MER degradation in a broadcast mobile network

Jose Bóveda, Gorka Marcos, Jesús María Pérez, Sara Ponce, Ane Aranaz

***Abstract*—Many of the implementation guidelines and network planning tools of DVB-H rely on the existence of an Single Frequency Network (SFN) gain due to the co-existence of several rays within the guard interval. This presents three experiments performed in some field trials which results lead to some conclusions that are not aligned with the existence of the SFN gain.**

***Index Terms*—Modulation Error Ratio, SFN gain, DVB-H**

I. Introduction

IMPORTANT efforts have been made by industry, academic community and standardization organizations to define, implement, validate and promote mobile broadcasting technology. The first commercial DVB-H networks in Europe are a proof of this. DVB forum provides the community with plenty of bibliography about different field trials, implementation guidelines and coverage maps.

In the context or FURIA project (FUtura Red Integrada Audiovisual), supported by Spanish Ministry of Industry, Trade and Tourism, some DVB-H field trials were carried out. Based on the conclusions of these trials, this work aims to contribute to the community due to the difference found between some of the results of these trials and the existing theoretical information.

Some of the measurements performed during the trials had as objective the evaluation of the impact of the multipath effects in the quality of the received signal. To evaluate the quality the following figures were used: C/N (Carrier to Noise Ratio) and MER (Modulation Error Ratio). The value of the MER of the signal measured is directly related to BER (Bit Error Ratio) parameter and provides an objective measurement of the received signal quality.

Although the C/N is a parameter to be taken into account, the main conclusion obtained from this work is that, in contrary to the theoretical definition of the SFN gain [1], for some cases in an SFN an increase of the C/N does not guarantee an improvement in the reception quality. This fact, which should not be ignored in coverage planning tools or in channel model simulators, is not currently reflected in the implementation guidelines.

This paper aims to cover the following issues. Firstly, the contextualization of the work with respect to similar initiatives; secondly the description of the experiments performed and their results; and finally, some hints about the conclusions and future work are included.

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II. State of the Art

A. Enabling a desired quality at the reception site

The implementation guidelines defined by the communication protocols standardization organizations provide the means to ensure a minimum quality at the reception site. In most of the cases the method is based on guarantying a minimum signal to noise ratio on the coverage area.

This is the case for DVB-H [2], which employs the signal to noise ratio of the modulated signal or carrier to noise C/N. In the guidelines of this standard the reader will find continuous references to the minimum C/N to ensure the quality at the reception for the different configurations of the network.

This minimum quality is defined by the degradation criterion named MFER5 [3], which limits the amount of erroneous frames after the MPE-FEC correction to 5%.

In the context of our publication it is important to mention that, according to the bibliography, the quality at this reception side is significantly improved by the establishment of a Single Frequency Network or SFN. For instance, in the following articles [4]-[7], the reader may see how the establishment of an SFN has as a consequence an improvement on the C/N ratio known as SFN gain. In Handbook of Mobile Broadcasting [1] the SFN gain is estimated to be between 3 and 7 dB.

B. Network Planning tools and methodologies

When the attention is paid to the planning tools that aim to facilitate the design and deployment of networks the situation is similar. The design methodology and calculations are driven by the establishment of a C/N threshold and assume that in an SFN network a C/N gain can be added for the area where the different transmitters overlap [3],[8]-[9]. In those articles, the reader may find formulas and tables that define the quality of the reception according to the estimated C/N perceived by the receptor.

C. Quality measurement in field trials

The approach is similar for the field trials performed in mobile broadcast environments. During the last years, multiple field trials have been performed to test the feasibility of the deployment of the mobile broadcast technology [10]. In the field of the DVB-H, one of the pioneer experience was the trial made by the WingTV project, which engineer team was deeply involved in the generation of the technical documents of the standard [11]. In [12] the user may find technical documentation regarding some more recent trials performed in Hong Kong.

In all the documentation about the results of field trials known by the authors, the main parameter to measure the quality at the reception side is the C/N.

D. Our contribution to the state of the art

The results presented in this paper have been achieved through the experimentation carried out in the DVB-H field trials enabled by the FURIA project. These trials have employed 2 transmitters and one gap-filler. During the trials, apart from experiments similar to the ones performed in the mentioned bibliography, some innovative testing protocols have been included. The objective of this was to measure the SFN gain under special circumstances: the border zones among cells.

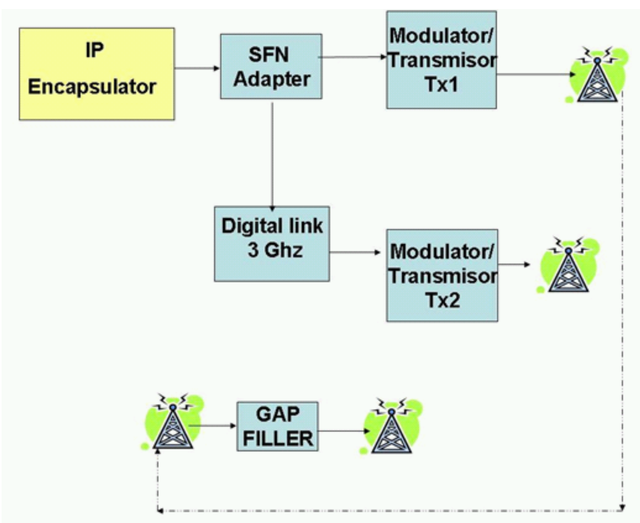

Fig. 1. Network architecture

III. Trials Set-up

The trials were performed in Durango, a village of the Basque Country. The network (see Figure 1) was composed by a fixed main transmitter (channel UHF-23) located on the roof of a building and a second transmitter and one gap-filler that were alternatively employed using a mobile unit equipped with a 12 meter pole.

In Figure 2 the reader may find the distribution of the different locations that will be employed during the rest of the paper. The coordinates of those locations are listed in Table I.

Fig. 2 Aerial view of Durango and main locations for the trials

TABLE I
Location Coordinates

Coordinate	TX	GF	San Yurgi
Latitude	43º 10,84 N	43º 9,28 N	43º 9,6 N
Longitude	2º 38,56 W	2º 37,77 W	2º 38,74 W
Altitude	138 m	250 m	242 m
Dist. to TX	0 m	3080 m	2330 m
Course with TX	--	340º	006º
Dist. to GF	3080 m	0 m	1430 m
Course to GF	160º	--	114º

Both the establishment of the network and the measurement at the reception side have been enabled by the usage of professional equipment. .

In the following section we describe three of the trials performed. All of them are related with the analysis of the SFN gain.

IV. Experiments

This section compiles the description of the three experiments mentioned and their results.

A. Impact on the quality by the "appearance" of a second transmitter

The objective of this test is to measure the impact on the quality at the reception side when two signals with similar level are received. The procedure is the following:

1) The measurement equipment is located in "San Yurgi", at about 2,5 km away from the TX location.
2) Before the experiment is started, the main transmitter (located TX) and the GF (located in GF) are calibrated in order to receive similar level from both in San Yurgi.
3) The main transmitter (TX) is started.
4) When the signal is stable, the MER of the signal is observed to be around 27 dB and the level around -52dB.
5) Then the gap filler is turned on and this transition process is recorded (see Figure 3).

6) Once the transmission is stable, the GF is turn down again. This phenomenon is registered (see Figure 4).

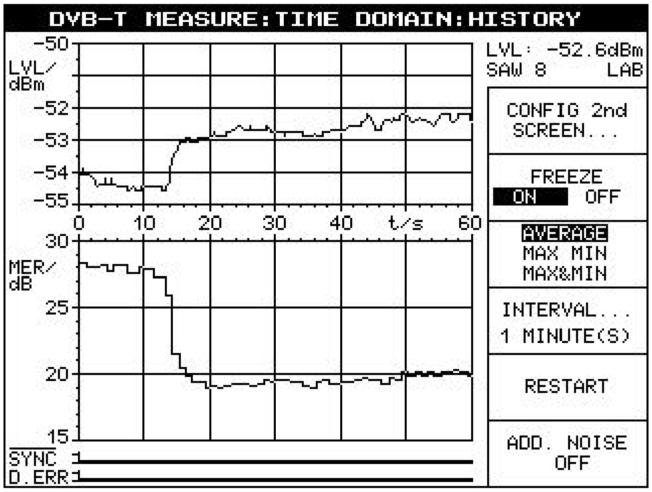

Fig. 3. Turning GF on in experiment A.

As can be seen in the images, while the presence of the second signal, coming from the GF, implies the expected increase of 3dB in the level of the signal, the quality of the signal represented by the MER, decreases significantly.

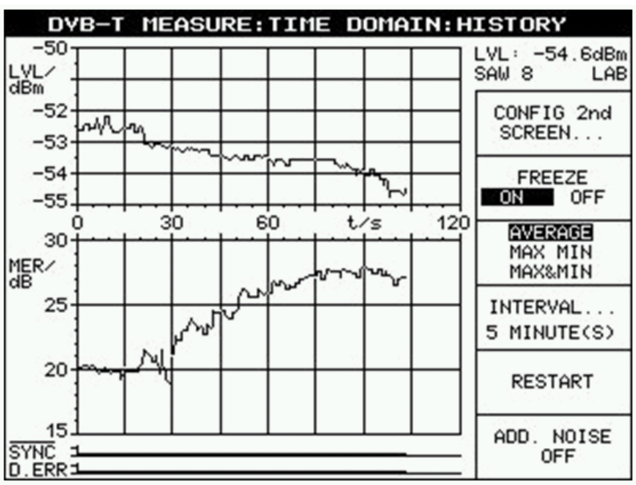

Fig. 4. Turning GF off.

The procedure of this test could seem to be atypical. However in an urban mobile broadcast network, the presence of signals with similar levels is normal due to the multipath propagation. This is also the case for the border areas among cells.

B. Multipath and MER degradation

This experiment, aims to record the impact of severe multipath in an urban location (see Fig. 2). In order to do this, several measurements were performed in some areas where the intensity of the reflected signals was significant. The experiment aims to show how the presence of the multipath deteriorates significantly the quality of the received constellation.

Regarding the configuration of the network for his experiment, only the main transmitter (TX) was employed.

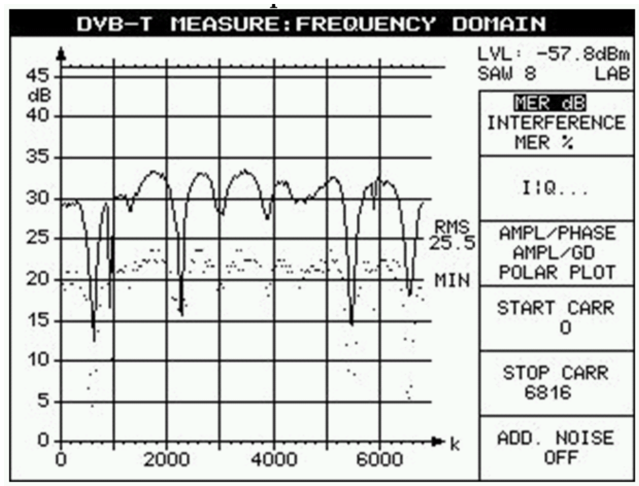

Fig. 5. MER in the Frequency Domain with strong multipath presence

Figure 5 shows the MER for the different carriers in a point with high presence of multipath. This presence is reflected in Figure 6.

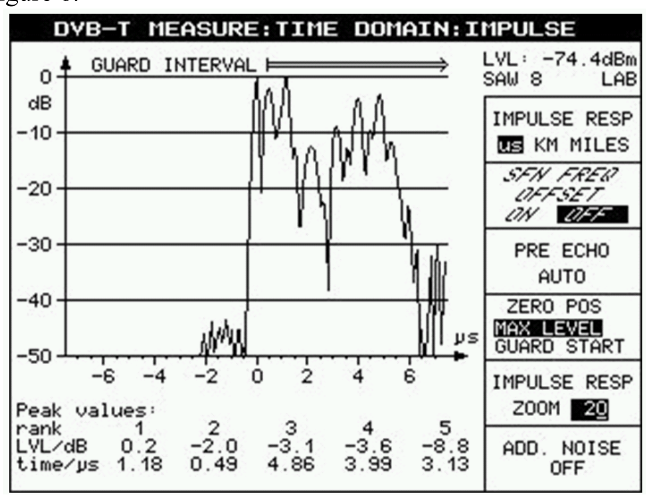

Fig. 6. View of the Time Domain for the same location that Figure 5.

The degradation due to the destructive reflections suffered by the signal is clearer if we compare the graph with the Figure 7, where the MER for a location without multipath is shown.

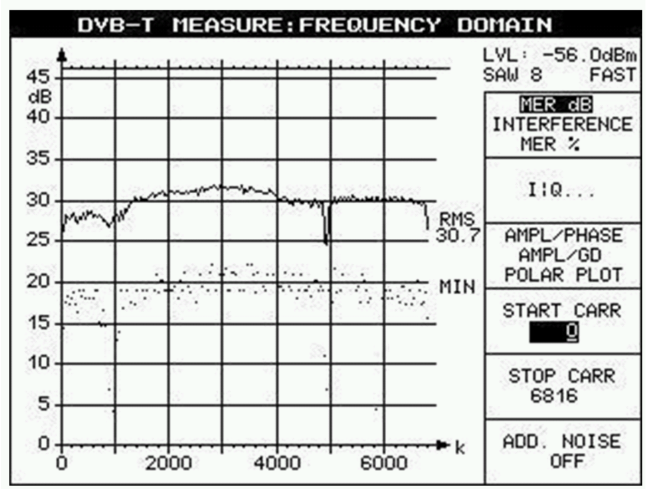

Fig. 7. MER in the Frequency Domain without multipath presence

C. Multipath and MER degradation

The main objective of this test was to evaluate the impact of the multipath reception in the MER for different power differences between the main and the secondary paths.

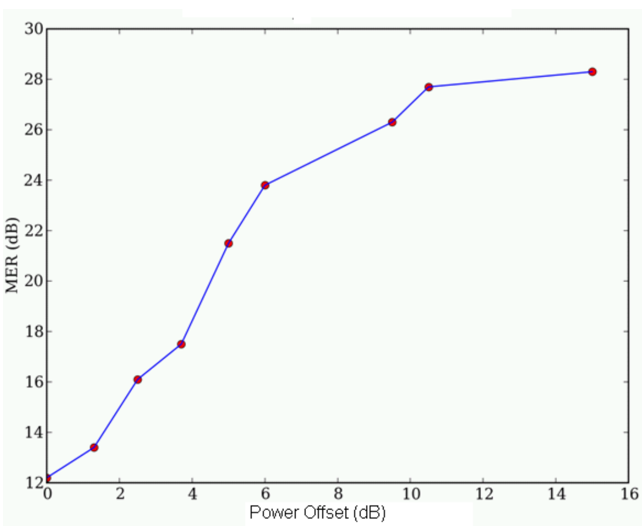

Fig. 8. MER observed for the Power Offset

In order to simulate this situation, both transmitters were employed. Having the receptor within clear sight of both transmitters, the power of the second transmitter was calibrated to have similar fields in the reception side.

Once this was done and registered, the power of the second transmitter was gradually decreased in order to register the positive evolution of the MER on the reception side.

The results are shown in Figure 8 and Figure 9. The first one reflects the evolution of the MER for the different power offsets defined while the second ones shows the evolution of the Bit Error Rate (BER) after before Viterbi.

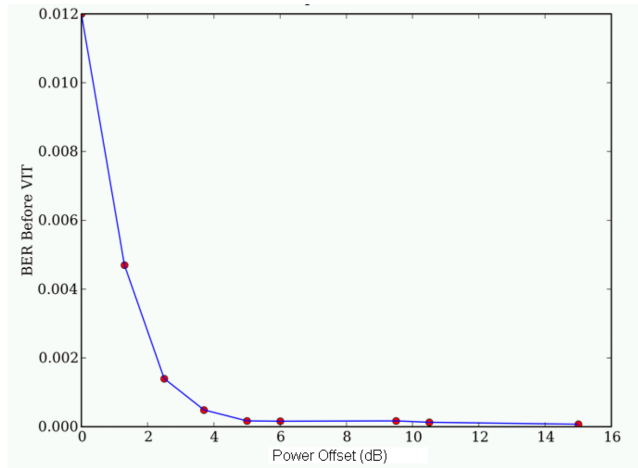

Fig. 9. BER observed for the different Power Offsets

Once again an increase in the C/N has as a consequence a significant decrease in the quality at the reception site.

V. Conclusions and Future Work

This paper presents the results of some unique experiments performed thanks to the establishment of an end to end DVB-H network. According to the understanding of the authors, in spite of the simplicity of the tests, the results are by themselves a contribution to the state of the art described in section II.

The results of the experiments are aligned. The three of them lead to the following conclusion: an increase of the C/N due to the co-existence of different rays may not be beneficial for the reception process. This statement is clearly against the well spread “SFN gain”.

Regarding the future actions, we foresee the quantization of the interference in order to support the developers of the network planning tools to consider this effect in their software.

VI. Acknowledgment

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