MIPv6: New Capabilities for Seamless Roaming Among Wired, Wireless, and Cellular Networks

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NOTE: Much of this article assumes reader familiarity with Mobile IP in general and *an earlier article on the subject* in particular.

Overview

Mobile Internet Protocol (MIP) technology enables network-application users to transparently roam between wired, wireless, and cellular networks without dropping their connections. With the Internet Engineering Task Force (IEFT) close to announcing a draft standard for MIPv6 (mobile IP support for IP version 6), software developers can begin planning product designs based on the new standard.

In this article, developers will learn about the new MIPv6 standard, the differences between it and the prior standard, and the opportunities it brings. They also will learn a rudimentary transition strategy for device and application mobility on emerging IPv6 networks that exist as “islands” within IPv4 networks.

Why a Mobile IP Standard?

The motivation behind the development of the Mobile IP standard stems from user demand for mobile devices that can connect and move seamlessly across a growing number of connectivity options. For users, the Mobile IP standard maintains session continuity for network applications as you roam across different networks by presenting a consistent IP address to these applications.

Mobile IP technology has traditionally (as defined for IP version 4) consisted of three fundamental components: the home agent, the mobile node, and, optionally, the foreign agent. The home agent can be either a server or router that is deployed on the user’s base network (for example, an operator’s IP services network or in an enterprise intranet). The mobile node client resides on the mobile device and works with the home agent to transparently handle IP address management and connection rerouting. The foreign agent, which resides on (“foreign”) networks visited by the mobile node, preserves globally routable IP addresses, thereby reducing the need for local routable addresses on the foreign network (an important consideration for IPv4 networks).

MIPv6: A New Version of the Mobile IP Standard

There are a number of reasons for software developers to begin thinking more about the new usage models enabled by MIPv6, the latest update to the Mobile IP standard: increasing deployment of wireless LANs (local area networks) and WANs (wide area networks), IPv6 pilots and early deployments by enterprises and operators, and a maturing specification for MIPv6 (in IETF-IESG “last call” at the time of this paper).

Here are the primary similarities and differences between MIPv6 and MIPv4:

- *Foreign agent.* Both standards rely on a home agent and a mobile node, but MIPv6 does not define a foreign agent to issue a care-of address (CoA), since routable address constraints are not an issue in IPv6 networks. Instead, MIPv6 derives the CoA directly from autoconfiguration schemes such as router advertisements or a DHCP (dynamic host configuration protocol) server on the network being visited by the mobile node. This approach enables the mobile node to operate in any location without requiring special support from the local router.

- *Route optimization.* MIPv6 enables direct-packet routing between the mobile node and corresponding nodes located on an IPv6 network. When the mobile node moves into a foreign network, it obtains a new CoA (as described in the preceding bullet), and reports this to its home agent in the form of a binding update. The home agent registers the new CoA in its binding table and then intercepts all packets destined for the home address of the mobile node and tunnels them to its registered CoA. In an MIPv4 scenario, a corresponding node's traffic must pass through the home agent, but MIPv6 route optimization allows the mobile node to send binding updates to an IPv6-based corresponding node. The corresponding node caches the current CoA and then sends packets directly to the mobile node. This is an optional procedure for MIPv4 that requires special options to be enabled on each corresponding node, and is rarely implemented or used.
- *Security.* MIPv4 and MIPv6 will often be used with a VPN (virtual private network) solution for data security, when the user is roaming into networks outside the corporate firewall. Both protocols will in theory allow the use of a v4 IPsec (Internet protocol security) VPN solution, providing in the case of the MIPv6 client that the IPv6 protocol stack includes a 6-to-4 function. In addition, the MIPv6 client allows the use of a v6 IPsec VPN solution.
- *Home agent address discovery.* Using the IPv6 anycast feature, the mobile node can send a binding update to the home agent anycast address. The mobile node will get only one response from one home agent even if several are present on the network. This is an efficient way of keeping track of multiple home agents, which may be required in many networks for redundancy or scalability.

Making the Transition

As developers of software for mobile devices begin to consider usage models enabled by the Mobile IP standard in general and MIPv6 in particular, there are a few points to keep in mind:

- The MIPv6 home agent and mobile node differ from the MIPv4 home agent and mobile node; therefore, an MIPv6 home agent is required for working with an MIPv6 mobile node and vice versa.
- An MIPv6 mobile node can roam into IPv4 networks as long as it registers with an MIPv6 home agent as it roams.
- MIPv4 and MIPv6 mobile nodes can coexist on visited IPv6 and IPv4 networks.
- As IPv6 islands expand on an enterprise network, IT should expand MIPv6 components simultaneously.

In addition, developers should consider using MIPv6 components to become familiar with their use on IPv6 networks and to be prepared for the eventual wide-scale adoption of IPv6 networks.

MIPv6 Roaming in IPv6 Networks

To better understand the way MIPv6 supports seamless roaming between one network and the next, consider the process as it occurs when a device supporting MIPv6 roams from one network or subnet to the next:

1. As the mobile node moves into an IPv6-based foreign network, it obtains a new CoA using an auto-configuration scheme such as prefix advertisements from routers, or from a DHCPv6 server on the network.
2. The mobile node informs its home agent of the new CoA by sending a binding update to the home agent, and the home agent acknowledges this by replying with a binding acknowledgment.
3. The home agent intercepts any packets addressed to the home address of the mobile node and tunnels them to the mobile node at its registered CoA.
4. An IPv6-based corresponding node can communicate directly with the mobile node, using route optimization. As mentioned above, this happens after the mobile node sends a binding update to the corresponding node with its CoA. The corresponding node then forwards packets directly to the mobile node (**Figure 1**).

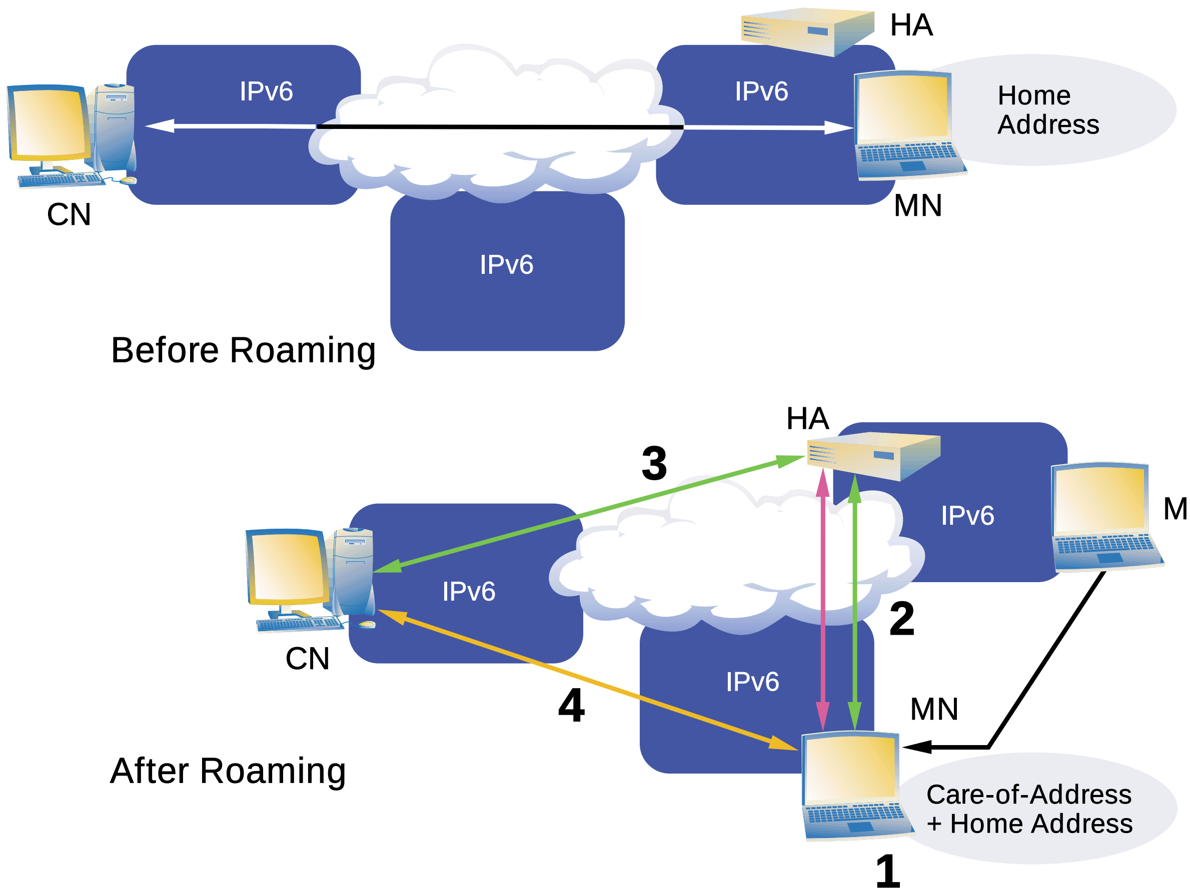

Figure 1. Mobile Node before and after roaming to IPv6 Network

MIPv6 Roaming in IPv4 Networks

Note: *the traffic between mobile node and home agent is encapsulated/decapsulated in both directions by a 6-to-4 routing function that interfaces the IPv6 islands with IPv4 networks.*

1. As the mobile node moves into a foreign network, it obtains a new IPv4 IP address from a DHCP server on the new network. The mobile node then uses this address to generate an IPv4 mapped IPv6 CoA (Note: if there is an MIPv4-based foreign agent on the visited network, the (v6) MN will effectively ignore it and get its CoA from the DHCP server).
2. Using IPv4 tunneling, the mobile node informs its home agent of the new CoA by sending a binding update to the home agent, and the home agent acknowledges this by replying with a binding acknowledgment.
3. The home agent intercepts any packets addressed to the home address of the mobile node and tunnels them to the mobile node at its registered CoA.
4. To communicate with a mobile node, an IPv4 corresponding node traffic is forwarded by the home agent (**Figure 2**).

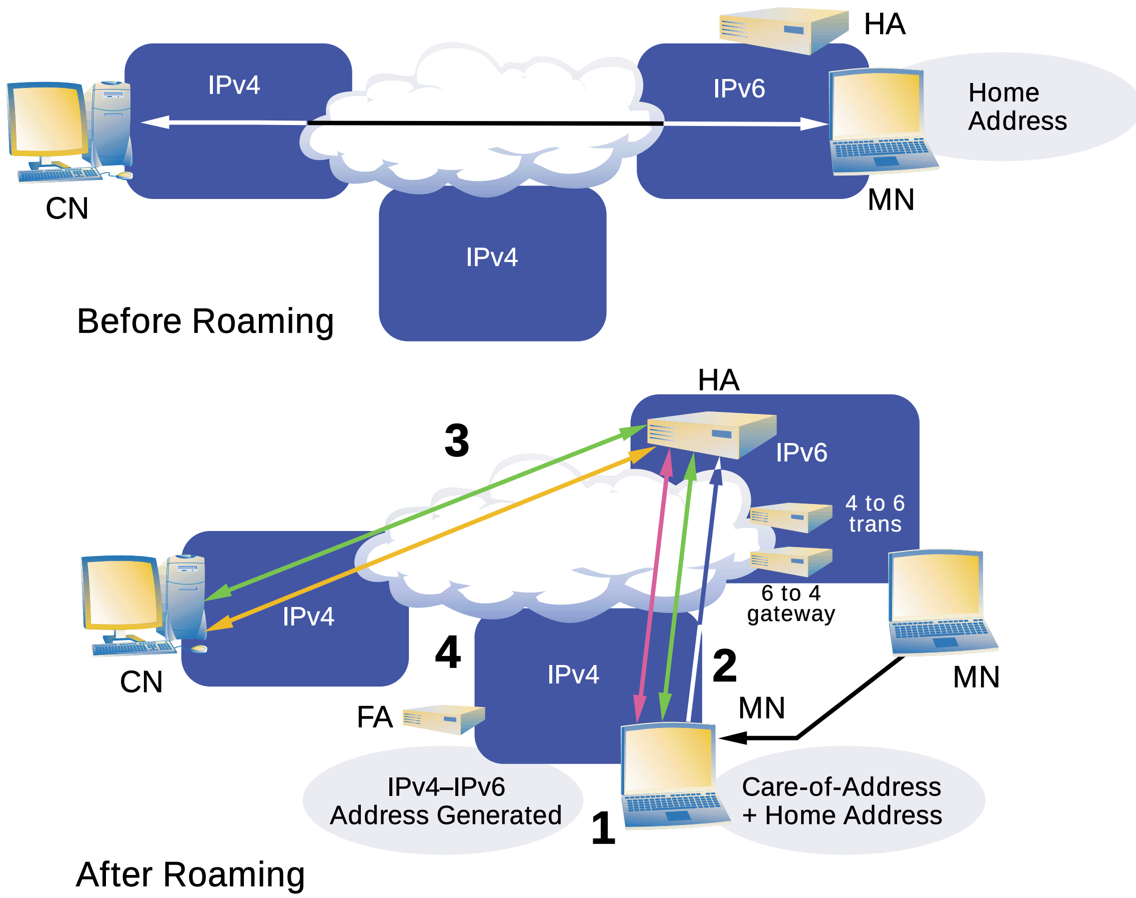

Figure 2. Mobile Node before and after roaming to IPv4 Network

Summary

With near-term IETF approval of the new MIPv6 standard, software developers can deliver seamless connectivity for laptops, PDAs, cellular phones, and other mobile devices that are based on an IPv6 network. Developers who already have worked with MIPv4 (the prior version of the standard) will find MIPv6 to be similar yet better suited to take advantage of the new capabilities on IPv6 networks. For this reason, software developers targeting mobile devices or applications that will operate on IPv6 networks should seriously consider the benefits of MIPv6 functionality.

More Info

Readers seeking more information on MIPv6 are urged to review recent documents published by the IETF. These documents are available by visiting http://www.ietf.org/ID.html, selecting I-D Keyword Search, and searching on the "MIPv6" keyword. A continually updated version of the draft itself is at http://www.ietf.org/internet-drafts/draft-ietf-mobileip-ipv6-18.txt.

For a more detailed overview of the prior version of the standard, MIPv4, visit http://www.intel.com/ids/wireless.

Learn more Intel R&D efforts in wireless, and about how Intel is working to help build the wireless tomorrow.

Author Bios

Paul Schmitz is a technical marketing engineer in the Network Architecture Lab. There, he focuses on the development and marketing of mobility technologies and network architectures targeted for the enterprise, Internet, and home environments, including wired and wireless networking, firewalls, and end-to-end security. Before joining the Network Architecture Lab in January 2002, Schmitz was co-manager of an internal ISP that provided Internet hosting, co-location, and network-design services to Intel startups and other organizations.

Geoff Weaver is a business development manager for the Network Architecture Lab, where he focuses on network roaming technology developed by Intel Research and Development. Weaver has worked with the Network Architecture Lab since May 2001, first on Voice over IP, followed by Mobile IP technologies, and before that, on electronic commerce and the Intel® Wired for Management initiatives. Before joining Intel, Weaver was a senior product manager at Network General and at National Semiconductor.

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