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Digital Radio Mondiale

RESULTS OF THE DRM FIELD TRIAL IN SRI LANKA

Introduction

The DRM Consortium carried out a field trial of the DRM system in the FM band in the Colombo area of Sri Lanka in November 2010.

The DRM Consortium members contributed their expertise and equipment to the trial to enable the system to be tested in a real commercial environment with a variety of different reception conditions. This document describes the trial and results.

Proposal

That the observations and measurements of the DRM system in the VHF bands reported in this document be used in furtherance of the acceptance of Digital Radio Mondiale (DRM) as digital system G in Recommendation ITU-R BS.1114 as given in **Annex 6** of Working Party 6A Chairman's Report (Document **6A/454**) and that they be used to develop a Working Document towards a Preliminary Draft New Report ITU-R BS.[DRM+] which will gather together appropriate field trial data and so provide a reference document on the capabilities of DRM+.



First DRM+ trial in the Asia-Pacific Region

Colombo, Sri Lanka 2010

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1 Introduction

DRM+ is an enhancement of the existing DRM (Digital Radio Mondiale) standard up to the VHF band III. It has been approved in the ETSI DRM standard [1] in 2009.

Prior to a DRM+ Workshop organized in Colombo, Sri Lanka, in December 2010 by the Telecommunications Regulatory Commission of Sri Lanka (TRC), the Sri Lanka Broadcasting Corporation (SLBC), Deutsche Welle (DW) and the Asia-Pacific Broadcasting Union (ABU), a two day mobile measurement campaign was conducted in the city of Colombo. Additionally during the Workshop a Live Surround Sound transmission was installed between the SLBC and the World Trade Centre, Colombo.

FIGURE 1
DRM+ Trial/Workshop announcement at the SLBC



This report contains a description of the DRM+ system parameters, the system setup and equipment that was used in the trial and the measuring results that were obtained in the mobile measuring campaign.

2 DRM+ System parameters

The DRM+ system parameters are shown in the following table:

System parameter	
Modulation	OFDM
Data rate	37 - 186 kbps
Sub-carrier modulation	4-/16-QAM
Signal bandwidth	96 kHz
Sub-carrier spacing	444.444 Hz
Number of sub-carriers	213
Symbol duration	2.25 ms
Guard interval duration	0.25 ms
Frame length	100 ms
Number of programmes	1-4

2.1 Encoding

In the DRM+ system Equal Error Protection (EEP) and Unequal Error Protection (UEP) are implemented. With UEP the parts of the audio bit-stream that are more susceptible to errors causing audible disturbances are provided with more protection. With 4-QAM modulation and EEP, the MSC (Main Service Channel), which contains the user data, offers four different protection levels with the following code and bit rates:

MSC: 4-QAM		
Protection level	Code rate	Bit rate [kbit/s]
0	0.25	37.3
1	0.33	49.7
2	0.4	59.6
3	0.5	74.5

With 16-QAM modulation the MSC uses multilevel coding and the following EEP protection levels with the corresponding code and bit rates can be chosen:

MSC: 16-QAM		
Protection level	Code rate	Bit rate [kbit/s]
0	0.33	99.4
1	0.41	122.4
2	0.5	149.0
3	0.62	186.3

Further configurations with UEP are possible.

The SDC (Service Description Channel), which contains signalling data, is modulated with 4-QAM. The following code rates can be chosen:

SDC: 4-QAM
Code Rate
0.5
0.25

The FAC (Fast Access Channel) uses a fixed code rate of $R = 0.25$.

2.2 Interleaving

In order to improve the robustness of the bit stream against channel errors, bit interleaving is carried out over one frame (100 ms) and convolution cell interleaving over 6 frames (600 ms).

3 System setup

The Sri Lanka Broadcasting Corporation switched off their FM transmitter broadcasting City FM with a power of 2 kW to enable the feeder and antenna system to be used for the DRM+ trial broadcast. The transmitter is located at the Sri Lanka Broadcasting Corporation's headquarters in Colombo. Six other FM transmitters with several kW power are radiated with circular polarization by the antenna array shown in Figure 2. The DRM+ trial used the City FM frequency of 87.6 MHz for the mobile measurements conducted on 29th and 30th November 2010, but due to coverage of an important cricket match on City FM on 2nd December 2010, was switched to 95.6 MHz for the surround sound demonstration to the World Trade Centre.

FIGURE 2

Transmitting antenna array with circular polarization



The transmission parameters were set to the most robust possible for the mobile tests since only a low power exciter was available. However, for the surround sound demonstration to the World Trade Centre, a less robust set of parameters were chosen in order to allow a higher payload and thus show a wide range of the available features.

3.1 Transmitter setupThe following transmitter equipment was used for the measurements

- Fraunhofer DRM ContentServer
- RFmondial Modulator
- Nautel Exciter/Amplifier NVE, output power: 47 W

For the mobile measurements the following parameters were used:

- MSC: 4-QAM, protection level 0 ($R = 0.25$)
- Transmission frequency 87.6 MHz

For the surround sound demonstration the following parameters were used:

- MSC: 16-QAM, protection level 2 ($R = 0.5$)
- Transmission frequency 95.6 MHz

3.2 Receiver setup

- Antenna: Kathrein K 51 16 4/BN 510 351 magnetic monopole antenna mounted on the roof of a van at a height of around 2 m
- RFmondial DRM+ Frontend
- RFmondial Software Receiver

FIGURE 3

Measuring van of 'Deutsche Welle' with the mounted antenna



3.2 Transmission content

The normal programme content of SLBC's City FM was transmitted in stereo over DRM+ while conducting the test.

3.3 Measurement parameters

The following parameters were recorded and analyzed during the measurements:

- GPS coordinates;
- Receiver Status and Control Interface (see RSCI specifications [2]) Data and the audio frame availability have been analysed.

3.4 Field strength prediction and measurement locations overview

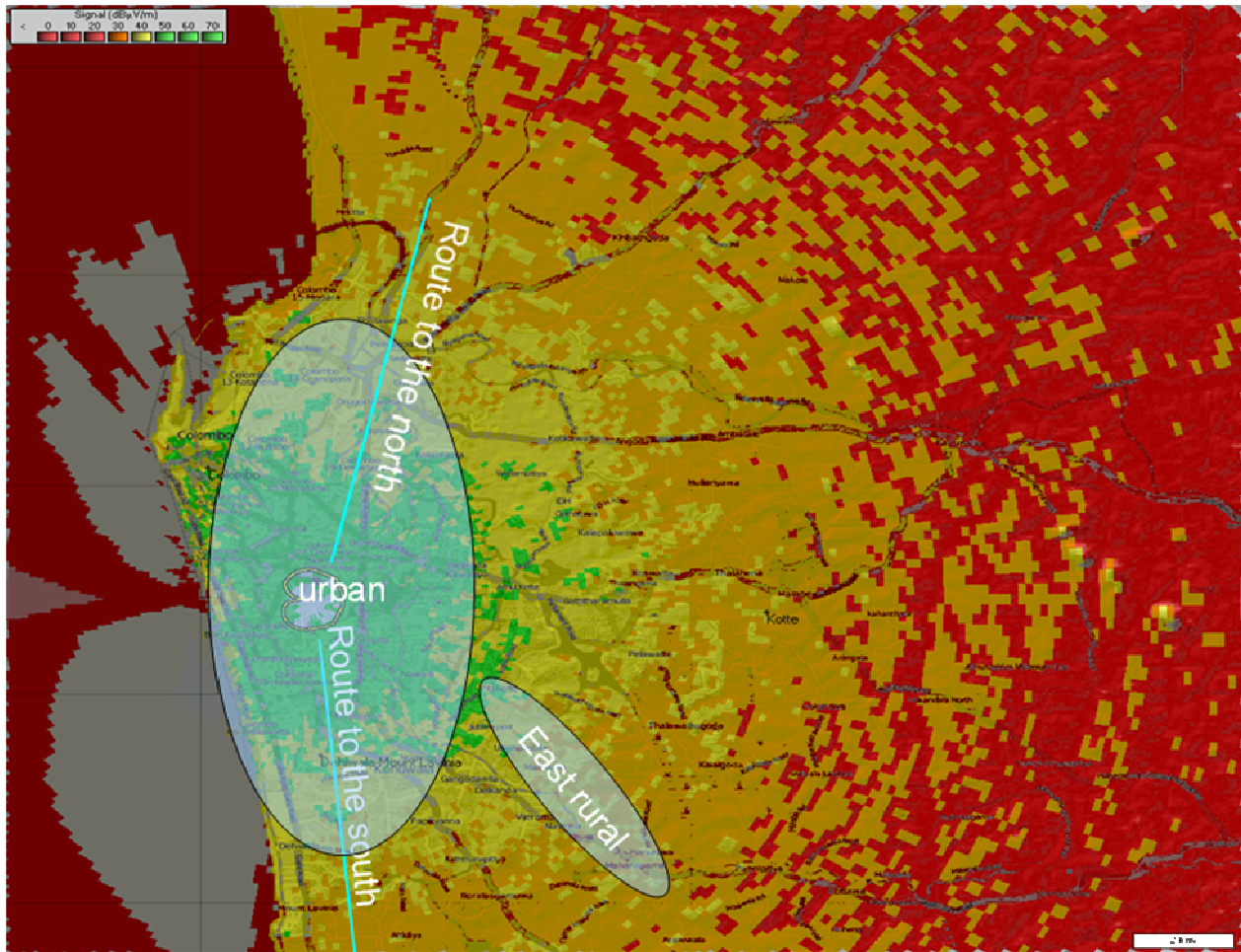
A field strength prediction was made with the free radio propagation simulation program Radio Mobile in order to get an overview of where reception should be expected. Radio Mobile is based on the ITS (Longley-Rice) propagation model.

The program uses topographic data (SRTM data from the Space Shuttle Radar Terrain Mapping Mission), but no morphology (buildings, woods, etc.). Therefore in urban areas the predictions are very optimistic. The prediction in Figure 4 has been conducted with a transmission power of 47 W with a probability of 95% of the locations and 50% of time.

Mobile reception with DRM+ 4-QAM should be possible with field strength above around 35 $dB\mu V / m$ according to the DRM+ planning parameters. Accordingly, in the green and parts of the yellow regions in Figure 4 reception should be possible. However, due to the morphology not taken into account in the prediction in urban areas the field strength can be affected by severe fading which results in a lower median field strength.

FIGURE 4

Field strength prediction and measuring routes and environments (Map data (c) OpenStreetMap and contributors, CC-BY- SA, <http://www.openstreetmap.org>)



On the left side the antenna pattern of the transmitting antenna is plotted at the location of the transmitting station.

Additionally the different measurement routes and environments are added to the prediction in Figure 4.

4 Mobile measurements

Measurements were conducted in the City of Colombo on 3 radial routes to the north, south and east. Towards the west, the station is located near to the sea. The north and south measurement routes are characterized by a mostly urban environment, whereas the east route is more rural in nature.

4.1 Measurements towards the north

On the route to the north, good reception was possible up to a distance of around 9 km from the SLBC. Figure 5 shows the audio frame availability on the route to the north.

FIGURE 5
Route towards the North

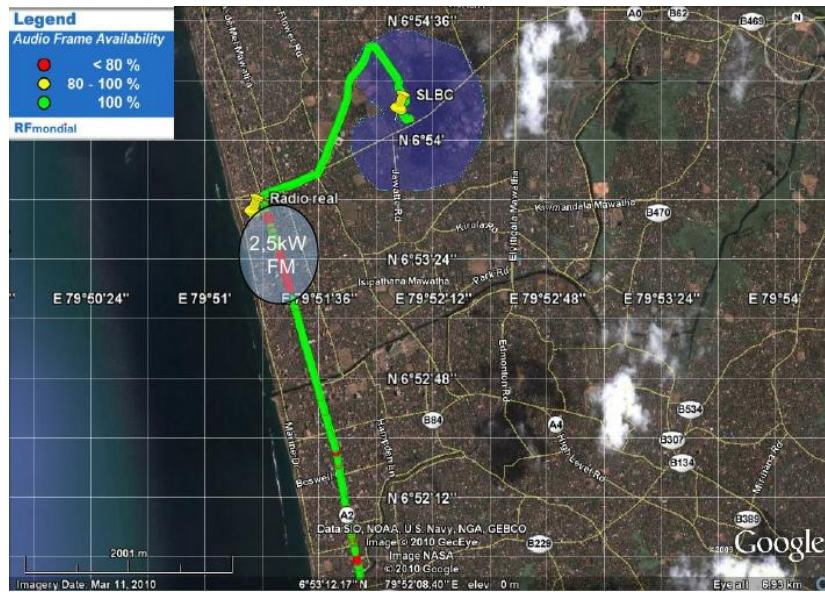


4.2 Measurements towards the south

The measurement route towards the south passed a strong FM interferer in the second adjacent channel at 87.8 MHz (200 kHz above the DRM+ signal) with a transmission power of 2.5 kW. The incoming field strength of the FM transmitter when driving past is around 120 dB μ V/m, whereas the DRM+ signal at this location has a field strength of around 50 dB μ V/m. The selectivity of the measuring receiver is insufficient to be able to decode the DRM+ with such a strong interferer. The coverage towards the south extended to around 5 km from the transmitter.

FIGURE 6

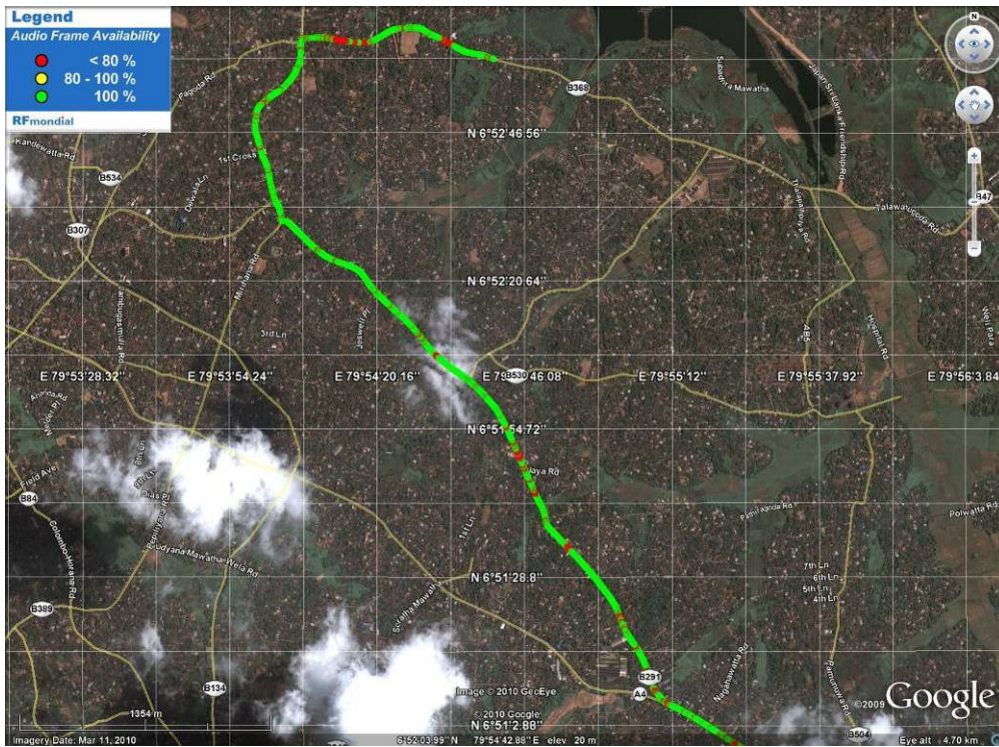
Measurement route toward the south



4.3 Measurements towards the east in a rural area

Additional measurements in a rural area were conducted. The area was characterized by small buildings and agriculture. Here, reception was possible up to around a distance of 9 km from the transmitter station. Figure 7 shows the rural route which is located in the south east of Colombo (see Figure 4).

FIGURE 7
Measurement in a rural area



5 Live Surround Sound Transmission

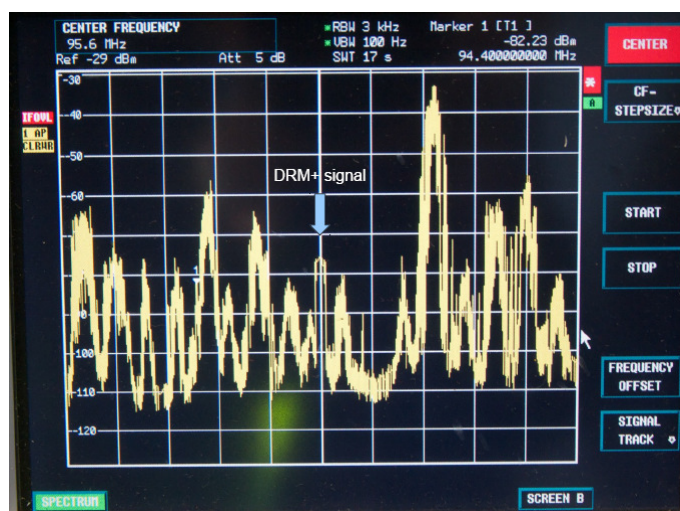
During the DRM+ Workshop, a live Surround Sound transmission was installed between the SLBC and the World Trade Centre, Colombo. Using a 16-QAM modulated signal with protection level 2, sufficient capacity was available to carry the live SLBC City FM programme in stereo, a surround sound audio stream, together with a Journaline service which provided different news and information content. The World Trade Centre, Colombo is located at a distance of 4 km from the transmission station and all services were received successfully without errors. The total bit rate of the signal was 149.3 kbps.

FIGURE 8
Surround transmission location



Figure 9 shows the FM spectrum received in the World Trade Centre. The DRM+ signal is located in the centre at a frequency of 95.6 MHz.

FIGURE 9
FM Spectrum received in the World Trade Centre



6 Conclusions

The first DRM+ trial in the Asia Pacific was conducted successfully in Colombo, Sri Lanka at the end of November 2010. The functionality of the DRM+ system was also presented with the field trial.

A good stereo audio quality was possible down to a field strength of around $35 \text{ dB}\mu\text{V} / \text{m}$. In comparison, an FM stereo signal needs a field strength of $66 \text{ dB}\mu\text{V} / \text{m}$ in an urban environment at a height of 10 m (+ 10 dB at a height of 1.5 m) [3].

The DRM+ coverage area extended to between 5 and 9 km from the transmission site with only 47W of transmitter power.

Additionally, a DRM+ live Surround Sound transmission could be received without errors in the World Trade Centre, Colombo.

Many thanks to all involved persons and organizations in the trial!

References

- [1] ETSI. ES 201 980, Digital Radio Mondiale (DRM), System Specification. 2009.
 - [2] ETSI. TS 102 349, Digital Radio Mondiale (DRM), Receiver Status and Control Interface (RSCI). 2009.
 - [3] ITU. ITU-R BS.412-9, Planning Standards for terrestrial FM sound broadcasting at VHF. 1995.
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