By
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The White Spaces Project in 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/countries/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
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

**Date:** 18th June, 2013

### Key Partners

- 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.

### Key Activities

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.
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 ($takeholders Meeting)

### Value Propositions

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.

### Customer Relationships

1. Virtual relationship with doctors for e-health application
2. Provision of free internet services for education and health purposes
4. Self service by providing a platform for development of e-health and e-learning.

### Customer Segments

1. Rural Secondary Schools
2. Rural health centers
3. Leadership for Environment And Development (LEAD) Southern Africa
# Pilot Phase Budget Elements

<table>
<thead>
<tr>
<th>S/N</th>
<th>Activity/Item</th>
<th>QTY</th>
<th>Unit Cost (MK)</th>
<th>Total Cost (MK)</th>
<th>Total Cost (USD)</th>
<th>Time Frame</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Developing of modules for the White Spaces measurement training.</td>
<td>1</td>
<td>836,000.00</td>
<td>836,000.00</td>
<td>2,090.00</td>
<td>April, 2013</td>
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<td>2</td>
<td>White Spaces preliminary measurements for pilot sites.</td>
<td>1</td>
<td>750,000.00</td>
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<td>1,875.00</td>
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<td>3</td>
<td>Planning and fact finding mission with Marconi Wireless Lab Staff</td>
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<td>1,177,000.00</td>
<td>2,942.50</td>
<td>June, 2013</td>
<td>Done</td>
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<tr>
<td>4</td>
<td>White Space/PMR Audit for new pilot phase sites</td>
<td>1</td>
<td>184,000.00</td>
<td>184,000.00</td>
<td>460.00</td>
<td>20th – 21st June,</td>
<td>Not Done</td>
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<td></td>
<td></td>
<td></td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Equipment (10 X Laptops, 2 X Desktop Computers and Printer)</td>
<td>1</td>
<td>4,310,000.00</td>
<td>4,310,000.00</td>
<td>10,775.00</td>
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<td>6</td>
<td>2X 1Mbps Broadband bandwidth</td>
<td>1</td>
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<td>6,220,000.00</td>
<td>15,550.00</td>
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<td>7</td>
<td>Training on White Spaces measurements using the developed modules</td>
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<td>11,874,000.00</td>
<td>29,685.00</td>
<td>22nd - 26th July,</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>National wide field measurements for White Spaces and Private Mobile Radio (PMR) audit.</td>
<td>1</td>
<td>4,393,536.00</td>
<td>4,393,536.00</td>
<td>10,983.84</td>
<td>17th August, - 15th September, 2013</td>
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<td>9</td>
<td>Analysis of the captured data</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>30th September, 2013</td>
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<td>10</td>
<td>TV White Spaces spectrum allocation.</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>30th August, 2013</td>
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<td>11</td>
<td>Deployment of radio equipment</td>
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<td>26,520.00</td>
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<td>400,000.00</td>
<td>1,000.00</td>
<td>September 2013</td>
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## Total Budget in USD for the Pilot Phase

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<th></th>
<th>Description</th>
<th>Unit 1 (USD)</th>
<th>Unit 2 (USD)</th>
<th>Amount  (USD)</th>
<th>Month</th>
<th>Status</th>
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<tbody>
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<td>13</td>
<td>Dissemination of results in Malawi (Stakeholders</td>
<td>924,000</td>
<td>924,000</td>
<td>2,310.00</td>
<td>June, 2014</td>
<td>Not Done</td>
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<tr>
<td></td>
<td>Meeting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>Project review meeting by project team</td>
<td>1,200,000.00</td>
<td>1,200,000.00</td>
<td>3,000.00</td>
<td>20th June, 2013</td>
<td>Not Done</td>
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<tr>
<td>15</td>
<td>Publications of results</td>
<td>850,000.00</td>
<td>850,000.00</td>
<td>2,125.00</td>
<td>July, 2014</td>
<td>Not Done</td>
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<tr>
<td></td>
<td>Total</td>
<td>44,126,572.00</td>
<td>44,126,572.00</td>
<td>110,316.43</td>
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<td></td>
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</tbody>
</table>

In MWK: 44,126,572.00

In USD: 110,316.43
The White Spaces Scan Setup

240-960 MHz monopole antenna

2.4-2.5 GHz monopole antenna

GPS

USB-Connect-1

RF Explorer

USB-Connect-2

Laptop running bash scripts

eCRG Scanning Saloon

RF Explorer

Handheld Spectrum Analyzer

Laptop for data acquisition

Control panel for the spectrum Analyzer

2013/6/19

Dr. Chomora Mikeka, eCRG Coordinator, University of Malawi
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

```bash
#!/bin/bash

count=1

while : 
  do
    # Measure Latitude
    latitude=$(gpssip -w -n 5 | grep -m 1 TPV | cut -d, -f4,6-8,13 | cut -d, -f3)
    echo $latitude
    sleep 2

    # Measure Longitude
    longitude=$(gpssip -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 03000000 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 03000000 04000000 050 120 $count
  
```

2013/6/19
Dr. Chomora Mikeka, eCRG Coordinator, University of Malawi
#!/bin/bash

# TO DO: convert data to .csv file
#
# initialize to this and change accordingly...tricky one this one :)

day="2012-09-12" # one part of the date (doesn't change)... will be concatenated with the time
work_dir=/408/caffe

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 $count.txt | cut -c1-18)
incident_date=$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 $count.txt | while read LINE
    do
        lines=$(($lines+1))
        max=113
        if [ $lines -lt $max ]; then
            freq=$(echo $LINE | cut -c1-9)
            signal=$(echo $LINE | cut -c11-28)
            echo "$freq $signal","$incident_date","$category","$lat","$lon" >> testdata.csv
        fi
    done
    echo $count
    let COUNT++
done

#pwd
# echo $date
# echo $latitude
Malawí City Preliminary Results: 400 - 800 MHz White Spaces Survey

470 - 698 MHz is Available Carlson Radio Compliant

Received Power [dBm]
Frequency [GHz]
Level 1 (-82.5 dBm)
Level 2 (-97.5 dBm)

-120
-105
-90
-75
-60

0.4 0.42 0.44 0.46 0.48 0.5

-120
-105
-90
-75
-60

0.5 0.52 0.54 0.56 0.58 0.6

-120
-105
-90
-75
-60

0.6 0.62 0.64 0.66 0.68 0.7

-120
-105
-90
-75
-60

0.8 0.82 0.84 0.86 0.88 0.9

-120
-105
-90
-75
-60

0.8 0.82 0.84 0.86 0.88 0.9

2013/6/19  Frequency [GHz]  Dr. Chomora Mikeka, eCRG Coordinator, University of Malawi
Malawi Rural Preliminary Results: 400 - 600 MHz White Spaces Survey

470 - 698 MHz is Available Carlson Radio Compliant

St. Michaels Girls Sec School
Providence Girls Sec School
Holy Family Phalombe Hospital
Chikwawa District Hospital
Mwanza District Hospital

Received Signal Power [dBm]
Frequency [GHz]

0.4 0.42 0.44 0.46 0.48 0.5
-120
-100
-80
-60
-40
-20
-100
-80
-60
-40
-20

0.5 0.52 0.54 0.56 0.58 0.6
-120
-100
-80
-60
-40
-20

2013/6/19
Dr. Chomora Mikeka, eCRG Coordinator, University of Malawi
Malawi Rural Preliminary Results: 600 - 800 MHz White Spaces Survey

St. Michaels Girls Sec School
Providence Girls Sec School
Holy Family Phalombe Hospital
Chikwawa District Hospital
Mwanza District Hospital

Received Signal Power [dBm]
Frequency [GHz]

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
Reaching out and connecting rural institutions

- Health
- Education

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

862 MHz

DD 2 (96 MHz)

Identified for IMT services subject to WRC-15 confirmation

470 - 698 MHz is targeted by Carlson Radio
e-Readiness Assessment and ICT-Compliance Test in Rural Malawi_DS-1

St. Michaels Girls Secondary School, Malindi in Mangochi

Photo taken: May, 2013

Computer Room: Form IV Class

Dr. Mikeka and MACRA Team: TVWS Scan
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

Mwanza District Hospital, Mwanza

*Photo taken:* May, 2013

Dr. Chomora Mikeka explains to the Hospital Administrator, Mr. Nkhonjera on the whole concept of TVWS
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 = \[
\frac{60hrs}{week} \times \frac{10hrs}{week} \times \text{US$2.5} = US$15
\]
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
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.


http://www.youtube.com/watch?v=fcbUP59MfeE
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 in case 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 30-31st, 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.
**MODULE I**
Familiarization of the handheld spectrum analyzer, portable GPS and Linux OS

*by*
Caspa Kamunda
Panji Harawa

**MODULE II**
Bash scripts for simultaneous data acquisition from GPS and spectrum analyzer

*by*
Justice Mliatho (PhD)
Martin Thodi

**MODULE III**
Ushahidi mapping platform for the received signal strength, spectrum occupancy on Google or GIS-like maps

*by*
Innocent Mghogho
Chomora Mikeka (PhD)

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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

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-Radiness Assessment in Malawi with support from the Wageningen 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).

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Alexander Mmembezweni

http://malawitech.com
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