White Spaces for Broadband Access

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White Spaces for Broadband Access

Need for more spectrum to satisfy the growing demand.

Spectrum refarming: opportunistic spectrum usage

Many standard efforts

Several trials have been conducted

Evolution of Spectrum usage

Fixed allocation

1) Government assigned
2) Auction
3) Beauty Contest

Dynamic Spectrum allocation

http://www.apc.org/en/faq/citizens-guide-airwaves

Television White Spaces: definition

a) The spectrum that has been assigned to TV broadcasting but it is not currently being used. This applies particularly to developing countries, in which there has been no economic incentive for broadcaster to use every available TV channel.

b) The spectrum that must be left free in between two analogous TV channels to prevent interference.

c) The spectrum that has been reclaimed as a consequence of the transition to digital terrestrial TV, which is more spectrum efficient.

See: “On the relevance of using affordable tools for white spaces identification” at http://wireless.ictp.it/publications.html

Propagation advantages of TV bands

The superior propagation features of the lower frequencies bands for two way transmission have been proved in several trials of the CDMA 450 MHz technology, like the one in the Argentinian Patagonia operated by Cooperativa Telefonica de Calafate, with subscribers up to 50 km from the base station.

This is due to three factors:

a) Lower free space loss

b) Better diffraction efficiency

c) Lower building attenuation

TV Band Devices Standards

IEEE 802.22 for long range transmission Wireless Regional Area Networks (WRAN).
IEEE 802.11af for short range, OFDM PHYs with 5, 10 and 20 MHz channel widths
IEEE 802.15.4m for device control and command applications
IEEE 802.19 for coexistence among multiple TV white space networks
IEEE DySPAN aimed at Dynamic Spectrum Access Networks
IEEE 802.16h originally meant for the 3650-3700 MHz contention band but now also specified for the TV bands
ECMA 392 directed at personal and portable wireless devices,
Weightless mainly focused at Machine-to-Machine interactions
IETF PAWS covering the specification of the mechanism for discovering a white spaces database and method for its access.

Data Base Query

Currently, Data Base approach is the only one allowed in USA and UK.
Radios authorised and operating as white space devices (**TVBDs**) are required to provide their geographic location, by means of a secure Internet connection, to a TV band database system authorised by the Commission. The database will return a list of authorised channels available for operation by the TVBD for its reported location.

IEEE 802.22

Uses Cognitive Radio techniques to enable sharing of geographically unused spectrum allocated to TV broadcast services to build Wireless Regional Area Networks (WRAN), to deliver wireless broadband access to rural and remote areas.
TV spectrum from 54 MHz to 862 MHz, with restrictions in different countries

Main features of IEEE 802.22

Spectrum Sensing and Reuse, to address the spectrum crunch by means of Cognitive Radio (CR).

Paves the way for Dynamic Spectrum Access, as a new paradigm for spectrum usage.

Lower frequencies, greater range thanks to less attenuation by walls, greater diffraction and lower free space loss. Non Line Of Sight propagation.

Transmit Power control, Adaptive Modulation/Coding,

Synchronization by means of GPS.

Main features of IEEE 802.22

Protection of TV broadcasting
Protection of Part 74 wireless microphones
802.22.1 wireless microphone beacon
Quiet periods for sensing
Self-coexistence among WRAN systems
BS can serve up to 512 fixed or portable CPE units.
Capacity of the Base Station is up to 22 Mbit/s per channel.

Antennas

- Each CPE would need two antennas: one omni and one directional
- Omni used for spectrum sensing and measurement
- Directional used for actual data communication.
- There might be need for a third antenna to perform database consultation, say through a cellular system

ICTP involvement in White Spaces

Three pronged approach

1) Measurement of real on-site spectrum usage

2) Lobbying the Regulator to authorise deployment

3) Perform installations in collaboration with a local university that will be in charge of the performance assessment and maintenance

Architecting a Low Cost Television White Space Network For Developing Regions

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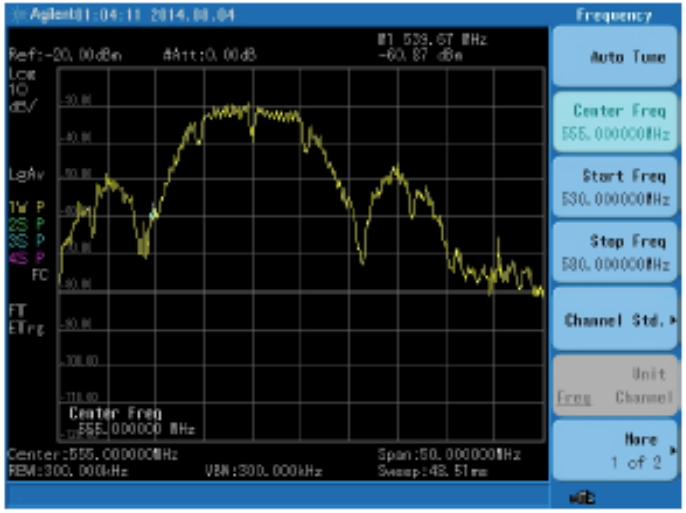


Figure 1: Spectrum of Doodle Labs as shown by a Agilent 9344C Spectrum Analyzer

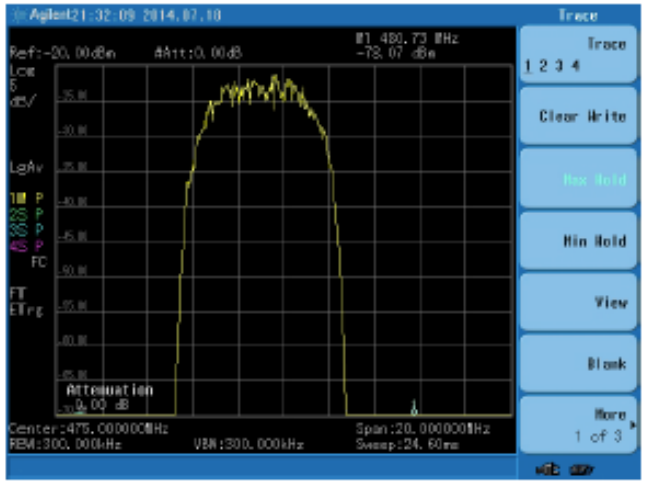
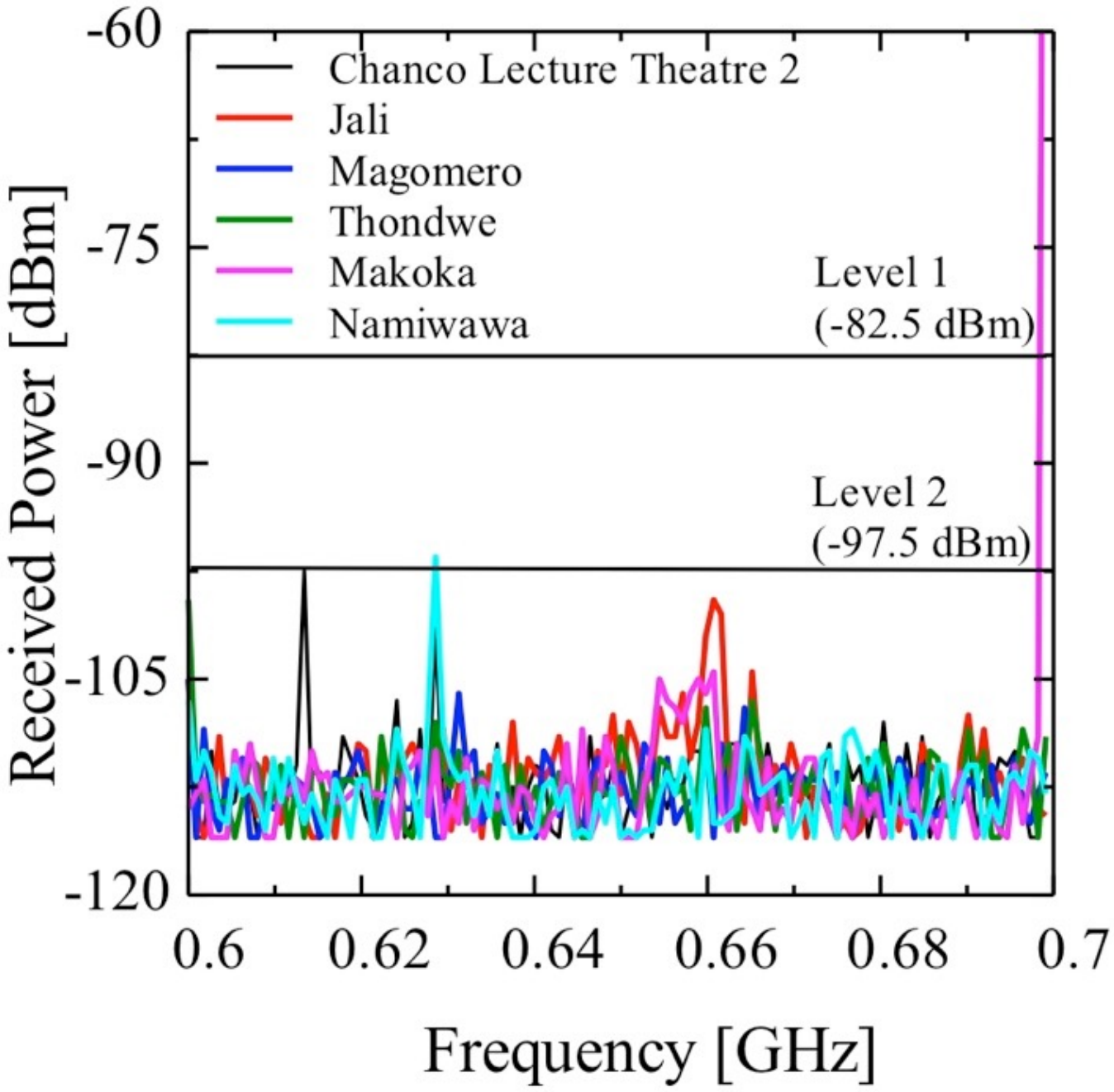


Figure 2: Spectrum of Carlson Wireless TVWS radio as shown by an Agilent 9344C Spectrum Analyzer


MacBook Air
RFExplorer


Chanco Lecture Theatre 2
Jali
Magomero
Thondwe
Makoka
Namiwawa
Level 1
(-82.5 dBm)
Level 2
(-97.5 dBm)
Received Power [dBm]
-60
-75
-90
-105
-120
0.6
0.62
0.64
0.66
0.68
0.7
Frequency [GHz]

TV White Spaces, I presume?

The quest for TVWS in Malawi and Zambia

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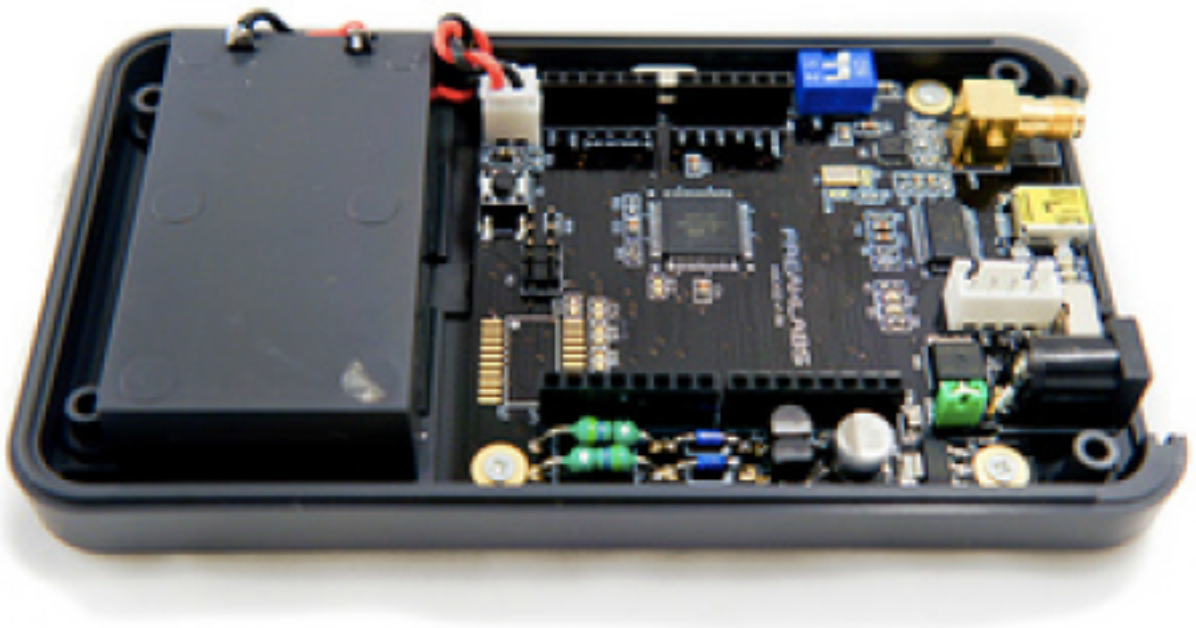


Figure 1: Low-cost ASCII-32 device.

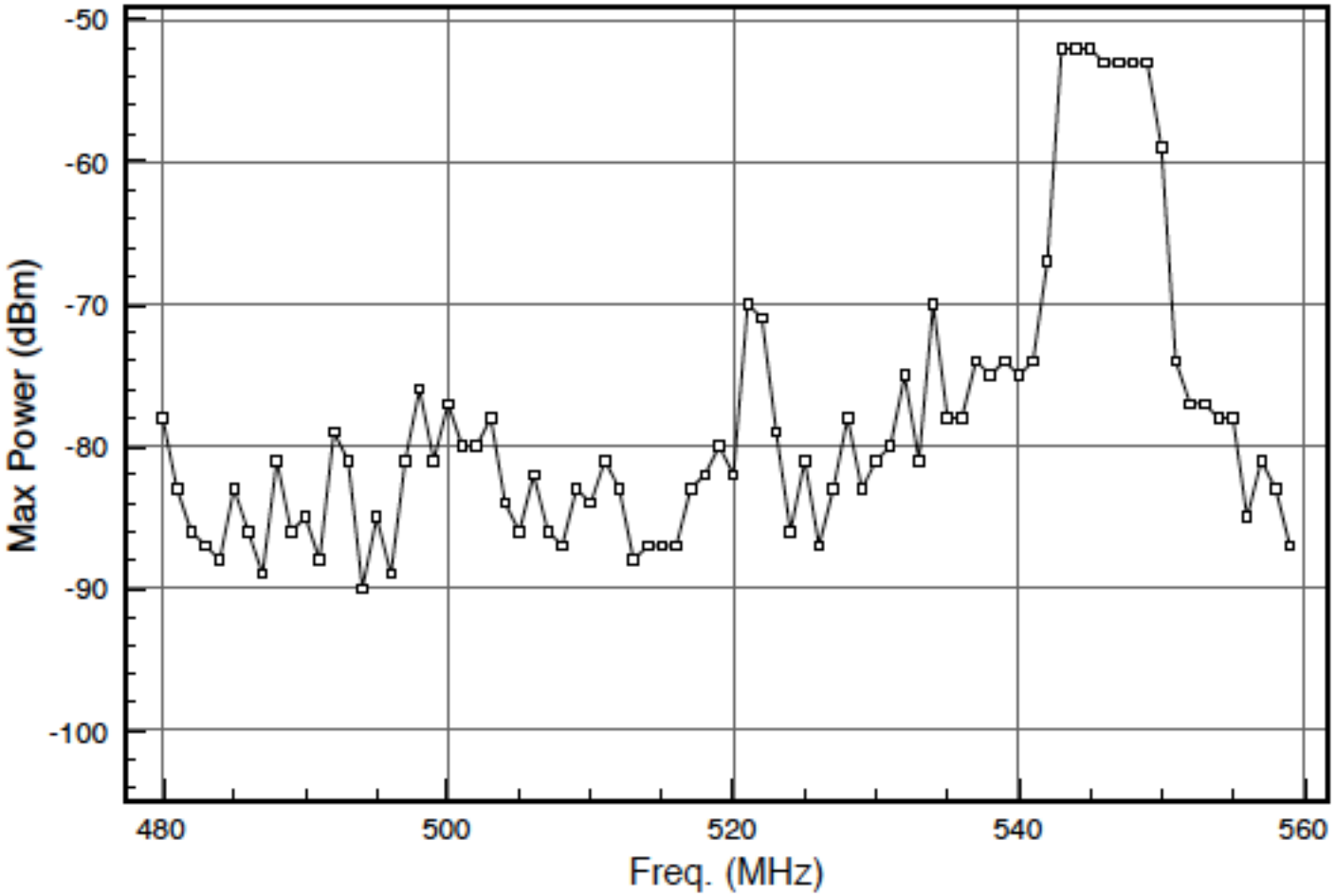


Figure 3: Spectrum measured in Malawi, maximum value in 25000 samples.

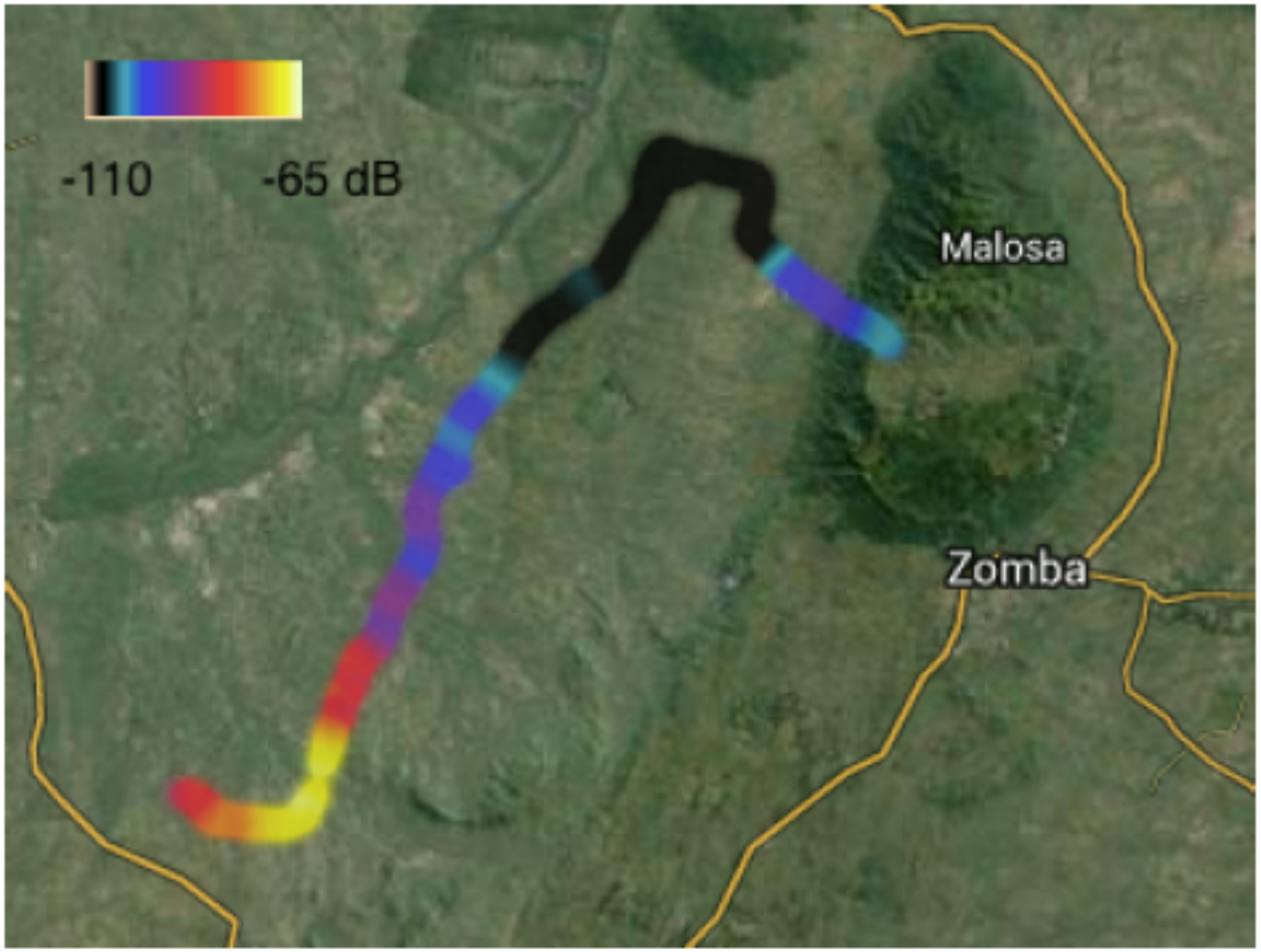
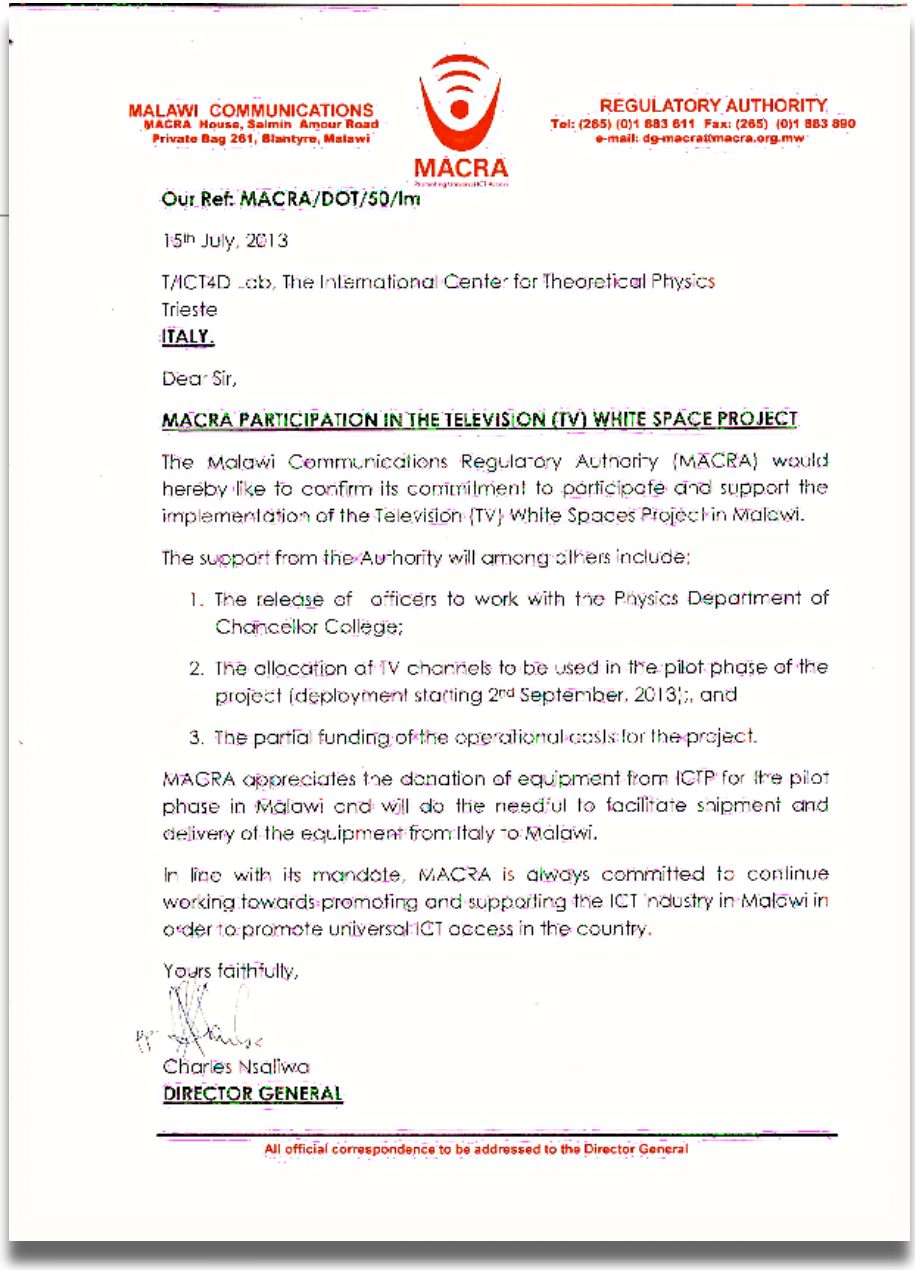


Figure 4: Heatmap for 546 MHz in Malawi.

Malawi



MALAWI COMMUNICATIONS REGULATORY AUTHORITY
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Tel: (265) (0)1 883 611 Fax: (265) (0)1 883 890
e-mail: dg-macra@macra.org.mw

MACRA

Our Ref: MACRA/DOT/50/Im

15th July, 2013

T/ICT4D Lab, The International Center for Theoretical Physics
Trieste
ITALY.

Dear Sir,

MACRA PARTICIPATION IN THE TELEVISION (TV) WHITE SPACE PROJECT

The Malawi Communications Regulatory Authority (MACRA) would hereby like to confirm its commitment to participate and support the implementation of the Television (TV) White Spaces Project in Malawi.

The support from the Authority will among others include;

1. The release of officers to work with the Physics Department of Chancellor College;
2. The allocation of TV channels to be used in the pilot phase of the project (deployment starting 2nd September, 2013);, and
3. The partial funding of the operational costs for the project.

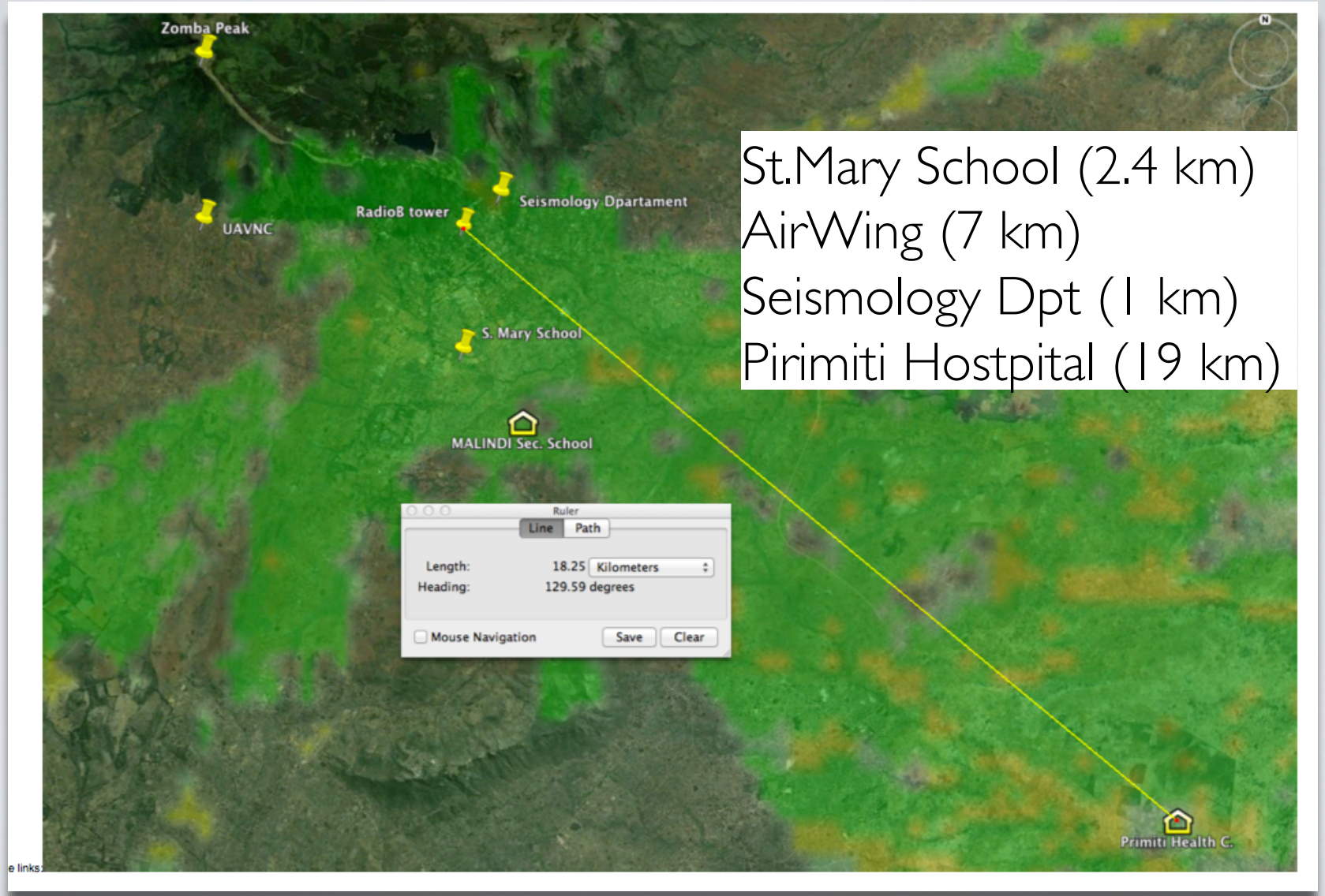
MACRA appreciates the donation of equipment from ICTP for the pilot phase in Malawi and will do the needful to facilitate shipment and delivery of the equipment from Italy to Malawi.

In line with its mandate, MACRA is always committed to continue working towards promoting and supporting the ICT industry in Malawi in order to promote universal ICT access in the country.

Yours faithfully,

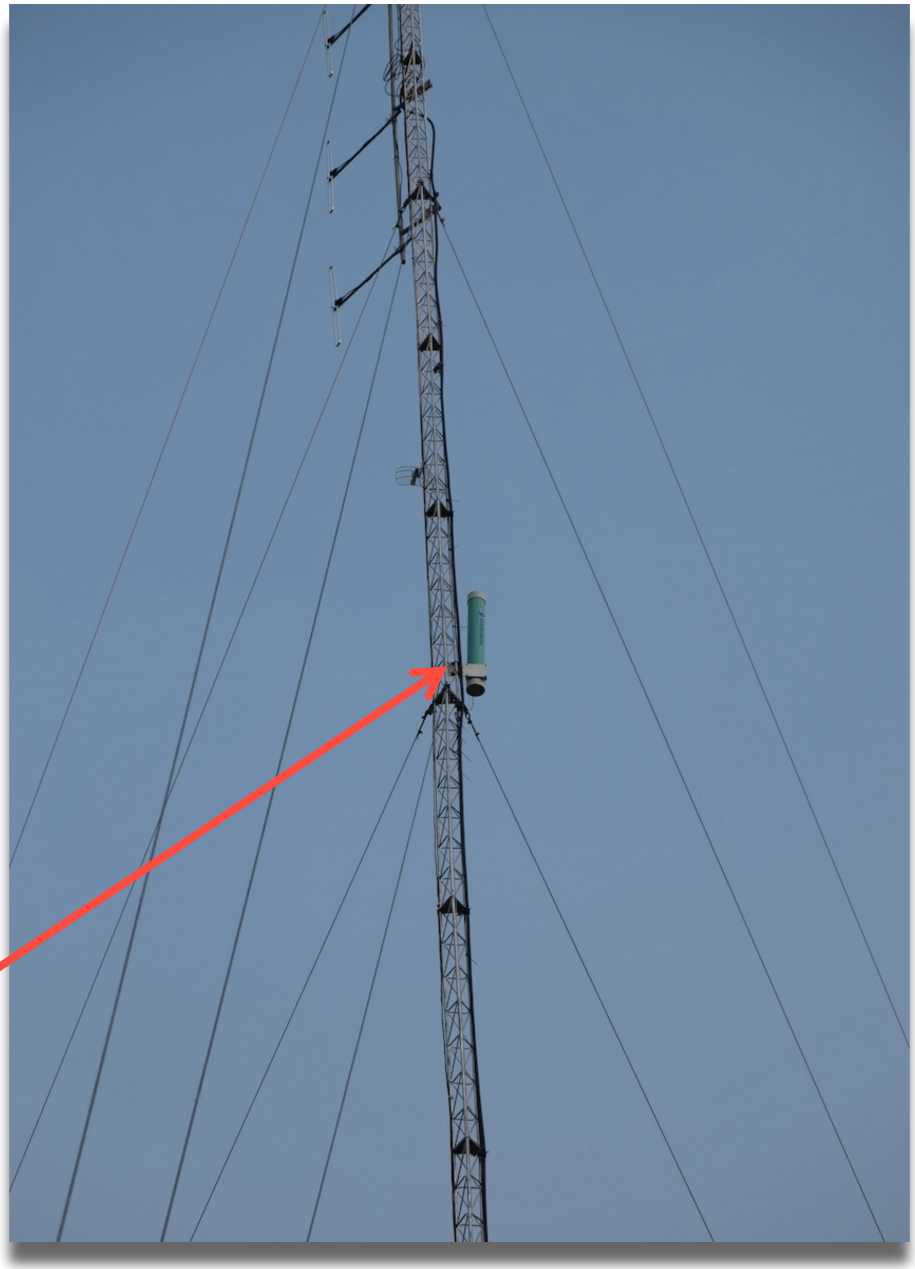
Charles Nsaliwa
DIRECTOR GENERAL

All official correspondence to be addressed to the Director General


Zomba Peak
UAVNC
RadioB tower
Seismology Dpartament
S. Mary School
MALINDI Sec. School
Primiti Health C.
Ruler
Line
Path
Length:
18.25
Kilometers
Heading:
129.59 degrees
Mouse Navigation
Save
Clear
St.Mary School (2.4 km)
AirWing (7 km)
Seismology Dpt (1 km)
Pirimiti Hostpital (19 km)

FM tower

The TVWS base station antenna was installed in a tower built to house the Chancellor College FM Broadcasting station at the University of Malawi, below the existing broadcasting antennas




Television White Spaces
Training Programme - Malawi 2013
CARLSON

Conclusions

TVWS offer an opportunity to provide Internet access in rural areas of developing countries.

Regulator approval is the main requirement, since hardware is already available and newer manufacturers are coming up.

Developing countries could leapfrog in deployment, since fewer TV channels are currently exploited there.

Future is in dynamic spectrum access.

Thank You
Questions?

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http://wireless.ictp.it