RFID Networking Mechanism Using Address Management Agent

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Abstract

The ubiquitous network aims at the communication using IP between entities by the converged network like BcN. RFID is the core technology for comprising ubiquitous network. RFID is also applied to the above features. In RFID network, the communication has to be possible.

In this paper, we propose a networking mechanism using address management agent so that networking using IP in RFID. Network mechanism using address management agent receives RFID tag ID of various length and generates IP address. Also, the information of RFID tag ID and IP address is mapped and it stored in address management agent. By using the mapping information stored in the address management agent, RFID is able to make the networking using IP between RFID tags.

1. Introduction

Presently, the research about ubiquitous network is comprised. In the overseas, 6LoWPAN working group of IETF is actively processing the standardization and research. In the case of the national, the IP-USN forum is composed and the standardization research progresses.

In the ubiquitous network environment, RFID is the wireless identification technique of the next generation capable of recording or reading without contact through a RFID Reader as core technology.

In RFID, a networking is initiated from the thing in which the RFID Reader reads the RFID Tag ID in the product in which the RFID Tag is attached. The next RFID reader questions about the information about the read-out RFID Tag ID and is responded with the information about a product. The networking of these form is the networking at the narrow range of RFID. The RFID Tag ID cannot do the IP networking by an itself because of being the object identifier like the bar code. Therefore, in RFID, the IP address need for the IP networking.

Presently, in RFID, there is the mechanism for generating the IP address of IPv6 by using the RFID tag ID for the IP networking among things which a research is accomplished. In this mechanism, by using EPC(Electronic Product Code) of EPCglobal, the address of IPv6 is created [1].

EPC has various lengths of 64 bit, 96 bit, and 256 bit as electronic product code in order to identify a product. In this mechanism, EPC of 64 bit is used.

The IP address of IPv6 has the length of 128 bit. In this mechanism, 64 bit of the front uses the network prefix information among the IP address 128 bit in order to generate the IP address of 128 bit and 64 bit of after uses EPC of 64 bit. By using the IP address generated as this mechanism, the communication is possible between an Internet and object.

Although the length of EPC was various, IP address is just generated by using EPC of 64 bit length. But EPC of the other length could not generate the IP address. Therefore, the IP networking between an Internet and RFID tag ID can't be made.

In this paper, for the IP networking in RFID, we propose the RFID networking mechanism using address management agent. Network mechanism using address management agent receives RFID tag ID of various length and generates IP address. Also, the information of RFID tag ID and IP address is mapped and it stored in address management agent. By using the mapping information stored in the address management agent, RFID is able to make the networking using IP between RFID tags.

The remainder of this paper is as follows. In chapter 2, we describe about the related research. In chapter 3, the proposed mechanism is described. And the

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networking scenario about the proposed mechanism is presented. Finally, in chapter 4, a conclusion is formed.

2. Related Works

2.1. IP-USN

IP-USN refers to the USN Service which provides the extensive expandability based on the existing IP infrastructure and guarantees mobility of the sensor node, gateway and sink node.

Particularly, IP-USN builds the sensor network in desiring place which connects with the infrastructure like the BcN, IPv6, WiBro, Wireless LAN and provides various services.

The IETF 6LoWPAN working group which is the international organization for standardization related to IP-USN progresses the standardization. And there is the ZigBee in which is centralized the enterprise league as competitive technology. If the Zigbee is suitable to the small scale network, IP-USN is useful to the large-scale network like u-City and has the advantage of being immediately connected with the existing Internet service.

2.2. 6LoWPAN

The sensor network builds network of the low-power connecting the cheap sensor device as core technology at the ubiquitous environment.

The representative standard 6LoWPAN of the sensor network is the technology standardized at 6LoWPAN working group of the IETF Internet Area.

In the IEEE 802.15.4, 6LoWPAN is the technology which transmits a packet of IPv6 by adding IP layer in layer of MAC and PHY in sensor network. 6LoWPAN technology has the advantage that it can use the IP infrastructure which is in existing network.

In 6LoWPAN, the size of a packet is considerably small for the low cost radio communication under the limited electricity in comparison with the IPv6 packet. In 6LoWPAN, the Adaptation Layer exists in order to support the IPv6 packet having the large-scale size. In the adaptation layer, a fragmentation and reassembly about a packet are made.

In 6LoWPAN, the address supports the Short address of 16 bit and extension address of IEEE 64 bit. Also, The automatic address allocation function of IPv6 has to be supported in order to reduce many overhead related to setting a number of devices[2].

2.3. IP Autoconfiguration

IPv6 has the IP Autoconfiguration function of automatically setting the IP address in the terminal.

The IP autoconfiguration can give the IPv6 address to the device in which there is general personal computer or no display.

A user is no need to set the separate IPv6 address by using the IP Autoconfiguration function. Moreover, an administrator can reduce the inconvenience assigning the IP address per the user.

In the IP autoconfiguration, there are two methods of the stateless address autoconfiguration and stateful address autoconfiguration.

2.3.1. Stateless Address Autoconfiguration

In stateless address autoconfiguration, each device generates the IPv6 address without the separate system. A IPv6 address of the total 128 bit is automatically generated through the combination of 64 bit prefix allocated to a router and the MAC address given to an interface[3].

2.3.2. Stateful Address Autoconfiguration

There exists the separate server assigning the IPv6 address in the Stateful Address Autoconfiguration. The specific server manages the table and assigns the address to each PC. Representatively, there is the DHCP Server [4].

2.4. DHCP

The DHCP (Dynamic Host Configuration Protocol) was proposed for the static or dynamic address establishment. DHCP provides the configuration parameter to the internet host.

DHCP is comprised of the protocol for delivering the host detail configuration parameter to a host and the mechanism for assigning the network address to a host from the DHCP server.

DHCP supports three mechanisms for the IP address assignment.

In the static allocation, the DHCP server statically binds the IP address and physical address and has the managed static database. In the case of the static allocation, the DHCP server assigns the persistent IP address to a client.

Moreover, the DHCP server has the database having the pool of IP addresses. This database makes the dynamic allocation possible.

If a client requests the temporary IP address, firstly the DHCP server confirms in the static database whether there is the physical address of a client or not. If the requested physical address exists, the permanent

IP address is assigned. If not, the IP address is assigned to a client with for limited time.

The address assigned by the IP address pool is a temporary. And the DHCP server leases the IP address during the constant time. If the lease time is finished, a client discontinues the IP address use or has to be newly assigned.

In the manual allocation, the client IP address is allocated by the network operator. And DHCP is used in order to deliver the address assigned to a client[4].

2.5. EPCglobal Network

EPCglobal is the non-profit organization which is set up at October 2003 in order to standardize the automatic identification system technology based on RF. EPCglobal is active for the standardization and the commercialization of technology developed in Auto-ID center.

EPCglobal defines EPC Network which is set of technology in order to organize EPC based Internet of Physical Objects in unique of identification of the object. EPCglobal classified the technical element field according to the implementation of the EPC Network into the hardware, the software, and the business field. And EPCglobal organizes each part Action Group and promotes the technical specification and standard enactment as the EPCglobal member enterprise center.

The EPCglobal EPC Network is comprised of the EPC, the ID System (Tag, Reader), the ALE (Application Level Event), the EPCIS (EPC Information Service), the ONS (Object Name Service), EPCIS Discovery System. The EPC is the code for uniquely distinguishing the physical object. The ID System is made of the EPC Tag and EPC Reader. And the EPC Reader reads the EPC Tag information. ALE refines the information which is read with the EPC Reader and it performs the gathering, and the removal of the overlapped information and grouped role of the information. The EPCIS provides the refined EPC information. And ONS provides the global search service on the EPCglobal Network. The EPC Discovery System helps so that the information consumer can search the information about EPC and it can approach.

The operation of the EPC Network starts from the thing attaching to the EPC Tag which is designed in order to distinguish uniquely to an object. By using the RFID technology, the EPC Tag attached to an object delivers its own unique number to the EPC Reader.

The EPC Reader delivers the delivered unique number to a computer or the region application system known as ONS.

The ONS informs the information about the given product to delivered EPC whether it can find on a computer or not. Reader obtains the information based on the information provided in ONS from EPCIS storing the detailed information about a product[5].

2.6. Previous Work

In this section, we describe about the research that it relates to the method proposed in this paper. It is comprised of the tag in which embedded EPC code and the reader with TCP/IP stack. By using radio frequency communications the object in which the tag including the EPC code is adhered, a reader can bring about the EPC code information of the object. Also, the reader has the function of transmitting the EPC code.

Because it was connected via Internet, the EPC code can be accessible using its code trough the reader. Therefore between object and Internet can be possible for bidirectional communication using proposed EPC-IPv6 mapping mechanism.

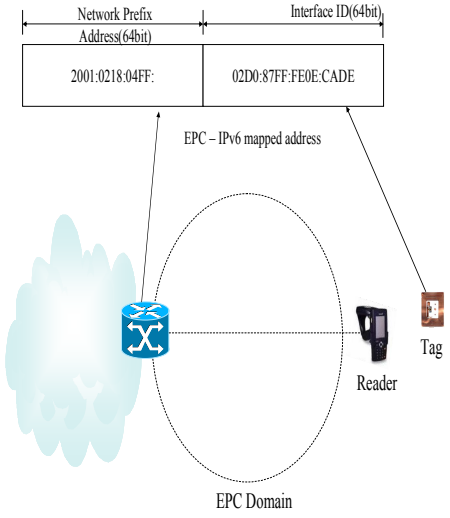

Figure 1. Process of EPC vs. IPv6 code mapping

Generally, the node at the IPv6 network environment receives the RA (Router Advertisement) message from a router and produces its own address. But in a mapped EPC-IPv6 code mapping mechanism, the EUI-64 portion of the network prefix will be replaced by the EPC (64 bit) code value to make mapped EPC-IPv6 address.

IPv6 address is comprised of the network prefix (64bits) and EUI-64 part which is designed to be unique to make 128 bit address space. EUI-64 was

made by expanding network MAC (48bits) address. (i.e., EUI stands for Extended Unique Identifier).

In a reader, the process for making the IPv6 internet address from the RFID tag generate its mapped EPCIPv6 address using IPv6 Prefix address and EPC code.

Figure 1 shows the process of making mapped EPCIPv6 address the reader keeping the record mapped EPC-IPv6 addresses which are produced by using EPC code of the tag and EPC code value. If the reader receives request messages whose destination address is equal to the EPC-IPv6 address pools, the reader read from the tag using mapping table on prefix pool and produces the message fitting for the request of an opponent and transmits[1].

3. Proposed Mechanism

3.1. Network configuration

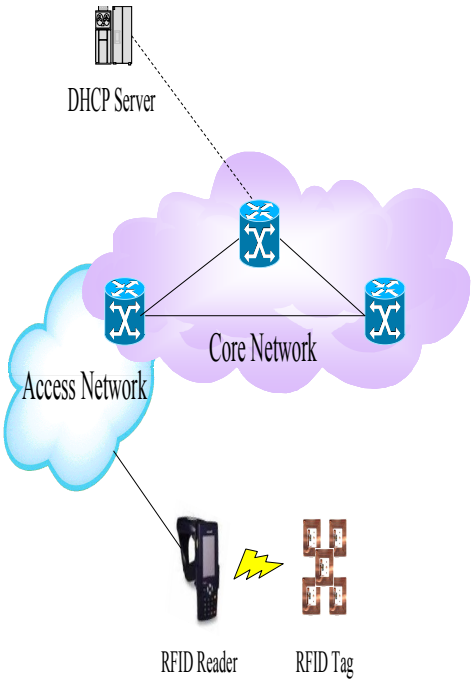

Figure 2. Network Configuration

The network configuration of figure 2 is comprised of the core network and access network. In the core network, a router and DHCP Server are located and in the access network, RFID Reader is connected.

The role of each compositional element is reviewed below. In core network, a router delivers the packet as confirming IP address of the destination. The DHCP server dynamically assigns the IP address.

The RFID Reader performs the role that it reads the RFID tag ID or records data in the RFID tag. Moreover, the address management agent is positioned inside the RFID Reader. The address management Agent is delivered the RFID tag ID and creates the virtual physical address of forty-eight bits. And the RFID tag ID, the produced virtual physical address, and the IP address assigned at the DHCP server are mapped and it stores in the storage device.

3.2. Operation procedures

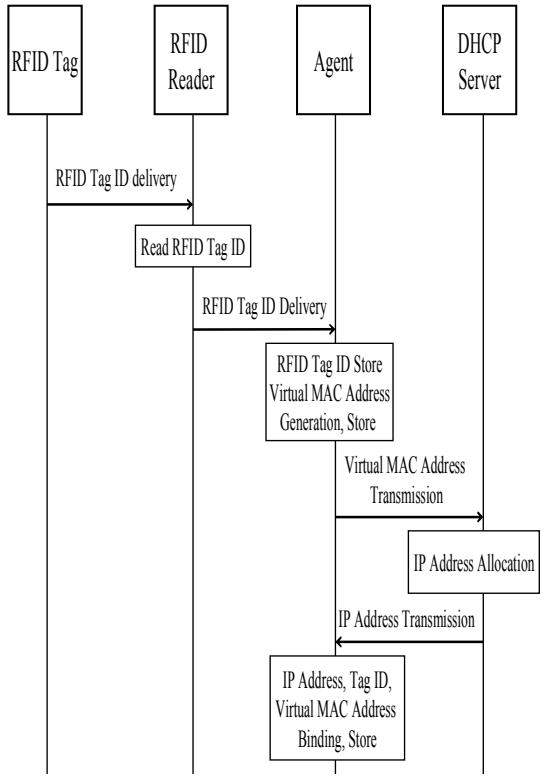

Figure 3. IP address generation process flow diagram

The figure 3 is the process flow diagram showing the procedure of producing the IP address about the RFID tag ID.

In figure 3, the RFID tag ID is delivered to a RFID reader. A delivered RFID tag ID is read by the RFID reader. The RFID reader delivers the read tag ID to the agent. The agent stores the tag ID in storage device. Moreover, the agent generates a virtual physical address by using the RFID tag ID. The agent maps these information and stores in storage device. An agent transmits the generated virtual physical address to the DHCP Server. The DHCP server receives the virtual address and assigns the IP address. And the

DHCP server transmits the assigned IP address to an agent. An agent binds the received IP address, the RFID tag ID, and the virtual physical address and stores in the storage device.

3.3. RFID Networking Scenario

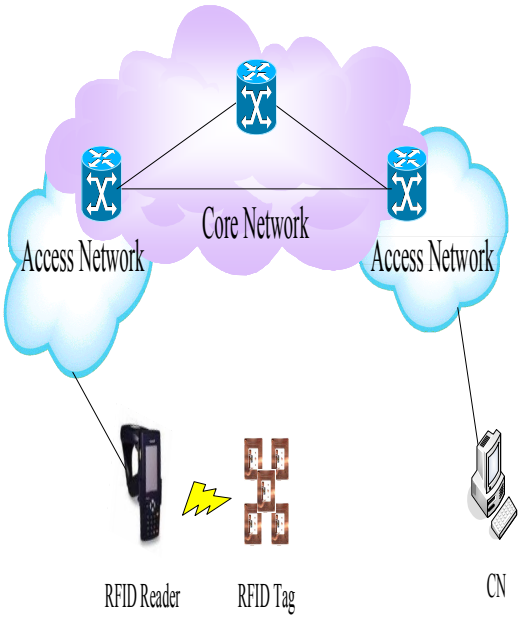

Figure 4. RFID networking scenario network configuration diagram

In the proposed mechanism of this paper, the IP address could be produced through the IP address generation process. The generated IP address is mapped with the RFID Tag ID and the virtual physical address and is stored in the storage device of the agent.

Figure 4 shows the network configuration diagram of the simple RFID networking scenario. In the figure 4, the network is comprised of each access network with the core network. Firstly, the following assumption is made. The RFID reader has its own unique IP address. And we assume that the mobility is supported by the mobility support mechanism including MIP, and etc.

In case external CN(Correspondent Node) reads the RFID Tag or it reads, CN transmits a packet with the IP address of the RFID Tag ID. At this time, a packet is encapsulated with the IP address of the RFID reader and is transmitted. A packet transmitted through the core network arrives at the RFID reader. The RFID reader decapsulates received packet. The RFID reader searches for the mapped RFID Tag ID by using the destination IP address in the agent. If the RFID Tag ID exists in the storage device of the agent, a packet is delivered to the RFID Tag having this RFID Tag ID.

On the contrary, the active RFID can transmit data to CN. In the RFID Tag, the various restrictions are existed in order to the packet transmission. Therefore, in case there is the request of the RFID Tag, the RFID reader handles the practical processing for the packet transmission.

The RFID reader transmits a packet to the IP address of CN by the destination address and to the RFID Tag ID address by the source address in the packet transmission. The RFID reader transmits a packet to CN by encapsulating a packet to IP address of RFID reader. The CN decapsulates the received packet and confirms the packet.

4. Conclusion

The RFID tag ID having the various lengths could not use as the IPv6 address having the length of 128 bits.

In this paper, we propose a networking mechanism using address management agent so that networking using IP in RFID. The address management agent is positioned inside the RFID Reader. The address management agent generates the virtual physical address about the RFID Tag ID and is assigned the IP address from the DHCP server.

Network mechanism using address management agent receives RFID tag ID of various length and generates IP address.

Also, the information of RFID tag ID and IP address is mapped and it stored in address management agent. By using the mapping information stored in the address management agent, RFID is able to make the networking using IP between RFID tags.

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References

[1] Sang-Do Lee, Myung-Ki Shin, and Hyoung-Jun Kim, "EPC vs IPv6 mapping mechanism", *ICACT2007*,ICACT, Korea, 2007, pp.1243-1245.

[2] G. Montenegro, N. Kushalnagar, and J. Hui, D. Culler, “Transmission of IPv6 Packets over IEEE 802.15.4 Networks”, *IETF RFC4944*, IETF, USA, 2007.

[3] S. Thomson, T. Narten, “IPv6 Stateless Address Autoconfiguration”*, IETF RFC2462*, IETF, USA, 1998.

[4] R. Droms, Ed, “Dynamic Host Configuration Protocol for IPv6(DHCPv6)”, *IETF RFC3646*, IETF, USA, 2001.

[5] EPCglobal, "The EPCglobal Architecture Framework Version 1.2," *EPCglobal*, USA, 2007