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Integration in the Heterogeneous Wireless Sensor Networks Based on Network Layer

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Abstract: In the next generation wireless sensor networks system, various wireless technologies and wired networks in together, in order to meet the various needs of users. Our focus in this paper is to introduce a few design goals, different wireless/wired networks complement each other, thus help users to access the best network in accordance with the current business. Each network is different with each other in the network structure, application protocol and user demand, therefore need a unified public architecture to connect multiple access network. This paper surveys the novel approach of using IP technology recognized as the next generation of integration means of wireless sensor networks. This paper also presents using all-IP network architecture to support the heterogeneous access of the next generation wireless sensor networks, to support the integration and interoperability between heterogeneous wireless sensor networks, and to complete wireless mobile terminal roaming in a heterogeneous environment. *Copyright © 2013 IFSA.*

Keywords: Wireless sensor networks, Network-based mobility management, Mobile IP, MN, FA, HA, Tunnel.

1. Introduction

Wireless sensor network (WSN) is referred to as "ubiquitous network", widely used in environmental monitoring, national defense military, industrial control, intelligent household, health care and other fields. However, they cannot be thought of as a total replacement for more traditional wired networks in such environments, at least in the short/mid term. In these applications, wireless sensor network (WSN) is not existed in isolation, but in some way connected to the existing network, to facilitate users to remote access, control and use wireless sensor network resources. This means that for the time being it is worth focusing on their integration with the existing heterogeneous wired/wireless solutions, in order to achieve enhanced flexibility, efficiency, and performance for the overall networked system [1].

Integration in the heterogeneous wireless sensor network is the inevitable trend of the development of mobile communication network, will be faced with many technical challenges. Seamless mobility problem between multiple access networks is one of the keys to realize network integration. Mobile IP which is acknowledged as the solution of heterogeneous wireless sensor networks are the most competitive mobility management scheme, mainly used in switching and roaming between different access networks [2].

Along with the increasing convergence of wireless communication and Internet, the main business of the industry has realized wireless data provided by wireless sensor networks.

It is necessary for mobility management in next generation wireless communication system, based on the network layer mobility management,

performance optimization of mobile IP and mobile IP in wireless communication system deployment and other issues for further discussion. By improving and enhancing the performance of mobile IP, finally make it become a kind of suitable for future wireless sensor network in the macro and micro mobility management scheme.

2. The Next Generation of Mobility Management in Wireless Sensor Networks

Mobility management is refers to the problems which relate the mobile nodes involved in wireless network. Because of node mobility, it request network support this feature and management. Wireless node mobility usually involves in the different network, roaming between different domains. In the wireless network, mobility refers to the change of the user and the position of terminal-the ability to continue to access services, continue to communication. At present, the mobile wireless network management mechanism depends on the specific technology used in the protocol, there is not a common network infrastructure or protocol support roaming between different types of access networks.

One of the characteristics of the next generation of wireless communication network is a variety of heterogeneous wired/wireless access technology, able to transmit real-time business, applications Smooth and adaptively; terminal and the business can keep entire network roaming [3]. Heterogeneous network exist coexist and fusion, the scenario has brought new challenges for mobility management scheme design.

The future wireless network mobility management must address the following questions:

a) To provide a flexible, theoretical model which is layered, meet safety requirements and mapping mechanism between the layers is established.
b) Whether domain mobility or inter-domain mobility, must reduce the mobility management signaling load, as far as possible to reduce the interaction between the entities, to minimize position update signaling cost, reduce the session time delay.
c) Switch between heterogeneous network management must satisfy the QoS requirements, routing optimization problem and reduce the session delivery time delay.

Has the scalability, in order to new wireless access network can be simple and quickly integration into the mobility management framework.

The heterogeneity of network and the diversity of business put forward higher request of the mobility. In the traditional sense of the mobility management model and architecture need to reconsider. In the heterogeneous network environment, the mobility of user experience can be divided into the following categories achieve the form: terminal mobility, personal mobility, session mobility and business mobility. Because the user in the overlapping coverage of different types of access networks, the researchers suggested a variety of different technical solutions and ideas, using different methods to realize the integration of heterogeneous network and communication. In wireless sensor networks, mobility management purpose is to provide mobility to terminal and business, mainly includes the location management and change management.

Location management make system with the capacity of locating and tracking possible roam or the location of the mobile host/terminal, then will accurately submit call or grouping to mobile host/terminal. As shown in Fig. 1, location management concept involves the two sub-processes, location update and call to submit. Network must to track and record the location of mobile station, can send the switching speed of the call to the correct user according to the requirements.

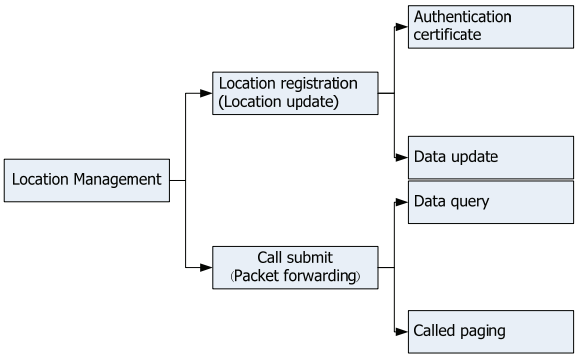

Fig. 1. Location Management.

Switch management is one of the most important and challenging problems in the wireless sensor networks mobile management. Allows the terminal still stay ongoing connections when changing the network access. Mainly includes three steps: Initialization of the switch, the establishment of the new link and data flow control. As shown in Table 1, switch management research mainly contains switch architecture and design of the algorithm. Key problem is the switch decision strategy and performance evaluation.

3. Network Layer-based Mobility Management

The future of mobility management in heterogeneous network environment needs a general agreement to block out the differences of different types of wireless/wired networks. While IP technology can blocking the second access technology, providing a unified interface for the upper levels. The mobility management protocol based on the IP network layer provides a unified

solution for terminal node roaming in heterogeneous network environment. The traditional wireless communication network transmit signal through specialized SS7 signalling network [4]. Signal transmission with the business is independent of each other. In the whole IP network, Core network and the air interface are all IP-based. All the business is directly beared by the IP. That is control and business all at the IP level load. Due to the performance of IP network itself and traditional differences in no. 7 signaling network, it need to consider the transfer performance requirements of transmission in IP in the plane at the same time.

The network layer mobility management not only can provide mobile function between different access networks, also can pass on any specific access link protocol stack by adopting general agreement to simplify the design of wireless mobile terminals. At present, common network layer mobility management protocol are mobile IP and various improvement schemes. Mobile IP designed enables the wireless mobile terminal to move freely in the Internet. And doesn't change the IP address in the process of moving between different subnets [5].

From the current technological development situation analysis, using the network layer mobility management scheme based on mobile IP for wireless sensor terminal roaming in heterogeneous network environment, can better shielding the lower various wireless/wired communication technologies, to realize the unity of the users seamless roaming and the mobility management, so as to achieve the ultimate goal of wireless personal network communication.

4. Integration in the Heterogeneous Wireless Sensor Network Based on Mobile IP

The working mechanisms of mobile IP.

Mobile IP is a new routing mechanism allows a wireless mobile node to use a permanent IP address connected to any link. The purpose is to provide the Internet with mobile computing capabilities. It has many characteristics, such as scalability, reliability, and security [6]. The main design goal of mobile IP is that when change the network access point, does not need to change the node's IP address, able to keep the continuity of communications in the process of moving, allows the user to be able to free Internet access in the process of roaming.

The following introduce the relevant technology of the mobile IP and working mechanism.

4.1. The Working Mechanisms of Mobile IPv4

In the mobile IPv4 work mechanism, when the mobile host (MN) detected you have roaming to foreign network, it will obtain a temporary address by nonlocal transfer agent FA. There are two types of transfer address: FA care-of-address and Co-located Care-of Address. MN put the address through the Internet to inform its local agent HA. Since then, the IP datagram of other subnet sent to the MN will be sent to the home network. In the home network, via proxy ARP, HA intercepts the message sending to MN, reassemble the IP datagram sending to MN, changes the destination IP address of the IP datagram domain to the care-of-address of MN when Assemble (tunneling technique), and then sends out. If the transfer address is FA care-of-address, the receiving end of the tunnel is FA. The FA reassembles the IP datagram back to the original format to MN. If the transfer address is Co-located Care-of Address, the receiving end of the tunnel is the MN, work is completed by its own unpacking. When the MN outer net send IP packets, using the usual IP protocol to send, No access of HA and FA.

As shown in Fig. 2, when the wireless mobile node moves to nonlocal network, through the agency to determine their position and care-of address, then make agent can complete forwarding function through registration, finally through the tunnel technology to complete packet forwarding.

a) Agent Discovery

Wireless Mobile node complete the following functions using agents search process:

- Decide it is on the home link or foreign link in the current;
- To test whether it switch the link;
- When on the foreign link, get a temporary care-of address [7].

Table 1. Switch management content.

Switch management					
Switching architecture			**Switching algorithm**		
Switch categories	Switch control	Switching implementation	Switching criterion	Ruling strategy	Switching performance
Hard switch Soft switch seamlessly switch	Network control wireless station control wireless station help	attach repeat attach detach Registration of communication	RSS Priority BER, BLER SIR Path loss Power budget	traditional method neural network Pattern recognition fuzzy logic Take after test	Switch time delay Switching rate handover blocking rate Drop-Call rate call blocking rate

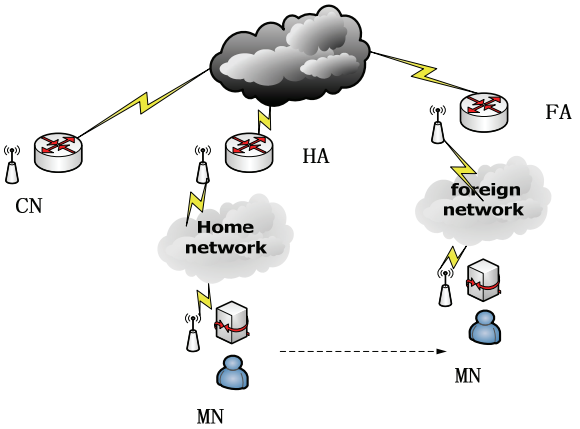

Fig. 2. The working mechanisms of wireless mobile IPv4.

Agent Discovery made up of two simple message:

- A message is the Agent Advertisements, agent use the news to announce their function to the wireless mobile node;

- The other news is the Agent Solicitation.

When the wireless mobile node didn't receive the Agent Advertisements message, can send the Agent Solicitation message that let all agents on the link immediately sent an Agent Advertisements message. Wireless mobile node can use the survival time domain or network prefix of the Agent Advertisements message's ICMP router part as mobile testing standards, so as to determine whether the mobile node to switch from a link on another link.

b) Register

Registration is the method that a wireless mobile node to request routing and unpack/pack service of from Foreign Agent, and to tell home agent the current care-of address. When wireless mobile node found itself on the switch from a link on another link, then start the registration process. When some special condition, also need to register. For instance, when wireless mobile nodes found that the foreign agents it connected conducted a reboot, it would have to register again; Current registration if expired, also wants to register again. Mobile IP registration includes the interaction of the two kinds of messages: Registration Request and Registration Reply.

c) Packet Delivery

Packet Delivery means Packet routing, including two cases: wireless mobile node on the home link and wireless mobile node on the foreign link. When the mobile node on the home link, the packets which destination address is the wireless mobile node's home address are sent to the home link of wireless mobile node, common network prefix routing analysis technology can be used. When the wireless mobile node on the foreign link, the packets which destination address is the wireless mobile node's home address are sent to the home link of wireless mobile node, it is actually sent to the wireless mobile node's home agent. After the home agent intercepts these packets, it sends a packet backup to care-of address through the tunnel. Raw packets were then removed from the tunnel, unpacked later and sent to the wireless mobile node.

d) Tunneling technology

The transfer path of the packet which is encapsulated in another packet payload is called a tunnel. There is no doubt, tunnel is the indispensable key technology of wireless mobile IP. It mainly contains the IP fragmentation and encapsulation [8]. There are 3 kinds of tunnel technology used in the wireless mobile IP technology as following:

- IP in IP Encapsulation;
- Minimal Encapsulation;
- Generic Routing Encapsulation, GRE.

4.2. The Working Mechanisms of Mobile Ipv6

Along with the rapid development of network technology and scale, in order to meet growing demand, the Internet TCP/IP protocol is evoluting from v4 version to the next generation Internet protocol IPv6 versions step by step mobile IP as a network layer protocol for the network will provides a perfect mobility support to the network node in the v6 version. At present, IETF mobile working group take formulate and revise mobile IPv6 standards as the main research topic of mobile IP working group agenda. And some progress has been made [9].

Mobile IPv6 is the basis on inheritance of many advantages in mobile IPv4, and is designed using many new features adding in IPv6. It has become an integral part of the IPv6 protocol, providing a more perfect mobility support for wireless sensor networks. Compared with the mobile IPv4, mobile IPv6 made many improvements, the most important are eliminating "Triangle Routing" problem, integrated with routing optimization mechanism, allow any direct route packets between communication nodes and mobile nodes. In addition, originally the mobile node's home address is replaced by global routing and link local address; foreign agents were instead of a pure IPv6 routers on the foreign link, and care-of address all configured in automatic or manual way; Home agent certified registered were instead of Home agent and other communication partners' notice with certification; Data transfer mode is also based on the original mode of tunnel and increases the source routing. All these improvements mechanism improves the performance and efficiency of mobile IPv6. A reference for design of mobile IPv6 is mobile IPv4 development experience, but there is much difference with mobile IPv4. Both comparisons are shown in Table 2.

4.3. The Working Mechanisms of Hierarchical Mobile IPv6

Hierarchical mobile IPv6 (HMIPv6) is a kind of micro mobility management model. By means of

hierarchical routing architecture, Localize registration signaling process, Reduce the signaling interaction of communication between the wireless mobile node and home agent, Correspondent Node. To reduce the communication interruption caused by switching time. HMIPv6 is on the basis of the MIPv6, introduced a new entity, referred to as mobile anchor point (MAP). Through the MAP to manage local switch, the global mobility is still managed by the MIPv6 protocol. HMIPv6 protocol made smaller expansion operation for mobile nodes and HA [10]. The main reason is that mobile noderegister MAP's CoA in HA. As a result, when the wireless mobile node in mobile local, only need to register it's new location on the current MAP, without need of operation with HA or any CN out of access network. By using this method, signaling occurs only in a smaller area, will not spread to the core network, the time of complete position update is shorter. MN has 3 different addresses: MN Home Address, Regional Care-of Address (RCoA), Local Care-of Address (LCoA). When MN is connected to the new network, request registration from the MAP which services the network. The MAP intercepts all the packet of its servicing MN, then forward the packet to the MN's LCoA by the way of the tunnel.

Table 2. Compare mobile IPv4 and IPv6.

The concept of mobile IPv4	The concept of mobile Ipv6
Mobile node, home agent, home link, foreign link	Mobile node, home agent, home link, foreign link
Mobile node's home agent	Global routing home address and Link - local address
Foreign agent / foreign agent care-of address	A pure IPv6 routers on the foreign link, No longer have foreign agent, all the care-of addresses are Co-located Care-of Addresses
Co-located Care-of Address, through Agent Discovery, DHCP or Manual for Care-of Address	By proactively address automatic configuration, DHCP or Manual for Care-of Address
Agent Discovery	Router Discovery
Home agent certified registered	Home agent and other communication partners with certification notification
The data transmission to the mobile node adopts the tunnel	The data transmission to the mobile node adopts the tunnel and source routing
Routing optimization is performed by other protocols	Integrated with routing optimization

5. Conclusions

Mobile IP technology is the network layer fusion technology to realize the wireless mobile node access to heterogeneous networks. Mobile IP based on the premise of network prefix routing in the current Internet, the mobile node (MN) still keep communication between different networks. It is a kind of very good solution to provide mobile support based on the network layer.

Acknowledgements

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