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A rapid transit Handoff processing in Mobile Network using the Extended Macro with the Local Agent

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Abstract

Increased use of PDA and Laptop has accelerated the development of wireless networking. With the tendency, the need to support efficient and seamless data transmission technique has also been increased. However, current mobility management protocol, such as the Mobile IP, which is defined in RFC 2002 [1], does not cover well these requirements. To satisfy these requirements, we should reduce Handoff processing time occurred by the movement of MN (Mobile Node) about the other networks. This paper proposes efficient Handoff mechanism on the new Mobile IP architecture using the Extended Macro that is a group organized with subnetworks, and served by a new added agent.

1. Introduction

The Mobile IP is a new technique based on the understanding of IP. This offers a convenient design point for a protocol operation to support node mobility. The Mobile IP has the following functions [2]:

- Identifying of each node (mobile node) and subnetwork (home and foreign net)
- Forwarding packets when the MN arrive at subnetwork which is not the final destination
- Triggering mechanisms for resolving IP addresses into lower-level addresses

However, according to movement of the Mobile Node, the required registration and binding update make the Mobile Node change its connection of communication for the new subnetwork. Like this processing, the Handoff means that the mobile host switches a current connection about a new network to maintain communication. The Smooth Handoff minimizes loss of data, which can be occurred when the Mobile Node moves to the far neighboring subnetwork, through the quick binding list removal and update.

Not only to minimize the data loss but also to make the rapid transit Hand-off for the real time service, many Handoff processing proposals, such as Mobile IP Regional Registration [3], Hierarchical MIPv6 mobility management [4], Fast Handovers for Mobile Ipv4 [5] and etc, are suggested.

The paper is organized as follows. In Section 2, we describe the Low Latency Handoff protocol [6] using the pre-registration Handoff method, and the MRSVP and HMRSVP using the hierarchical topology supporting the resource reservation service. In Section 3, to resolve problems in a structure and method in the related work, we propose the new rapid Handoff processing technique on the mobility of the Mobile Node. The technique is to reserve the virtual data path using the LA (Local Agent), which manages the FA (Foreign Agent)s to maintain the connection information of the MNs on the Extended Macro Mobile IP. In Section 4, we analyze flows about Handoff in different three cases. We make future work and some conclusion in follow Section 5, 6.

2. Related Work

In this section, we introduce three following technologies. The *Low Latency Handoff protocol* is the technique for the Handoff processing on mobility in the Mobile IP. The ideas about reservation and structure of the MRSVP [7] and HMRSVP [8] for QoS are related with our new path reservation method for the rapid transit Hand-off processing.

2.1 The Low Latency Handoffs

To achieve rapid transit Handoff performance so as to reduce end-to-end delay, when the MN moves to the neighboring subnetwork, the Low Latency Handoffs in Mobile IPv4 describes the pre-registration Handoff method. The following premises about delay separate a protocol stack operating Handoff to Layer2 and Layer3.

- The MN can only make the registration process after an Layer2 Handoff to the FA of a neighboring sub-network has completed.
- Through the network, transited registration requests make the registration process take a non-zero time and during the time, the MN can not send or receive the IP packets.

2.1.1 The Pre-Registration Handoff Method

The pre-registration Handoff method is based on processing of sending the advertisement for new FA to the MN, for the MN moving about new subnetwork and registering with the new FA. The figure 1 shows the operation of the pre-registration handoff.

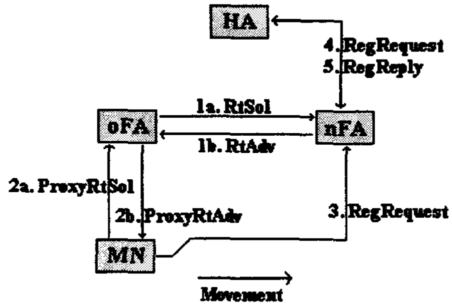

Figure 1. Pre-Registration Handoff Protocol

In Figure 1 (1a) (2b), in advance of the Pre-Registration Handoff, a routing solicitation and advertisement message to the nFA and oFA should occur not to delay the Handoff. In Figure 1 (2a) (2b), a proxy routing solicitation message occurs if there is an L2 trigger in the MN to solicit for a proxy routing advertisement. In Figure 1 (3), when the MN start to moves and reside near the nFA, it sends a registration request message. In Figure 1 (4) (5), a registration request and reply message complete the standard Mobile IP registration processing.

However, in a domain, the FA's state information can be present in some other FA's tables. It is not efficient on a management aspect and means the need for another agent managing FA's state information.

2.2 MRSVP

The Mobile ReSource reservation Protocol (MRSVP) guarantees a mobility independent service for real-time multimedia applications in an Integrated Service Packet Network. At multiple locations where the MN may possibly visit during the service time, MRSVP protocol reserves advance resources. Therefore, the MN can have the required quality of service when it moves to a new location where resources have been reserved in advance. We describe the MRSVP protocol as follows.

2.2.1 Active and Passive Resource Reservation

With the exchange of a pair of PATH and RESV messages between the sender and MN, an active resource reservation can be built between the local proxy agents of the sender and MN, and passive resource reservation can also be built between the remote proxy agents of the sender and MN. The active resource reservation is the path that packets are actually transmitted, but the passive reservation paths are only reserved in advance without any actual packet flows. When the MN moves to the new network, MRSVP changes the passive reservation of the new visited location into an active state, and the original active reservation is transformed to a passive state at the same time. In this way, the resources for the MN within a new network are quickly retrieved because the resources were pre-preserved in the pre-passive resource reservation. However, to set up the advance resource reservations for the MNs, MRSVP needs too much bandwidth, and unused bandwidth makes the system performance degrade.

2.3. Hierarchical MRSVP

HMRSVP improved MRSVP in respect to resource reservation for making advance resource reservation only when the handoff delay tends to be long.

In the Mobile IP regional registration, a term region is referred to a cluster of routers and subnet encompassed by an enterprise or campus network. MA (Mobility Agent)s which are proxy agents or gateway mobility agents in a region are arranged hierarchically in the region topology.

Figure 2 illustrates the active and passive resource reservation paths embodied in the HMRSVP scheme. As shown in Figure 2 (A), the MN is currently moving to a non-boundary subnetwork MA2 and the MN will make only intra-region handoffs in the future. Therefore, the HMRSVP only switches the active resource reservation along the path from the sender to the MN without making any passive resource reservation. This method is the regional registration. In the Figure 2 (B), when the MN is within an overlapped area of the two networks, the HMRSVP will set up an extra passive resource reservation along the path from the sender to the boundary subnetwork MA3, which is the MN's neighboring region. Therefore, the HMRSVP only makes an extra passive resource reservation on the MN's neighboring boundary subnetwork when the MN tends to move to an inter-region network unlike the MRSVP having all extra passive resource reservation on the MN's surrounding subnetwork.

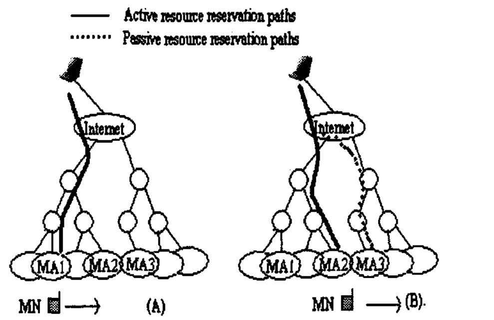

Figure 2. The hierarchical MRSVP scheme

3. EM Mobile IP (Extended Macro Mobile IP)

In standard Mobile IP environment, when the MN moves to a new subnetwork, the new FA (Foreign Agent) create a new data structure on information related with the MN. In addition, the old FA (Foreign Agent) exchanges Handoff control messages with the new FA for removal of a data structure having been related with the MN. Therefore, this Handoff control messages occurred by the MN moving to a new subnetwork make FAs have a high overhead.

In this paper, to resolve this consideration, we propose the EM Mobile IP scheme consisted of three-tier structure with the new agent, the Local Agent. By using this model, each time the MN moves around in the intra-network, the occurred overhead by frequent Handoff message exchanges can be reduced. When the MN, also, moves to the inter-network, the LA communicates with the new LA in inter-network for the new COA (Care-Of-Address) and path reservation of the MN.

3.1 Local Agent in the Extended Macro network

When we assume that the Mobile IP subnetwork is a macro network, the Extended Macro network is described as a group of macro networks overlapped. The Local Agent is an agent that represents one extended macro and acts by fixed COAs of all FAs that exist on each subnetwork (macro). Figure 3 shows the EM Mobile IP scheme.

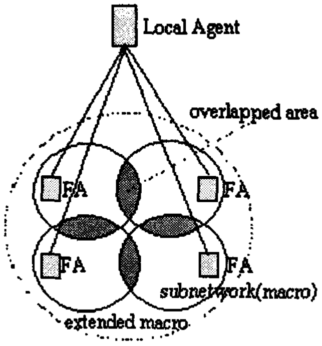

Figure 3. The EM Mobile IP scheme

The Extended Macro is tied together macros having FAs. This independent structure, which has simply the added Local Agent on a standard Mobile IP model, is more efficient than a referred HMRSVP structure. A hierarchical structure connected as an Internet area like the HMRSVP has the fatal problem. For instance, in shown Figure 2 (B), when the MN has moved from MA2 to MA3 in the inter-network, the GMA (Gateway mobility agent) registering the MN should bind update with the MN's HA. However, a binding update message should pass through the Internet. It makes the message to be a transmission delay. Therefore, we need to consider new structural concept. It does not have problem that the MN can pass through the Internet area to exchange messages.

The Local Agent, which is responsible for managing FA (Foreign Agent)s of a subnetwork, acts by COAs of all MNs that is registered. When the MN moves about within an Extended Macro, just the Local Agent sends binding message to the CH (Correspondent Node) to prepare a virtual data path or to change path. When the MN moves about neighboring Extended Macro, the Local Agent informs and requests the neighboring Local Agent to reserve a virtual path for moving MN and to have new COA.

3.2 Handoff processing on the standard Mobile IP model

using the EM Mobile IP

A Handoff can be divided with LH (Local Handoff) that occurs within an Extended Macro and GH (General Handoff) that occurs between Extended Macros. We describe the Handoff processing as dividing by local and general process. In Local Handoff process, the Local Agent manages its all addresses of MNs, so the MNs do not need new COA when they move to other subnetworks served by the same Local Agent. However, in General Handoff process, the MNs should have new COA when they move to new networks served by new Local Agents.

Local Handoff (LH) process

Figure 4 expresses LH handoff process. Initially, the MN registers to the HA through exchanging a registration request and response message. While the MN resides within a subnet not including the overlapped area, the MN receives data through the HA from the CH. However, in the Figure 4 (1), (2) and (3), when the MN resides within an overlapped area of the boundary of neighboring subnet, the MN informs the LA with a message, that the MN may move to neighboring subnet, through the FA. In the Figure 4 (4), The LA informs the CH with the binding reservation message of the MN about moving to neighboring subnet. In the Figure 4 (5), The CH reserves a virtual data path, but not a real data path, to the FA of neighboring subnet. Finally, when the MN has moved to the neighboring subnet, the link layer of the MN switches to the radio link on the neighboring subnet taking up the virtual data path. As soon as the MN switches the link and informs the FA, the virtual data path is changed to the real data path.

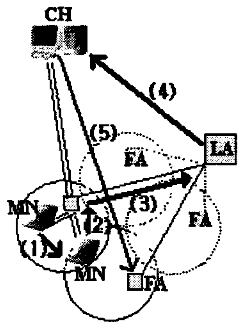

Figure 4. LH handoff process

General Handoff (GH) process

Figure 5 expresses GH handoff process. First, the communication between the LAs is achieved on the three–tier architecture. It guarantees independency of an Extended Macro. Also, unlike the HMRSVP that can be caused to have all of failed descendant MNs connected by the GMA of a failed high degree, the EM Mobile IP topology has just the three-tier. Although the service of the LA fails, the LA will be responsible for only its serving MNs and neighboring LAs, as before, can communicate each other.

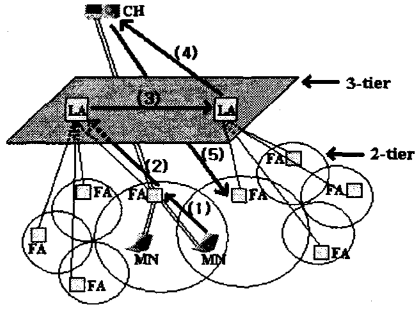

Figure 5. GH Handoff process

In Figure 5, the MN have being served by the LA moves to an overlapped area of the boundary of neighboring subnetwork. The MN notices its future movement to a neighboring subnet and sends a message to the LA through the FA in the Figure 5 (1)(2). The LA received sends the message to the neighboring LA for requiring new COA of the MN and binding reservation of the virtual data path in the Figure 5 (3). The neighboring LA replies the old LA with new COA of the MN and the LA sends binding update message to the HA of the MN. Then, the neighboring LA sends a binding message for a new path of the MN to the CH in the Figure 5 (4). The CH reserves the data path to the neighboring FA, which has new COA of MN in the Figure 5 (5).

4. Comparative analysis

This paper analyzes flows that defined three different cases.

□ Support only FA function, flow about handoff that occurs between FAs

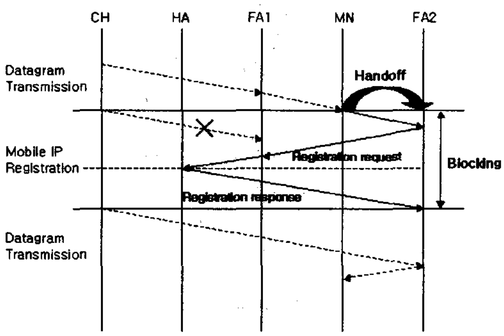

Figure 6. Mobile IP Handoff (FA-FA)

□ Support LA function, flow about handoff that occurs between FAs in Group with LA (Local Handoff)

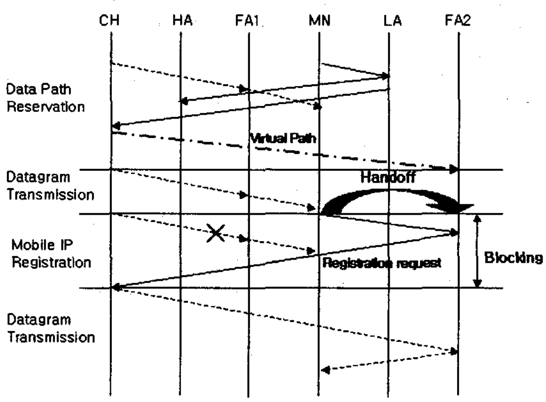

Figure 7. Local Handoff (in Group with LA, FA-FA)

□ Support LA function, flow about handoff that occurs Groups (General Handoff)

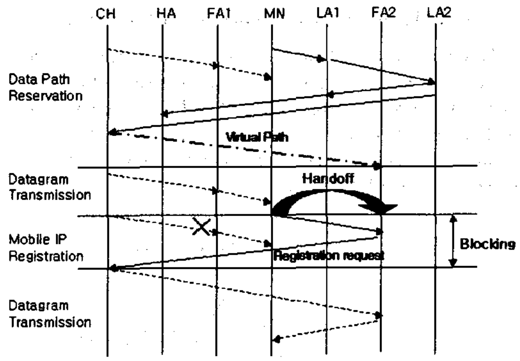

Figure 8. General Handoff (LA-LA)

5. Future Work

A demand for multimedia data service is coming out at an unprecedented speed. Basically, the Mobile IP supports the best effect transfer service. However, for a multimedia data, which is a real-time audio/ video, a sufficient bandwidth and seamless fast Handoff should be considered significantly. A sufficient bandwidth is supposed to be constructed for the EM Mobile IP. A seamless fast Handoff can be resolved adding a mechanism for QoS, such as a resource reservation, on our proposed Handoff processing. When the MN, Thus, demands the multimedia data service, the infrastructure composed by the EM Mobile IP can support the service efficiently.

6. Conclusion

To support a rapid transit Handoff processing in Mobile Network environment, we proposed the EM Mobile IP topology and method. They guarantee communication between independent EM Macros, and thus do not cause to make that all descendent agents and the MNs can not operate functions by failed higher agent, such like a hierarchy topology. The path reservation method supports the Mobile Node to process Handoff fast and efficiently by pre-connected data path.

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