Seminar on
Technical Findings from Trials and Pilots

Presentation by:
Dr Ntsibane Ntlatlapa
CSIR Meraka Institute
14 May 2014

DSA
DYNAMIC • SPECTRUM • ALLIANCE

"When wireless is perfectly applied the whole earth will be converted into a huge brain, which in fact it is ……

…… and the instruments through which we shall be able to do this will be amazingly simple compared with our present telephone. **A man will be able to carry one in his vest pocket**."

1926

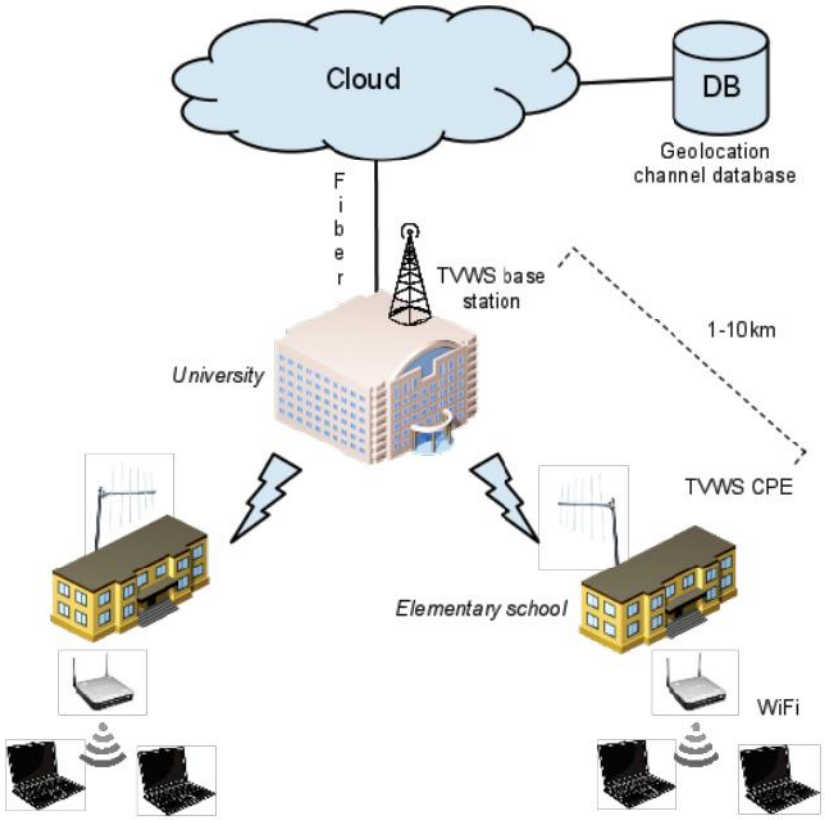
DSA
DYNAMIC • SPECTRUM • ALLIANCE

Contents

- Use Cases
- TV White Spaces trial in Cape Town
- Conclusion

Use Case 1: connecting schools and clinics

- Target market could be schools/libraries/clinics:
  - This target would mitigate problems of interference as the user terminals would be fixed rather than mobile.
  - Would mitigate the problem of 'crowding out' commercial providers as this would be a social service.
  - Introduces the potential of use of White Space for transmission (backhaul) to rural localities and
  - The use of conventional Wi-Fi for local access.

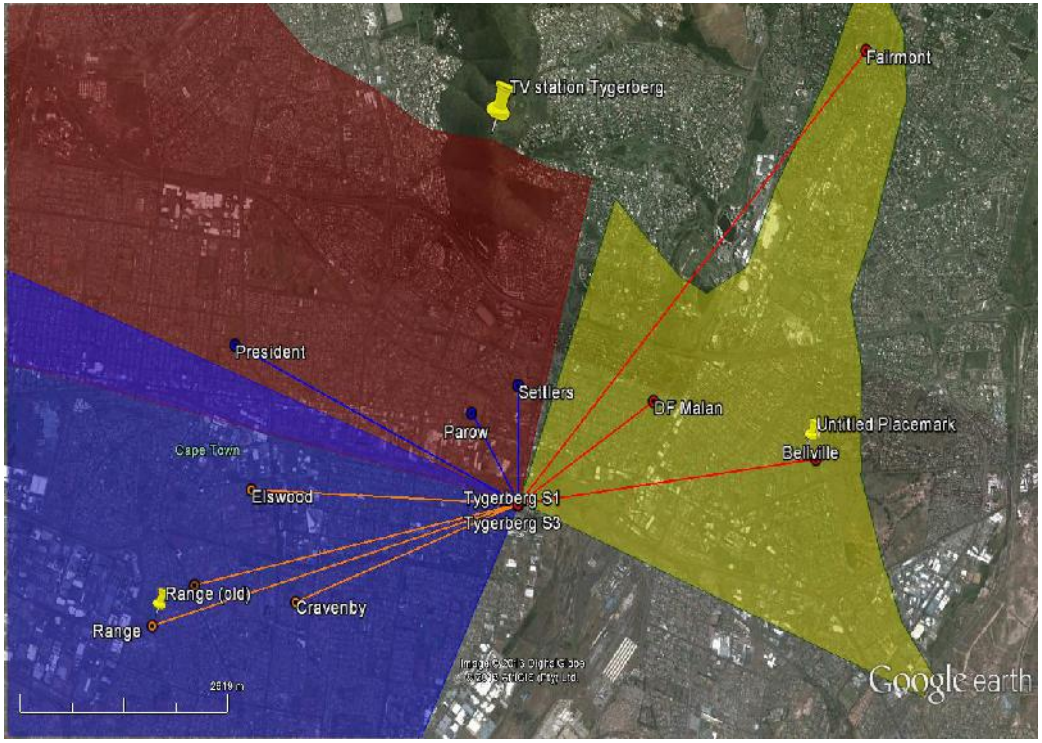


The Objectives of the TV White spaces trial in Cape Town

- The objectives of the trials are
  - to demonstrate that wireless devices (or TVWS devices) can operate on TV frequencies without causing any interference to the incumbent and
  - to obtain regulatory support for TVWS technology and the use of TV White Spaces for the delivery of broadband.

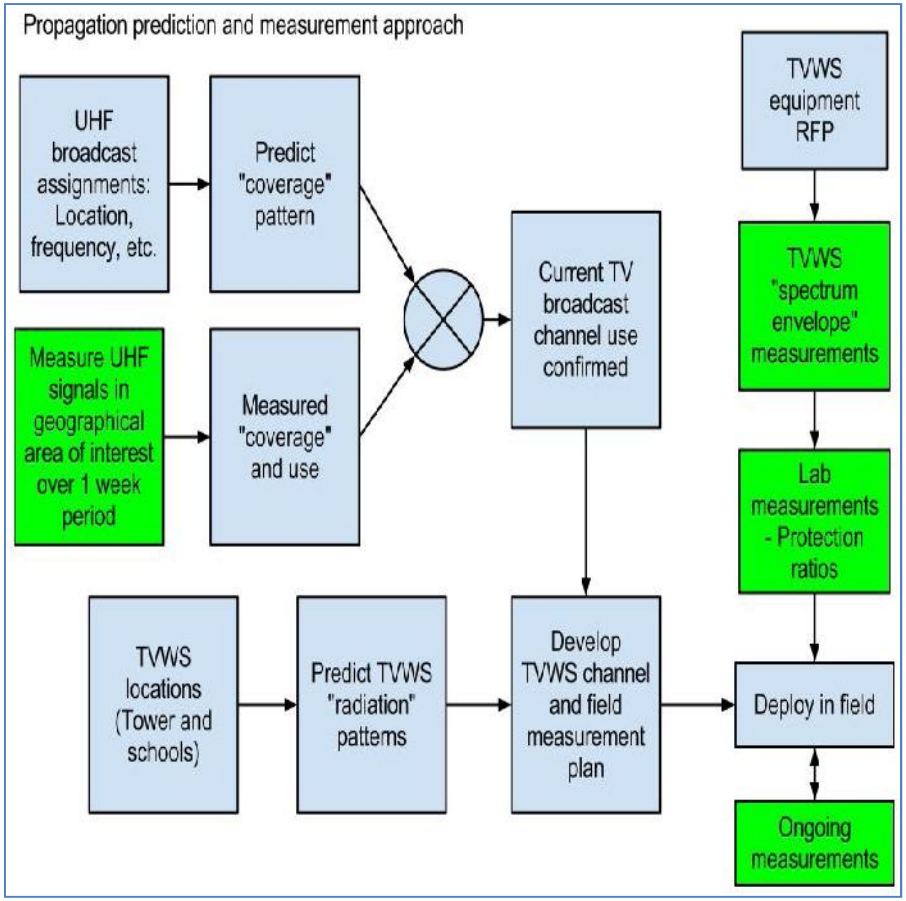
Trial location

- One “high site”
  - 3 base stations
  - serving 3 sectors
  - serving 10 schools
  - 28 dBm transmit power
  - 10 dBi antennas
- Estimated coverage map shown per sector



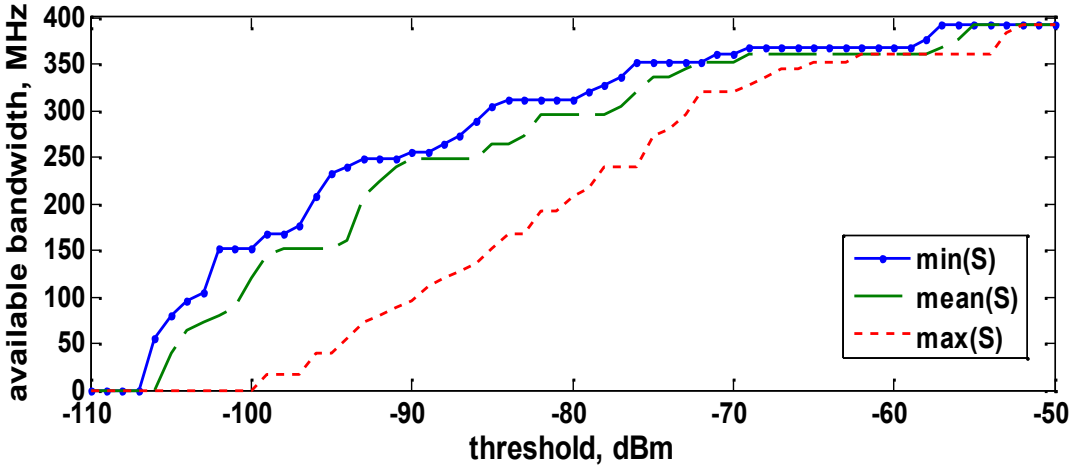
Objective 1: Ensuring non-interference

- Identify availability of white space in terms of unused and underused frequency bands
  - at the desired location, for the desired period of time, by analysis based on existing data and measurements;
- Test white space equipment to ensure
  - Correct spectrum power mask/envelope;
  - Correct behaviour;
- Estimation of the protection ratios and actual availability of white space in terms of the WSD's and TV performance parameters;
- Monitor for interference during operation.
- Developed interference management protocol with broadcasters.



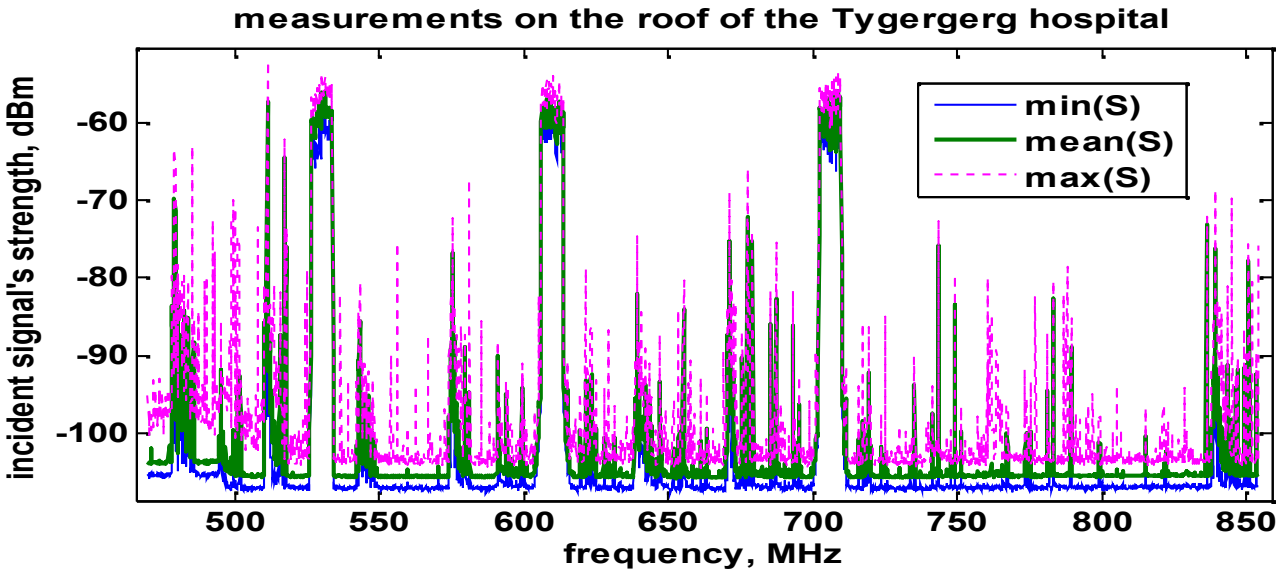
Availability of TV White spaces

- several factors need to be considered to determine White spaces availability:
  - Difference of distances from the TV station and white space transmitters to the TV viewers
  - Acceptable average level of noise in the channel
  - Acceptable quantity of occasional (sporadic) signals and acceptable level of occupancy
  - Leakage into the channel from the neighbouring channel



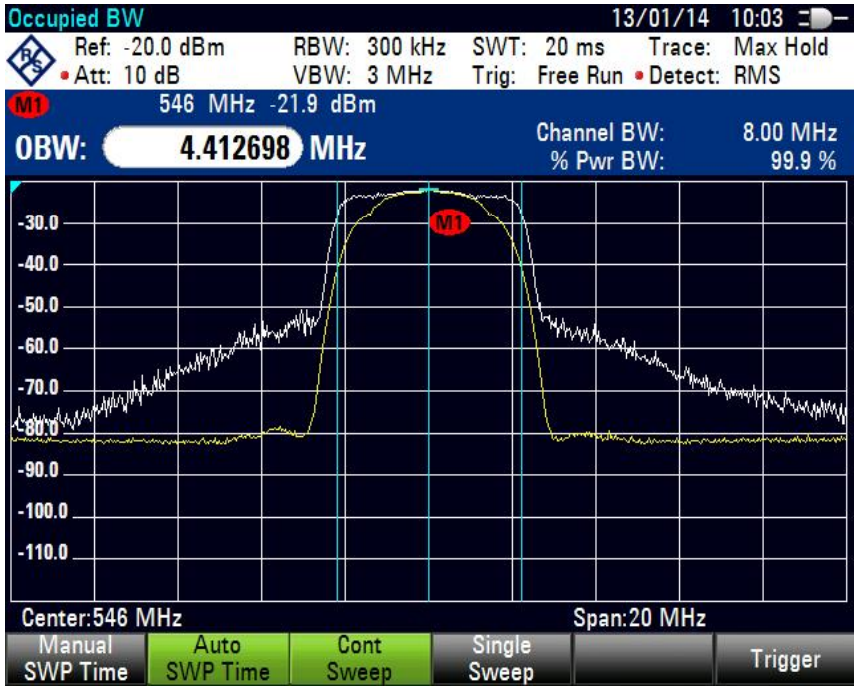
Availability of TV White spaces

- Are there white spaces in urban Tygerberg (area of the trial)? …
  - Up to 200-300 MHz could be available for very low power devices
  - Eight TV channels were found unused (locally; with high safety margin)
  - Finally, six channels were then selected as the most suitable, using several various criteria



Validation of equipment for operation

Device 1

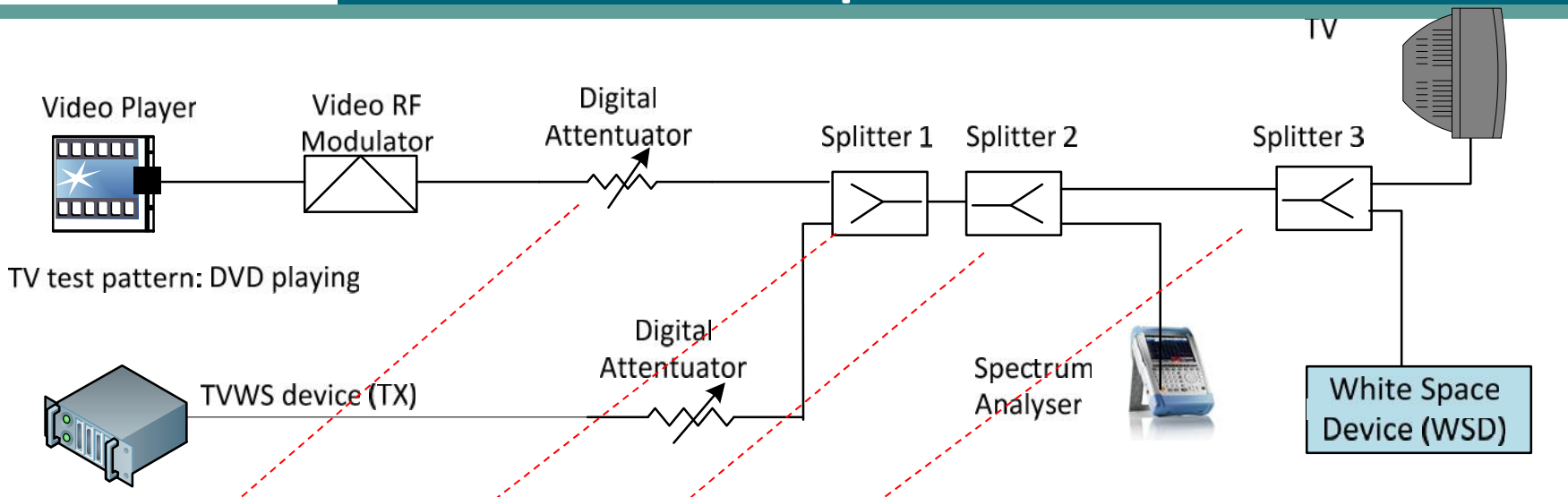


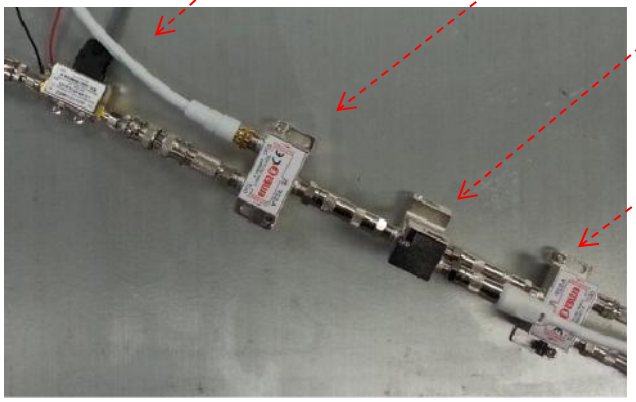
Device 2

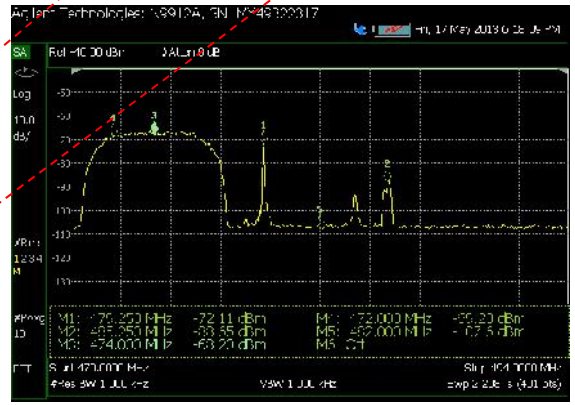
Validation of equipment for operation

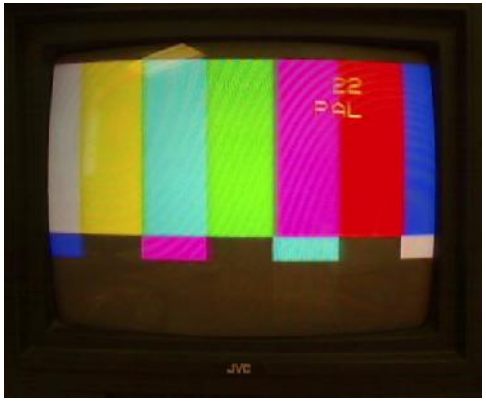
- Does the equipment have an appropriate (narrow and steep enough) spectrum mask?
  - **YES**; Device 2 has a better mask than Device 1. Device 2 also has a higher occupied bandwidth
- Does the equipment behave to minimize possibility of interference (e.g. terminal talks only on request of base station, and base station talks only after it knows where a usable white space is)?
  - **YES**;
- Conclusion: The operation of WSDs was as expected.

Determine protection requirements









Laboratory set up

Determine protection requirements

Device 1

Channel offset N	PR (dB)
N-1	-5.7
N+1	N/A

- The N+1 channel may not be used.
- The N-1 channel may be used provided the devices are configured as per the protection ratio values in table above.
- Adjacent channel to digital television can be used

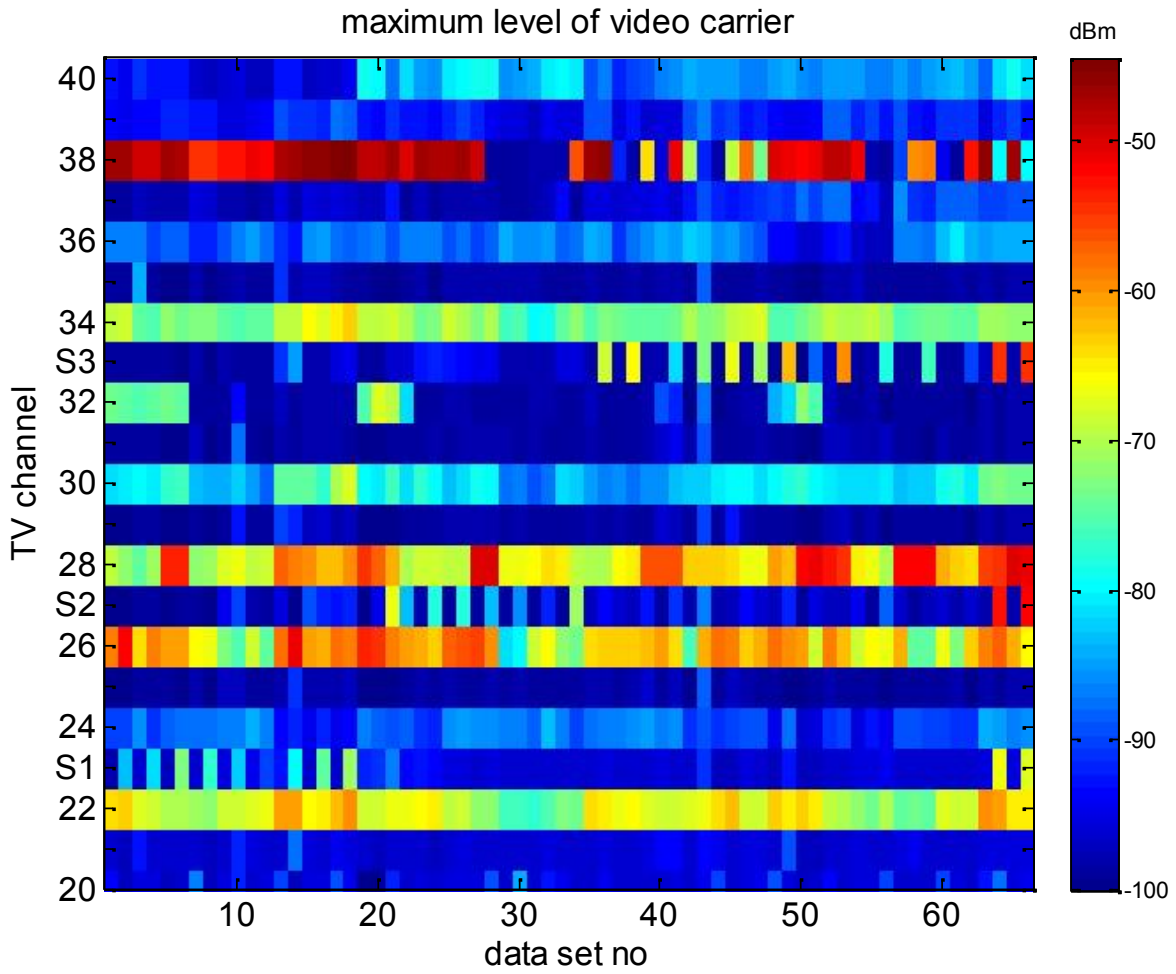
Device 2

Channel offset N	PR (dB)
N-1	-7.4
N+1	-13.6

- The N+1 channel may almost always be used.
- The N-1 channel may be used provided the devices are configured as per the protection ratio values in Table above.

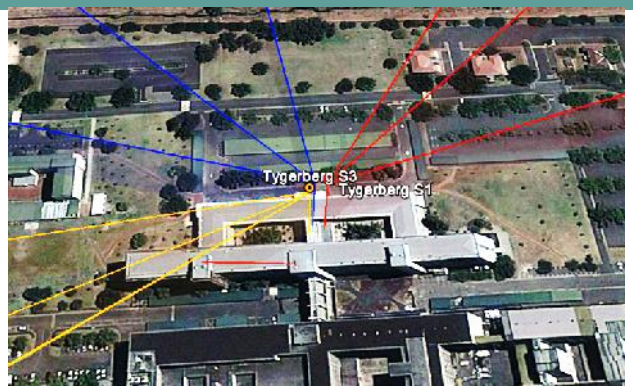
DSA
DYNAMIC • SPECTRUM • ALLIANCE

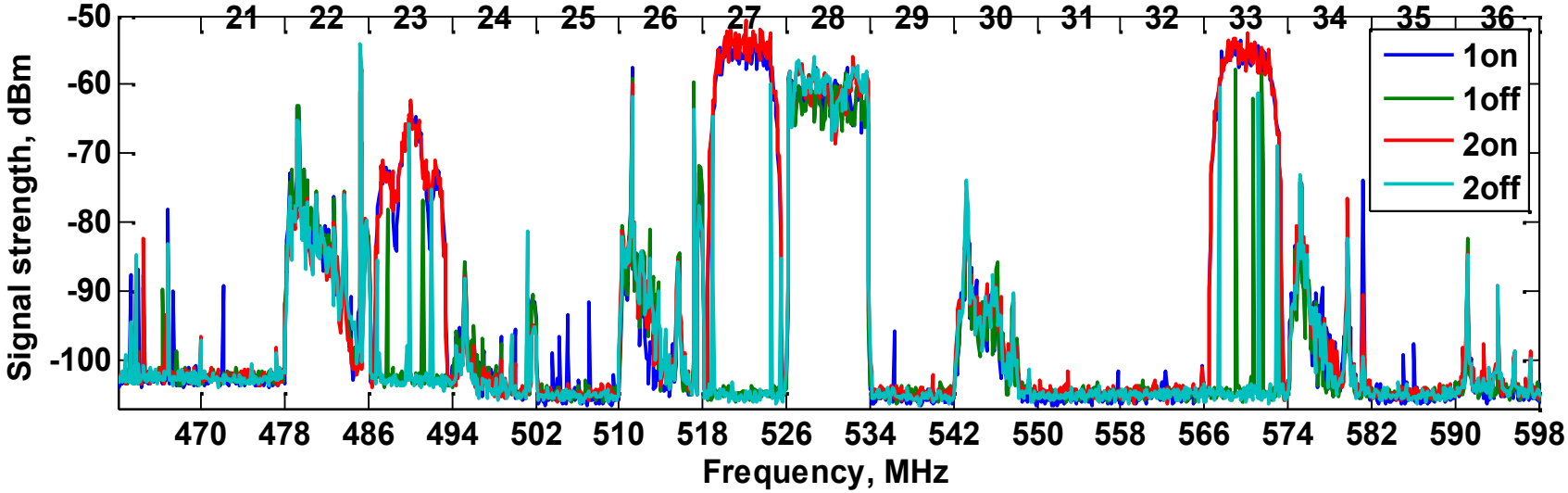
- Shows video signals strength for a given location/TV channel
  - Limited to channel 40 for picture clarity
- S1-S3 denote the three TV channels used to support services on the 3 sectors
- Datasets correspond to the measurement sites and WS transmitter's **ON** / **OFF** state



DSA

DYNAMIC • SPECTRUM • ALLIANCE





DSA
DYNAMIC • SPECTRUM • ALLIANCE

On analysis the following were observed:

- For WSD channel 23
  - channel 22: protection ratio are well satisfied;
  - channel 24: TV signal too low.
- For WSD channel 27
  - channel 26: PR almost always satisfied except at one measurement; interference can be contained within 32m* of the WSD.
  - channel 28: This is a digital TV channel
- For WSD channel 33
  - channel 32: broadcasting intermittent;
  - channel 34: PR satisfied at two of the schools and not always satisfied at the other two. interference can be contained within 160m* of the WSD.

*radius within which the interference is contained was calculated using this formula

$$R = D.10^{(dPR/20)}$$

Conclusions

- Technically, we
  - used a combination of predictions (Longley-Rice propagation model) and measurements to confirm the results
  - characterized the behaviour of each device before deploying it
  - did both theoretical computation of protection ratios and lab measurements for each device
  - Extensive monitoring of Cape Town network, planned to do a less intensive one for the second trial, however this will be done together with the broadcasters.
- Results prove that the technology works, there is no need to wait before starting the rule making process
- Stakeholder management
  - Broadcasters are important stakeholders – they must be consulted during the trial.
- Adopting this technology today can assist to connect the government and education facilities in rural where there is currently no connectivity.

DSA

DYNAMIC • SPECTRUM • ALLIANCE

Thank you!!