Proactive Hand-Off Target Orientation Cache in Fast Handover for Mobile IPv6

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Abstract

In order to efficiently utilize wireless environment network resources, Fast Handover for Mobile IPv6 (F-MIPv6) technology is currently being considered. It is necessary for Access Routers to exchange information with their neighbors. However, this method is outside the scope of the F-MIPv6 Internet draft. In this article, we propose an approach to assist F-MIPv6 in obtaining IP addresses for subnet Candidates from Layer 2 information. The proposed Proactive Hand-Off Target Orientation (PHOTO) provides a realistic geographical relation without using wireless location technology. We demonstrate that PHOTO helps F-MIPv6 to overcome its' inability to obtain IP addresses immediately through the Access Point MAC address.

I. Introduction

Handover is an important issue for mobility management in wireless infrastructures. In recent years, a lot of network engineers dedicated much effort to developing movement prediction mechanisms to eliminate disruptions in physical connectivity and service provisions [1]-[3].

Next-generation networks are envisioned an IP-based core network infrastructure. One of the research challenges is to develop mobility techniques that take advantages from IP-based technology to achieve global roaming [4].

A proactive method is therefore being considered as a solution for mobile issues. It gives the advantage of immediate response with minor maintenance overhead. During handover, the infrastructure could surpass the negative effects of handovers and also enjoy a pre-arranged configuration for the mobile node [5][6].

As stated in the F-MIPv6 draft: “The method by which Access Routers exchange information about their neighbors and allows construction of Proxy Router Advertisement (PrRtAdv) with information about the new subnet is outside the scope of this document” [7], F-MIPv6 lacks a mechanism to provide crucial information. In this paper, we present an approach to preserve a channel between the Home Agent (HA), Corresponding Node (CN) and mobile node (MN). This approach maintains the Proactive Hand-Off Target Orientation (PHOTO) cache. Ordinarily, present F-MIPv6 mechanisms could take advantage of the PHOTO cache to indicate the handover candidate for a specific MN. Using such channel pre-construction, the MN could immediately obtain the data stream after handover.

The rest of this article is structured as follows. Section II discusses the relevant prior contributions and imperfection. Section III exhibits an idea for motion prediction, and we elaborate on protocol cooperation between our proposed method and the present F-MIPv6. Such a system is demonstrated in Section IV, and we evaluate the benefit and overhead within the mechanism. Section V presents a conclusion and future work.

II. Background and Motivation

Mobility poses many challenges in wireless networks, and the handover problem is one of the major subjects. A number of contributions have been proposed to improve performance during handover. In the IP mobility aspect, we could categorize the current schemes as both reactive and proactive approaches.

The Link layer trigger is the representative for reactive handover. This scheme reduces handoff latency, but it does not eliminate the disruption between the link-layer and network-layer handoff [8]. Investment in proactive approaches occurred in consideration of the incorrigible latency gap caused by the link layer trigger mechanism.
There are two major Mobile IPv4 schemes. They are the buffering and multicasting approaches. The buffering approach temporarily stores packets that are then sent to a departing node. The first difficulty is the disorder of the packets. This is a crucial point in this scheme [9]. The other major approach is the multicasting solution, which cooperates with the hierarchical Mobile IP [10]. The leading problem is how to recognize a future subnet. Numerous researches focused on this topic.

The IETF works on MIPv6 to cope with the limitation of MIPv4. While a MN is away from its' home network, it is associated with a care-of-address (CoA). IPv6 packets addressed to a MN's home address are transparently routed to its CoA. In MIPv6, the HA will not deal with the address mapping. However, each CN may have its own binding cache with a pair of home addresses and a CoA. The protocol enables IPv6 nodes to cache the binding, and then send packets to the MN directly. MIPv6 also eliminates the need for Foreign Agent. This simplifies its deployment.

To reduce the handover service degradation, Fast Handover for Mobile IPv6 (F-MIPv6) was proposed. F-MIPv6 describes both Predictive Handoff and Layer-2 trigger based scenarios [7]. In this paper, we focus on the Predictive Handoff scenario.

In the Predictive Handoff scenario, the network layer handoff to the New Access Router (newAR) is initiated while the Mobile Node still has Layer-2 connectivity to the old access router (oldAR) for moving to a newAR. This method covers the following sub-scenarios: Network Determined Handoff versus Mobile Determined Handoff.

A Network Determined Handover scenario were the access routers are responsible for handoff processing and a Mobile Determined Handover scenario were the mobile itself has to define and initiate the handovers.

F-MIPv6 looks nice, but has a critical unresolved issue, in which the F-MIPv6 draft does not manage well. When the MN acts for handover, it senses whether there is any better Access Point (AP) or not. If there is a proper AP, the MN will notify the oldAR that a handover is coming. This is a blind spot that may not be available to obtain the IP address of the newAR using Layer 2 information, which comes from AP. We will present a solution for this problem in the next section.

III. Cache of Proactive Hand-Off Target Orientation

Traditionally, many methods to depict network topology are based on direct links between each of nodes. As well as the wired network, we could image that there is a pseudo link between two wireless devices if they are within communication range. The concept of traditional topology may not be proper for wireless handover, because the MN may move to another subnet, which is not directly connected to the current subnet. Figure 1 shows a scenario involving less overlapped networks, where two APs are capable to handover to each other but two ARs doesn't directly connect.

![Figure 1. Handover candidates may not directly connect to current subnet](image)

Under above scenario, we could understand the possibility for a mobile node to move to a subnet which is not directly connected to current subnet. In the aspect of handover in wireless environment, we propose to build a relationship between all handover candidates and the current subnet. Figure 2 is the geometric transforming between geographical diagram (GD) and the approach we proposed, which is called Proactive Hand-Off Target Orientation (PHOTO).

Figure 2(a) is the concept appearance of realistic networks. The dot circle represents a communication range of respective AP. In order to simplify analysis, we redraw the networks as Figure 2(b). The region of Geographical Diagram (GD) represents a subnet and the edge, which is clipped by two regions of GD, shows the possibility for two subnets to handover to each other.

![Figure 2(b)](image)

Figure 2(c) is a transformation from Figure 2(b). The original idea comes from the dual relation between Voronoi Diagram and Delauney Triangulation [11]. The region of GD is dual to the vertex of PHOTO. The connectivity between two regions of GD is dual to an edge of PHOTO. In most cases, the handover capability depends on the realistic geography, and we would like to describe such relation by the proposed PHOTO.

According to the principle of F-MIPv6, oldAR makes a new Care-of-Address when it recognizes that the MN must move to a newAR. At the same time,
oldAR sends a Handover Initiate (HI) message to the newAR by indicating the old and the new CoA of MN. To change the forwarding path, the MN will send a Fast Binding Update (F-BU) to oldAR and Fast Neighbor Advertisement (F-NA) to newAR. It is easy for newAR to add an entry in the PHOTO cache according to F-NA message. For oldAR, it extracts F-BU and adds corresponding entry as well. After these processes, the bi-directional PHOTO cache is built and provides the mapping between the subnet prefix and MAC address of the attachment point, which is capable for handover. This MN helps following MN to get information for F-MIPv6, we call it plowing MN. After PHOTO building, if any node plans to move to neighbor subnet, the only necessary information is the MAC address of candidate AP.

(a) Realistic Networks  
(b) Geographical Diagram  
(c) PHOTO

Figure 2. Geometric dual between geographical diagram and handover topology

Plowing MNs  
MN  
Old AR  
New AR

F-BU: Fast Binding Update
F-BAck: Fast Binding Acknowledgement
HI: Handover Initiate
F-NA: Fast Neighbor Advertisement

Handover Initiate

Handover

Data Flow
Control Message
Deliver packets

Figure 3. PHOTO-MIPv6 Message interaction between MN, HA, and CN