Internet Portal of the SEMONT Information Network for the EM Field Monitoring

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***Abstract* – Recently, the electromagnetic pollution of the environment starts to be a highly important scientific and research concern. Growing number of the electromagnetic field sources have caused the increased interest of the public about potentially harmful effects of the long-term exposure to the electromagnetic radiation. As support for the efforts to inform public about the real-time and the overall level of the electromagnetic field in the environment, our team proposed wireless information network – SEMONT, intended for remote and continuous, 24 hours a day based, monitoring. This paper briefly explains the work in progress related to development of SEMONT system and dedicated Internet portal for the public presentation of the measuring results. Information network SEMONT is a unique project at national level and develops within the program of technological development of the Republic of Serbia, for the period of 2011-2014 year.**

Keywords – electromagnetic field; radiation exposure; wireless network; monitoring

I. INTRODUCTION

The electromagnetic (EM) radiation starts to be ordinary phenomenon in the last few decades. It is considered in many scientific articles, since introduction of the any modern wireless transmission technology results with a variety of the EM field sources, particularly in range of the non-ionizing radiation [1]. Their presence increases level of the EM field in the environment, since they are simultaneously present and most likely emits the EM field over the same area as sources that already exist in a power system and systems for the power transmission (transmission lines, distribution and substation equipment), together with sources from systems of radio and TV broadcasting.

Diversity of the EM field sources characteristics enforces the problem of the safety of these devices both for the human health and the environment. In the same time it gives rise in numerous research studies focused on various aspects of EM field effects on the biological systems [2].

The inevitable EM exposure of the general population in their everyday lives resulted in a necessity to keep the public informed about the real-time level of the EM fields and their distribution in the areas that are related with human activities. The necessity encourages development and utilization of some modern technologies, such as wireless sensor networks (WSN), for sophisticated EM field monitoring [3]-[4]. Such systems are to be used to get the real-time information about the current in-situ EM field strength and in addition for the exposure assessment of population in the covered area.

As a support for the Ministry of the Environment, Mining and Spatial Planning of the Republic of Serbia and the municipal Agency for non-ionizing radiation protection [5]-[6], our research team is requested to develop the EM field monitoring network – SEMONT [7]-[9]. This system employs the existing WSN technology for the area, broadband, remote, automated and permanent monitoring of the EM field level. SEMONT performs measurements of the instantaneous and the overall level in the range of non-ionizing EM radiation. The feature of this system is that results of the measurements will be publically available in a real time over dedicated Internet portal [10].

The proposed SEMONT system has been recognized by the Government of the Republic of Serbia and Ministry of Education and Science of the Republic of Serbia [11], which has approved its development within the program of technological development of the Republic of Serbia, for period of 2011–2014.

In this paper, the basic description of the partially developed SEMONT system is given in Section II, while focus of this paper is concept and several technical details about design and realization of the Internet portal, presented in Section III. The Section IV explains directions of the further development of the SEMONT Internet portal and Section V brings conclusion of this work in progress.

II. BASIC IDEA OF SEMONT SYSTEM

SEMONT is established on the well known technology of the WSN and represents implementation of the existing technology for new application. It is intended for the area supervision, introducing a new approach of the continual EM field monitoring.

SEMONT is designed as a fully automated network, offering the real-time monitoring. The utilization concept of this system is shown in Fig. 1.

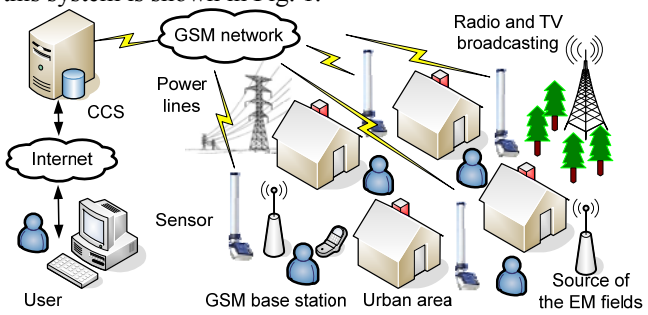

Figure 1. SEMONT utilization over urban area.

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SEMONT system implements basic star network topology of the WSN, with all benefits and weakness of such approach, especially in case of the EM field monitoring [12].

The system is designed to consist of the following parts:

- number of autonomous and independent monitoring sensors [13]-[16], spatially distributed over the supervised area, having the task of monitoring of the EM fields from the all active sources around and in designated frequency range,
- centralized control station (CCS) with Internet portal which coordinates activities of the remote sensors, collects data, processes and stores them in centralized database,
- communication network, which provides interaction between the remote sensors and the CCS, and
- management software that supports functionality of SEMONT information network.

SEMONT is planed to implement commercially available sensors for the area EM field monitoring [13]-[16]. Those sensors have been developed in recent years and offer the long-term autonomy of the monitoring process [13]-[15].

The sensor nodes are equipped with solar panel and internal rechargeable battery, providing autonomous and continual monitoring for nearly 169 days [13]-[16], without to require the intervention of the technical personal.

Such sensors are intended to be spatially distributed over the supervised area and have to be installed on remote location without wiring to the CCS. In order to satisfy such demands the remote sensor nodes communicate with the CSS, using the Global System for Mobile Communications (GSM) standard. Both the CCS and sensor nodes are equipped with a quad-band GSM/GPRS modems for remote control and for uploading/downloading the data [17]-[18].

Moreover, the sensors are equipped with certain amount of the internal memory, storing the results of the performed measurements. Data are kept in sensor memory until the programmable time for the data download.

The sensor nodes are isolated units that are deliberately left to perform the self-alone monitoring without intention to perturb the current distribution of the EM field. Their main and only purpose is monitoring, considering that their presence must have the smallest possible influence on the original spatial distribution of the field. Thus, SEMONT system is designed so that remote sensors communicate only with CSS, without mutual communication. In addition, it is planned that once a day the data will be downloaded from sensors and stored in centralized database of the CCS. With such approach the energy of the sensors are more preserved.

Several technical details about sensors have been already presented in some previous work [13]-[18]. Unfortunately, it is not possible to repeat all of them, since the focus of this paper are on some other part of SEMONT system, the Internet portal [10].

Main idea behind SEMONT system is to employ the isotropic broadband measurements in combination with permanent daily monitoring of the EM field. Such a method provides information about the overall field level at any instant of time, without considering which of the sources are present in the observed area. Besides, the broadband measurements approach can, also, be much more convenient when it is necessary to inform the general population.

Moreover, the systems with continual monitoring provide history of the EM field changes, thus after some time we can have a so called register of the EM field, giving an overview of the daily fluctuations of the field level, as shown in Fig. 2.

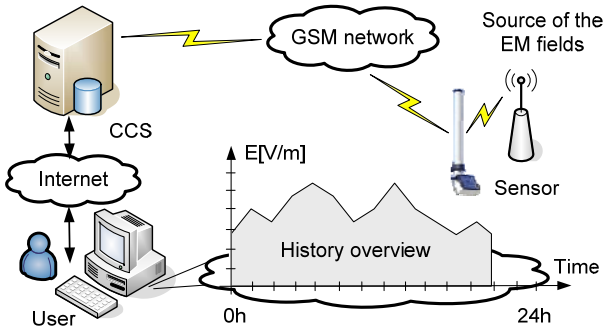

Figure 2. The long-term monitoring and history overview.

Due to the broadband measurements, where contributions of the all active EM field sources are included, SEMONT system is designed to offer a history overview of the cumulative EM field level, during the entire day [7]-[9].

Moreover, SEMONT system compares the measurement results with the Serbian prescribed limits [19]-[21] and recommendations of International commission on non-ionizing radiation protection (ICNIRP) [22].

SEMONT system has been partially developed, with full functionality only of the Internet portal [10]. At the moment, development is work in progress, where communication part of the system and implementation of ten sensors are the priority. When they finished, those tasks will result with more technical analyses and performance studies of the system.

Unfortunately, at this moment, SEMONT system can not present the real measurement results, but we expect that very soon the system will be operative.

The present development will face several challenges that are intended to be in focus of some other presentation. This paper mainly presents some details about Internet portal realization.

III. INTERNET PORTAL OF SEMONT SYSTEM

In order to transparently inform the general public about the real-time EM field level and the EM pollution of the environment, our research team developed dedicated Internet portal of SEMONT system [10].

The Internet portal is a part of the CCS of SEMONT and mainly it is intended to present the measurement results obtained from the sensor nodes, as well as related information about SEMONT system and its purpose.

The Internet web portal is publically available and it is designed to present the results of the measurements for each sensor nodes separately. The location of each sensor nodes is displayed on the electronic map of the supervised territory, while the measurements results are presented over graphs, as shown in Fig. 3.

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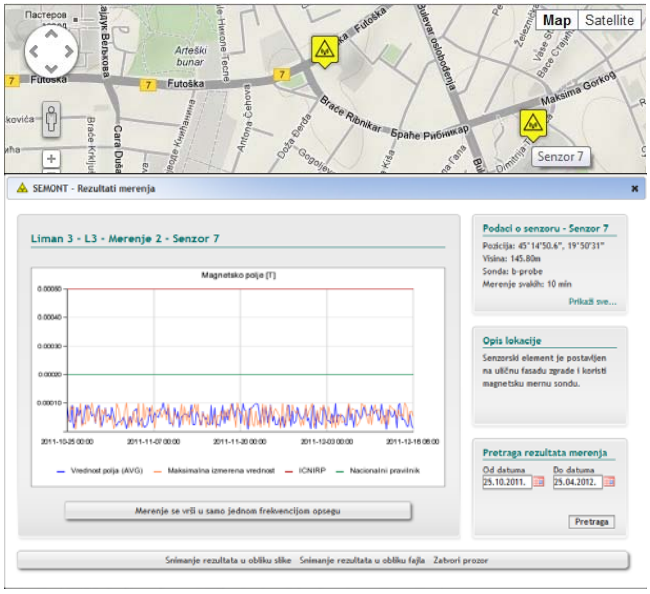

Figure 3. Example of the measurements presentation.

The electronic map will help users to analyze the cumulative level of the EM field, particularly the data from the sensor node that is closest to their location.

The sensors are able to perform measurements every six minutes, permanently and 24 hours per day. Thus, the monitoring can be considered as a continual and in combination with the history overview can offer a clear picture about the EM field fluctuation on particular location.

Comparing with the classical measurements that are performed in one moment, SEMONT system and its Internet portal possess superiority and offer significantly more information about surrounding EM fields.

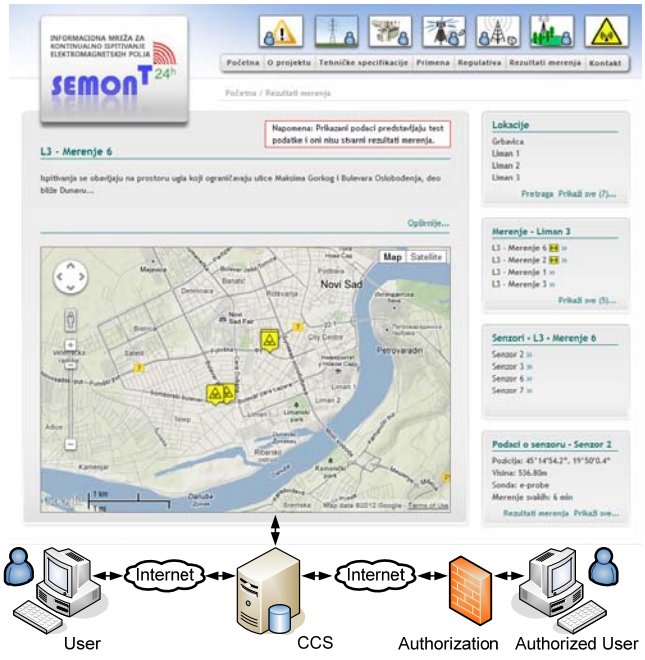

Figure 4. Access to the CCS and Internet portal.

The Internet portal consists of two separated parts: public part – available for public access and protected part – which is restricted area available only for authorized personnel, as shown in Fig. 4.

The public access is allowed only for the front-end of the portal, while for the authorized users the access is in addition granted for the back-end part, besides to the CSS.

The back-side of the portal is responsible for information upload/download and for maintenance of the CSS and Internet portal.

A. *The front-end and presentation of SEMONT system*

The front-end of the Internet portal presents some of the key facts about SEMONT, in addition to the results of the measurements. Portal is hierarchically organized, presenting information as shown in Fig. 5.

Figure 5. Front-end of the Internet portal.

The interested users can find basic information about SEMONT features, its technical specification, several examples of the application, some for low frequency and some for high frequency EM field monitoring, and finally, the measurement results.

Furthermore, SEMONT system is designed for monitoring according to the Serbian legislation framework [19]-[21] and recommendations of the ICNIRP [22] and EU standards [23]. That information is also present on Internet portal and can be valuable, especially for accredited laboratory that deals with the EM investigation.

B. *Measurement results organization and presentation*

The measurements data obtained from sensor nodes will be on automated way remotely collected and stored in a centralized database of the CSS. The Internet portal is designed to present those results respecting the hierarchy of the data, as shown in Fig. 6.

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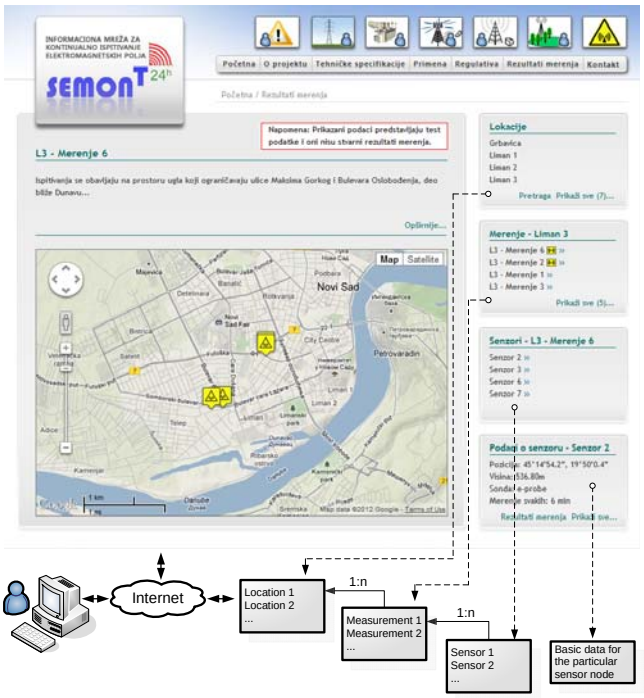

Figure 6. Hierarchy of the measurement results.

The monitoring process is intended for particular location or area and it is possible that several independent measurement campaigns can be performed during some period, using different sensor nodes.

The Internet portal is planed to show for each location which measurements are to be performed and which sensor nodes are to be used for the specific measurement. As a result, relationship between Locations, Measurements and Sensors are of the "1:n" type, which means that Location as a parent, can have several different Measurements, as children. Moreover, particular Measurement can have several associated Sensors and for each node several details are shown, as GPS coordinates, height on which sensor is installed, used field probe [13]-[16], etc.

Internet portal is designed with several search functionality allowing full history overview for a long-time period, as shown in Fig. 3. The search is available through the Locations and Measurements, over selected time period and active/inactive measurement.

C. *Employed technology for realization of the portal*

The foundation of the Internet portal is the CCS centralized database, relaying on the MySQL server, which starts to be the standard in the open source programming.

The most of the Internet portal is programmed using PHP programming language, and its special CakePHP application development framework. In addition, the Web Content Management System (WCMS) is implemented for the back-end side of the portal, providing website authoring, collaboration, and administration tools.

The web form of the portal that presents measurement results also implements the Google maps technology. It can be expected that this page will be the most visited and in order to perform the smooth change of page content, the jQuery and AJAX web development techniques are employed.

The AJAX enables that web applications can send data to and retrieve data from a server asynchronously (in the background) without interfering with the display and behavior of the existing page.

Finally, the measurement results are displayed using the charts realized with open source JpGraph library for PHP.

D. *Directions of the further Internet portal development*

The shortly presented Internet portal represents the work in progress. At this phase the most planed features are realized, but there are some that will be accomplished in the next phase. At the moment, Internet portal is able to present only results of the measurements of the existing and cumulative level of the EM filed. In next phase the portal functionality will be expanded so that it can perform the global exposure assessment, related to the increased risk of possible harmful effects of the EM radiation, according to the EN 50492:2008 standard [24].

The idea is to exploit the 24 hours a day monitoring and to calculate the daily limits of the global exposure, as shown in Fig. 7.

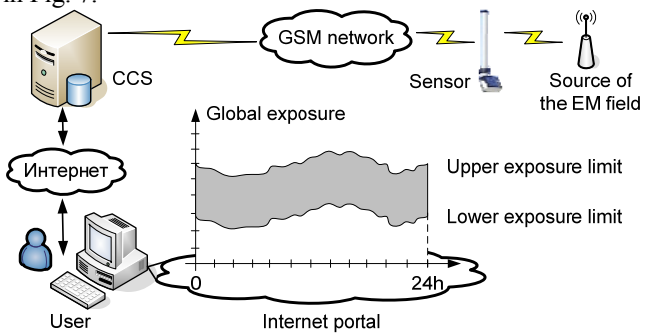

Figure 7. Daily limits of the global exposure.

SEMONT system is based on the broadband measurement approach, resulting with the unknown frequency at which the source emits the EM fields. As a result, the lowest and the highest frequency of the sensor filed probe are considered, resulting with upper and lower exposure limits.

Those daily limits can be quite valuable for the general public, because it can be unknown if some present source is active or not at the moment. Moreover, such method is a new approach that is able to inform the general public about the possible daily ranges of the exposure, something that is not possible with classical approach of the EM field measurement in the moment.

IV. CONCLUSION AND FUTURE WORK

SEMONT system introduces an advanced approach of the wireless sensor networks implemented for a daily supervision of the overall and cumulative level of the various EM field sources, over the area of interest.

The proposed SEMONT monitoring system is a unique idea at the national level and it is the most suitable solution for a constant supervision of the EM field strength, as well as for the global exposure assessment of the general population.

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The Internet portal of this system is a significant support for the local authorities in their efforts to take a systematic care of the potential unhealthy effects of the non-ionizing radiation.

Moreover, the Internet portal and SEMONT system are a respectable answer to public concerns about the long-term exposure to the EM fields.

The potential of the proposed SEMONT system has been recognized by the Ministry of Education and Sciences of the Republic of Serbia, endorsing its development.

Currently, SEMONT system has been partially developed, but we expect that very soon this system will be operative and that will be able to offer the real-time results of the measurements. Moreover, the upcoming work will be based, also, on the Internet portal feature enhancement, especially for the global exposure assessment of the general population.

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