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MIPv6 Based Framework for RF-GSM Enabled Mobile Wireless Sensor Nodes

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Abstract

The terms "ubiquity" can be achieved by the mobility of wireless sensor networks that denotes networks of intelligent sensor nodes that monitors physical and environmental conditions and can be deployed anywhere and anytime. The emergence of mobility that allows sensor nodes in WSNs to move spontaneously and actively is considered for a more sophisticated control and monitoring capabilities of applications based on a WSN. In this paper, a structure of a Mobile Wireless Sensor Network system has been presented. An introduction for the design of a mobile controller that can act as the moving device and interface for a sensor node or a group of nodes to the base station. The proposed scheme provides a communication link for the sensor nodes and the Base Station. The design makes use of the radio frequency (RF) signaling incorporated with short messaging system of GSM (Global System for Mobile Communication) to activate the communication between the Central Server and the sensor nodes.

Keywords: *RF, GSM, Mobility, Wireless Sensor Networks*

1. Introduction

A wide variety of applications have been utilizing Wireless Sensor Networks to be deployed in various physical environments for accurate control and monitoring. Thus, the need for obtaining sensed events is critical accurate and immediate interpretation and knowledge of what actual scenario in the monitored area.

Typically, WSN is deployed having static sensor nodes that can integrate the different properties of sensing the environment, data processing and communication among other sensors. The initial deployment of WSN can have the following impacts to critical applications:

- Since sensor nodes are battery operated and prone to errors, WSN may loss the connection to a node at anytime.
- Since the existence of a dynamic change in the area or region of sensing fields, the scope of the deployment and connectivity may not cover the entire sensing field.
- Some sensor nodes that have been deployed may have multiple functionalities and some group of sensor nodes may have common functionalities, thus management among these nodes is essential.

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The capabilities and advantages of sensor nodes can be enhanced through providing WSN with mobility and thus extending its flexibility. Mobility in WSN is an essential solution to have a more sophisticated and wider scope of coverage for controlling and monitoring an application [1, 3, 10].

In this paper, a structure of a Mobile WSN has been presented. An introduction for the design of the mobile controller that can act as the moving device and interface for a sensor node or a group of nodes to the base station. The proposed scheme provides a communication link for the sensor nodes and the base station. The design makes use of the radio frequency (RF) signaling incorporated with short messaging system of GSM (Global System for Mobile Communication) to activate the communication between the Central Server and the sensor nodes. The principles of MIPv6 for moving nodes are adopted for a more refined mobility solution.

The rest of this paper are organized as follows: Section II explains the wireless sensor networks; In Section III we illustrate how Mobile IPv6 works; the proposed scheme for communication among mobile sensor nodes is outlined in Section IV; and the concluding remarks in Section V.

2. Wireless Sensor Networks

A WSN is composed of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a base station.

It consists of multifunction sensor nodes that are small in size and communicate wirelessly over short distances. These sensor nodes integrate the different properties for sensing the environment, data processing and communication among other sensors. A wireless sensor network performs an important role in many applications, such as battlefields surveillance, patient health monitoring, home automation, traffic control, environmental observation and building intrusion surveillance [2][6]. The wireless networking has improved productivity through increased accessibility to information resources and easier, faster and less expensive network configuration. WSNs provide convenience, cost efficiency, and ease of integration with other networks and network components. Figure 1 shows the structure of WSN.

The basic functionalities of a sensor node is similar with a computer, wherein, a sensor node receives input data through sensing, it processes it and produces an output to send on to its destination. They are usually deployed directly or closely to the area to be observed and works unattended in remote geographical areas.

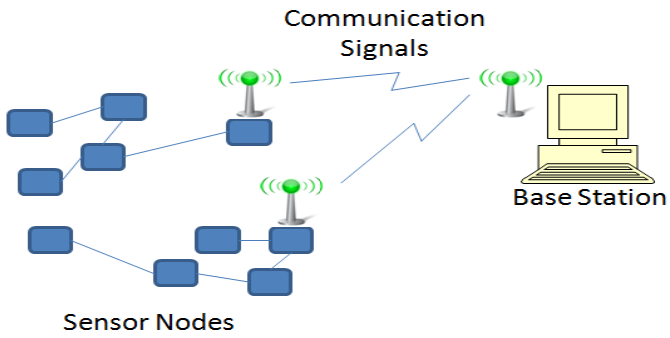

Figure 1. WSN(Wireless sensor network) Structure

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The following are the basic patterns for WSN communication:

- Sensor Node to Base Station communication (sensor readings and specific alerts);
- Base Station to Sensor Node communication (specific requests and key updates);
- Base station to all Sensor Nodes (routing beacons, queries or reprogramming of the entire network);
- Communication amongst a defined cluster of nodes (a node and all its neighbors).

The WSNs consist of two main components: the sensor nodes and the base station. The base station can be a laptop or computer remotely connected to the Internet or satellite that gathers information from the sensor nodes, processing it and making appropriate decisions and actions on receipt of the data. The sensor nodes are capable of gathering sensory information, performing processing and communicating with other connected nodes in the network. The main components of a sensor node are a microcontroller, transceiver, external memory, analogue to digital converter (ADC) and power source as shown in Figure 2.

A base station acts as a gateway to another network, a powerful data processing or storage center, or an access point for human interfaces. It can be used as a connection to disseminate control information into the network or extract data from it. The sensor nodes – low sampling rate magnetic, thermal, visual, infrared, acoustic or radar sensors, are usually scattered in a sensor field which are able to monitor a wide variety of ambient conditions and has the capability to collect data and route back to the base station and end users [6].

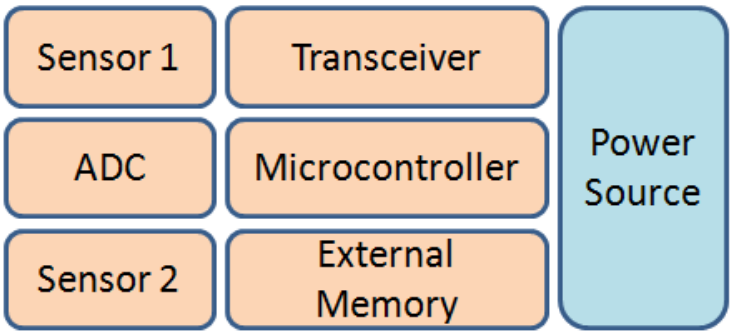

Figure 2. Sensor Node Architecture

WSNs present a new set of properties that differs from traditional networks. WSN's structure changes according to its applications. The number of applications that utilizes WSNs is increasing rapidly. WSNs are used in many applications such as healthcare applications, home automation, traffic control, environment and habitat monitoring, and military applications.

3. Related Technologies

3.1 Mobile IPv6 Principles

Mobile IPv6 was designed to allow nodes or devices to be reachable and maintain ongoing connections while changing their location within the network. To be reachable, mobile nodes are provided with a permanent IP address, called the home address. To maintain ongoing

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connections while moving, Mobile IPv6 uses the redirection function provided by the home agent. The home agent redirects packets addressed to a mobile node's home address to its current location. Mobile nodes always update their home agent with their current location (i.e., every time they move) [8]. The Mobile Node as it moves to another location is shown in Figure 3.

The Mobile IP protocol allows location-independent routing of IP datagrams on the Internet. Each mobile node is identified by its home address disregarding its current location in the Internet. While away from its home network, a mobile node is associated with a care-of address which identifies its current location and its home address is associated with the local endpoint of a tunnel to its home agent. Mobile IP specifies how a mobile node registers with its home agent and how the home agent routes datagrams to the mobile node through the tunnel.

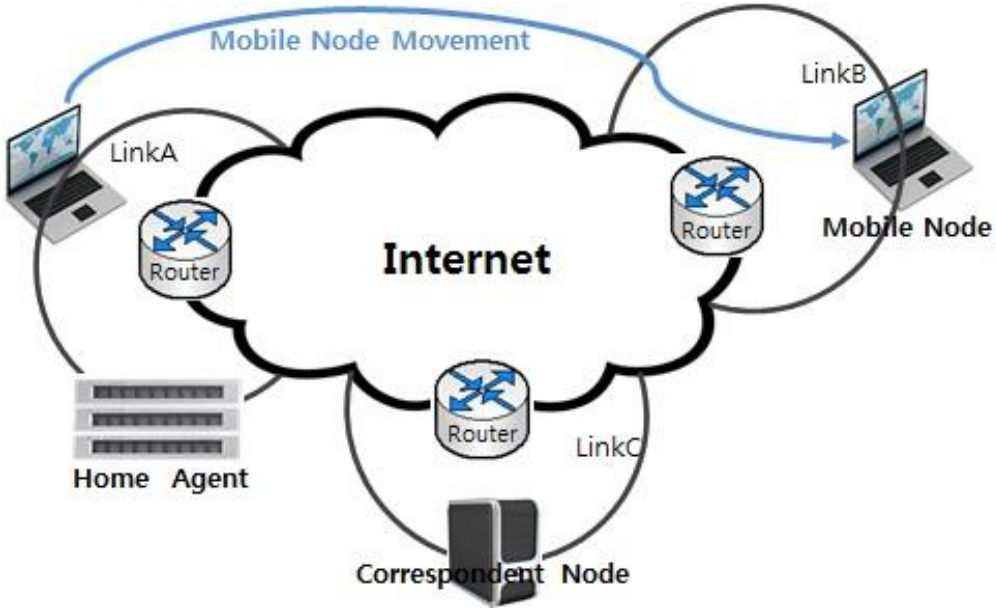

Figure 3. Mobile IPv6 Operation

The uses of IP based service technologies are becoming increasingly important in wireless communications as well as in applications that utilize WSNs. MIPv6 is the key enabling technology for a new generation of mobile data and multimedia services with seamless roaming - even between wireless and wired networks.

3.2. Radio Frequency

Radio frequency (RF) is a technology that uses radio waves to transfer data from an electronic tag called RFID tag or label that is attached to an object through an RF reader. It is used to describe the use of wireless communication. The RFID tag includes an RF transmitter and receiver. RF modules are specified by their operating frequency, modulation type, maximum data rate and maximum distance of operation (in both open fields and in buildings) [9].

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3.3. GSM Technology

Global System for Mobile Communication (GSM) is a standard set developed by the European Telecommunication Standards Institute (ETSI) to describe technologies for second generation digital cellular networks [5][7]. It is a digital circuit switched network optimized for full duplex voice telephony.

Short Message Service (SMS) is a text messaging service component of the GSM that uses standardized communication protocols and allow exchange of short text messages between mobile phone devices. It was originated from radio telegraphy in radio memo pagers using standardized phone protocols and defined as part of GSM series of standards as means of sending short messages [4].

4. The Proposed Framework for RF–GSM Enabled Mobile Wireless Sensor Networks Conclusion

A communication link between the sensor nodes and the base station is established with the proposed mobile controller. This mobile controller acts as the moving device and interface for a sensor node or a group of nodes to the base station. The proposed scheme utilizes the numerous capabilities of the radio frequency (RF) signaling incorporated with short messaging system of GSM (Global System for Mobile Communication) to establish the communication between the base station and the sensor nodes. Figure 4 illustrates the concept for the main framework of the communication link for mobile wireless sensor network.

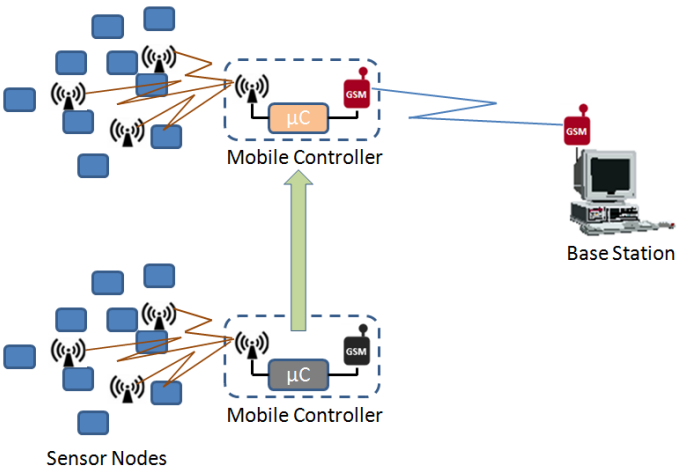

Figure 4. Proposed Framework of Communication Link for a Mobile Wireless Sensor Network

The idea of establishing mobility to each remotely deployed sensor nodes is too expensive and not that easy to employ. The proposed scheme is consist of the following components:

The base station acts as the central controller and server for all of the nodes connected to a Wireless Sensor Network. It functions as the gateway to other networks, performs processing to the information fetched by sensor nodes, acts as the storage center, and serves as an access point for human interface.

The sensor nodes are capable of collecting data and are able to monitor a wide variety of ambient conditions. They are remotely deployed and scattered in a sensor field and routes back the information gathered to the base station and end users

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The mobile controller interacts between the sensor nodes and the base station. Instead that the base station directly controls the sensor nodes, its capability of controlling and gathering information from the sensor nodes is through the mobile controllers. A mobile controller is comprised of a microcontroller capable of reading the sensory data from sensor nodes through RF signals then translates these signals into an SMS form and transmitted to the base station.

Sensing nodes could be formed into groups with same applications to be implemented with one mobile controller to minimize cost and installation schemes. Instead of the sensing device itself to be mobile, the mobile controllers can act as the mobile entities of the system. The function of the base stations is still the same but the base station will be able to redirect the commands to the specific mobile controller the sensor node is currently connected. The principles of the mobility of nodes in MIPv6 are the basis for the structure of the proposed framework for mobile wireless sensor network.

The sensor nodes periodically read, accumulate and store the sensory data through a low cost but high-performance microcontroller. The RF transmitter and receiver provide the window for the sensor nodes to communicate with the mobile controller. The node can include more components depending on the additional functions added to the system. At the Mobile Controller, the utility's orders to the system are received as Short-Messaging-Service (SMS) messages through a GSM modem. A microcontroller analyzes the message and sends the proper commands to all nodes in its area or to a specific node only. Any readings, alerts or reports sent by the nodes are received in the mobile controller, reshaped to an SMS message form and sent again to the base station of the WSN.

The basic idea in using GSM communications in the mobile controller is to receive control messages from the WSN's base station in SMS form. The mobile controller executes the proper routine related to the message content and passes its commands to the sensor nodes through RF signals. Conversely, the sensor nodes sends its replies, whether they are readings, reports or alerts, to the mobile controller through RF signals, then the mobile controller is responsible for transforming this signals in SMS form and directs to the base station via the GSM network. The mobile controller highly benefits from the GSM Module feature that it alerts for any action within the GSM network, so the mobile controller can always monitor what is delivered to the GSM module from network.

5. Conclusion

In this paper we have presented a design of a communication link for Mobile Wireless Sensor Network based on the principles of MIPv6. Node mobility is exploited to create enhanced data communication among sensor nodes and the base station of a WSN. A Mobile Controller is introduced to act as the moving device and interface between the sensor nodes and the base station. The proposed scheme is an integrated system consisting of the base station, mobile controller, and sensor nodes. The use the RF (radio frequency) signaling incorporated with short message system of GSM (global system for mobile communication) to build the communication between the base station and the sensor nodes were utilized. With the use of mobile controllers for sensor nodes, WSNs mobility becomes more powerful and more efficient.

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References

[1] K. Römer and F. Mattern, "The Design Space of Wireless Sensor Networks", IEEE Wireless Communications, vol. 11, pp. 54-61, Available at: http://www.vs.inf.ethz.ch/publ/papers/wsn-designspace.pdf, Accessed: **(2011)** December.
[2] F. L. Lewis, "Wireless Sensor Networks", Smart Environments: Technologies, Protocols, and Applications, 2004, Available at: http://arri.uta.edu/acs/networks/WirelessSensor NetChap04.pdf, Accessed: **(2011)** December.
[3] D. Johnson, C. Perkins, *et al.*, "Mobility Support in IPv6", IETF RFC 3775, **(2004)** June.
[4] "SMS", http://en.wikipedia.org/wiki/SMS, Accessed: **(2011)** December.
[5] "European Telecommunications Standards Institute (ETSI)", http://en.wikipedia.org/wiki/European_ Telecommunications_Standards_Institute, Accessed: **(2011)** December.
[6] "Wireless Sensor Networks", http://en.wikipedia.org/wiki/Wireless_sensor_network, Accessed: **(2011)** December.
[7] "GSM", http://en.wikipedia.org/wiki/GSM Accessed: **(2011)** December.
[8] "Mobile IP", http://en.wikipedia.org/wiki/Mobile_IP, Accessed: **(2011)** December.
[9] "Radio Frequency Identification", http://en.wikipedia.org/wiki/Radio-frequency_ identification, Accessed: **(2011)** December.

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