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Brazil (Federative Republic of)

MEASUREMENTS OF MEDIUM WAVE FIELD STRENGTH
IN SÃO PAULO – BRAZIL

Results of two campaigns

1 Introduction

This document describes the experimental setup and presents the results of medium wave propagation measurements campaigns that are being carried out Brazil. A hybrid signal composed of an analog AM signal and a digital DRM signal, with the same content, were broadcasted in diurnal and nocturnal transmissions.

The experiment is part of a series of field trials that are being conducted by the Brazilian Government to evaluate the performance of DRM standard, which includes campaigns at MW, HF and VHF frequency bands in the cities of São Paulo, Rio de Janeiro and Belo Horizonte.

Results presented here correspond to measurements of field strength and signal-to-noise ratio at MW from the two campaigns in São Paulo.

The tests were conducted by the National Institute o Metrology (Inmetro), the National Institute of Science and Technology in Wireless Communications (INCT-CSF) and the public broadcaster Padre Anchieta Radio Foundation (Radio Cultura), whit support from ANATEL and supervision of the Ministry of Communications.

2 Measurements setup

The transmissions for these trials were done from two Medium Wave transmitter station at South-East of São Paulo City (Figure 1).

In both measurements campaigns the radio station transmitter consists of two Harris 3DX-50 transmitters, which outputs are added in a coupler. The power of each 3DX-50 is 50 kW giving a total transmitter output power of 100 kW. A DRM content server and a DRM modulator generated the DRM signal. The modulator was connected to one of the two 3DX-50. Thus, the maximum transmission power was 50 kW. Table 1 shows the main technical characteristics of the transmission setup for each measurements campaign.

The tests were made in simulcast mode. The DRM signal was transmitted on the adjacent channel at 1 210 kHz (1st campaign) and 790 kHz (2nd campaign). The DRM signal was modified in amplitude by spectral shaping, decreasing the DRM signal strength in the vicinity of the AM signal to cause less interference to AM receivers. Although the DRM signal is degraded by about 2 dB due to the shaping, it allows reducing the protection ratio to 12 dB (the typical protection ratio for DRM in MW is 16 dB). The DRM signal strength can be increased in 4 dB, providing an overall improvement in DRM signal reception of approximately 2 dB.

FIGURE 1

Transmitter location

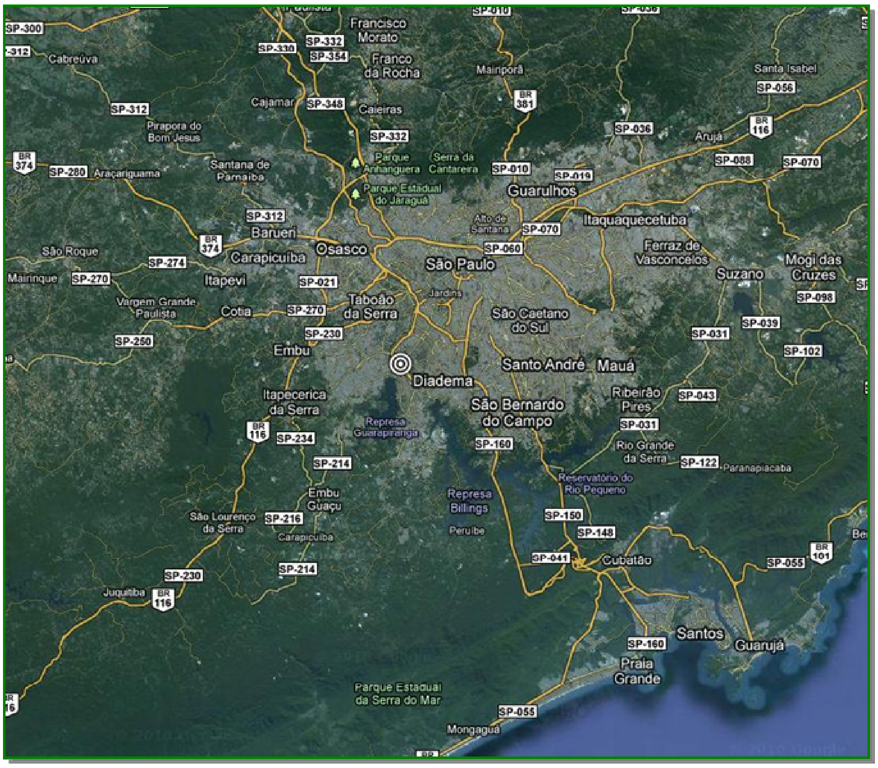


TABLE 1

Transmitter setup

Transmitter site	**São Paulo**	**São Paulo**
Broadcaster	Radio Cultura	Radio CBN
Transmission centre coordinates	46°42’53.84”W; 23°40’37.16”S	46°32’20.20”W; 23°36’20.85”S
AM Frequency	1200 kHz	780 kHz
AM transmission power (Day/Night)	50 kW/20 kW	50 kW / 10 kW
DRM Frequency	1 210 kHz	790 kHz
DRM transmission power (Day/Night)	3.15 kW / 1.26 kW	3.15 kW/1.26 kW
Radiating system	Vert. Monopole (70 m height)	Vert. Monopole (130 m height)
Transmission scheduling	24/7	24/7

Two DRM transmission modes were used for daytime and another two for nighttime. For each period two transmission modes were used: a relatively robust mode (16 QAM in the MSC channel) and a high bit-rate channel (64 QAM modulation in the MSC channel). The daytime modes are based on robustness mode A, while the nighttime modes are based on B robustness mode, following the DRM standard recommendation 0. The details of these modes are shown on Table 2.

TABLE 2

DRM transmission modes

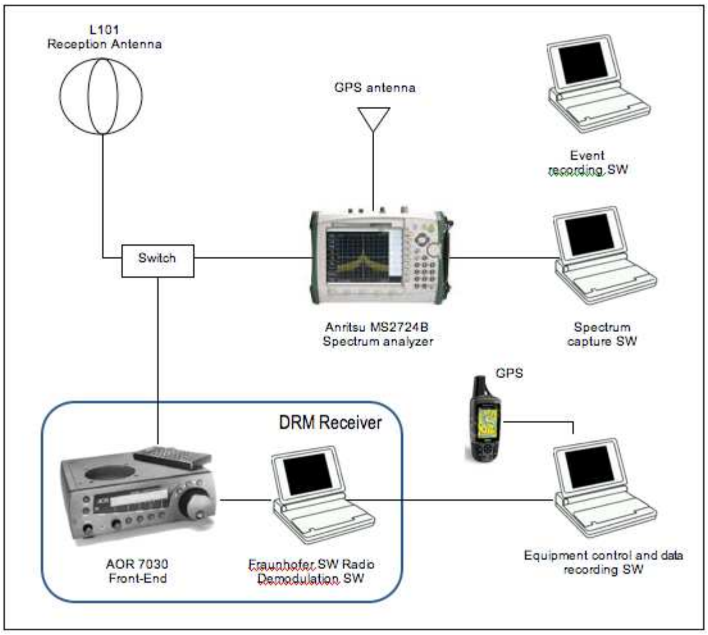
Name	**OFDM Robustness Mode**	**Bandwidth**	**MSC Modulation**	**SDC Modulation**	**Code Rate**	**Interleavin g**	**Bit-rate (kbps)**	**Audio**
DAY16	A	10 kHz	16-QAM	4-QAM	0,62	Long	18,4	P. Stereo
DAY64	A	10 kHz	64-QAM	16-QAM	0.6	Long	26,5	Stereo
NIGHT16	B	10 kHz	16-QAM	4-QAM	0,62	Long	14,5	Mono
NIGHT64	B	10 kHz	64-QAM	16-QAM	0,6	Long	20,4	P. Stereo

To measure the received signals a mobile unit shown in Figure 2 was used. The two main components of the reception setup are a professional DRM receiver and a spectrum analyzer.

Figure 4 shows a scheme of the receiver setup. A calibrated double loop active antenna, with an omni directional radiation pattern, is used to receive the signal. The antenna can be connection is switched between the two measuring devices, the DRM receiver and the spectrum analyzer.

FIGURE 2

Receiver setup



3 Measurements campaigns

A software tool running on a laptop records the spectrum analyzer data are recorded and the time and location information provided by a GPS. Another laptop controls the DRM receiver and records the data generated by it. The software adds the position information generated by a GPS to the records. Finally a third laptop is used to the input of information about events along the route (passing through tunnels, crossings under power lines, etc.), that is, any additional information that may help to understand the results and cannot be recorded automatically. A technician is responsible for manually input these events.

The trials included both mobile and static measurements. In this document however, only static reception results are shown. Measurements were performed in two types of routes: radial routes, to analyze signal behavior with distance to the transmitter and define the coverage area; and local routes to evaluate the effect of different reception environments on DRM signal reception.

The daytime routes for the 1st campaign are shown on Figure 4. During the night measurements were performed in three routes, 7, 8 and 9, very similar to routes 2, 8 and 5 respectively.

FIGURE 3

Measurements routes 1st campaign and fixed measurement points

The daytime routes for the 2st campaign are shown on Figure 4. During the night measurements were performed also in three routes, in routes 2, 3 and 7.

FIGURE 4

Measurements routes 1st campaign and fixed measurement points

4 Field strength measurements results

4.1 Results of the 1st Campaign

Results of the field strength measurements at 70 fixed points along the six daytime measurements routes are shown in Figure 5 and Figure 6, corresponding to the 16 QAM signal reception at daytime and nighttime, respectively, and Figure 7 and Figure 8, corresponding to the 64 QAM signal reception at daytime and nighttime, respectively. These figures also show the field strength predicted by the method in Recommendation ITU-R P.328-9. Table 3 shows the parameters used in the calculation. The ground conductivity was obtained from Recommendation ITU-R P. 832-2.

TABLE 3

Parameters for field strength prediction

Relative ground permittivity	15
Ground conductivity	1 mS/m
Transmitted power	Daytime 50 kW Night time 20 kW
Characteristic field	315 mV/m (110dBμV/m)

FIGURE 5

Received field strength (16 QAM - daytime) and ITU-R P.368 prediction – 1st campaign

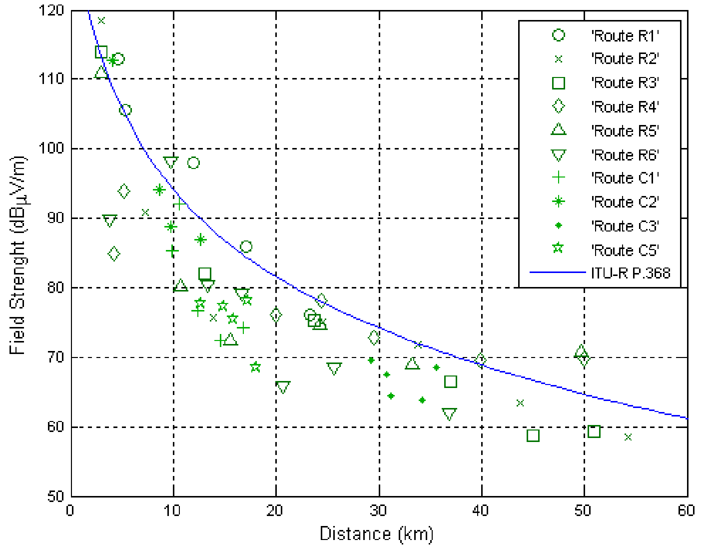


FIGURE 6

Received field strength (16 QAM - nighttime) and ITU-R P.368 prediction – 1st campaign

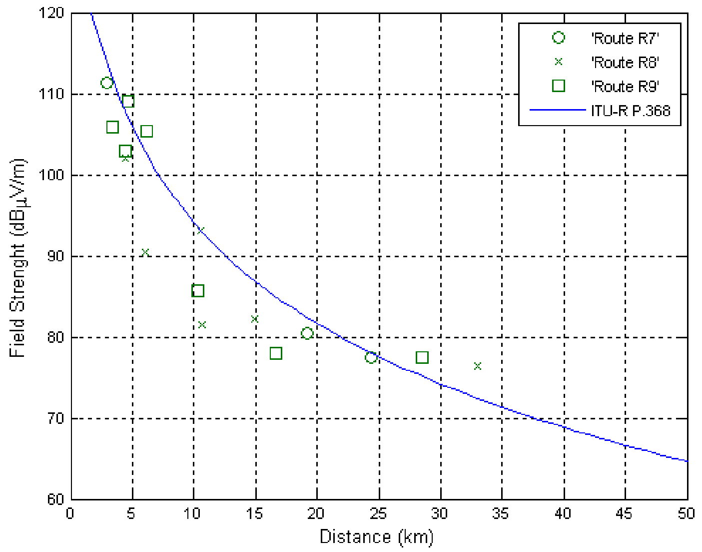


FIGURE 7

Received field strength (64 QAM - daytime) and ITU-R P.368 prediction – 1st campaign

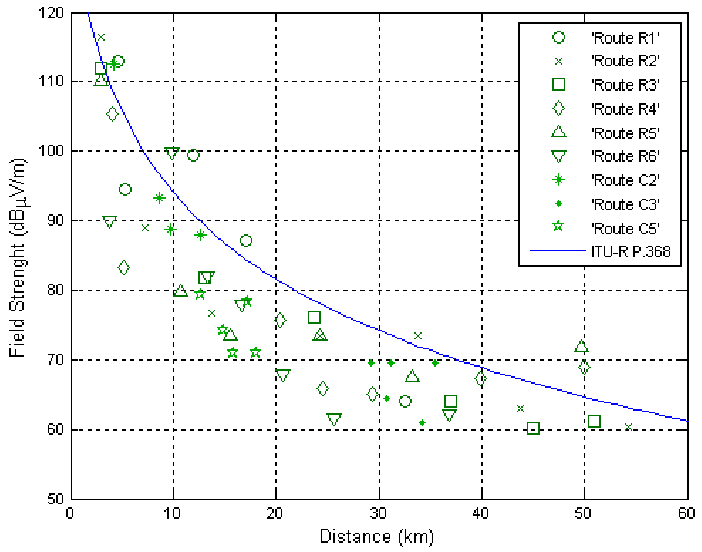
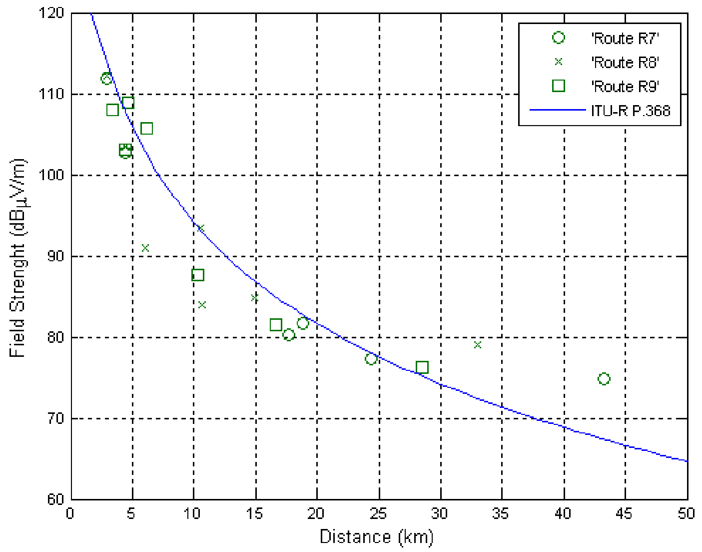


FIGURE 8

Received field strength (64 QAM - nighttime) and ITU-R P.368 prediction – 1st campaign



4.2 Results of the 2st Campaign

Results of the field strength measurements at 85 fixed points along the six daytime measurements routes are shown in Figure 5 and Figure 6 corresponding to the 16 QAM signal reception at daytime and nighttime, respectively, and Figure 7 and Figure 8, corresponding to the 64 QAM signal reception at daytime and nighttime, respectively. These figures also show the field strength predicted by the method in Recommendation ITU-R P.328-9. The parameters used in the calculation are the same as in Table 3.

FIGURE 9

Received field strength (16 QAM - daytime) and ITU-R P.368 prediction – 1st campaign

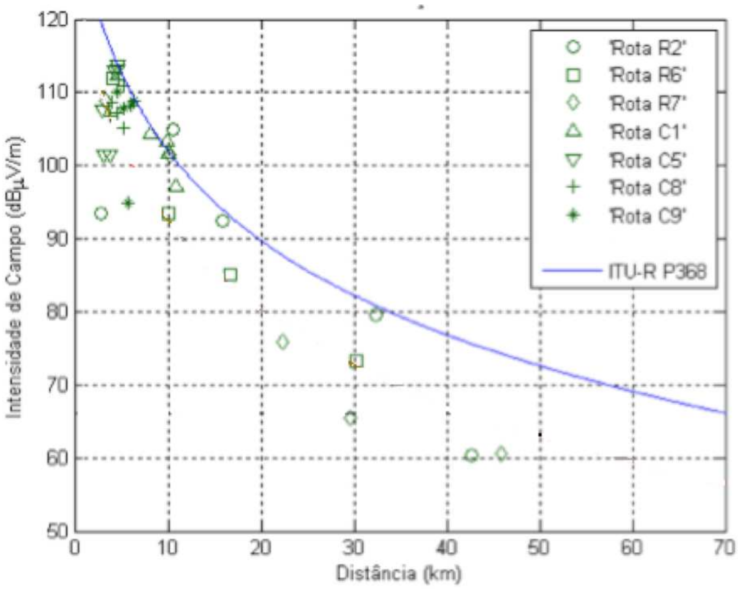


FIGURE 10

Received field strength (16 QAM - nighttime) and ITU-R P.368 prediction – 1st campaign

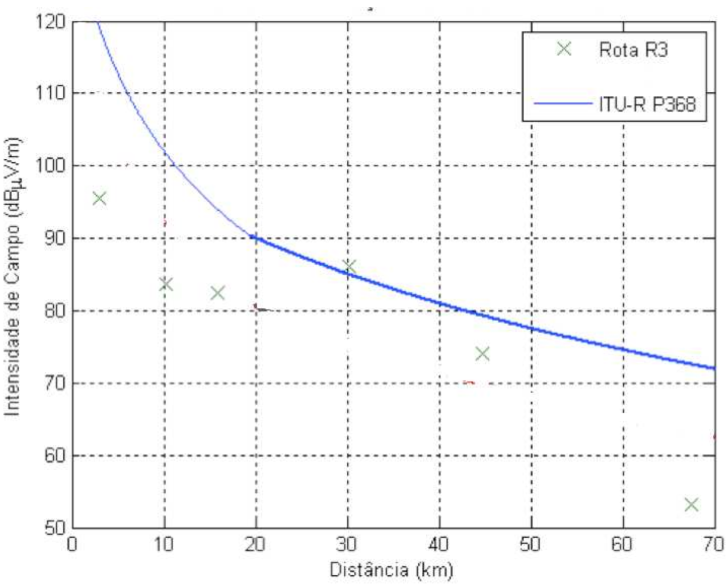


FIGURE 11

Received field strength (64 QAM - daytime) and ITU-R P.368 prediction – 2nd campaign

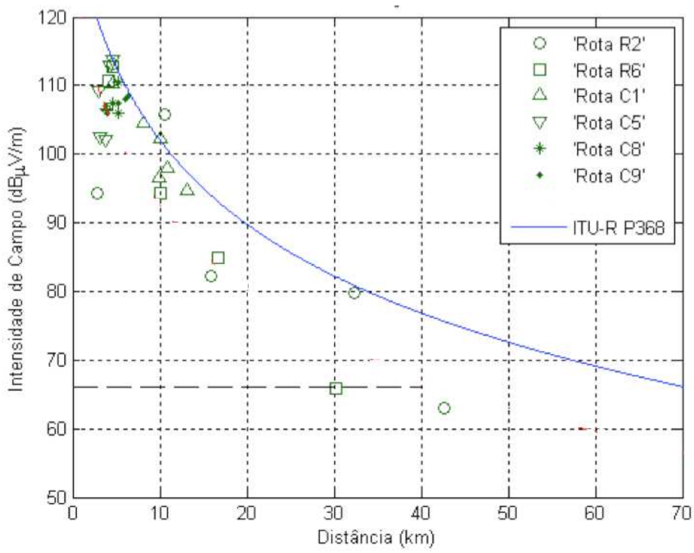
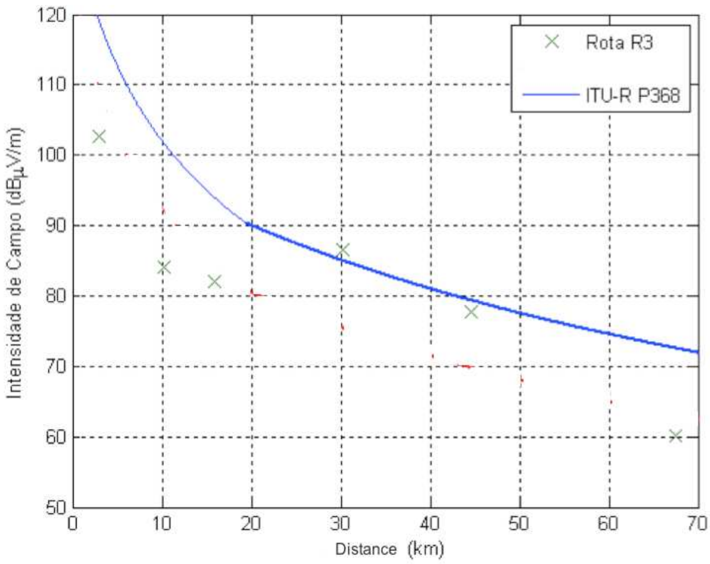


FIGURE 12

Received field strength (64 QAM - nighttime) and ITU-R P.368 prediction – 1st campaign



5 Conclusions

The measured received field strengths are very similar for the two modulations, as expected. The predictions of Recommendation ITU-R P.368 overestimate the received field at daytime and show better agreement at nighttime. Sao Paulo is a huge city, very densely urbanized with lots of skyscrapers. This may be the reason for the additional attenuation of the signal.

The experiments underway in Brazil also include two another trials in MW and trials in VHF band II and 26 MHz band in two different regions. The analysis of the data collected in these trials, as well as the mobile test results, is still being performed and will soon be available. The results will allow a more detailed analysis of the accuracy of Recommendation ITU-R P.328-9 for these environments, as well as the modeling of the variability of the field strength due to the ground-wave field with location or with time in mobile reception conditions.

References

[1] ETSI ES 201 980: "Digital Radio Mondiale (DRM); System Specification", v3.1.1, 2009.

[2] Recommendation ITU-R P.368-9, "Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz".

[3] Recommendation ITU-R P.832-2, "World atlas of ground conductivities".

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