

Educational tool for the MF broadcasting reticular network design

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Abstract: - The main objective of this work is to develop a software tool that allows studying the reticular network planning in hectometric wavelengths. This tool is intended to perform the practical teaching about surface wave broadcasting in the educational laboratory. The program has been developed using MATLAB 6.

Key-Words: - Broadcasting, Education, MATLAB, radio noise, reticular network, surface wave.

1 Introduction

The broadcasting by using reticular networks is a very important theoretical instrument for planning. This allows evaluating the coverage and the transmitter density, as well as the number of simultaneous programs that we can radiate in a frequency band. The model is simple and it allows calculating the usable field and the reticular coverage. Later, the reticle is deformed for adapting it to the real disposition of the broadcasting. At this time we should calculate again the usable field and introduce the convenient modifications.

In order to simplify the problem, we only consider the Plan of Diffusion for Hectometric Waves in Region 1 [1]. We also assume conventional emitters and low power channels, corresponding to broadcasting stations in hectometric waves with a maximum PRAVC of 1 kW and the use of synchronized emitters.

The rest of the paper is organized as follows: first we describe the characteristics of a reticular broadcasting AM network and the necessary propagation data in order to calculate signal and noise intensities. We explain later the application flowchart and its graphic interface, as well as the results calculated by this tool. We specially refer to the coverage maps represented in the cases of ideal propagation and real propagation. We also refer to the error check introduced. Finally, we present the main conclusions of the work.

2 Considerations for developing tool

The broadcasting systems in hectometric wavelengths studied use amplitude modulation [2]. The signal can propagate using surface wave [3] or ionospheric wave [4]. This allows us to distinguish between daily and night services for surface wave and night service for ionospheric wave.

A reticular network is considered in an area of great extension in which it is supposed that all emitters are working in the same frequency. We also assume that the Earth is plane. In our case, we have chosen the Iberian Peninsula scene.

For the cochannel emitters, the higher density is achieved when each one of them is located in the vertex of an equilateral triangle whose side is equal to the cochannel distance D (km), supposing in this case a good use of the spectrum.

If we consider now noise and interferences, coming from the surrounding cochannel emitters, the reach R (Km.) of each transmitter depends on the frequency, the propagation characteristics that affect to the wanted field intensities and interference, the minimum usable field intensity and the radiofrequency protection relationship.

Since the surface wave propagation depends on the ground properties, we have worked with the data provided by the World Atlas of Conductivities [5]. For the case of the countries in the Iberian Peninsula, we know the conductivities for a frequency of 1 MHz, without considering the possible seasonal variations. These values should be normalized according to [6].

The radiofrequency protection ratio should be introduced by the user. This value doesn't necessarily have to be the established one in the Diffusion Plan. We do the same about signal to noise ratio.

There are three categories of emitters, so it is necessary first the selection of one type. For calculating the noise power we will keep in mind the atmospheric noise, depending on the year season and of the day time, and the industrial noise that will depend on the type of considered area [7].

We will carry out the planning considering the coverage limited by noise, limited by interference or limited by both noise and interference. For each case the results are the field in the limit of the coverage

area, the radius of the coverage area, considering homogeneous conductivity, and the characteristic parameters of the emitter network: coverage factor, number of programs, reuse index, reuse distance, density of emitters per square kilometer and number of frequency assignments.

3 The tool: PREOH

The educational tool developed has been called PREOH. It allows the user to obtain the results once the characteristic parameters of the radio link have been introduced.

For that purpose, the ITU-R recommendations have been followed, introducing improvements with the purpose of getting much more exact and closer results to the real field levels. The calculations are conditioned to the radiating element that in this case is a Short Vertical Monopole that radiates a power of 1kW.

The software has been developed using MATLAB 6.1. For the use of PREOH it is not necessary to have any knowledge of the programming language. The user interaction is carried out in a graphic and intuitive way [8].

The flowchart shown in the figure 1 shows the most important states in the program.

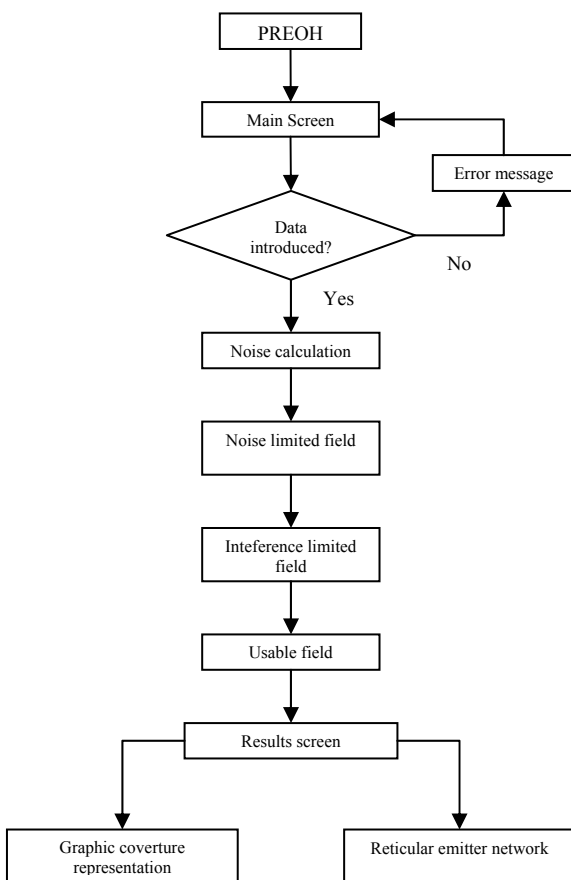


Fig. 1. PREOH flowchart.

3.1 Graphic interface

The developed tool allows working in an environment that is based on the following screens:

- Presentation screen (figure 2). It is activated when executing the program in the worksheet of Matlab, staying during some seconds.
- Data acquisition screen. Screen form in which we will introduce the different data that allow us to carry out the planning.
- Results screen. With the introduced data, the tool shows the planning results.

Next we proceed to describe each one of the fields of these screens.

In each case the most important characteristics will be indicated for each one of them.



Fig. 2. Presentation Screen.

3.2 Data acquisition screen

Once we have accessed to this interface (figure 3), we have to complete each one of the fields that are necessary for developing of the subsequent calculations.

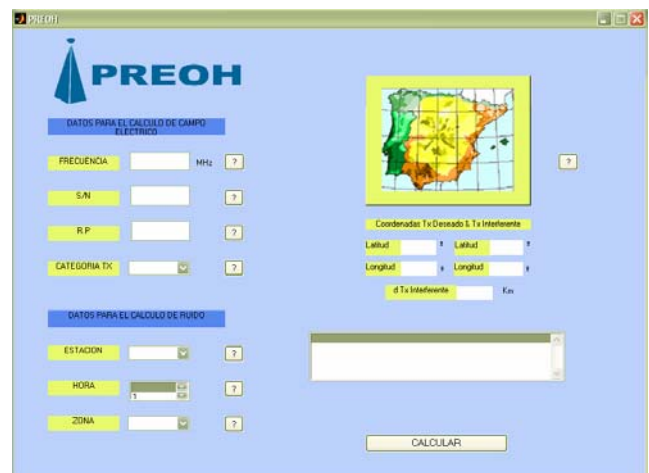


Fig. 3. Data acquisition screen.

The screen is divided into five areas. The first of them is dedicated to the data that are needed in the calculation of the electric field: frequency, signal to noise relationship, protection relationship and category of the transmitter. The three first of them are introduced by keyboard, and the last one is selected in a spread menu.

The second area is dedicated to pick up the necessary data for the noise calculation: year season and time for the atmospheric noise calculation, and area type to determine the industrial noise. In all the cases, this is done by means of spread menus. In the case of year season, you can select to calculate one or all of them. Something similar is possible about time.

The third area is the corresponding to the localization of the desired transmitter and the interference to consider. We have it in an icon representative of the Iberian Peninsula, that give us access to an interactive map when is being pressed. In that map you can mark by mouse the positions of the desired transmitters and the interference. Once they have been marked, the map closes and in the data acquisition screen will appear the information corresponding to these stations. It also shows the distance between them.

The fourth area is informative. Close to each parameter, an icon appears with an interrogation character (?) that shows in the text box of this area a brief explanation about it when is being pressed.

The last area is dedicated to the button “Calculate”.

3.3. Results screen

The results screen (figure 4) is divided into seven different areas.

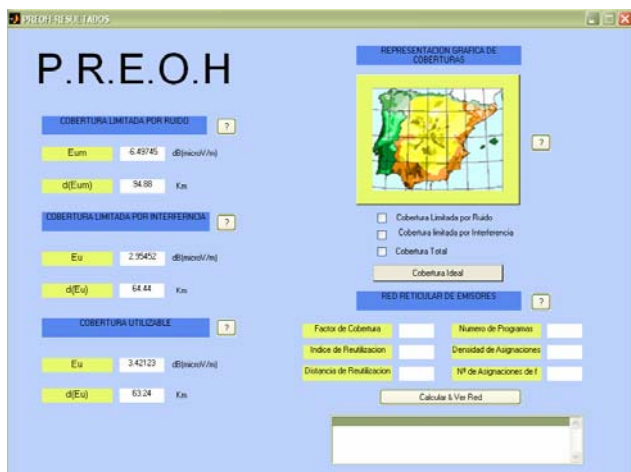


Fig. 4. Result screen.

The first area is dedicated to show the results of the minimum usable field (minimum field in the limit

of the area assuming limited coverage by noise), together with the corresponding coverage distance.

The second area shows the minimum field in the limit of the coverage area in the case of limitation by interference and the value of the radius of the coverage area.

The third one shows the nominal field, quadratic sum of both, and the radius of the area of corresponding covering.

In the develop of the calculations for these results, we have employed the selected values of conductivity and we have used the numerical methods for field calculation given by ITU-R in [3] and modified in [9], [10] and [11].

The fourth area is the corresponding to the graphic representation of the coverings. It has a button that allows choosing among ideal coverage (a homogeneous conductivity of 15 mS/m is supposed for the whole Peninsula) and real coverage (we have considered the real variations of conductivity for each direction). In both cases, you have a menu button for choosing between the following graphic options: limited coverage only by noise, limited coverage only by interference or limited coverage by both noise and interference. Once selected the coverage type to visualize, clicking on the icon map, it spreads and shows it graphically (figure 5).

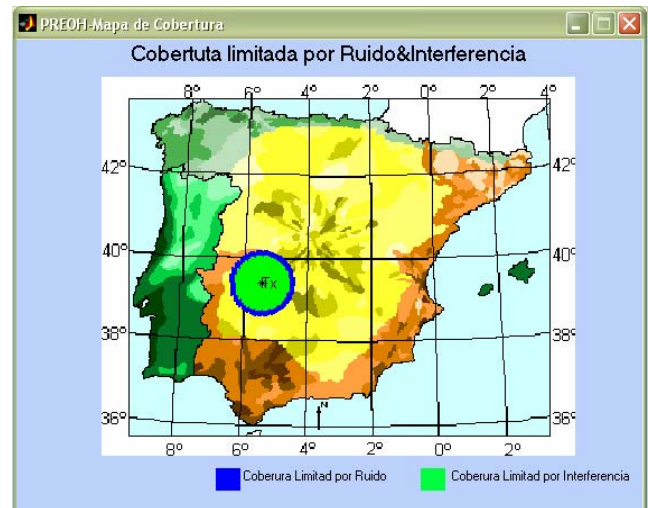


Fig. 5. Example of graphic representation of limited coverage by noise and interference. Ideal case.

The following area allows obtaining the results about the reticular networks parameters. When pressing the button “Calculate and show network” it deploys a map with the resultant rhombic network as a function of the calculated parameters: coverage factor, reuse index, reuse distance, number of programs, assignments density, frequency assignment

number and radio of the coverage area. In this representation it is considered the nominal field limited by noise and interference as reference for the calculations.

The informative area is similar to that one of the data acquisition screen. Finally there is an area for navigation buttons for leaving the program or going again to the data acquisition screen.

3.4 Error control

Some errors may occur when trying to obtain the results corresponding to the introduced data or trying to represent the coverages graphically. We have created some error controls to indicate to the user about no valid actions (figure 6):

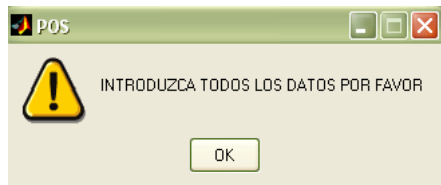


Fig. 6. Example of error window.

- “Please introduce all the required data”. When the user wants to follow on with the calculation of parameters without introducing all the fields in the form.
- “Please locate the transmitter in the Peninsula”. When the user tries to locate the transmitter outside of the territory.
- “Please introduce a valid value of frequency”. It is activated when a value out of frequency margin has been introduced.
- “Please select a coverage type”.

4 Conclusions

The software presented PREOH is a user friendly tool that provides numerical and graphical solutions for planning a network of broadcasting transmitters with amplitude modulation signals for day and night surface wave coverage.

The case of the ionospheric wave interference, which has influence in a seasonal way by the night, has been left for a later work.

References:

- [1] ITU, *Actas Finales de la Conferencia Administrativa Regional de Radiodifusión por Ondas Hectométrica y Kilométricas (Regiones 1 y 3)*, Unión Internacional de Telecomunicaciones (ITU), 1975.
- [2] *Orden CTE/630/202, de 14 de marzo, por la que se aprueba el Cuadro Nacional de Atribución de Frecuencias*, BOE nº 70, 2002.
- [3] ITU-R, *Rec. P.368-7. Curvas de Propagación por Onda de Superficie para Frecuencias comprendidas entre 10 kHz y 30 MHz*, ITU, 1992.
- [4] Mercader, L., *Apuntes de Radiocomunicación. Tema 2: Comunicaciones en Ondas Cortas*, Servicio de Publicaciones de la ETSIT-UPM, 1984.
ITU-R, *Rec P.435-7. Predicción de la Intensidad de Campo de la Onda Ionosférica de Frecuencias comprendidas entre 150 y 1600 kHz*, ITU, 1992.
- [5] ITU-R, *Rec. P.832-2. Atlas Mundial de la Conductividad del Suelo*, ITU, 1999.
- [6] ITU-R, *Rec. 527-3. Características Eléctricas de la Superficie de la Tierra*, ITU, 1992.
- [7] ITU-R, *Rec. P.372-7. Ruido Radioeléctrico*, ITU, 2002.
- [8] J. del Río Bellisco, J. Alpuente Hermsilla, R. Sánchez Montero and P. L. López Espí, Educational Tool for Optical Communications Engineering Teaching, *WSEAS Transactions on Communications*, Vol. 3, issue 2, 2004, pp. 535-538
- [9] Sergio Lafuente, *Desarrollo Software para Radiopropagación por Onda de Superficie*, Universidad de Alcalá, 2000.
- [10] Ramón J. Martínez, *Nuevo Modelo de Caracterización de la Propagación por Onda de Superficie para Trayectos más allá de la Distancia Crítica*, Universidad de Alcalá, 2000.
- [11] Raquel Torres, *Software para el Estudio de Propagación por Onda de Superficie*, Universidad de Alcalá, 2003.