

A new solution for micro-mobility management in next generation networks

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Abstract

One main feature of next generation networks should be its heterogeneous communication environment, where different systems coexist and various wireless access networks and corresponding services are used. Despite the large number of current protocols, we believe that no efficient solution is available for automatic handoff between different wireless technologies.

In order to develop an efficient technology agnostic solution, we propose to manage the problem just above the link layer. In this paper, we propose a novel architecture for the vertical handoff problem that operate at the layer 2.5. Our proposal is mainly based on an MPLS switching process and a Virtual Network Interface (VI) concept.

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1. Introduction

Mobility management has widely been recognized as one of the most important and challenging problems for a seamless access to wireless networks and mobile services. Future mobile communication systems evolve with the trend of global connectivity through the Internet working of heterogeneous wireless networks: towards an ubiquitous Wireless Internet. A major challenge in building ‘ALL-IP’ wireless access networks, besides the use of IP as the unifying layer, relates to transparency of the IP handoff process.

In fact, the IP address plays the dual role of both end-point identification and location identification. Routing of packets in the Internet is based on IP addresses. Routers check the destination address of incoming packets and forward them to the port assigned to the so-called best prefix. Today, as nodes move, this static association represents an important constraint and cause service interruption. Introducing mobile nodes requires several changes or enhancements of the current protocol suite.

As mobility should be transparent to most applications, changing the IP address of a node according to its current location is not possible. Neither would most applications continue to work after the address has been

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changed on-the-fly, nor could any communication partner find the node with the new, unknown address. By separating location from identity we will be able to manage transparent mobility.

Different approaches have been developed to address this problem and to manage transparent mobility to application layers. Some of the most relevant schemes that have been reported in the literature are Mobile IP [1] and its multiple variants [2], Cellular IP [3] and Hawaii [4]. These standards solve some of the inherent IP mobility problems, but as they are operating at higher layers (3 and 4), an additional important delay is introduced to the handover problem.

In this paper, we present a new scheme for supporting micro-mobility in wireless IP networks, namely a layer two mobility aware architecture for fast handover and an MPLS network based mobility solution (W-MPLS). The architecture requires very few changes to existing protocol stacks. In particular, no changes to non-mobile hosts is required. It provides efficient micro-mobility with continuous QoS support by combining the advantages of MPLS, such as IP QoS support, with those of a host-based link layer solution (Virtual Interface), such as low-latency handoffs.

The rest of the paper is organized as follows. Section 2 describes the virtual interface architecture. Section 3 presents VIP, a Linux prototype for the virtual interface. Section 4 describes the principles of wireless MPLS “W-MPLS”. Section 5 considers location update optimization scheme. In Section 6, our simulations results are presented. Finally, Section 7 concludes this paper.

2. Virtual interface architecture

To avoid delays during handover procedures generally due to layers crossing, we propose to act upon the data flow at the link layer level instead of at the higher layers of the protocol stack when this is possible.

The importance of the mobility in IP comes essentially from new wireless technologies. Clearly, large deployments of 802.11 networks both in private and public domains raise this problem. 802.15 and Bluetooth link layers, chosen as WPAN MAC protocols may imply vertical mobility. The architecture we present is not however restricted to these technologies, it could be applied to Hiperman/Hiperlan handover as well. The proposed scheme can bring consistent improvements to the World Interoperability for Microwave Access (WiMax) Forum [5], a group which is working to promote the emerging 802.16a wireless metropolitan area network standard.

We propose a specific adaptation layer interface [6] that will be implemented within the protocol stack of a mobile station supporting several access network interfaces. This virtual interface architecture will interact with the IP and link layer and makes it possible to have transparent IP service over different wireless technologies.

The architecture that we describe hereafter works when we stay on the same subnet or when we use a NAT and does not require any modification at the IP stack of the remote end-point.

The suggested architecture has these major desirable goals:

- Preserving communication: Once a session has been established between end points, from the application point of view the connection is persistent even though we change interface.
- Different network interfaces: from the host to the MAC layer (within the operating system) it should be possible to use different network interfaces for the physical connection to the network.
- Transparency: applications using the network should not notice switches between devices.
- Minimal changes to current network structure.
- Efficient handoff: the delay during handoff should be minimized and avoided, if possible. It should be considerably less than the previously mentioned solutions.

2.1. Interacting protocols and basic ideas

Conceptually, by assigning to all the physical devices on the host the same IP and MAC addresses (as they are in the same subnet), the mode of communication during vertical handover will be transparent to higher-

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