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Ad Hoc Networks 3 (2005) 351–370
Ad Hoc Networks
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A survey of Mobile IP in cellular and Mobile Ad-Hoc Network environments

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Received 6 January 2003; received in revised form 17 August 2003; accepted 26 September 2003
Available online 29 November 2003

Abstract

The Internet has become ubiquitous and there has been tremendous growth in wireless communications in recent years. Many wireless communication techniques are commercially available, such as the Wireless LAN, Bluetooth, GSM, GPRS and CDMA. Because an all-IP network will be a trend, access to the Internet via wireless communication devices has become an important issue.

To reduce power consumption and reuse the limited radio spectrum resources, a cellular network was formed. Cell size is one of the factors in the channel reuse rate. Basically, the channel reuse rate in a smaller cell size is higher than the channel reuse rate in a bigger cell size. Micro-mobility is therefore the inevitable direction for future mobile systems. Frequent and fast movements usually characterize micro-mobility. A cellular architecture would then present a challenge to the frequent handover procedures for a smaller cell size would usually induce a higher handoff frequency.

In addition to cellular networks, the ad-hoc network is another network architecture for wireless networks. The ad-hoc network is a non-infrastructure architecture; in which nodes can access services from one another regardless where they are. An excellent routing protocol is crucial for an ad-hoc networking to function at high performance. The main difference between a cellular environment and ad-hoc network is that the ad-hoc method has no fixed infrastructure, allowing nodes to communicate with one another at any time and anywhere.

We have mentioned that micro-mobility in a cellular environment would introduce a greater number of handoffs than before. The handoff probability drives the mobile IP mechanism due to signal changes. Using the Mobile IP mechanism, handoff breaking would take place within a micro-mobility environment. Therefore, in this paper, some handoff strategies that take the advantage of the ad-hoc mechanism to improve the handoff performance are investigated.

Keywords: Mobile IP; Ad-hoc; Handoff; CMIv6; Neighbor Assisted Agent (NAA); Cellular

1. Introduction

Access to the Internet via the wireless communication has become important due to the IP network trend. Mobility support in the Internet Protocol provides a standard solution for mobility at the IP layer. A cellular network is formed to

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doi:10.1016/j.adhoc.2003.09.011

reduce the power consumption and reuse the limited radio spectrum resources.

The ad-hoc network is another wireless architecture used in cellular networks. An excellent routing protocol is important for ad-hoc networking to operate at high performance. Numerous researches have been proposed for the ad-hoc routing, such as the Dynamic Source Routing (DSR) [1], Zone Routing Protocol (ZRP) [2], Ad-hoc On demand Distance Vector (AODV) [3] routing. Mobility in a cellular environment introduces a greater number of handoffs than before due to the micro-mobility trend. A mobility protocol that would provide a seamless micro-mobility scheme should preserve the following properties:

1. Manage local movements without informing the core network.
2. Decrease the update traffic for new locations.
3. Limit the diffusion of update messages.
4. Minimize the delay in the new location update.
5. Eliminate packet losses during handovers.
6. Provide superior QoS and support real time services.
7. Define optimal radio resource use.
8. Support paging.
9. Interact with Mobile IP.
10. Be independent of the radio technology.
11. Insure the robustness.
12. Be scalable.

This paper attempts to introduce the current integrated Ad-Hoc and cellular support strategies based on the Mobile Internet Protocol. Both the Mobile IP and Mobile Ad-Hoc Network (MANET) routing protocols are presented. We will point out the short-falls using Mobile IP and try to emphasize protocols for mobile management schemes that optimize high speed mobile stations moving among small wireless cells with Ad-Hoc functions. A comparison between these schemes will be introduced.

2. Mobile IP version 6

In this section the Mobile IPv6 according to the IETF draft Mobility Support in IPv6 is reviewed [4]. Mobile IPv6 defines four new IPv6 destination options. These options are used in IPv6 to carry additional information that is examined only by a packet destination node.

Under the Mobile IPv6, built-in route optimization eliminates triangle routing. The foreign agent is no longer necessary, packets are sent to a mobile node that can be tunneled to the mobile node using an IPv6 router header instead of IP encapsulation.

2.1. Mobile IPv6 operation

According to the IETF INTERNET DRAFT [4], the basic operation of the Mobile IPv6 mechanism is explained using Fig. 1:

1. The mobile node (MN) discovers its home agent (HA) using the Home Agent Discovery mechanism. The Home Agent Discovery mechanism will be described in Section 2.2.
2. The mobile node moves to foreign link-A, obtains a care-of address (CoA), CoA-A, and sends Binding Update messages to the HA to update its binding cache.
3. The CN sends packets to the MN's home address. The HA forwards the packets to the MN according to the CoA-A.
4. The mobile node moves to foreign link-B, obtains a new CoA-B and sends Binding Update (BU) messages to the HA and the correspondent node (CN) to update their binding cache.
5. After receiving the BU message, the CN replies to the MN with a Binding Acknowledgement (BA) message, and sends packets directly to the MN.

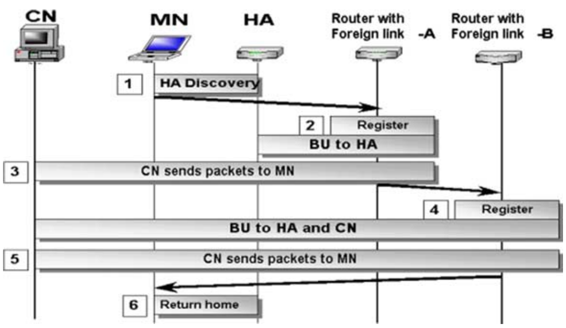

Fig. 1. Mobility in IPv6.

6. The MN returns to its home network, the HA stops encapsulating and tunneling for the MN.

2.2. Home Agent Discovery mechanism

Normally, a home agent sends out Router Advertisement message periodically, or in response to a Router solicitation. A mobile node can obtain its home agent's address using the modified Router Advertisement from the Router Advertisement used in the Neighbor Discovery for IPv6 [5].

The modified Router Advertisement from the Neighbor Discovery for IPv6 is shown in Fig. 2. It is used for the Home Agent to advertise its availability.

2.3. Dynamic Home Agent Discovery

Mobile IPv6 supports a Dynamic Home Agent Address Discovery mechanism that allows a mobile node to dynamically obtain its home agent's address [4]. This is necessary when the mobile node does not know its home agent or the mobile node's current home agent is shut down or the home network is reconfigured.

If a mobile node cannot obtain its home agent's address using the Home Agent Discovery mechanism, it can execute the Dynamic Home Agent Address Discovery mechanism as described below to obtain its home agent's address, as shown in Fig. 3:

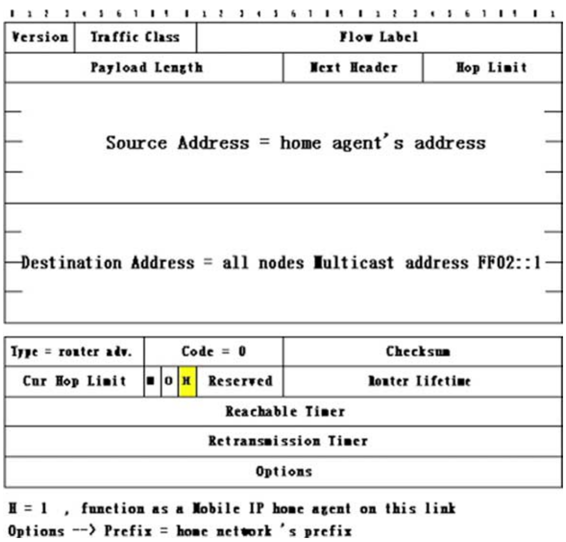

Fig. 2. Modified Router Advertisement.

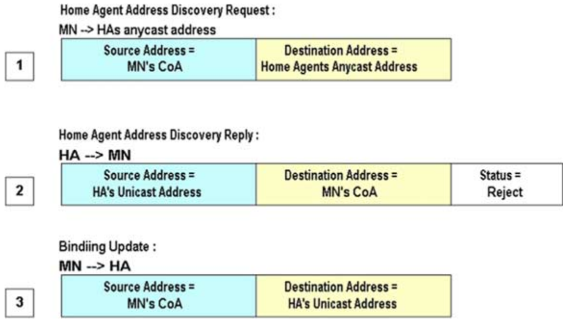

Fig. 3. Basic operation of the Dynamic Home Agent Discovery.

1. The mobile node sends a Dynamic Home Agent Address Discovery request message to the "Home-Agents anycast address" for its own home subnet prefix.
2. The home agent on the home link returns a BA with a reject status but includes a HA List.
3. The mobile node sends a BU to one of the home agents listed in the HA List and waits for the matching BA.

2.4. Mobile IPv6 Destination Options

The Mobile IPv6 Destination Options carry some information required for the nodes to exchange and examine additional information during Mobile IPv6 operation.

In Mobile IPv6, every IPv6 node has a Binding Cache that is used to hold the binding information of other nodes. If a fresh Binding Update message arrives, it will be added to the Binding Cache. When sending out a packet, a node looks into its Binding Cache to search for the node's care-of address. In this way, triangle routing can be avoided. Four new Destination Options are defined in Mobile IPv6.

2.4.1. Binding Update Option

A mobile node uses the Binding Update Option to notify other nodes of its new care-of address.