+49 2407 575 7032 —Tel (switch)
+49 2407 575 7050 —Fax (office)

METADATA

OBTAINING ENTITY

- RWTH Aachen University, Department of Wireless Networks

TYPE OF DATA

- Spectrum Use Measurement Data (power spectral density over frequency)

DATASET NAMES

1. IN (Aachen, Germany, indoor in a modern office building, December 2006 – January 2007)
   - Subband 1: centre frequency: 770 MHz
   - Subband 2: centre frequency: 2250 MHz
   - Subband 3: centre frequency: 3750 MHz
   - Subband 4: centre frequency: 5250 MHz
2. NE (Maastricht, Netherlands, rooftop of a school in a residential area, May – June 2007)
   - Subband 1: centre frequency: 770 MHz
   - Subband 2: centre frequency: 2250 MHz
   - Subband 3: centre frequency: 3750 MHz
   - Subband 4: centre frequency: 5250 MHz
3. AB (Aachen, Germany, 3rd floor balcony in a residential area, June – July 2007)
   - Subband 1: centre frequency: 770 MHz
   - Subband 2: centre frequency: 2250 MHz
   - Subband 3: centre frequency: 3750 MHz
   - Subband 4: centre frequency: 5250 MHz

FORMAT

There are separate files for the PSD-values over frequency and the measurement times.

1. MATLAB-data file format (.mat)
   One data file for approximately 180 minutes of measurement trace.
   Data files and time files are consecutively numbered: (MeasRes_%4d_%4d.mat, subband, measurement block, TimesRes_%4d_%4d.mat, subband, measurement block)
   Measurement parameters have been saved, additionally: (parameterPackage_%d.mat, subband_number)
2. MATLAB-data file format (.mat)
   One data file for approximately 30 minutes of measurement trace.
   Data files and time files are consecutively numbered: (MeasRes_%4d_%4d.mat, subband, measurement block, TimesRes_%4d_%4d.mat, subband, measurement block)
3. MATLAB-data file format (.mat)
   One data file for approximately 30 minutes of measurement trace.
   Data files and time files are consecutively numbered: (MeasRes_%4d_%4d.mat, subband, measurement block, TimesRes_%4d_%4d.mat, subband, measurement block)

START TIME

1. IN
    - Subband 1: 2007-01-23 20:27:21 (Central European Winter Time = UTC+1)
    - Subband 2: 2006-12-27 16:26:01 (Central European Winter Time = UTC+1)
    - Subband 3: 2007-01-02 13:34:05 (Central European Winter Time = UTC+1)
    - Subband 4: 2007-01-08 12:33:13 (Central European Winter Time = UTC+1)
2. NE
    - Subband 1: 2007-05-15 11:00:59 (Central European Summer Time = UTC+2)
    - Subband 2: 2007-05-22 11:23:50 (Central European Summer Time = UTC+2)
    - Subband 3: 2007-05-29 11:22:51 (Central European Summer Time = UTC+2)
    - Subband 4: 2007-06-05 10:35:40 (Central European Summer Time = UTC+2)
3. AB
    - Subband 1: 2007-07-03 17:03:35 (Central European Summer Time = UTC+2)
    - Subband 2: 2007-07-25 09:55:44 (Central European Summer Time = UTC+2)
    - Subband 3: 2007-06-19 14:53:49 (Central European Summer Time = UTC+2)
    - Subband 4: 2007-06-26 13:56:46 (Central European Summer Time = UTC+2)

STOP TIME

1. IN
    - Subband 1: 2007-01-29 11:22:24 (Central European Winter Time = UTC+1)
    - Subband 2: 2007-01-02 13:21:56 (Central European Winter Time = UTC+1)
    - Subband 3: 2007-01-08 11:16:56 (Central European Winter Time = UTC+1)
    - Subband 4: 2007-01-15 11:25:36 (Central European Winter Time = UTC+1)
2. NE
    - Subband 1: 2007-05-22 11:14:40 (Central European Summer Time = UTC+2)
    - Subband 2: 2007-05-29 11:10:57 (Central European Summer Time = UTC+2)
    - Subband 3: 2007-06-05 10:35:05 (Central European Summer Time = UTC+2)
    - Subband 4: 2007-06-08 13:21:56 (Central European Summer Time = UTC+2)
3. AB
    - Subband 1: 2007-07-10 14:59:41 (Central European Summer Time = UTC+2)
    - Subband 2: 2007-08-08 13:21:47 (Central European Summer Time = UTC+2)
    - Subband 3: 2007-06-26 13:25:54 (Central European Summer Time = UTC+2)
    - Subband 4: 2007-07-03 16:50:47 (Central European Summer Time = UTC+2)

CREATION PROCESS

Measurement device: Agilent E4440 spectrum analyzer

Measurement parameters:

1. IN
   - Subband 1
     centreFrequency: 770 MHz
     span: 1500 MHz
     nbPoints: 8192
     sweepTime: 1000 ms
     amplitudeAttenuation: 0 dB
     intPreamp: yes: 28 dB gain
     extPreamp: no
     nbMeasurements: 259666
     pauseTime: 0 ms between two consecutive measurements
     resolutionBW: 200 kHz
     DetectorType: Average
     buffSize: 6000 sweeps per data file
   - Subband 2
     centreFrequency: 2250 MHz
     nbMeasurements: 277639
     All other parameters have been same as for subband 1.
   - Subband 3
     centreFrequency: 3750 MHz
     nbMeasurements: 272605
     intPreamp: no
     extPreamp: no
     All other parameters have been same as for subband 1.
   - Subband 4
     centreFrequency: 5250 MHz
     nbMeasurements: 312301
     intPreamp: no
     extPreamp: no
     All other parameters have been same as for subband 1.

2. NE
    - Subband 1
      centreFrequency: 770 MHz
      span: 1500 MHz
      nbPoints: 8192
      sweepTime: 1000 ms
      amplitudeAttenuation: 0 dB
      intPreamp: yes: 28 dB gain
      extPreamp: no
      nbMeasurements: 339380
      pauseTime: 0 ms between two consecutive measurements
      resolutionBW: 200 kHz
      DetectorType: Average
      buffSize: 1000 sweeps per data file
    - Subband 2
      centreFrequency: 2250 MHz
      nbMeasurements: 338514
      All other parameters have been same as for subband 1.
    - Subband 3
      centreFrequency: 3750 MHz
      nbMeasurements: 330000
      intPreamp: no
      extPreamp: yes: ? 24 dB gain (AddOns/3000-4500_S21.mat)
      All other parameters have been same as for subband 1.
    - Subband 4
      centreFrequency: 5250 MHz
      nbMeasurements: 146000
      intPreamp: no
      extPreamp: yes: ? 24 dB gain (AddOns/4500-6000_S21.mat)
      All other parameters have been same as for subband 1.

3. AB
    - Subband 1
      centreFrequency: 770 MHz
      span: 1500 MHz
      nbPoints: 8192
      sweepTime: 1000 ms
      amplitudeAttenuation: 0 dB
      intPreamp: yes: 28 dB gain
      extPreamp: no
      nbMeasurements: 335000
      pauseTime: 0 ms between two consecutive measurements
      resolutionBW: 200 kHz
      buffSize: 1000 sweeps per data file
    - Subband 2
      centreFrequency: 2250 MHz
      nbMeasurements: 689668
      All other parameters have been same as for subband 1.
    - Subband 3
      centreFrequency: 3750 MHz
      nbMeasurements: 330000
      intPreamp: no
      extPreamp: yes: ≥ 24 dB gain (AddOns/3000-4500_S21.mat)
      All other parameters have been same as for subband 1.
    - Subband 4
      centreFrequency: 5250 MHz
      nbMeasurements: 337847
      intPreamp: no
      extPreamp: yes: ≥ 24 dB gain (AddOns/4500-6000_S21.mat)
      All other parameters have been same as for subband 1.

Further details are given in the following paper:

M. Wellens and P. Mähönen
"Lessons Learned from an Extensive Spectrum Occupancy Measurement Campaign and a Stochastic Duty Cycle Model", in Proc. of International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCom), Washington D.C., USA, April 2009.

CREATORS

Dipl.-Ing. Matthias Wellens
RWTH Aachen University
Department of Wireless Networks
Kackertstrasse 9
52072 Aachen
GERMANY

Prof. Petri Mähönen
RWTH Aachen University
Department of Wireless Networks
Kackertstrasse 9
52072 Aachen
GERMANY

PRIMARY CONTACT

Dipl.-Ing. Matthias Wellens
Email address, see http://www.mobnets.rwth-aachen.de

DESCRIPTION OF ANY KNOWN CORRUPTION OR ANOMALIES DURING COLLECTION

- No anomalies are known to the contributors.
- During the data collection at the balcony location some problems occurred due to too high temperature inside the measurement box. Those have been fixed by adding additional fans to the box. The only consequence for the data collection has been a changed order of subbands in time due to testbed crashes. The datasets collected during the later on crashed experiments have not been included due to shorter measurement durations.

PLATFORM

- Agilent E4440A spectrum analyzer with inbuilt pre-amplifier
- We deployed an additional pre-amplifier for the two higher subbands. We measured the amplification gain (S_{21}) over frequency with an Agilent E5071B network analyzer with same configuration as used for the spectrum analyzer (frequency, measurement points). The results are given in AddOns/3000-4500_S21.mat and AddOns/4500-6000_S21.mat. The PSD levels received can be determined by subtracting the amplifier gain from the measured values.
- During the measurements a standard laptop configured the spectrum analyzer remotely using VISA-commands over TCP/IP over Ethernet. The running software was a bespoke extension to MATLAB taking advantage of the instrument control toolbox, an Agilent instrument driver. All software ran under the Microsoft Windows XP operating system.
- The data was written to an external harddrive that could easily be exchanged during the switch from one to another subband.
- We used Omnidirectional antennas:
    - A large discone antenna of type AOR DA-5000 covered the lowest frequency band between 20 MHz and 1.52 GHz.
    - We deployed a smaller discone antenna of type AOR DA-5000JA to receive signals in the next subband from 1.5 GHz up to 3 GHz.
    - Finally, we used a radom antenna of type Antennentechnik Bad Blankenburg AG KS 1-10 specified up to 10 GHz to cover the frequency range between 3 GHz and 6 GHz.
- We used high quality N-connectors cables.
- All hardware was placed in weatherproof and RF-shielded wooden box that we explicitly built for the measurement campaign.

Figure 1: Measurement setup as deployed at the location in the Netherlands.

TIME ZONE

- The time zone in which the measurements were taken is mostly Central European Summer Time or Central European Winter Time. The measurement data is based on these times and has not been adapted to UTC.

GEOGRAPHIC LOCATION

- We performed the first measurements in our laboratory in a modern office building in Aachen, Germany (IN: Latitude: 50° 47' 24.01" North, Longitude: 6° 3' 47.42" East).
- We selected a location in the Netherlands as second location. We placed our measurement box on the roof of the main building of the International School Maastricht (NE: Latitude: 50° 50' 32.34" North, Longitude: 5° 43' 14.93" East.), Maastricht, the Netherlands.
- We chose the third location as an example for locations where end-user devices capable of dynamic spectrum access might work in real scenarios. We measured the spectrum usage on a third-floor balcony of an older residential building in a rather central housing area of Aachen, Germany (AB: Latitude: 50° 46' 8.90" North, Longitude: 6° 4' 42.59" East).
- The view from the roof in the Netherlands was rather open and the location is in a residential area near downtown Maastricht.
- The balcony is open towards the area between Aachen downtown and Aachen main station with an angle of about 130°. The other directions are blocked by surrounding buildings.

NETWORK LOCATION

- Among others transmitters for cellular networks, broadcasting services, and short-range communication (WiFi, DECT, etc.) have been deployed near to both measurement locations.

CLOCK PARAMETERS

- The time stamps saved in the data files are taken from the internal clock of the laptop. Thus, their accuracy is not very good but clearly sufficient for our application since each sweep including the data transfer to the laptop took about 1.8 sec.