

Adaptive Hierarchical Handoff Optimization Scheme for Heterogeneous Wireless Sensor Networks

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Abstract: This paper proposes a Mobile IP Handoff optimization scheme for heterogeneous wireless sensor networks. In the scheme, a complete solution is provided; and handoff can be effectively controlled, the network business environment can be real-time detected; the target network, the handoff type and time can be accurately judged. In addition, the handoff performance of mobile IP will be largely improved. From the theoretical and simulative perspectives, the paper analyzes the performance parameters, including the mobility handoff cost, the mobility handoff delay time and packet loss rate, and the analytical results show that the performance of the scheme is better than other schemes. *Copyright © 2013 IFSA.*

Keywords: Wireless sensor networks, Handoff, Mobile IP, Hierarchical mobile IPv6, Level 2.5, Adaptive fast HMIPv6, Fast-Handoff MIPv6.

1. Introduction

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.

In MIPv6 basic model's handoff mechanism. The performance is not good. There are problems such as packet loss rate and delay is larger, etc. It can't meet the needs of the delay sensitive real-time business. To this end, gradually put forward the hierarchical MIPv6 and Fast-Handoff Model for MIPv6 [1].

This paper proposes a Mobile IP Handoff optimization scheme for heterogeneous wireless sensor networks.

2. Mobile IP Handoff Technology

The main design goals of Mobile IP mobile is when the nodes change the network access point, don't need to change the node's IP address, to maintain the continuity of communications in the moving process and enable users to achieve multiple access freely in the process of roaming. In the working mechanism of mobile IP, when mobile sensor node moves to foreign network, through Agent Discovery to determine their position and care-of address. And then through the registration agent can complete forwarding function. Finally through the tunnel technology to complete packet forwarding [2].

In mobile IP, when MN Position moved, Moving from one subnet to another subnet, Creates a network handoff. Mobile IP handoff process is shown in Fig. 1. The entire mobile IP handoff process not only the link layer switch, and also need to complete the network layer switch.

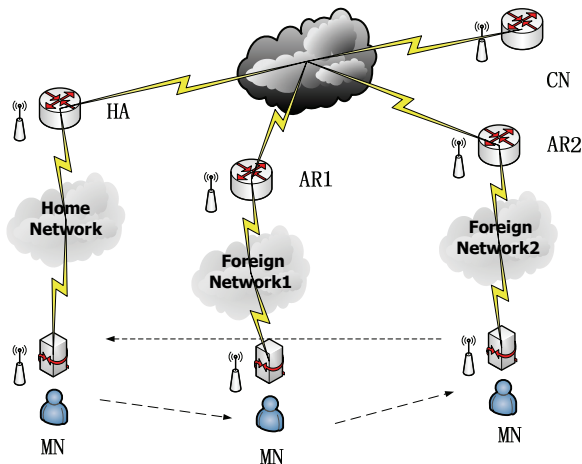


Fig. 1. Mobile IP handoff process.

Fig. 2 shows the mobile IP handoff signaling procedure. Before handoff process, Mobile sensor node through the old AR to send and receive data. At time t_0 , MN to enter a New AR's signal range. MN in the overlapping area of the old and the new AR (from t_0 to t_2 time). MN determine whether to need the link layer switch according to the link characteristics (RSSI receiving signal strength indication). The link layer switch using hard handoff technology [3]. Time t_1 and t_3 moment respectively, is the start time and completion time of the link layer switch. When the link layer switch is completed, MN can receiver new AP periodic broadcast announcement message. When MN receive the new BS broadcast's first announcement of a message (t_3 moment), to begin care-of address configuration, and complete at time t_4 . Then MN sent route update message, and registered to the home agent. After the path update is completed (t_5 moment), MN can receive and send messages through the new AP.

In the end, Send BU to CN communicating with it. MN handoff registration process of hierarchical mobile IP as shown in Fig. 4.

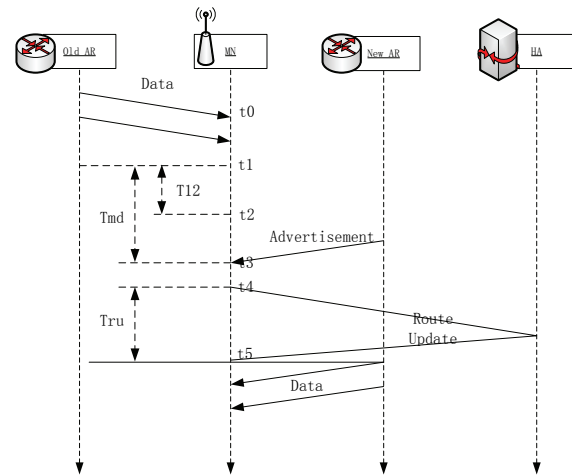


Fig. 2. Mobile IP handoff signaling procedure.

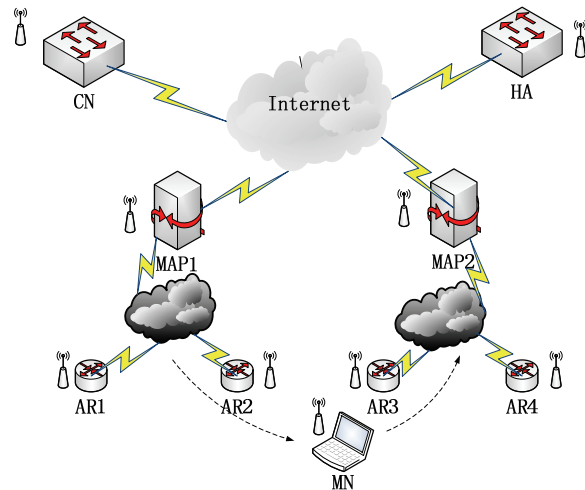


Fig. 3. Working mechanisms of hierarchical mobile IPv6.

3. Hierarchical Mobile IPv6

HMIPv6's basic idea is to divide network into different administrative domains [4]. The behavior of the mobile sensor node MN can be divided into macro mobile (mobile between domain), and micro mobile (move within domain), support Respectively by the traditional mobile IP and micro mobility management protocol. As shown in Fig. 3, in the hierarchical mobile IPv6 handoff process. If MN mobile sensor node switched between different access routers (AR) in the same administrative domain, LCoA changed, Need to bound MN's new LCoA to MAP. If MN moves to another MAP domain, need to get a new regional address RCoA and LCoA. After the address, MN send routine MIPv6 binding updates BU) to the MAP. The MAP bound MN's RCoA and LCoA. As a response, the MAP return a binding acknowledge (BA) message to MN and MN must specify the Home Address binding with the new RCoA through send another BU to HA.

In the process of mobile IP handoff. In order to ensure the quality of existing connection communication services, make the mobile sensor node communication connection interruption time minimum in the process of switching. Next, this paper presents a low-latency switching technology and the rapid switching technology [5].

MN move into MAP2 domain:

- The MAP found LCoA and RCoA.
- MN registered to the MAP.
- MN registered to HA.
- MN notified CN New RCoA.

MN switch from the AR3 to the AR4 in the MAP2 domain:

- The MAP found LCoA and RCoA.
- MN registered to the MAP.

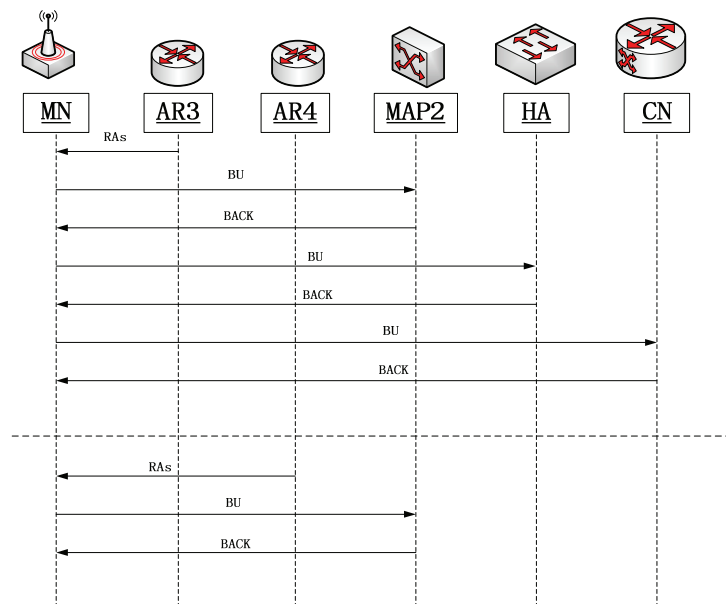


Fig. 4. Handoff process of hierarchical mobile IP.

4. Mobile IPv4 Low-Latency Handoff

In order to reduce the mobile IP handoff delay, three kinds of switch method is proposed: Registration advance of handoff method, Registration after the handoff method, Integrated handoff method [6].

4.1. Registration Advance of Handoff Method

Allows mobile sensor nodes take part in impending layer 3 handoff. With the support of the network layer, when the mobile sensor node did not complete handoff in the layer 2, to start part operation of the layer 3 handoff. The third layer switch can be initiated by the mobile sensor terminal, also can be launched by the network. In addition to the mobile sensor terminal cases, it need to expand agent request information, no new message type is put forward.

4.2. Registration After the Handoff Method

Use double tunnel to achieve low latency handoff. After successfully completed the registration of mobile IP between moving sensor node and the old foreign agents, Old foreign agent becomes the mobile sensor node's "Anchor Point". The mobile sensor node moves to a new foreign network, can delay the third layer handoff and continue to use the original foreign agents. If the mobile sensor node is not yet complete the register to new foreign agents and then move to the third foreign agents's network, the third field agents can be signaling interaction with "Anchor Point", and move the bidirectional tunnel to

the third foreign agency. When after the completing registration of mobile sensor node in foreign network, the bidirectional tunnel will be removed [7].

4.3. Integrated Handoff Method

Perform the registration advance of handoff method and the registration after the handoff method at the same time. If registration advance of handoff method can be done before completing the handoff in the layer 2 switch, integrated handoff method is transformed into registration advance of handoff method. If the advanced handoff is not complete. The old foreign agents started like after registration method, the data packet sent to the mobile sensor node will be sent forwarded to new foreign agents. In front of the layer 2 handoff to complete, advance registration does not guarantee can be certainly completed. This method provides an alternate mechanism.

5. The Mobile IPv6's Quickly Handoff

Quickly Handoff of mobile IPv6 can be divided into two kinds of mechanism: advance switch and the switch based on the tunnel. The definition of advance switch is basically the same with the advance switch mechanism in mobile IPv4. And the rapid switching based on tunnel is that, when the second layer connection has been established between mobile sensor node and the new access router, did not immediately start switch of the network layer to get the new care-of address, but the tunnel will be established between two network access routers. Mobile sensor node can receive data from the previous network through the tunnel.

Mobile IPv6 without detailed description for handoff mechanism. Through the analysis can be seen, handoff initiation and the establishment of a new connection is mainly done by MN. MN is still to establish the new data channel through sending new BU to HA. For the current active communications, No special treatment is given in mobile Ipv6. Only after a new connection is established, the data packet can be sent to the new CoA. So, in the process of switching, there must be packet loss [8].

6. Mobile IP Handoff Performance Optimization

6.1. 2.5 Layer Triggering Mechanism of Mobile IP

In the process of mobile IP handoff, the advantage of 2.5 layer trigger mechanism can be used to optimize switch performance. 2.5 layer functions, protocol architecture and some specific network entities must be redefined. The purpose is to adapt to the new network environment, effective use of available network resources. 2.5 layer may be defined as a logical function component between layer 2 and layer 3. Any event or static and dynamic information from 1 layer and 2 layers, can be provided to the upper layers, achieved by unity between

2.5 and 3 layer service access point (SAP).

Fig. 5 includes the architecture and functional components of 2.5 layer, also includes cross-layer information; and provides a complete solution; and

can effectively control switch, Real-time detection of network business environment; accurate judgment of the target network, switch type and time.

Key function of 2.5 layer

Information gathering.

2.5 layer can collect information dynamically from all the local interface and particular protocol layer on the far side. This information can be found in local and remote from non binding triggers or by timing from all interfaces. Dynamic information can be stored in the information entities, through cross-layer approach to assist handoff decision, to produce a multidimensional trigger [9].

Unified interface to trigger.

2.5 layer provides the upper layers a uniform interface: From layer 1, layer 2 and layer 2.5 can produce multidimensional trigger. Triggers can be divided into the following two categories:

- i. One-dimensional trigger: The trigger should only indicate one thing related to a parameter. For example, when the signal length exceeds a predefined threshold, a d trigger will produce.
- ii. Multidimensional trigger (abstract trigger): The trigger reflect an abstract events, is associated with multiple parameters. For example, "link will disconnect", indicating an abstract concept: A link will be disconnected. According to the specific algorithm, more exact link disconnection instructions should be integrated judgment under multiple input parameters, such as the signal intensity and FER. Algorithm should be carefully designed to produce a more accurate indicator.

Functional components of 2.5 layer architecture.

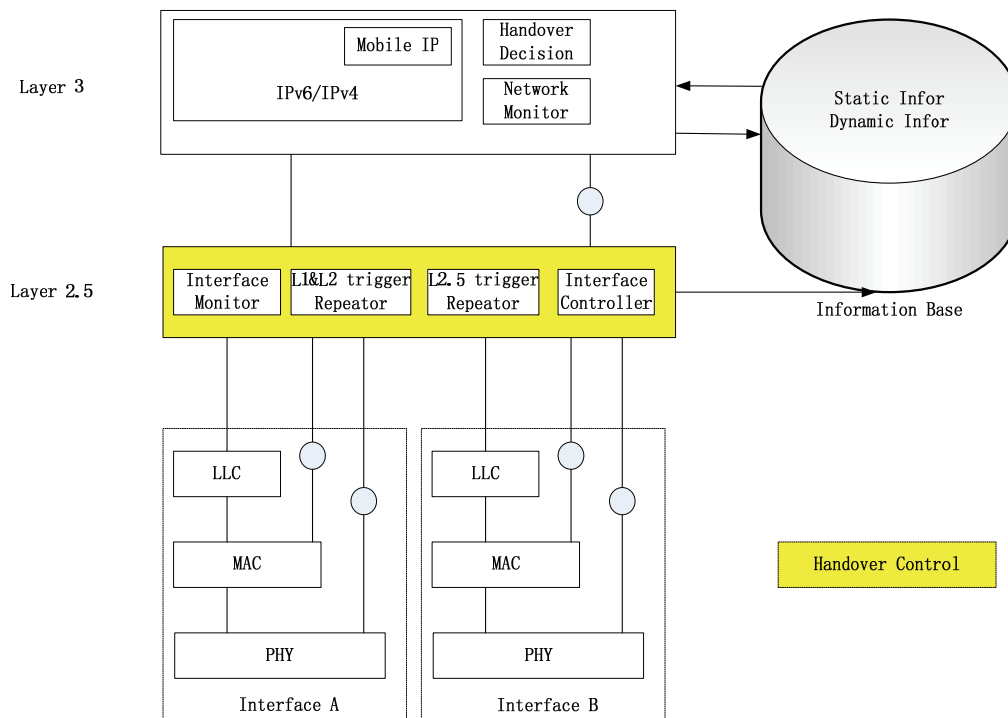


Fig. 5. Layer 2.5 functional architecture.

Interface Monitor: Responsible for the collection of the static and dynamic information from all physical interface, and all information will be stored in the information base station.

The trigger of 2 layers: Through the unified service access point (SAP), responsible for sending all registered L1 and L2 trigger to the upper layers.

L 2.5 Trigger: According to the specific algorithm and a variety of input parameters, Responsible for generating the abstract trigger (multidimensional trigger).

Interface Controller: Is responsible for providing limited control function to top layers at the bottom.

2.5 layer provided the upper layers limited control function. 3 layer should not interfere with the function process and working status, except the power management considerations. According to the cross-layer design method, 3 layer should choose the appropriate interface to use. But can't decide when to initiate a process attached new access points. Layer 2.5 can affect the activity of the layers 3. By triggering or gather input parameters to support layer 3's handoff decision.

Based on a 2.5 layer triggering mechanism, triggered by one or more parameters of the bottom, to provide an effective way to the top, to discover the changes in the underlying layers. The purpose is to improve the handoff performance of mobile IP.

6.2. Adaptive Semless Handoff Mobile IPv6 Optimizations

In MIPv6 basic model's handoff mechanism, the Performance is not good. There are problems such as packet loss rate and delay is larger, etc. It can't meet the needs of the delay sensitive real-time business. To this end, gradually put forward the hierarchical MIPv6 and Fast-Handoff Model for MIPv6. As shown in Fig. 6.

The purpose of fast mobile IPv6 is reducing the delay of mobile testing and the phase of care-of address configuration. And hierarchical mobile IPv6 processing is the time delay related to binding update (BU) operation. Time optimization was carried out by FMIPv6 and HMIPv6 in different parts of the process of MN handoff. But neither from the whole process of the handoff, mean from the perspective of the entire network, to improve the handoff's time delay problem. If consider the combination of FMIPv6 and HMIPv6, and adaptive (MN mobile features), to put forward an adaptive fast hierarchical mobile IPv6 handoff timing optimization method, will largely improve the handoff performance of mobile IP. That is the compared results with a subnet residence time of MN and the average residence time of the subnet (set threshold). Selectively routing optimization. If the former than the latter, MN register LCoA the on-link care-of address in the subnet. So between MN and CN can communicate

directly and not through the MAP. If the former is smaller than the latter, The MN's regional care-of address RCoA is registered to CN. At this point, the packet group between MN and CN need to be forwarded by the MAP. This adaptive packet burst transmission according to the moving characteristic of MN, not only reduces the load of the MAP, and reduces the packet routing between MN and CN. As a result, adaptive fast hierarchical mobile IPv6 handoff strategy reduced the handoff delay of MN from overall, and improved the performance of the entire network. Specific handoff flow as shown in Fig. 7.

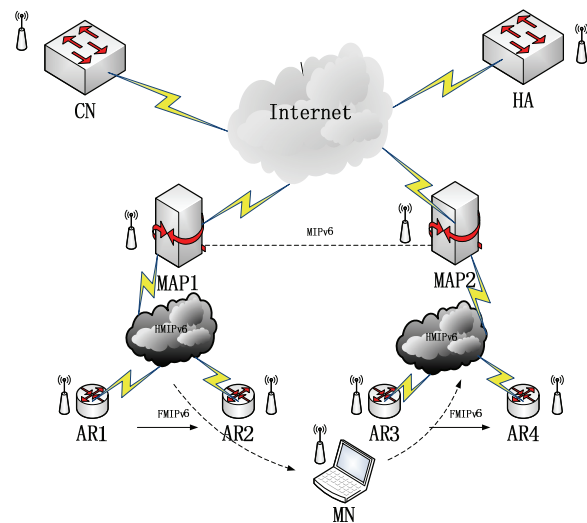


Fig. 6. Adaptive quick hierarchical mobile IPv6 handoff network topology.

7. Conclusions

This paper proposes a Mobile IP Handoff optimization scheme for heterogeneous wireless sensor networks. In the scheme, a complete solution is provided; and handoff can be effectively controlled, the network business environment can be real-time detected; the target network, the handoff type and time can be accurately judged. In addition, the handoff performance of mobile IP will be largely improved. From the theoretical and simulative perspectives, the paper analyzes the performance parameters, including the mobility handoff cost, the mobility handoff delay time and packet loss rate, and the analytical results show that the performance of the scheme is better than other schemes.

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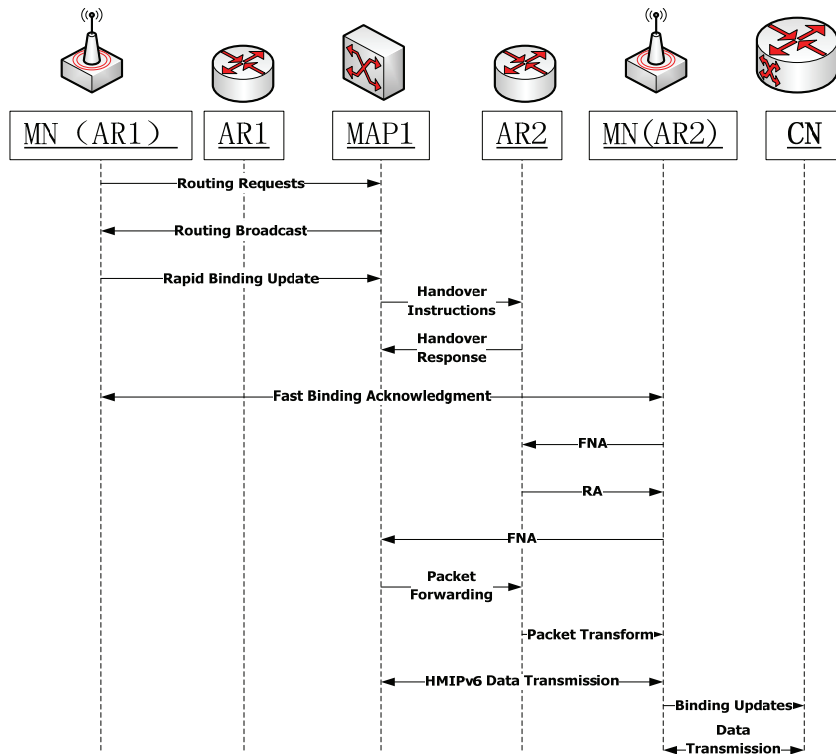


Fig. 7. Adaptive fast hierarchical mobile IPv6 fast handoff algorithm signaling flow chart.

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