Environmental wireless sensor node

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Abstract - **Intelligent sensors and their networks are increasingly gaining in importance. Special significance sensor networks have received in terms of wireless communication, which further expanded the scope of their application. Monitoring of environmental parameters is an area where intelligent sensors and their first of all wireless networks are increasingly coming to the fore. This paper presents the concept development and design of sensor devices intended for monitoring environmental parameters. It also includes a review of experience in the practical use of such systems.**

Keywords - **Environment, intelligent sensors, wireless sensor networks, Internet**

I. INTRODUCTION

The development of semiconductor technology enabled an application of computer systems it wide range of human daily life activities. Significant advances in the application of modern electronic components made in integration of computing and communications capabilities within the same devices and systems. Intelligent wireless sensors and their networks are an example of the symbiosis of Computer Science and Telecommunications [1].

Intelligent sensors and their wireless networks have found wide application in various fields of human activities, and everyday life. Computer, communication and physical characteristics of intelligent sensors maximally reduced restrictions on their use. The most important problems in intelligent sensors are, if necessary; work in remote locations, which require a high degree of autonomy, particularly in terms of power. Such requirements imply different approaches in terms of reducing energy consumption during operation of intelligent sensors. Two basic approaches are based on the reduction of the intensity of operations and level of communication between nodes within a sensor network.

An interesting application of intelligent sensors and their networks is monitoring environmental parameters. Potentially large number of physical parameters to be monitored, the design of hardware - software and communication features, a sensor node represents a serious problem [2]. In this paper, the elements of the research conducted in this area and the project of one sensor node intended for monitoring environmental parameters. This paper presents elements of research projects and projects a sensor system used for monitoring environmental parameters.

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II. CONCEPTS OF SYSTEMS

Monitoring of the parameters the environment could be an ongoing process, and the process initiated by the existence of significant differences in the values of the parameters in relation to the maximum permissible values. In general, the development of devices for monitoring environmental parameters can affect two main factors:

- The number of parameters to be monitored;
- Place in which to monitor the parameters.

Monitoring parameters can be based on different approaches. In the case of the realization process of constant monitoring of environmental parameters in a certain area, it shows that the system is best based on a network of intelligent sensors (Fig. 1). Depending on the type of parameters to be monitored, which is defined on the basis of an assessment of the existence of possible sources of pollution, the sensor nodes are connected to appropriate sensors that register the value of the corresponding parameter.

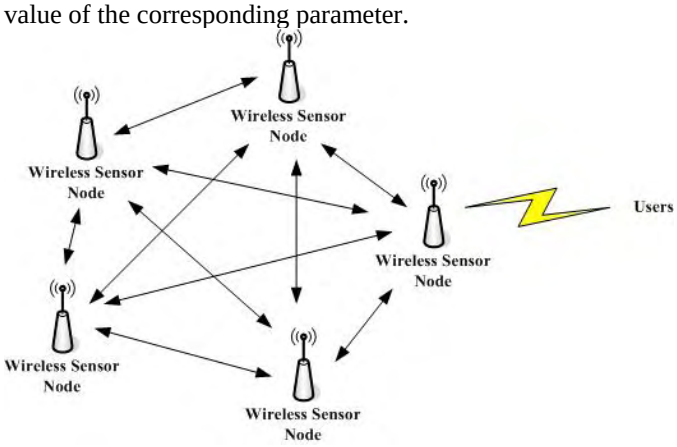

Fig. 1. Intelligent senzor network

Communication between sensor nodes depends on the area in which tracking is performed and intensity of communication between different nodes and the central computer on which monitor the state of the environment. For smaller distances and lower levels of intensity of communication as an acceptable solution can be used for communication standard IEEE 802.15.4 [3]. This type of communication can be convenient in terms of monitoring the environment in remote locations where power is a problem in the network. The most common implementation of the IEEE 802.15.4 is called ZigBee networks, which has significant advantages over alternative networks such as WiFi and Bluetooth. The most important advantages are:

- The maximum number of nodes in the network;
- The maximum distance between two nodes;
- Length of continuous operation in the event of battery power.

Lack of ZigBee networks to compare these alternative networks is relatively low data transmission speed. Depending on the distance from the central computer where it monitors environmental parameters data transfer can be done using the ZigBee network gateway (Fig. 2.).

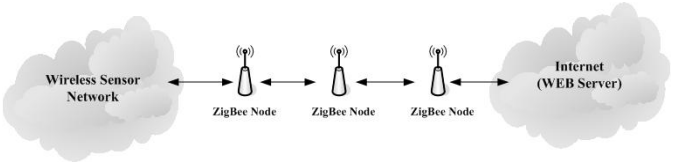

Fig. 2. Data distribution using ZigBee network gateway

However, in the case of large distances this approach can be no rational and required alternative solutions. For example, by GPRS can be connect such a monitoring system to the Internet. Thus ensuring high availability of data collected to users. In this case it is necessary in an environment ZigBee sensor network to realize the appropriate ZigBee - GPRS network gateway (Fig. 3.).

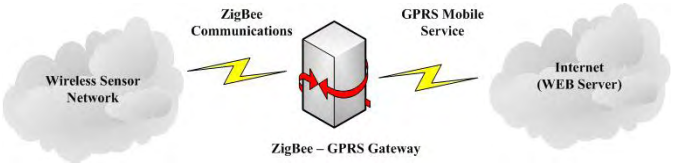

Fig. 3. Using ZigBee - GPRS network gateway

Communication in wireless sensor networks is a major factor of energy consumption. This means that the autonomy of such systems can be increased by reducing the intensity of communication within the network, or communication with the central computer. Monitoring of environmental parameters enables the monitoring process takes place under conditions of relatively low-level communication. In the research mode, when you need to monitor the changes of parameters in the exploitation conditions monitoring can be carried out in alarm mode. In this case the intelligent sensor, which is the heart of a sensor node, is performed comparison of accepted values of the parameters with the maximum permitted. Communication is only activated when there is a risk of exceeding the permitted level for the parameter.

A special case of monitoring environmental parameters can be ad hoc monitoring of appropriate values of physical quantities. This requires mobile sensor devices, whose use in a particular area can determine the state of the environment over time. The collected values of environmental parameters can be stored in the memory of the device or by using any of the communication systems transmit data to the central computer for further processing and memory. The concept of such a mobile system is shown in Fig. 4.

When considering the possibility of realization of sensor nodes attention should be given to the selection of a set of environmental parameters to be monitored. In addition to the choice of parameters according to their importance for the quality of the environment is very important criterion is the availability and characteristics of the corresponding sensors. In this primarily refers to the sensors on its output information about the physical size of the watch give in analog or digital form. It is very important from the point of view of design input - output subsystem of a sensor node.

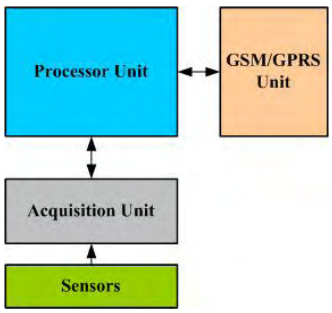

Fig. 4. Mobile system for monitoring environmental parameters

Finally, there remains the question of implementation of the of a sensor node. With the development of semiconductor technology designers are able to share their high-integration solution based on the electronic circuit. The starting solutions are mainly based on the application of microcontrollers. However, more and more came to the forefront of the development of sensor nodes based on programmable circuits, most FPGA type. In these solutions are based on computer IP core around which the addition of the appropriate input - output and memory blocks to build a system that needs to meet the requirements of specific applications.

The study, based on which the work was created, it had a comprehensive approach to examine the possible, especially hardware solutions in the monitoring of environmental parameters. The next section will show some of the solutions that have been adopted as the basis for the implementation of a system for monitoring environmental parameters.

III. Realization of Systems

In the implementation of a system for monitoring environmental parameters, it was assumed that the monitoring should be carried out under the following conditions:

- Stationary monitoring using wireless sensor networks using GPRS mobile service provider to connect to the Internet;
- Using mobile sensor devices connected to the Internet via GPRS mobile service.

During the research was considered and an option to inform users about the environmental parameters using the GSM mobile service. In addition, a special segment of the investigation is to consider the possibility of the realization of sensor nodes using an FPGA circuits.

Because possible scenarios for tracking environmental parameters are:

- Using a stationary monitoring system based on a network of wireless intelligent sensors;
- Using mobile devices for monitoring;

approached the consideration of the possible ways of practical implementation of the system elements. Given the preliminary analysis, it is assumed that the sensor node is based on microcontroller, which has low power consumption. As a communication, protocol was adopted ZigBee implementation of the IEEE 802.15.4 standard. The importance of environmental parameters for a man requires connectivity to the Internet for distribution to end users.

The aim of this study was to verify the possibility of implementing of a sensor node, which could later be implemented as an integrated circuit, primarily using FPGA technology. Having available a platform company Microsemi FPGA, SmartFusion [4], which is as an IP core can use CPU ARM Cortex-M3, has been adopted as the computational basis for the implementation of a sensor node uses microcontroller based on the same processor [5].

The sensor node is implemented according to the block diagram shown in Fig. 5. To check the functionality of the node are used development system Olimex LPC - P1343 [5] and transceiver module Microchip MRF24J40MA [6].

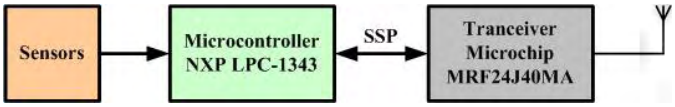

Fig. 5. Block diagram of sensor node

From standard interface, which has LPC-1343 microcontroller, implemented in sensor nodes are important:

- SSP (Synchronous Serial Port) - to connect to the transceiver;
- I2C - to connect to sensors with digital output;
- 8 analog inputs - that is multiplexed to the input 10 - bit A / D converter for connecting sensors with analog outputs.

Part of the wiring diagrams for connecting the microcontroller, transceiver and the sensor is shown in Fig. 6. For checking the functionality of a sensor node has been used temperature and humidity sensor SHT11.

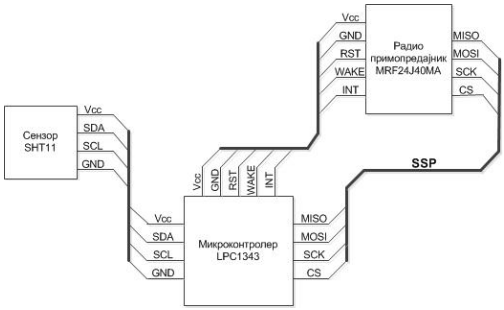

Fig. 6. Electrical schematic of a sensor node

Due to the demands of the environmental parameters published on the Internet, it was necessary to realize the network gateway between ZigBee network and Internet. This device was developed and implemented using GSM/GPRS module Telit GM862GPS [6], [7]. Block diagram of the network gateway is shown in Fig. 7.

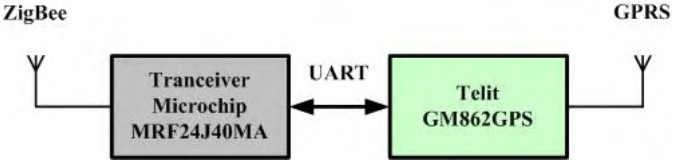

Fig. 7. Block diagram of Zigbee - GPRS network gateway

In the implementation of network gateway as ZigBee transceiver module was also used MRF24J40MA. The need for network gateway to the Internet was used for functionally upgrading device and used as a mobile device for monitoring environmental parameters. Therefore, an in device embedded microcontroller for connection with sensors and ZigBee transceiver, as shown in Fig. 8.

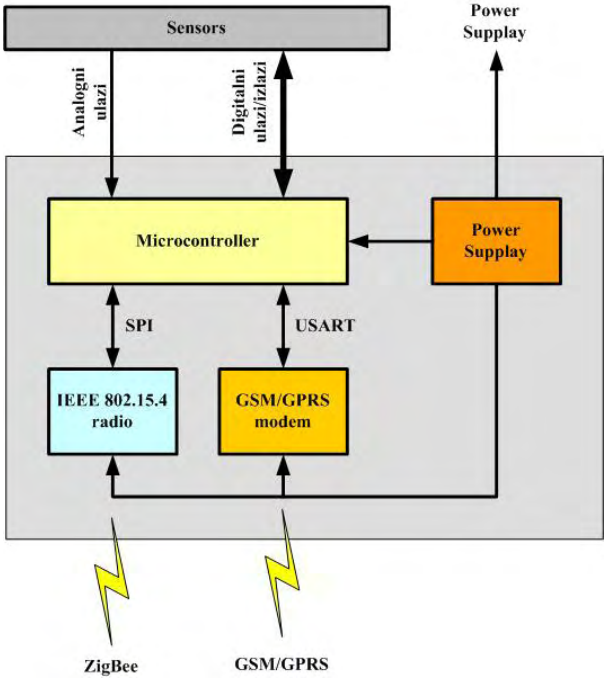

Fig. 8. Block diagram of the mobile node for monitoring environmental parameters

By monitoring parameters, based on stationary wireless intelligent sensor and using, a mobile of a sensor node is practically verified and obtained very good results. Further research attention has been given to the further development of software support at the level of intelligent sensors and a web server across which it has Internet distribution of the information collected. In addition, the study also aimed to the realization of a sensor node based FPGA circuits using ARM Cortex-M3 processor core.

IV. Conclusion

Implemented system components for monitoring environmental parameters - wireless of a sensor node and ZigBee - GPRS network gateway have shown that this task can be successfully addressed with the provision of reliable and high autonomous operation. Utilizing wireless sensor networks based on intelligent sensors showed great breadth of application, which significantly exceeds the area to which the system is initially developed. The way to apply the system for monitoring environmental parameters in alarm mode significantly reduced the volume of communication sensor nodes with the environment, which improves the conditions for achieving a high degree of autonomy in their work. Work in alarm mode also does not require too much processing at the sensor processor that also enhances the autonomy of individual sensors. The autonomy of the sensor can be provided using additional power from alternative sources as solar cells. Possibility to connect sensors with digital and analog outputs provides the conditions to be monitored a wide range of parameters.

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