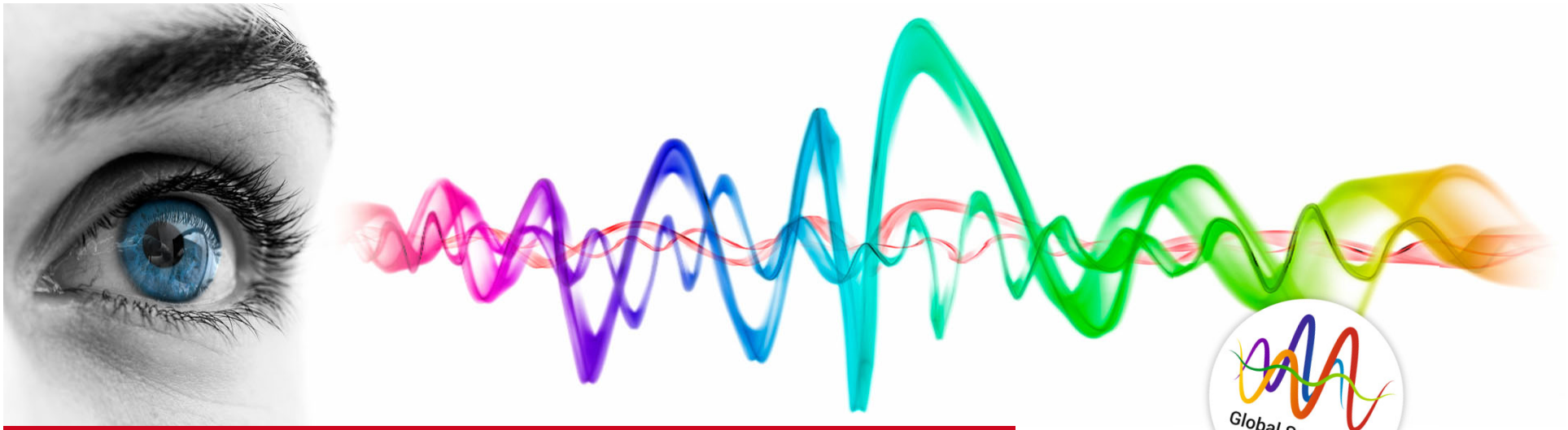
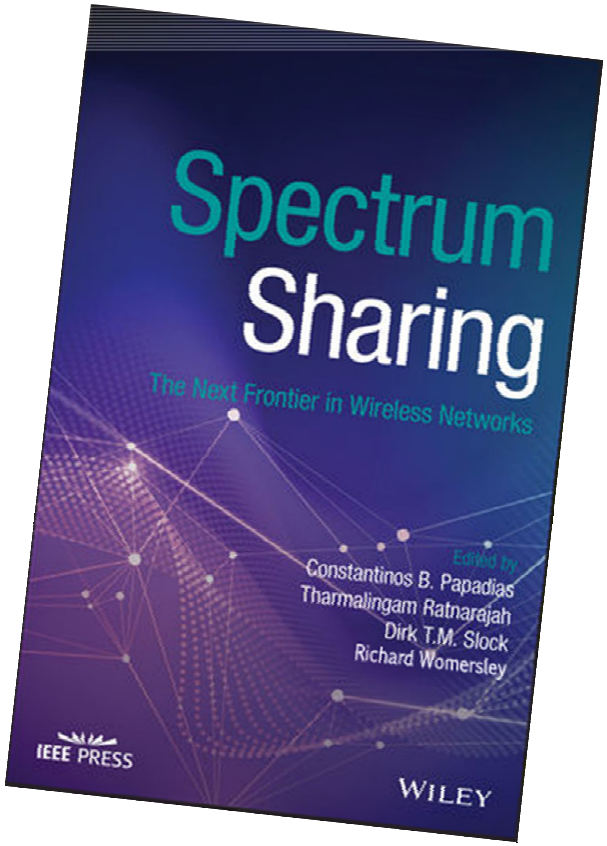


Richard Womersley | EUCNC | 7 – 11 June 2021

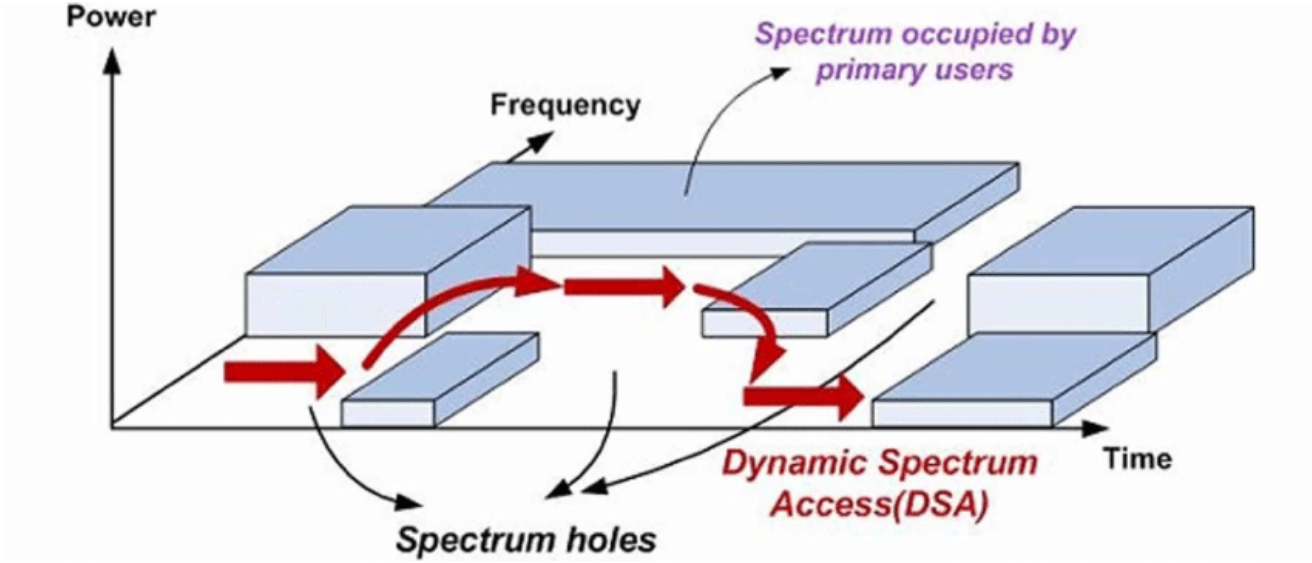
New Techniques for Sharing Spectrum – Monitoring and Big Data

Introduction

- Given the growing demand on the limited radio spectrum resources, regulators are looking at increasingly sophisticated ways to find opportunities for sharing between users
- Many ‘new’ sharing methods such as Dynamic Spectrum Access (DSA) and Licensed Shared Access (LSA) are fundamentally extensions of ‘command and control’ regulation
  - They do not take into account new developments in spectrum usage
  - They are based on old-fashioned sharing criteria
  - They do not provide the flexibility needed to fully embrace the opportunities presented by spectrum sharing



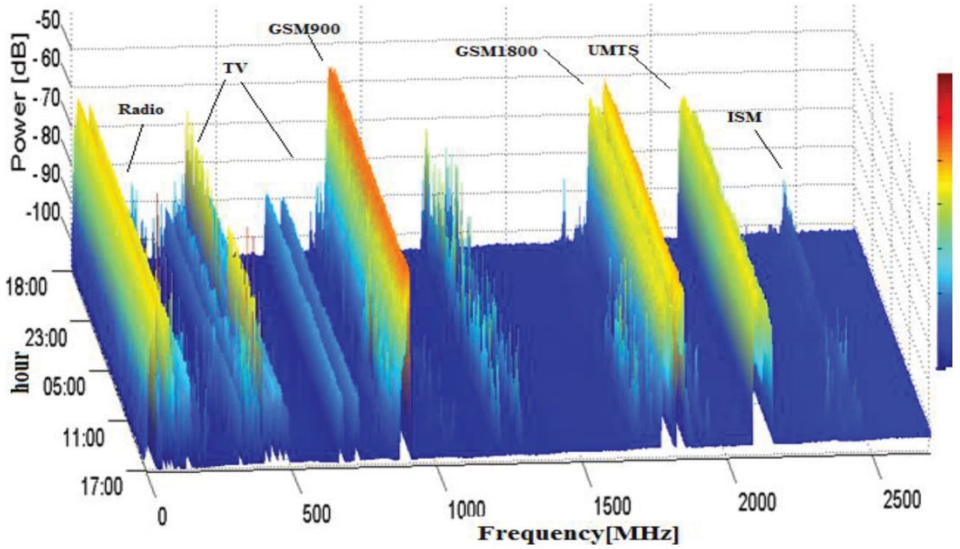
Dynamic Spectrum Access does…



- For example, **Dynamic** Spectrum Access relies upon:
  - **Static** and accurate knowledge of incumbent use of the spectrum
  - Planning criteria based on **fixed parameters** of the service sharing the spectrum
  - Propagation **predictions** which only provide a probabilistic view of sharing opportunities
  - Overly **cautious** approaches to protecting incumbent spectrum use

Dynamic Spectrum Access does not…

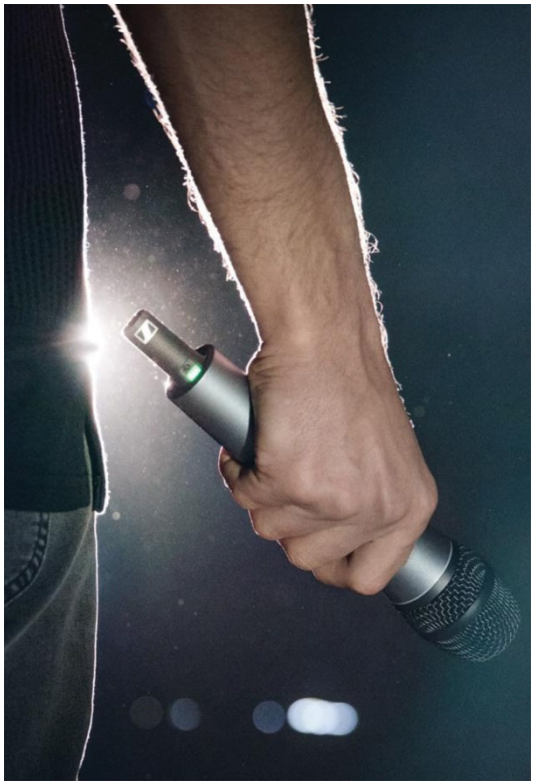
- Dynamic Spectrum Access ignores:
  - The so-called ‘hidden node’ **problem**
  - Hourly or diurnal **variations** in spectrum use
  - **Sophisticated** transmission waveforms which can adapt to spectrum conditions



Received power versus the frequency band (80MHz-2700MHz) for 24 hours
Meftah Mehdawi, N. Riley, K. Paulson, A. Fanan, M. Ammar

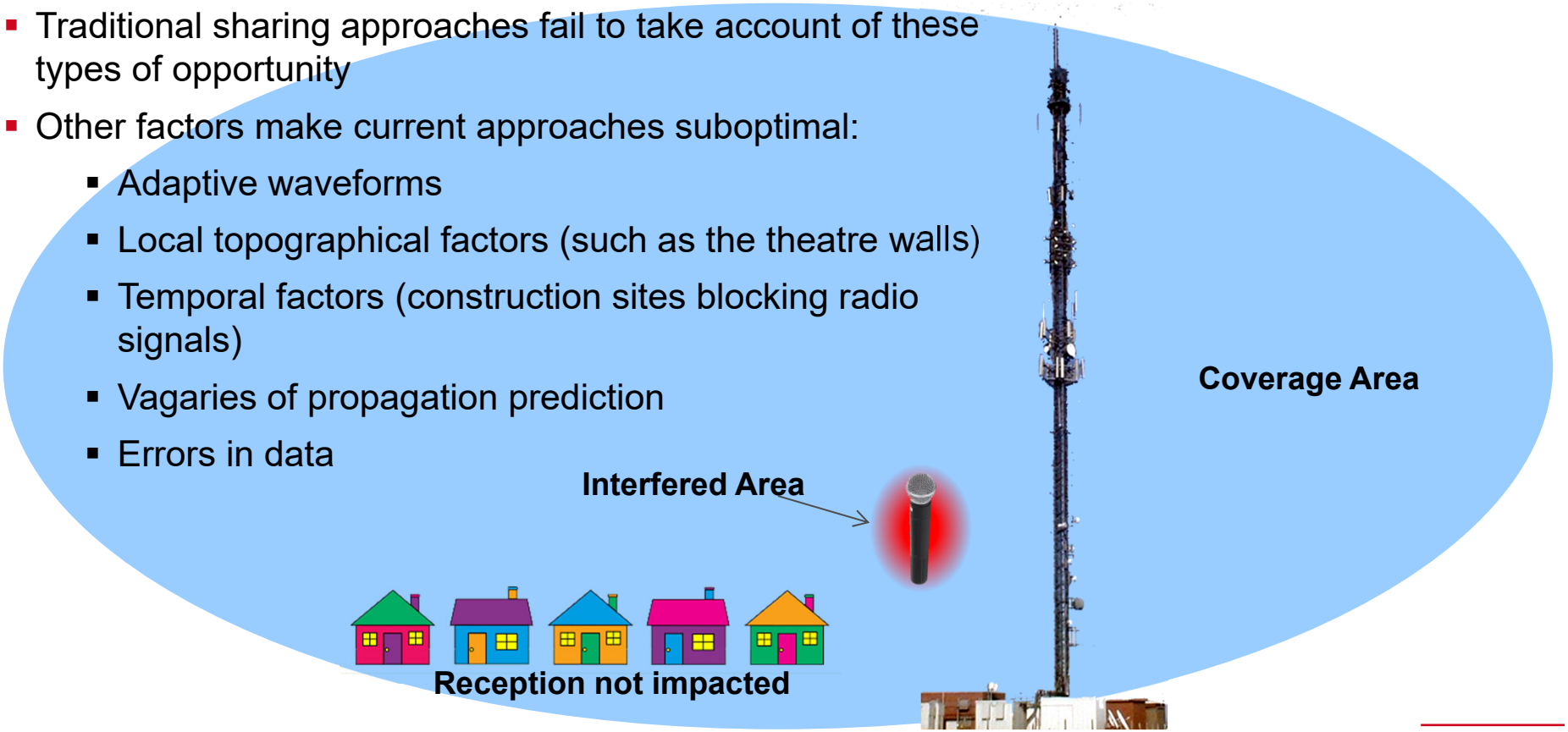
Example – Radiomicrophone in a Theatre

- Radiomicrophones share spectrum in the ‘white space’ inbetween television broadcasts in the UHF band
- Traditional rules are that they use frequencies which are not used locally for television in order to avoid interfering with television reception
- What if… a radiomicrophone used a frequency that **is** in use for television broadcasting nearby?
  - The frequency would be subject to high levels of incoming interference from the TV transmitter (though this would be reduced by the theatre walls), impacting the signal to noise of the received microphone signal, reducing its range and quality of operation
  - The radiomicrophone would cause interference to TV reception in the immediate vicinity. How small this ‘vicinity’ is depends upon the power of the microphone and the strength of the incoming TV signal (and the penetration loss of the theatre walls). The vicinity may be so small that it would not even impact TV reception in neighbouring buildings.



Traditional Sharing Approaches

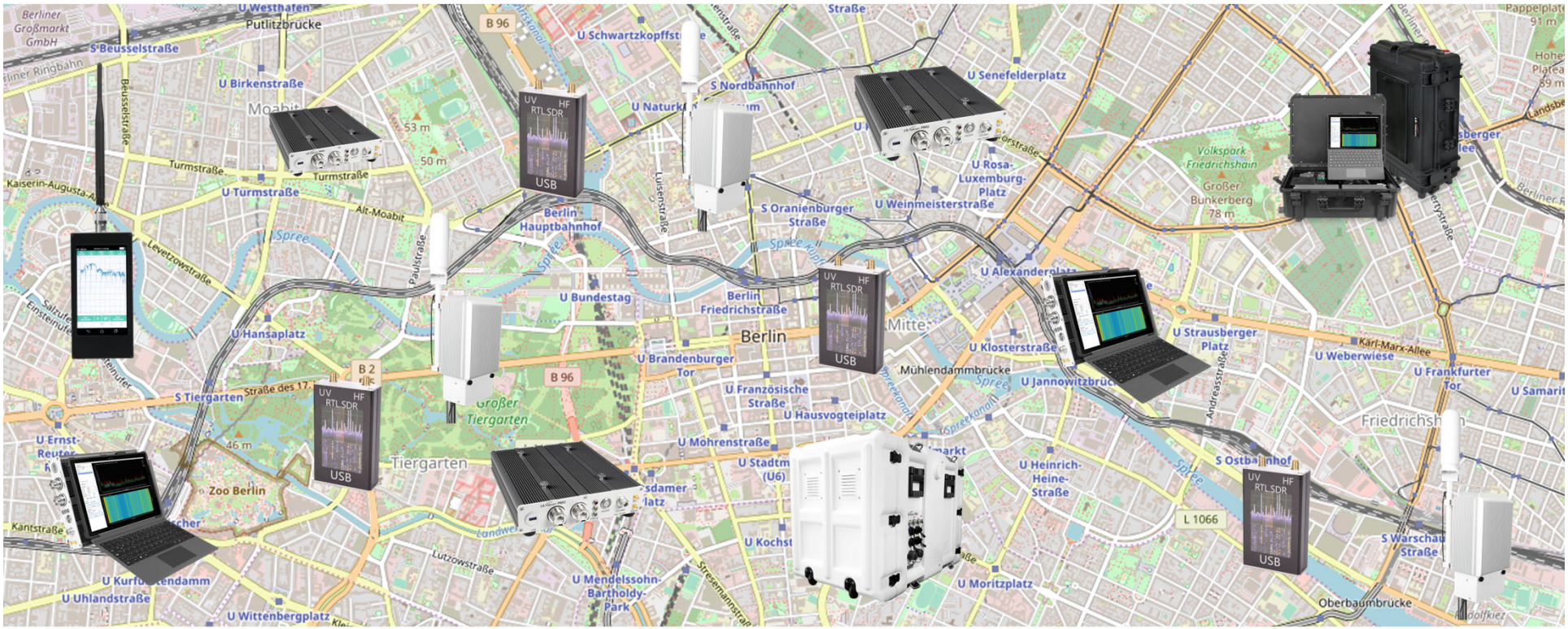
- Traditional sharing approaches fail to take account of these types of opportunity
- Other factors make current approaches suboptimal:
  - Adaptive waveforms
  - Local topographical factors (such as the theatre walls)
  - Temporal factors (construction sites blocking radio signals)
  - Vagaries of propagation prediction
  - Errors in data



A new sharing approach

- With the advent of:
  - spectrum monitoring capabilities (**data capture**)
  - big data (**data storage**), and
  - intelligent algorithms (**data mining**),
- it is now possible to implement far more innovative approaches to enabling shared access to spectrum whilst also increasing the accuracy of knowledge concerning the radio environment.

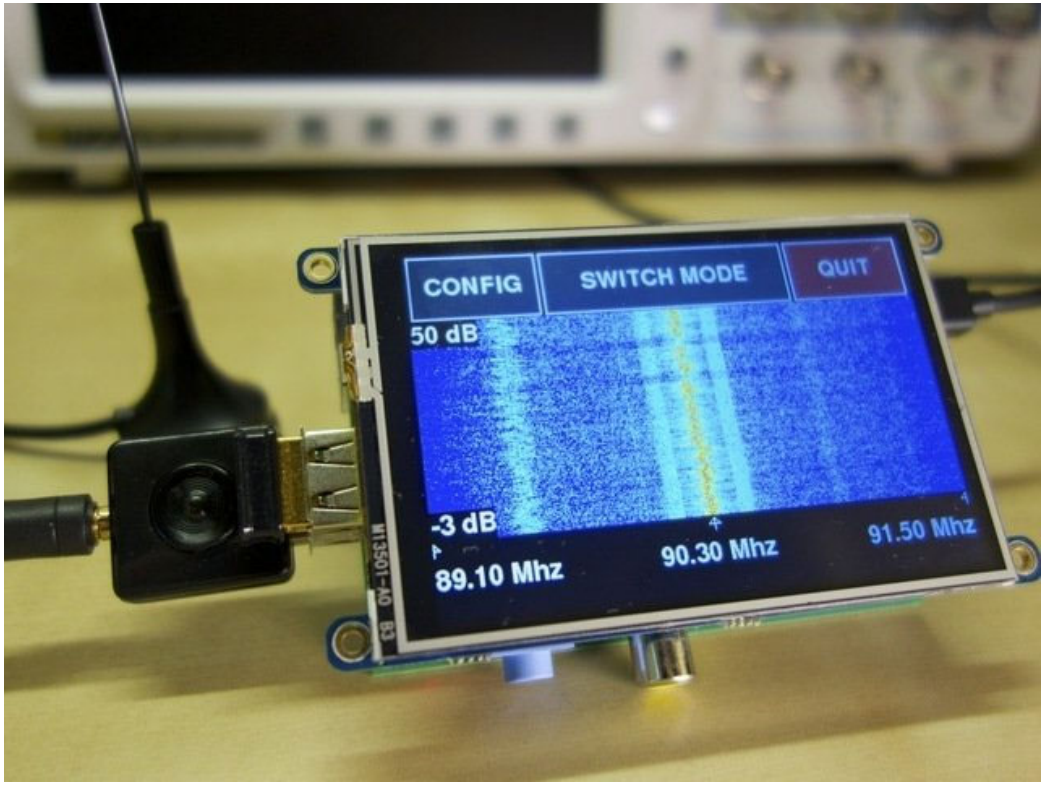
Data Capture



- Small, flexible, monitoring devices which can be mounted anywhere

Data Capture

- Raspberry Pi
- Software Radio ‘dongle’ } <€100
- Antenna
- Relatively uncalibrated (in absolute terms, though relative calibration can be achieved)
- Easily overloaded by strong signals
- Small sampling bandwidths
- Poor signal to noise performance
- Nevertheless they can provide **valuable information** on spectrum use



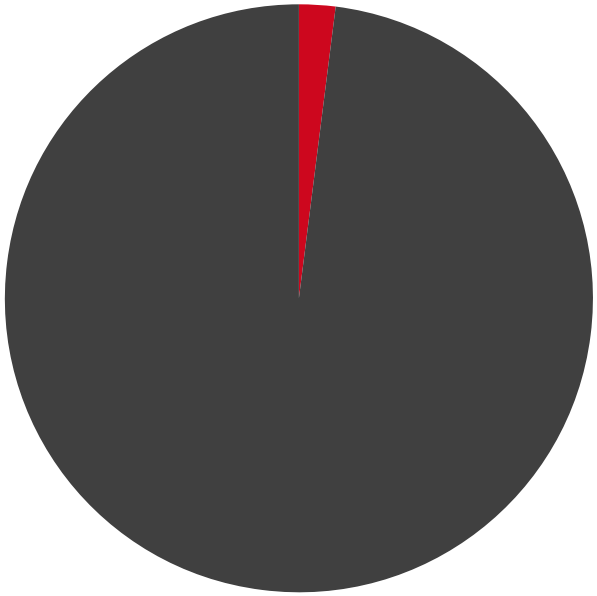
Data Storage

- High speed sensors produce vast data volumes

Why record everything if you don't know what you want?

Is there value in the business case?

Is it worth collecting all this data?



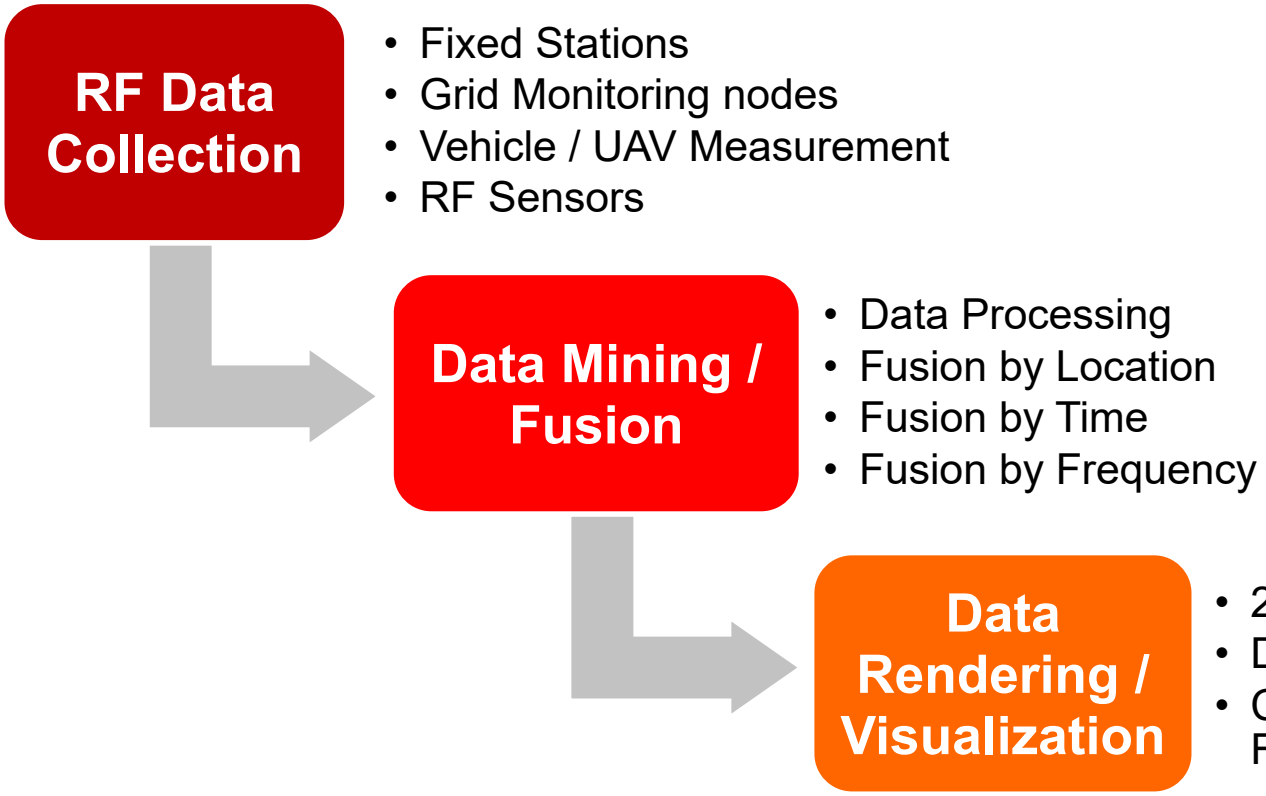
What use is it if we cannot analyze it?

How do I store / archive all this data?

Human analysis is pointless – too much data!

How do I network this volume of data together?

Data Mining

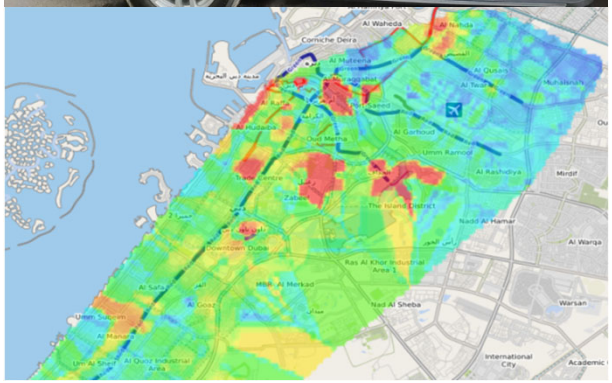


Applications

- Identification of unused frequencies, or areas of ‘white space’;
- Occupancy or coverage of a particular frequency;
- Occupancy or coverage of a particular set of frequencies (such as those belonging to a particular mobile operator) to identify, for example, coverage ‘not spots’;
- Comparative coverage of frequency bands of different networks to assess which provides the best signal;
- Channel occupancy or channel loading of a network;
- Mapping WiFi and ‘licence exempt’ spectrum usage;
- Pinpointing of unlicensed and illegal frequency usage, for example:
  - by comparing the licence database with the measured signals; or
  - by detecting signals which exceed their predicted level based on their licence parameters;
- Validating and calibrating coverage prediction models with real-world measurements;
- Checking the EM environment for potential infringements of EMF limits;
- Comparison of daily or hourly spectrum usage, to determine times of peak demand.

Example project: Dubai

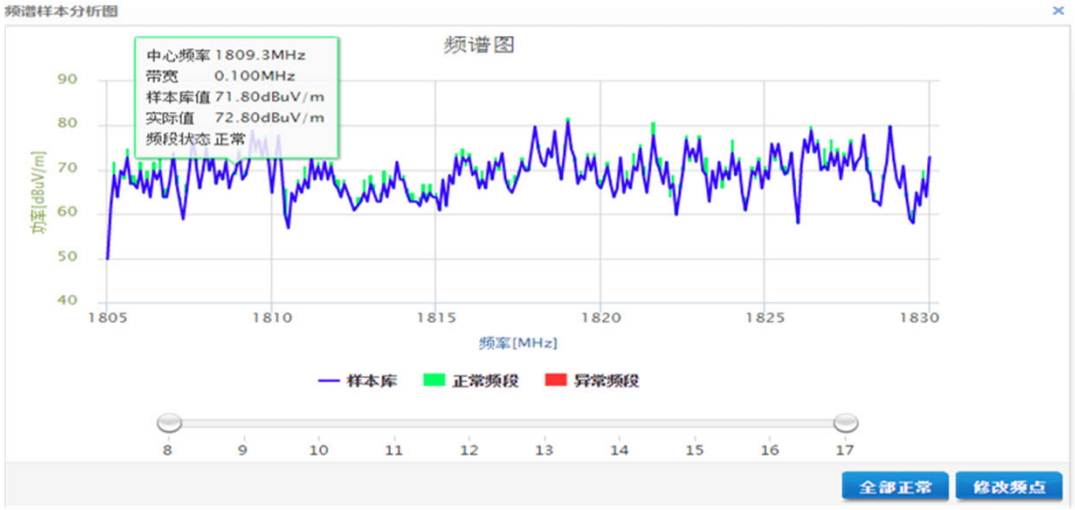
- Capturing the complete relevant spectrum in regular drive tests based on multiple mobile monitoring systems:
  - Measuring device: LS OBSERVER PPU 318w
  - Antenna: BAP1-218
  - Vehicle: Standard SUV
- Future vision: monitoring based on public-transport (e.g. busses, garbage trucks)
- Automatic data upload to server after drive test via WiFi
- Mapping the captured spectrum with SpectrumMap
  - Capturing various use cases
  - Coverage analysis, usage- and occupancy analysis



Example project: Shanghai

- **“Building systems for dynamically displaying of radio spectrum”** is one of the tasks listed in the Chinese five-year plan for radio management (2016－2020)
- Investigate spectrum usage based on real data
- Employ new technologies to improve the efficiency of radio management

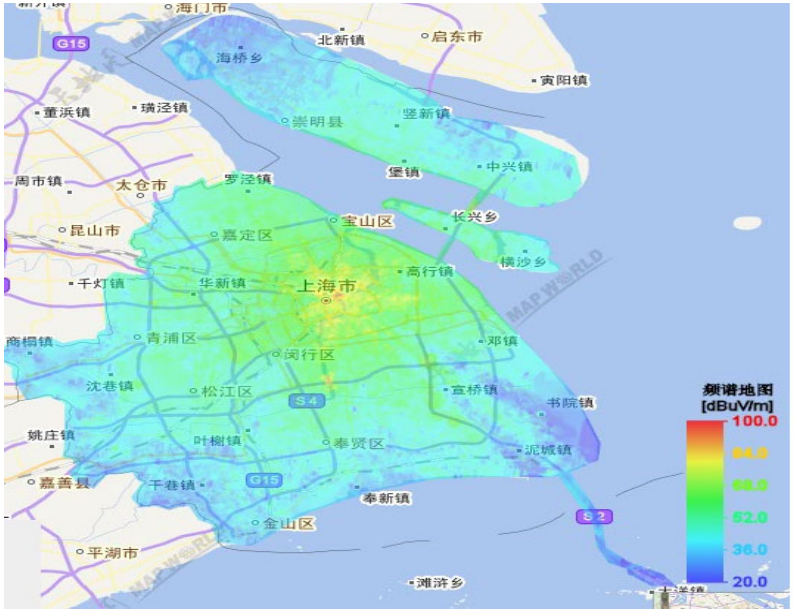
Measurement Data



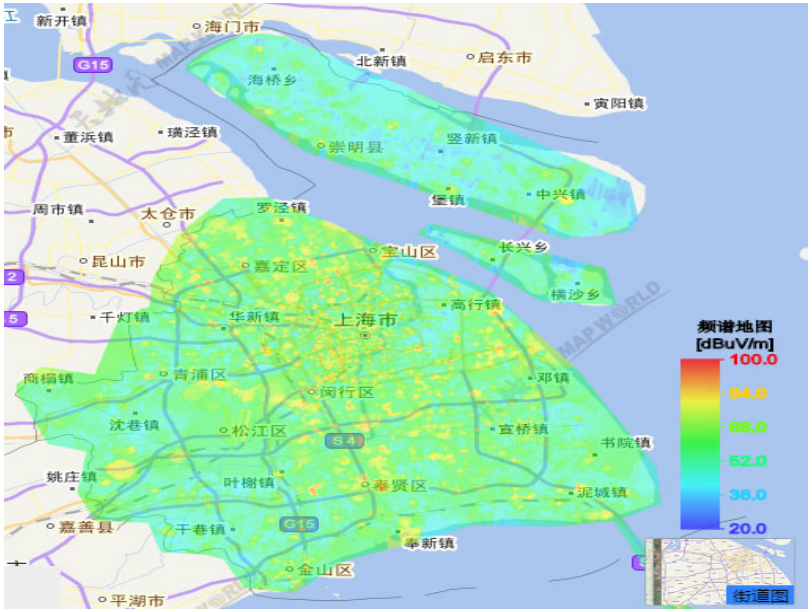
Raw Monitoring Data

Vehicle Measurement Data

Example of Results

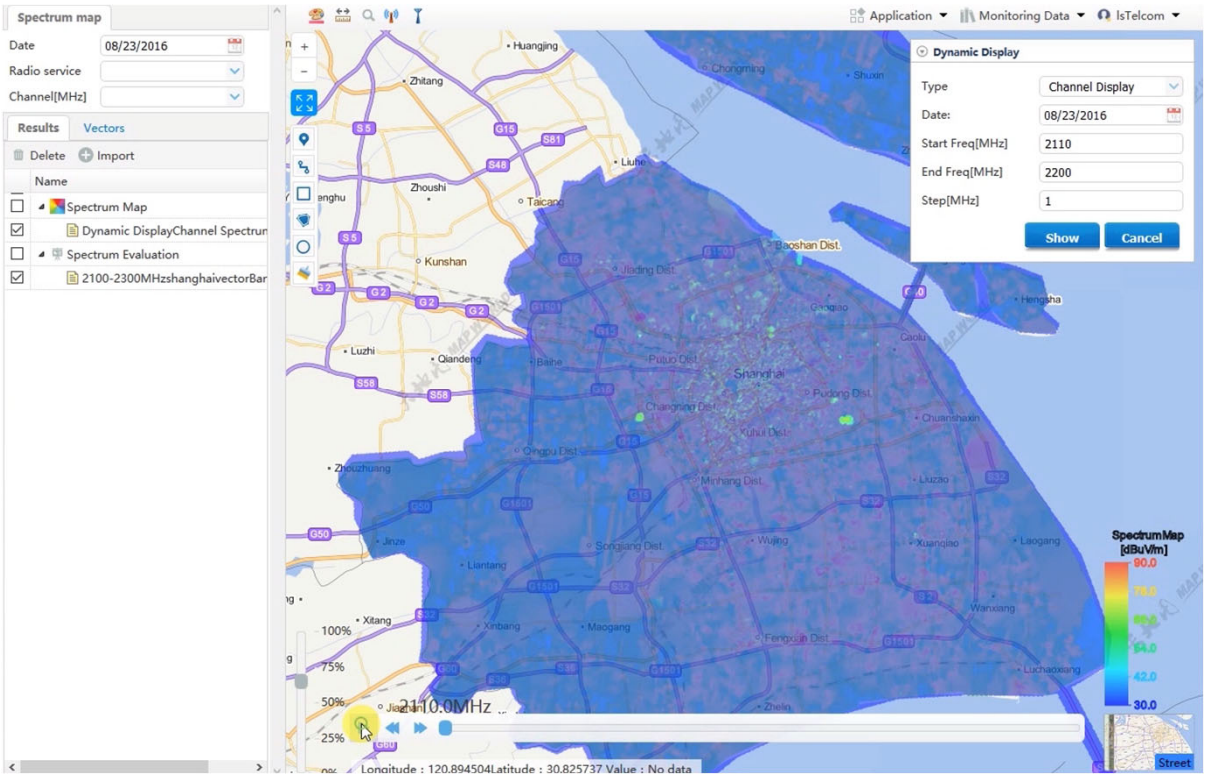


Field Strength of a Single Frequency (89.9 MHz)



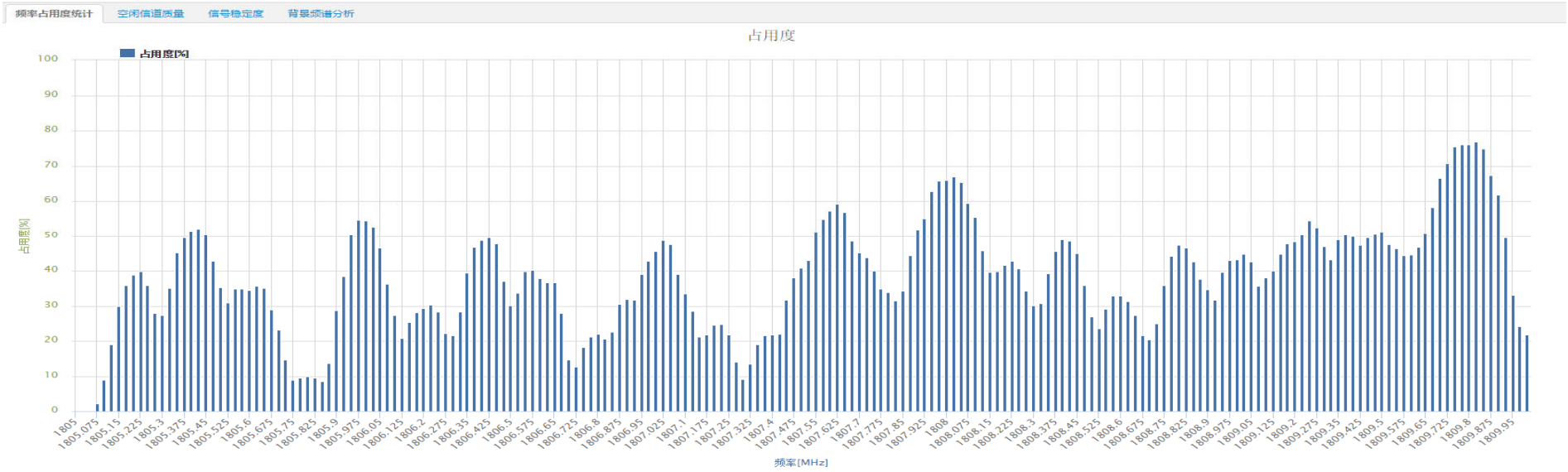
Field Strength of a Frequency Band (934 MHz - 936 MHz)

Example of Results



Dynamic Display (2110 MHz – 2200MHz, Step: 1 MHz)

Frequency Occupancy for a given location



Frequency Occupancy (1805 MHz – 1830 MHz)

LS telcom
Smart Spectrum Solutions

Safe and well-informed spectrum sharing is possible through intelligent processing of monitoring information

- Current spectrum sharing techniques use a bottom-up approach building on old fashioned compatibility analyses and a static view of spectrum utilisation options
- A top-down approach based on actual spectrum occupancy opens up new opportunities for sharing whilst fully protecting incumbent users

Thank you for your attention

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