USHA: a simple and practical seamless vertical handoff solution

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Abstract

We demonstrate a seamless vertical handoff solution, called Universal Seamless Handoff Architecture (USHA). USHA is simple and requires minimal modification to the current Internet infrastructure. Therefore, it is instantly ready for real-world deployment. In this demonstration, we present USHA in two scenarios. Using video streaming applications, we demonstrate that USHA is able to successfully maintain the application connectivity and achieve almost zero delay during a vertical handoff. Moreover, we present a vertical handoff detection technique based on the end-to-end link capacity monitoring. The ongoing work of this study is to improve the accuracy of the handoff detection and to enhance application QoS support for vertical handoffs given the accurate handoff detection is provided.

1. Introduction

In view of the proliferation of mobile applications, a universal seamless handoff solution across wireless domains is becoming increasingly important. While wired connections usually provide high speed, reliable access to the Internet, wireless networking technologies enable users to access customized Internet services even when they are moving. A seamless handoff solution with both low latency and low packet loss is mandatory for mobile users who wish to receive continuous, uninterrupted Internet service while frequently switching from one network connection to another. Additionally, the handoff solution should be network-layer-transparent and infrastructure-modification-free so that existing Internet server and client applications can painlessly survive the rapid pace of wireless technology evolution.

In this demo, we present Universal Seamless Handoff Architecture (USHA), a simple handoff solution that satisfies the requirements for seamless handoff. Compared to other seamless handoff solutions, USHA is simple and requires minimal changes to the current Internet infrastructure. Therefore, it is instantly ready for real-world deployment. Using testbed experiments, we show that USHA can successfully maintain the application connectivity with almost zero delay during a vertical handoff.

USHA is based on the fundamental assumption that handoff only occurs on over-laid networks with multiple Internet access methods (i.e., soft handoff), which translates to zero waiting time in bringing up the target network interface when the handoff event occurs. If coverage from different access methods fails to overlap (e.g., hard handoff), it is possible for USHA to lose connectivity to the upper layer applications.

In Figure 1, a handoff server (HS) and several mobile hosts (MHs) are shown. USHA is implemented using IP tunneling techniques (IP encapsulation), with the handoff server functioning as one end of the tunnel and the mobile host as the other. An IP tunnel is maintained between every MH and the HS such that all application layer communications are ``bound" to the tunnel interface instead of any actual physical interfaces. All data packets communicated through this IP tunnel are encapsulated and transmitted using the connectionless UDP protocol.

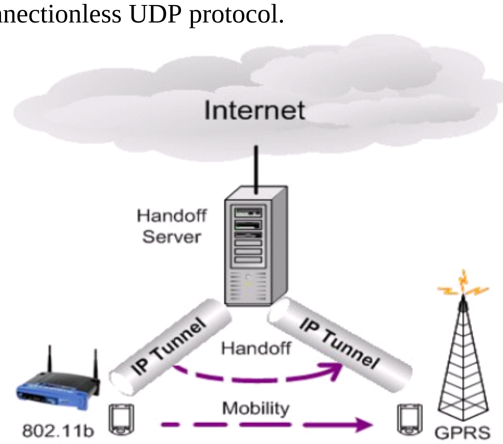

Figure 1: Illustration of USHA

The IP tunnel above utilizes two pairs of virtual/fixed IP addresses, one on HS and one on MH. The fixed IP addresses are necessary for an MH to establish a physical connection to the HS. When the

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handoff event occurs and the physical connection from MH to HS changes, the MH is responsible for automatically switching the underlying physical connection of the virtual tunnel to the new interface, as well as notifying the HS of its change in physical connection. Upon handoff notification, the HS immediately updates its IP tunnel settings so that any subsequent data packets will be delivered to MH's new physical link.

Since all data packets are encapsulated and transmitted using UDP, there is no need to reset the tunnel after the handoff. Therefore, end-to-end application sessions (e.g., TCP) that are bound to the IP tunnel are kept intact. This provides handoff transparency to upper layer applications.

2. System Requirements

2.1. Space, Power, and Networking Requirements (provided by the conference)

Space	This demo requires one table for the presentation. Moreover, since we will prepare one poster for this demo, a poster board is also needed.
Power	3 power outlets are required.
Networking	2 Internet connections is required (one 100Mbps Ethernet connection, and one 802.11b/g wireless connection).

2.2. Hardware and Software Requirements (provided by the demonstrators)

Software	1. USHA client 2. USHA server 3. Video Streaming client software: Real Player 4. Video Streaming server software: Helix Server
Hardware	1. 3 laptops 2. 2 802.11 a/b/g PCMCIA adapters 3. 2 Bluetooth USB dongles

3. Demonstration Details

We prepare two scenarios for the demonstration. If the Internet connection is available in the conference venue and the USHA traffic is not blocked by the firewall, the scenario 1 will be employed for the demonstration. Otherwise, we will demonstrate USHA using the scenario 2. We depict both scenarios in Figure 2 and Figure 3, and we describe the demonstration details as follows.

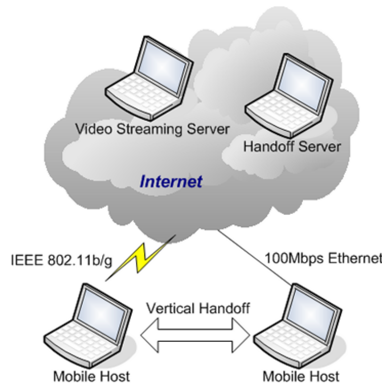

Figure 2: Scenario 1.

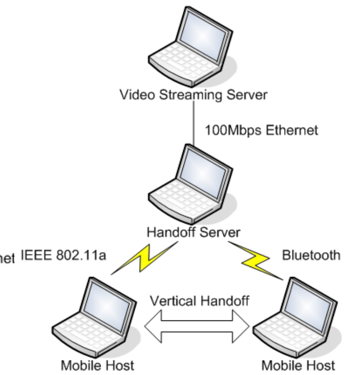

Figure 3: Scenario 2.

3.1. Demo Procedures

Case 1: when the scenario 1 is employed

1. Enable the Internet connection of the mobile host using the IEEE 802.11b/g interface.
2. Enable the Internet connection of the mobile host using the 100Mbps Ethernet interface.
3. Remotely start the USHA server program on the handoff server.
4. Start the USHA client program on the mobile host, and setup the IP tunnel between the mobile host and the handoff server.
5. Remotely start the Helix server on the video streaming server.
6. Start the Real Player program on the mobile host, and start the video streaming.
7. Perform vertical handoff from IEEE 802.11b/g to 100Mbps Ethernet, and vice versa.
8. Observe the link capacity, delay, and packet losses during the vertical handoff.

Case 2: when the scenario 2 is employed

1. Connect the handoff server and the video streaming server via 100Mbps Ethernet link.
2. Connect the mobile host and the handoff server via IEEE 802.11a link.
3. Connect the mobile host and the handoff server via Bluetooth link.
4. Start the USHA server program on the handoff server.
5. Start the USHA client program on the mobile host, and setup the IP tunnel between the mobile host and the handoff server.
6. Start the Helix server on the video streaming server.
7. Start the Real Player program on the mobile host, and start the video streaming.
8. Perform vertical handoff from IEEE 802.11a to Bluetooth, and vice versa.
9. Observe the link capacity, delay, and packet losses during the vertical handoff.