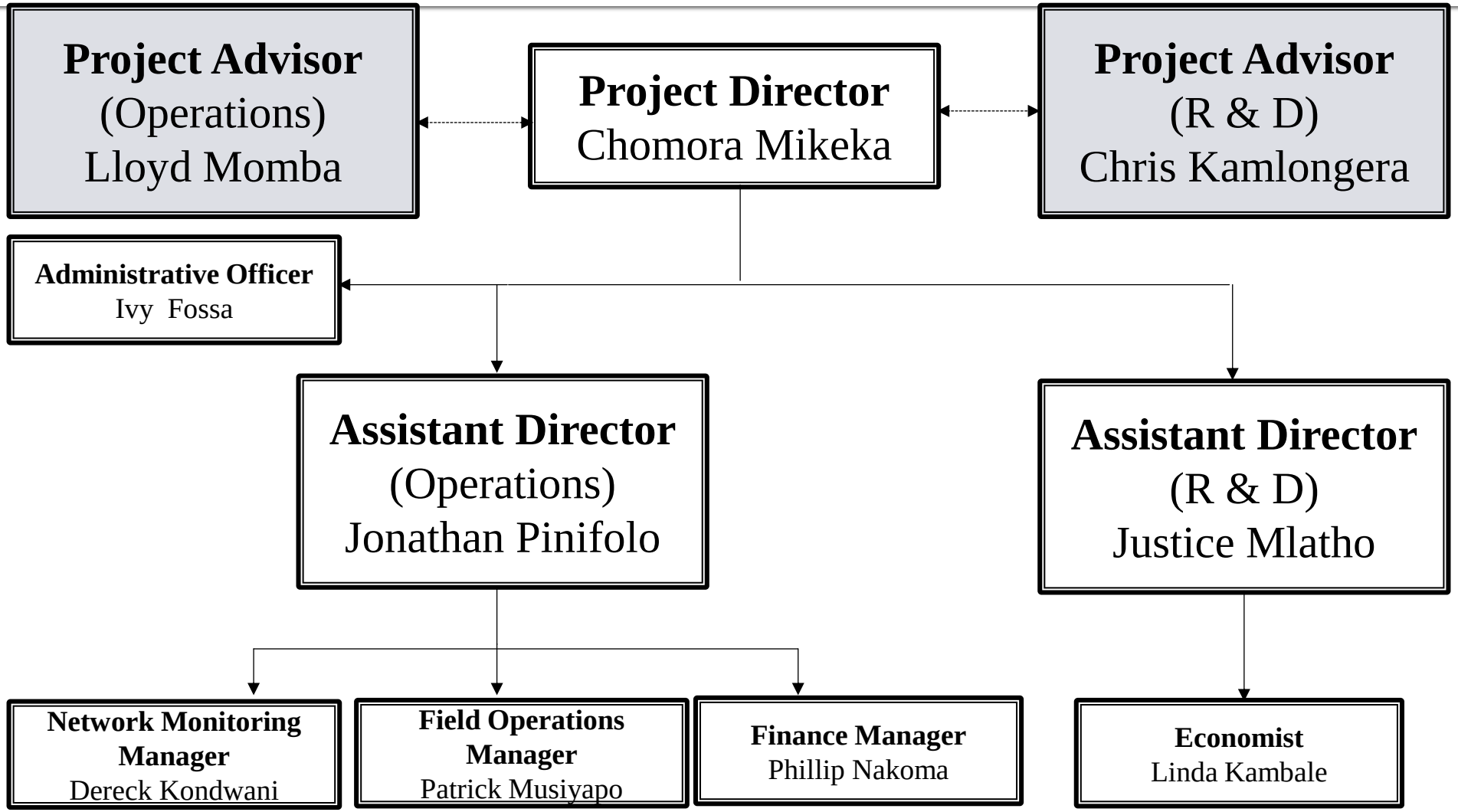
- Population pre-dominantly rural (85%)
- Less internet users but rapidly growing
  - 0.15% in 2000
  - 0.4% in 2005
  - 4.7% in 2009 (**UN-Data**)
- Very little broadband connectivity in rural areas
- ISPs refuse to connect to rural due to lack of business sense
- Telecom masts and towers do exist in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



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: 18th June, 2013

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

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	20th – 21st 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	22nd - 26th 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	17th August, - 15th September, 2013	Not Done
9	Analysis of the captured data	1	-	-	-	30th September, 2013	Not Done
10	TV White Spaces spectrum allocation.	1	-	-	-	30th August, 2013	Not Done
11	Deployment of radio equipment	1	10,608,000.00	10,608,000.00	26,520.00	16th September, 2013	Not Done
12	Link Monitoring (M & E)	1	400,000.00	400,000.00	1,000.00	September 2013	Not Done

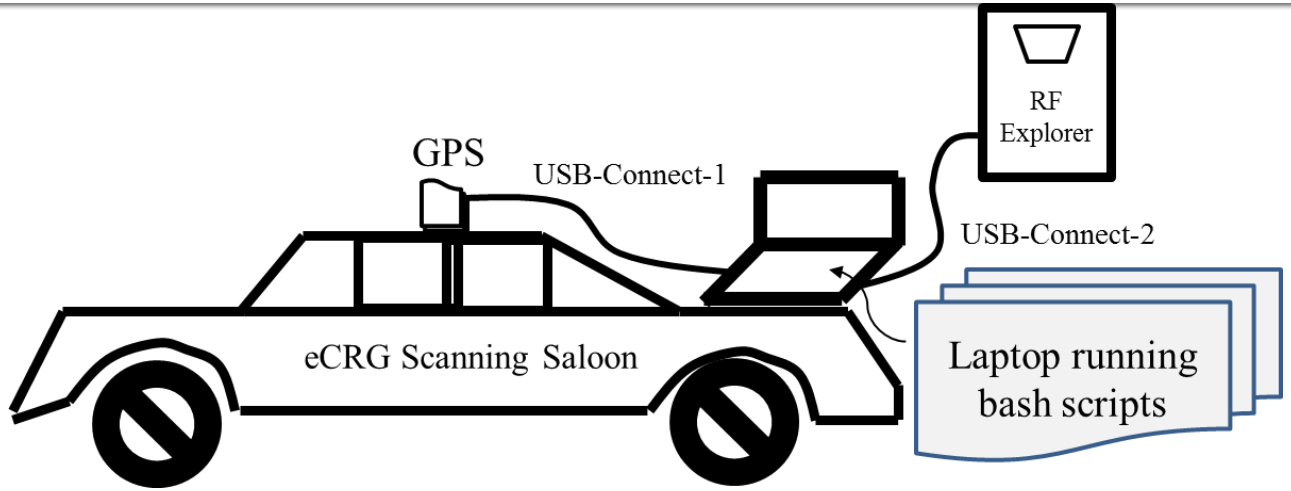
Total Budget in USD for the Pilot Phase

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**	20th 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**		

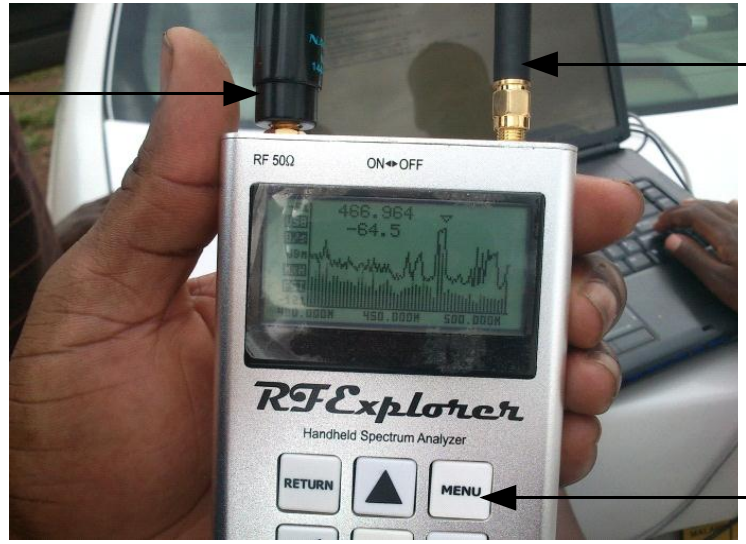
In MWK

In USD

The White Spaces Scan Setup



240-960 MHz
monopole antenna



2.4-2.5 GHz
monopole antenna

Laptop for
data acquisition

Control panel
for the spectrum
Analyzer

Cost-Effective RF Explorer

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

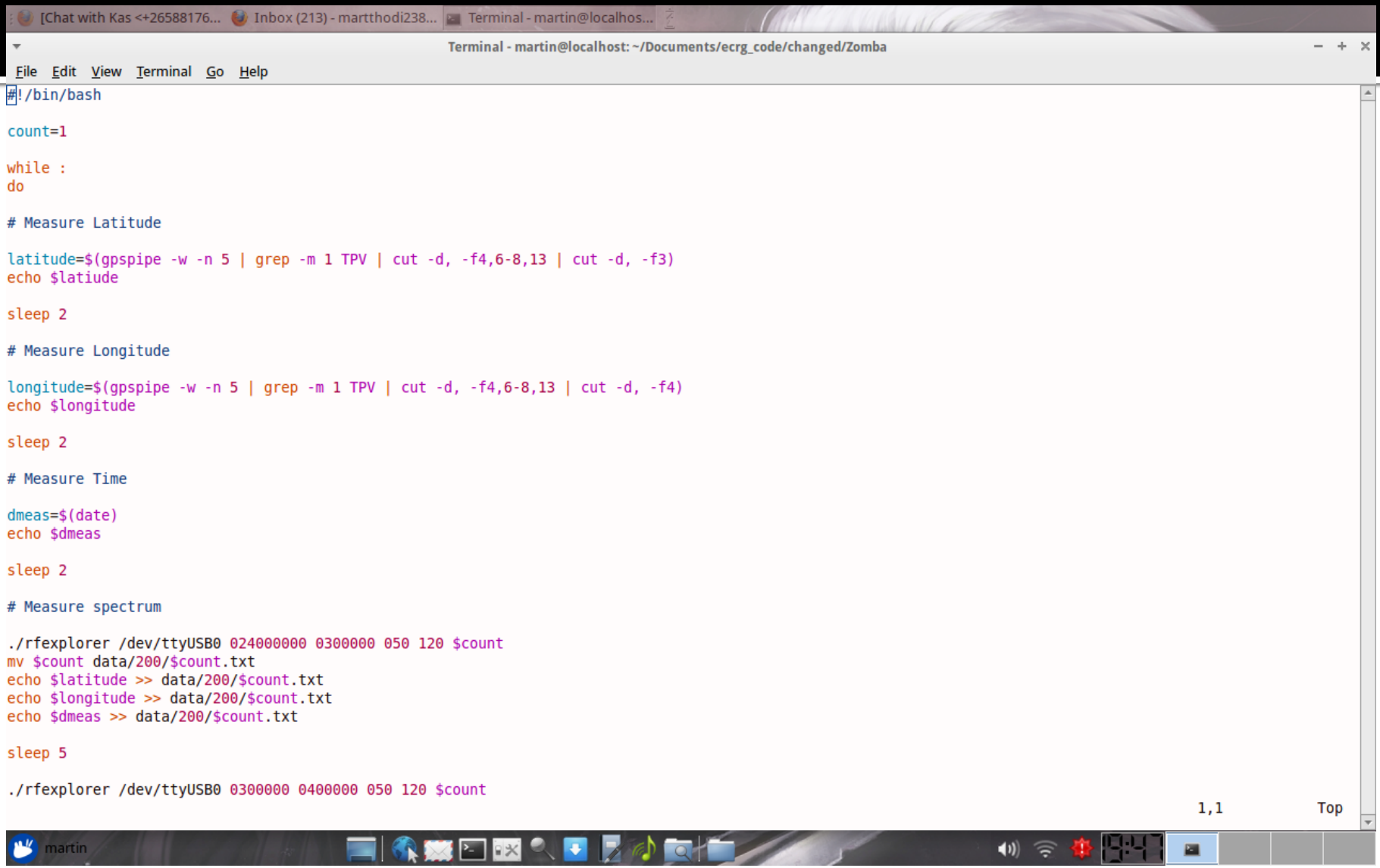
Advancing Research in Radio Wave Communications

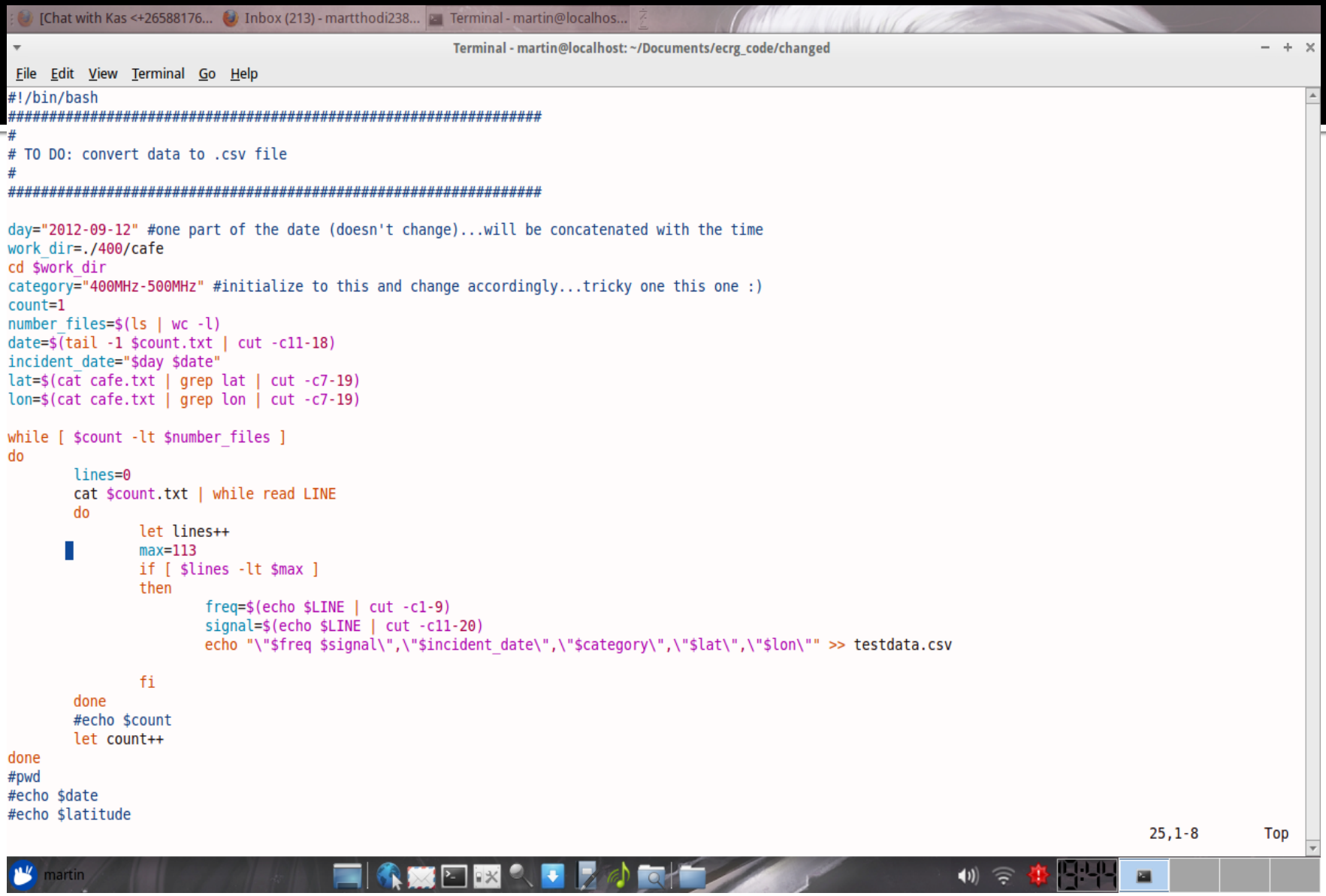
GPS Position and Time Stamping

- GPS Receiver

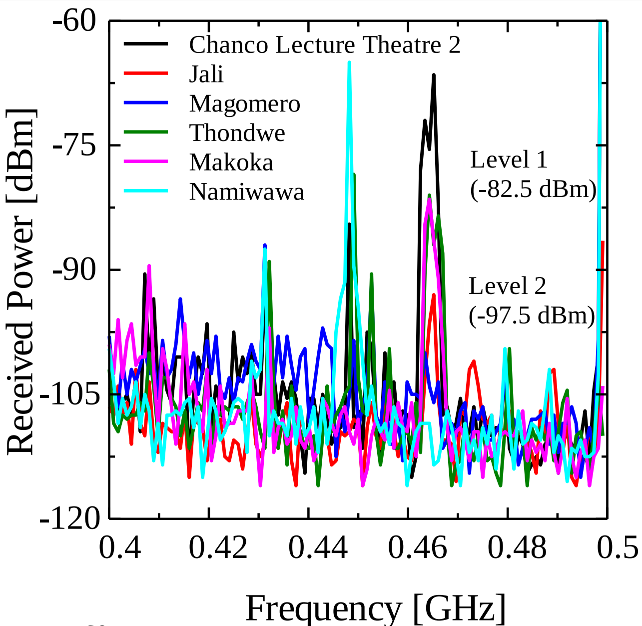
- Laptop (running Linux bash scripts)

The Scripts – Capturing Frequencies

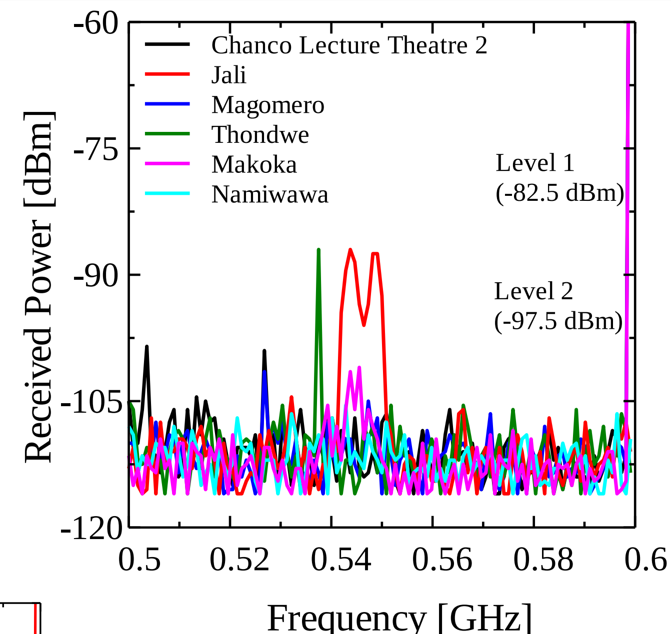


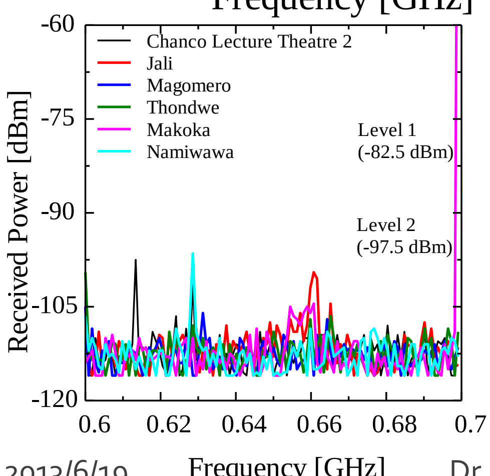

[Chat with Kas <+26588176...
Inbox (213) - martthodi238...
Terminal - martin@localhos...
Terminal - martin@localhost: ~/Documents/ecrg_code/changed
File Edit View Terminal Go Help
#!/bin/bash
###
#
TO DO: convert data to .csv file
#
###
day="2012-09-12" #one part of the date (doesn't change)...will be 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

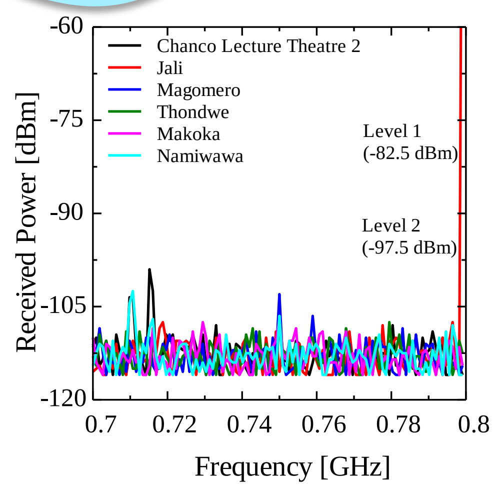
Malawi City Preliminary Results:
400 - 800 MHz White Spaces Survey

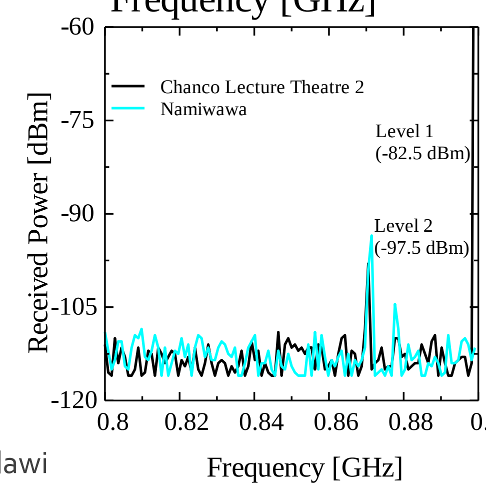


470 - 698 MHz
is Available
Carlson Radio
Compliant

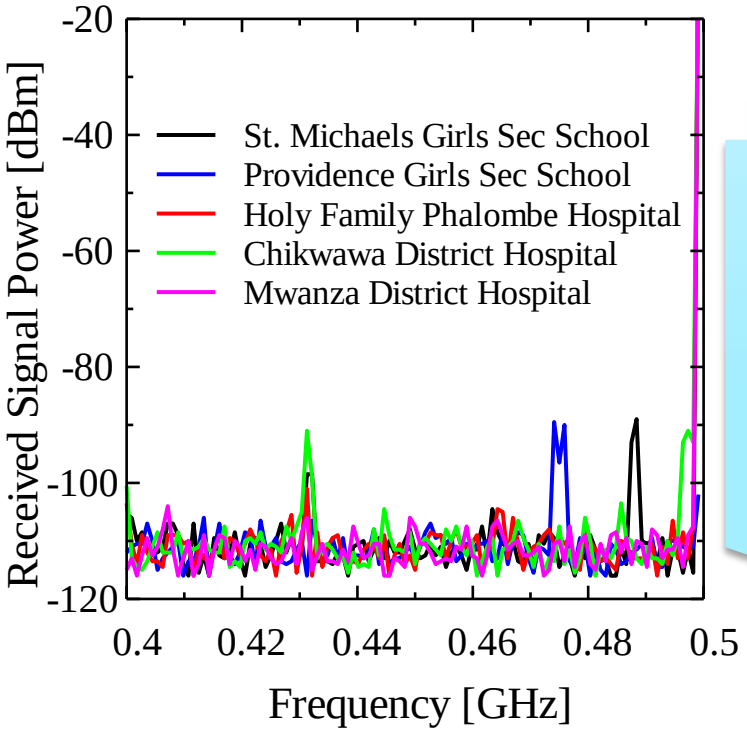




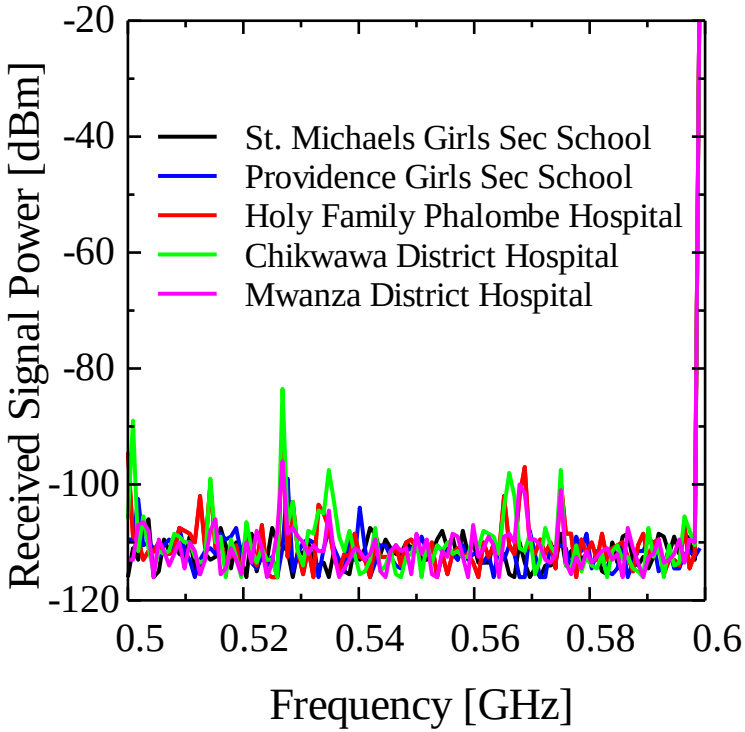




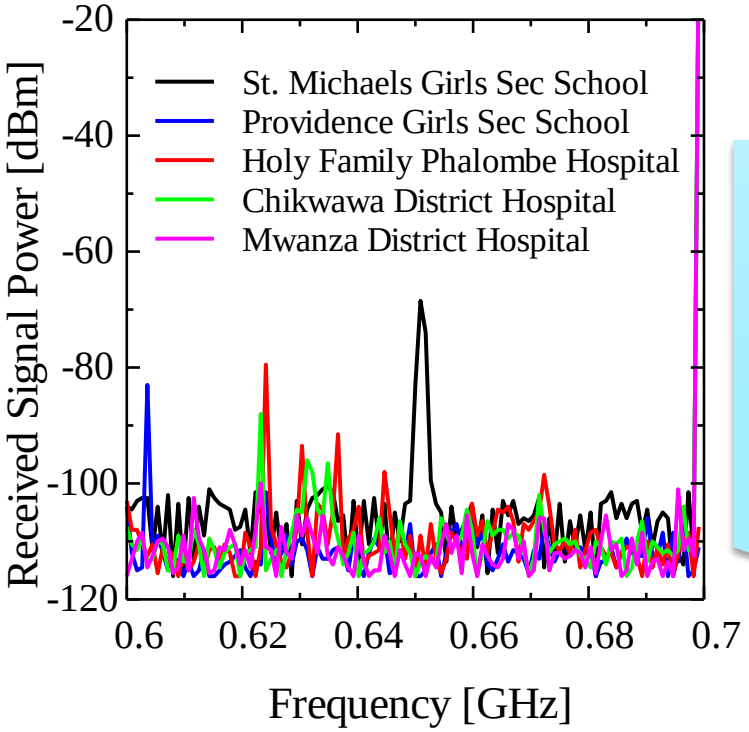
Malawi Rural Preliminary Results:
400 - 600 MHz White Spaces Survey



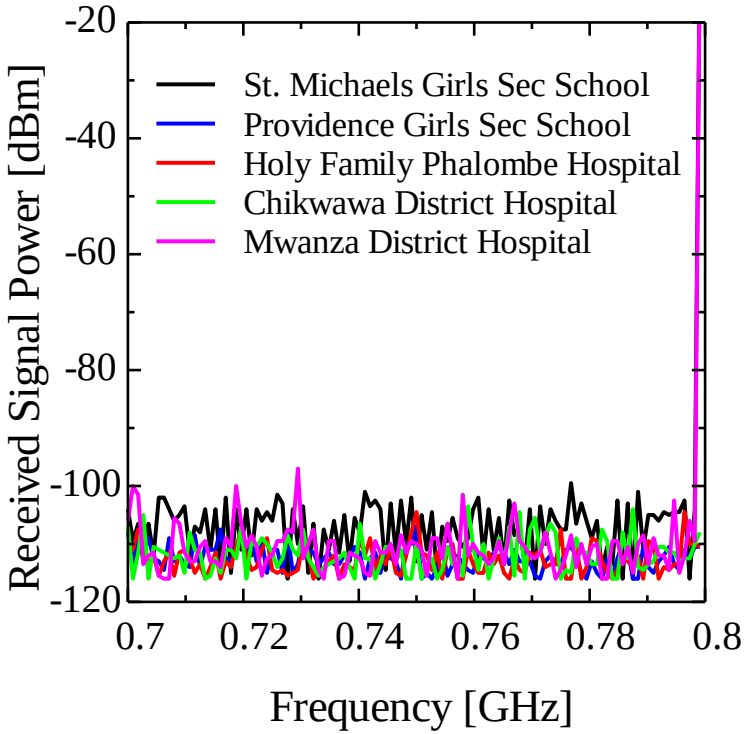
470 - 698 MHz is Available *Carlson Radio Compliant*



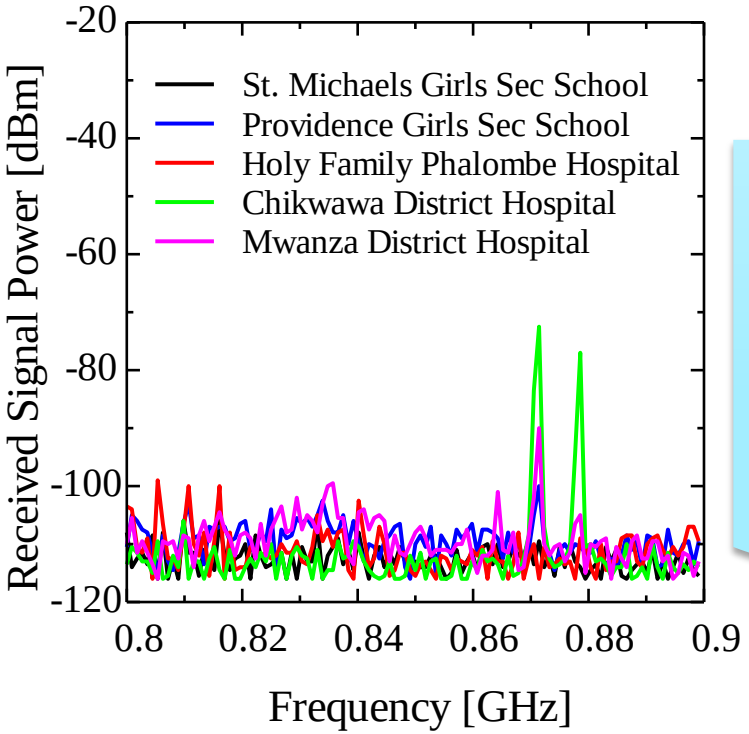
Malawi Rural Preliminary Results:
600 - 800 MHz White Spaces Survey



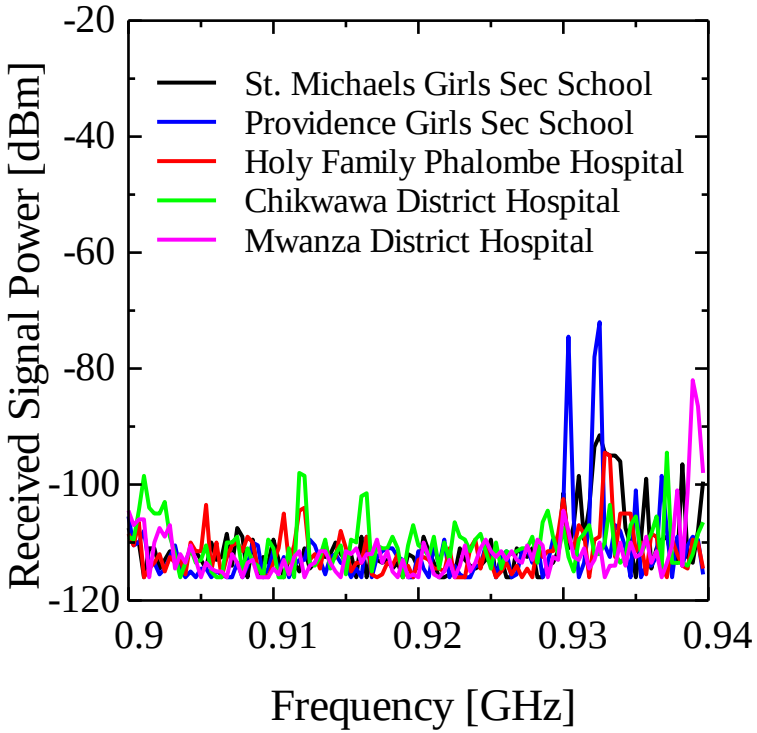
470 - 698 MHz is Available *Carlson Radio Compliant*



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



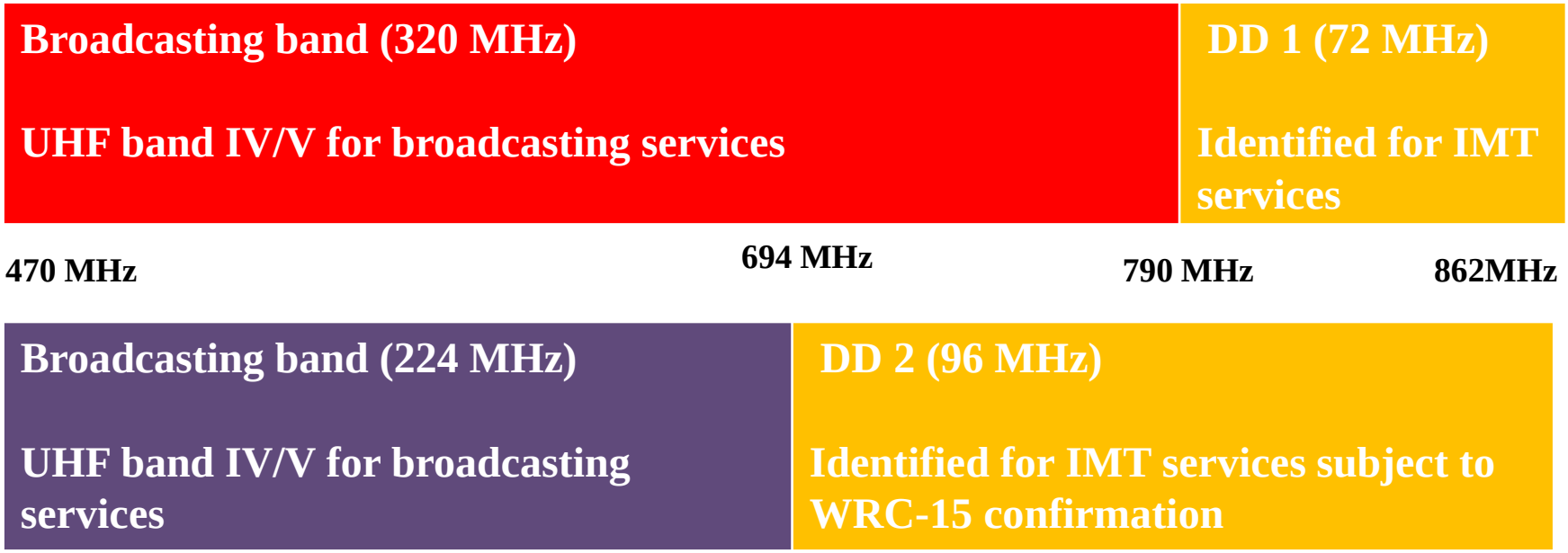
470 - 698 MHz is Available *Carlson Radio Compliant*



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*



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

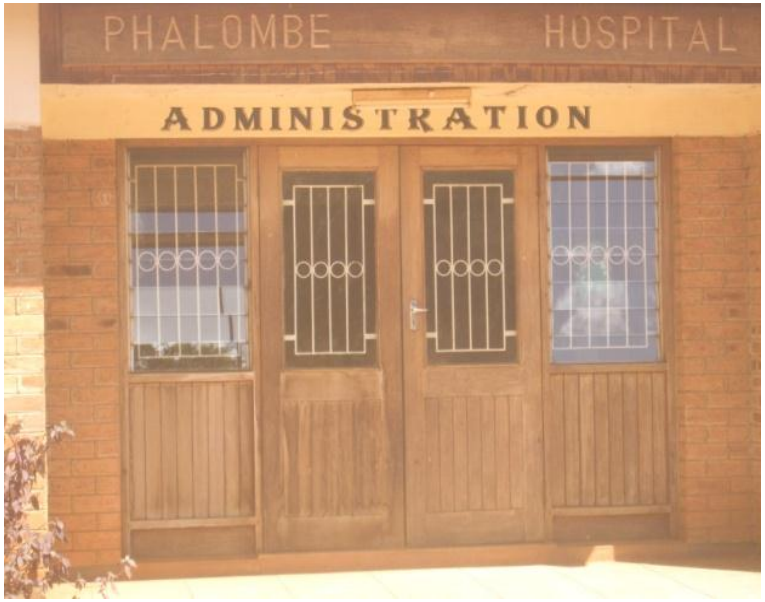
Gate: Providence Girls Sec., School

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

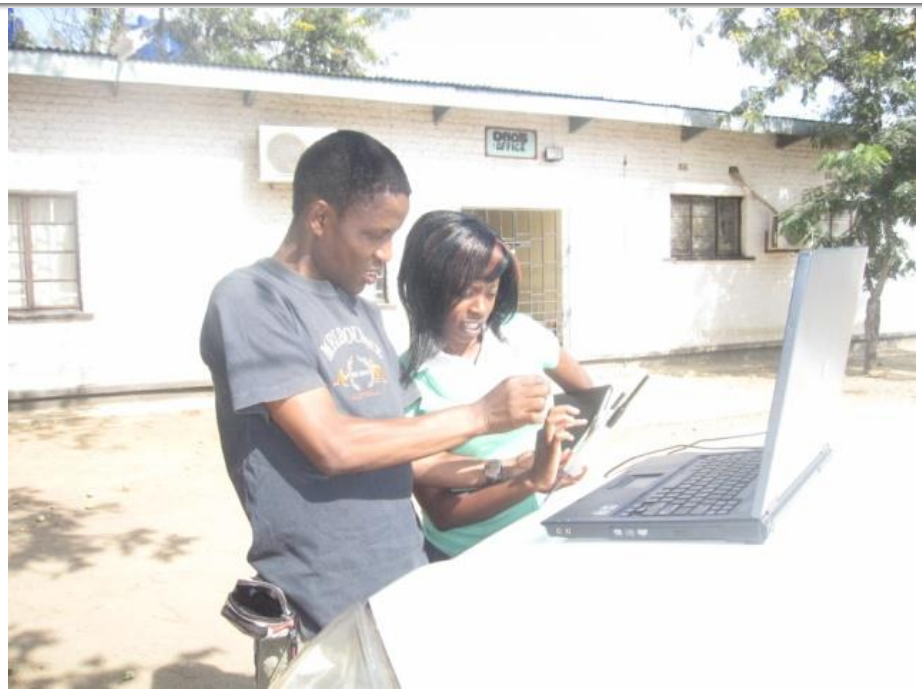
MACRA Partner (Linda Kambale): An economist being turned into an RF/Telcom Engineer. She conducts TVWS Scan at the rural hospital

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)

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

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 = $\frac{\frac{60hrs}{week}}{\frac{10hrs}{week}} * US\$2.5$

= US$15

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

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

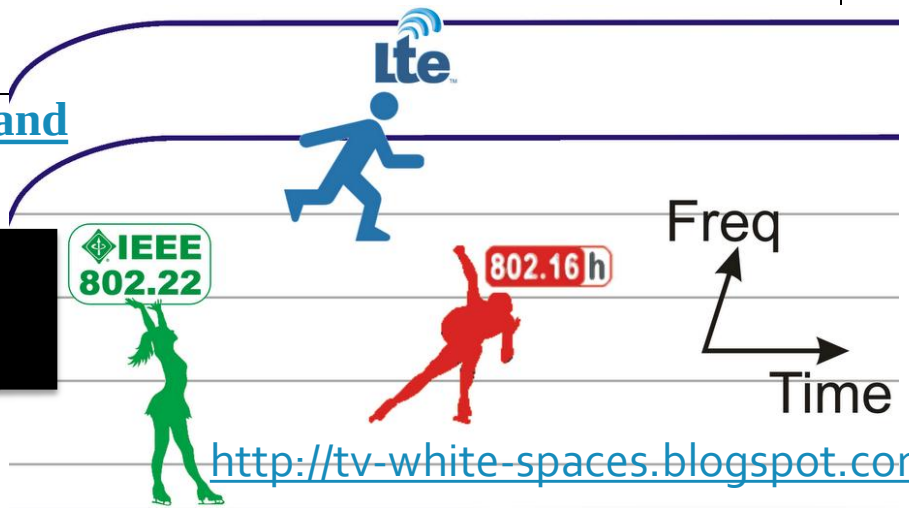
The **White Spaces Project in Malawi** aims at providing the necessary infrastructure in rural and undeserved places while ensuring:

- 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



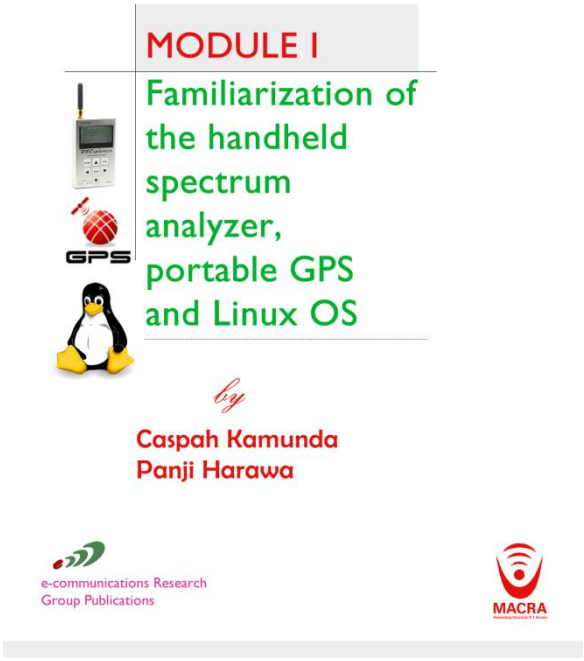
http://tv-white-spaces.blogspot.com/

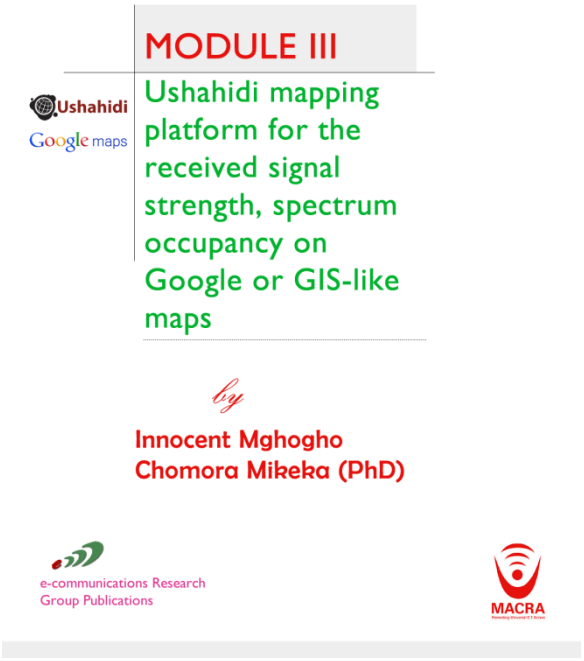
Major Outputs

- Preliminary White Spaces Measurements Results:- *In Rural and City Malawi, (400MHz to 960MHz), Presentation in Dakar, **Senegal (May 30-31st, 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





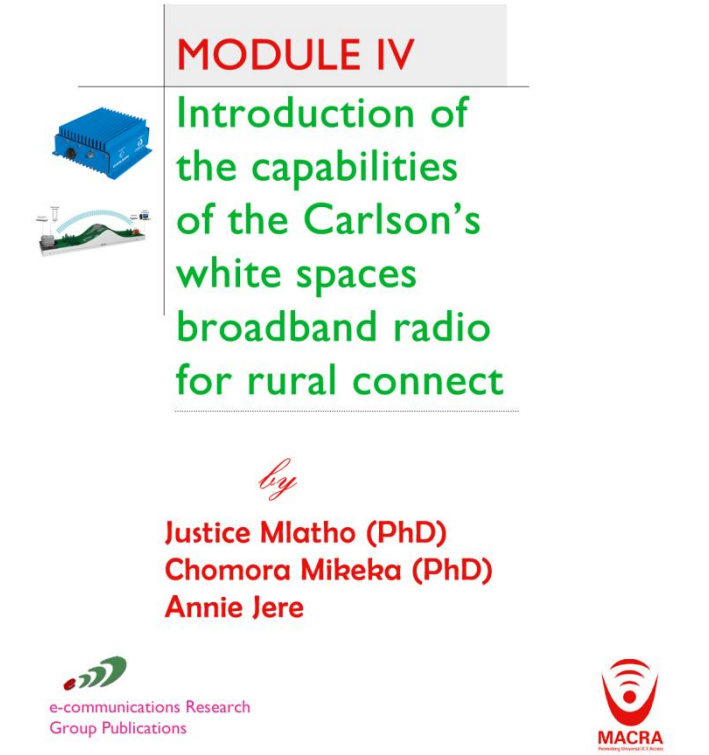
eCRG May, 2013 Publications.

***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



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