Domain Name Autoconfiguration in IP-based Wireless Sensor Networks

Sungjin Park[1], Seongkyun Oh[2], Seok Lee[3], Sun Ho Kim[4] and Hyung Seok Kim[5]
[1,2,5]Department of Information and Communication Engineering, Sejong University
Gunja 98, Gwangjin-gu, Seoul, 143-747, Republic of Korea
[3,4]Korea Institute of Science and Technology (KIST)
Wolsong-gil 5, Seongbuk-gu, Seoul, 136-791, Republic of Korea
E-mail: [1]sumer21@gmail.com, [2]gyun59@gmail.com, [3]slee@kist.re.kr, [4]shk@kist.re.kr, [5]hyungkim@sejong.ac.kr

Abstract: This paper provides a method for domain name autoconfiguration capable of enabling a user easily to obtain information on a sensor in a desired area through the Internet in a wireless sensor network using an IP address and enabling a domain name to be automatically set and registered without additional setting of a network operator by using the domain name of a new system for simply representing a type and a geographical position of the sensor.

1. Introduction

A wireless sensor network (WSN) is defined as a wireless network constructed with sensor nodes having a sensing function, a processing function, and a wireless communication function and sink nodes (referred to as data collection stations, gateways, or base stations). This sensor network may be widely used throughout industry [1].

Efforts for extending WSN to the network that is accessible through the Internet by allocating IP addresses to sensor nodes according to the IEEE 802.15.4 standard are gradually increased by combining the sensor network with the IP through researches such as current 6LowPAN [2]. Although an IPv6 address is unique for the entire area, it is inconvenient for the user to access the sensor node because the IPv6 address is represented with a 128-bit number.

As a method of solving this problem, Domain Name Service (DNS) in which an individual sensor node uses a conventional domain name like the Internet may be used. However, it is assumed that there are a considerably large number of sensor nodes in a sensor network, in general. In addition, it is difficult to apply unique domain names to sensor nodes in an aspect of combining the IPv6 having a large number of addresses and it is not suitable to use a form of an existing domain name for the sensor network. Accordingly, a new domain name system is necessary for the sensor network.

It is necessary to set an address of a sensor node by itself similarly to an IPv6 stateless autoconfiguration function [3] without causing inconvenience of recording a large number of domain names in the domain name server (DNS server). The IPv6 address generation method is largely divided into a manual configuration method similar to a conventional IPv4 address, a stateful address autoconfiguration method, and a stateless autoconfiguration method.

The address autoconfiguration function is one of new functions of the IPv6 address system. An IPv6 address is automatically generated for each terminal through the address autoconfiguration function. This is because it is desired to allocate IPv6 addresses to non-PC devices such as sensor nodes having no console or display, in addition to general personal computers (PCs). It is unnecessary for the user to set an IPv6 address because of the IP address autoconfiguration function. It is possible for a network operator to reduce inconvenience of allocating an IP address to each user.

Accordingly, a function of automatically generating a domain name such as the IPv6 address autoconfiguration function is necessary. The domain name has to be automatically set so that users can easily access the sensor network. The domain name has to simply represent properties and a geographical position of a corresponding sensor. Accordingly, the user has to easily request information provided by the sensor.

In this paper, we propose a method for domain name autoconfiguration in an IP-based wireless sensor networks. In order to better understand functions and operation of Domain Name Autoconfiguration (DNA), we first describe it with IPv6 autoconfiguration, and introduce its model with a procedure for sensor node to generate domain name and register it to DNS server.

The remainder of this paper is organized as follows. Section 2 describes Domain Name Autoconfiguration and Section 3 concludes the paper.

2. Domain Name Autoconfiguration

In Fig. 1, the wireless sensor network system includes a sensor node, a module for domain name autoconfiguration, and a domain name server. The sensor node measures its installed position and transmits the position to the domain name autoconfiguration module together with a type of data to be provided by the sensor node and an internet address of the sensor node.

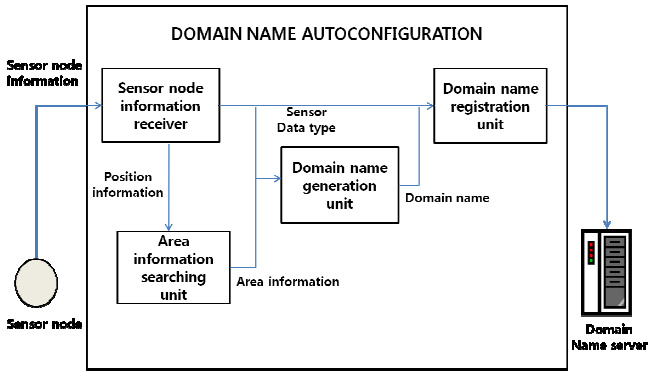

Fig. 1 Domain name autoconfiguration in an IP-based wireless sensor network.

The sensor node can measure a currently installed position obtained through various methods [4]. In the outdoors, it is possible to measure coordinates of a position of the sensor node by using a global positioning system (GPS). In the case where it is difficult to install the GPS or in the indoors, it is possible to measure an approximate position (coordinates) of itself by measuring a received signal strength indication (RSSI) between sensor nodes, a time of arrival (TOA) of a signal, a time difference of arrival (TDOA) of a signal, and an angle of arrival (AOA) of a signal and by using various positioning algorithms such as fingerprinting. In addition, it is possible to measure an accurate position by using a wireless communication medium such as an ultra wideband (UWB) with propagation properties capable of measuring an accurate position [5].

Specifically, in an IPv6-based wireless sensor network, a sensor node generates an IPv6 address by itself (IPv6 stateless autoconfiguration) and transmits the IPv6 address to the domain name autoconfiguration module. Accordingly, the IPv6 address and the domain name are set and registered. A synergy achieved by installing a sensor and easily monitoring the sensor through a domain name without efforts of the sensor network operator occurs.

The domain name autoconfiguration module includes a sensor node information receiving unit, an area information searching unit, a domain name generation unit, and a domain name registration unit. The sensor node information receiving unit receives sensor node information including position information for representing an installed position of the sensor node, a type of data to be provided by the sensor node, and an internet address of the sensor node. The area information searching unit searches for area information including an administrative address corresponding to the position information included in the sensor node information received by the sensor node information receiving unit.

The area information searching unit searches for the area information by using at least one of detailed local maps and building plans in which the sensor node is located. That is, the area information is recognized by comparing the installation position represented by the position information included in the sensor node information, the local detailed maps, and the building plans. Here, the administrative address indicates information on the position of the sensor node such as a lot number, a street name, a building name, and a room number, which is easily recognizable and available for a user.

The domain name generation unit generates a domain name of the sensor node based on a type of the sensed data included in the sensor node information received by the sensor node information receiving unit and the area information found by the area information searching unit.

The domain name includes an administrative address, a type of the sensed data, and a name for representing a sensor network including the sensor node. For example, the domain name may be constructed by serially connecting a sensor type name for indicating the type of the sensed data, a sensor position name for indicating for the administrative address, and a network name for indicating a sensor network including the sensor node.

The domain name registration unit binds the domain name generated by the domain name generation unit with an internet address of the sensor node included in the sensor node information received by the sensor node information receiving unit and registers the bound result in the domain name server. The domain name server receives the domain name and the internet address of the sensor node from the domain name registration unit,

binds the domain name with the internet address, and registers the bound result. The domain name server may be embodied at the same platform as domain name autoconfiguration module. Fig. 2 is a flowchart of a method for domain name autoconfiguration in an IP-based wireless sensor network system.

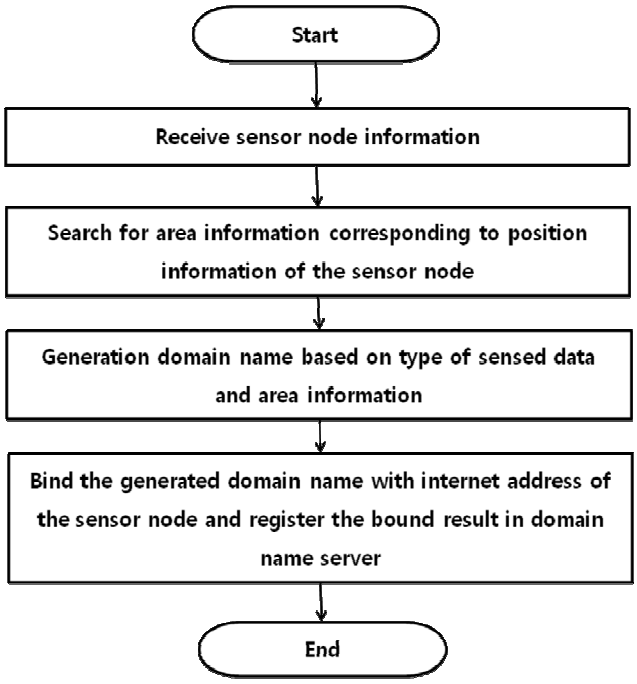

Fig. 2 A flowchart of a method for domain name autoconfiguration

3. Examples

In a case where a temperature sensor node is locate at room 305 of the seventh research building at Sejong University in South Korea, the domain name has a form of "temp.7-305.sejong.wsn.kr" by combining "temp" that is an abbreviated form of temperature, "7-305.sejong" , and "wsn.kr" with one another. In a case where various types of sensed data are provided by the sensor node located at the aforementioned position, a domain name has a form of "multi.7-305.sejong.wsn.kr". In addition, in a case where the sensor node is a sink node that gathers data sensed by other sensor nodes, the domain name generation unit 130 generates a domain name based on an area name including sensor nodes belonging to an area managed by the sink node.

For example, in a case where a sensor, which reads sensor values of major areas in Seoul city and averages the sensor values including itself, is located at the top of the City Hall of Seoul, a domain name may have a form of "http://temp.seoul.korea.wsn.kr", in addition to "top.City Hall of Seoul.korea.wsn.kr". Accordingly, it is possible to use necessary data by accessing a sink node or representative gateway that manages the sensor nodes by using an address including a name of an area including sensor nodes such as "http://temp.seoul.korea.wsn.kr" in a case where a user needs not each temperature of each area of Seoul but a mean temperature over Seoul.

4. Conclusion

In this paper, we have proposed the domain name autoconfiguration in IP-based WSN. The domain name autoconfiguration enables a user easily to obtain information on a sensor in a desired area through the Internet in a wireless sensor network using an IP address. It also enables a domain name to be automatically set and registered without additional setting of a network operator by using the domain name of a new system for simply representing a type and a geographical position of the sensor. The proposed algorithm is practically useful and therefore it is expected to be an effective tool in IPv6-enabled WSNs.

Acknowledgment

This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD, Basic Research Promotion Fund) (KRF-2007-331-D00388).

References

[1] I.F. Akyildiz, W.Su,Y.Sankarasubramaniam and E. Cayirci, "A survey on Sensor Networks", *IEEE Communication Magazine*, Aug. 2002, vol. 40, Issue: 8, pp. 102-114.

[2] Kushalnagar N. and Montenegro G., "6lowpan : Overview, Assumptions, Problem Statement and Goals", *IETF draft*, 2006.

[3] Thomson S. and Narten T., "IPv6 Stateless Address Autoconfiguration", *RFC 2462. IETF*, Dec. 1998.

[4] Wenhui Zhao, Daxin Liu and Yu Jiang, "Positioning Algorithm of Wireless Sensor Network Nodes", *Intelligent Information Hiding and Multimedia Signal Processing 2006 Conf*, Dec. 2006, pp. 271 – 273.

[5] Dongwoo Kang, Young Namgoong, Suckchel Yang, Sungsoo Choi and Yoan Shin, "A simple asynchronous UWB position location algorithm based

on single round-trip transmission," *The 8th International Advanced Communication Technology conf*, ICACT2006, Feb. 2006, Vol. 3, pp.20-22.