# Port-based Multihomed Mobile IPv6 for Heterogeneous Networks

Christer Åhlund, Robert Brännström, Karl Andersson and Örjan Tjernström
*Luleå University of Technology, LTU Skellefteå, SE-931 87 Skellefteå, Sweden*
*{christer.ahlund, robert.brannstrom, karl.andersson, orjan.tjernstrom}@ltu.se*

## Abstract
*Future wireless networks are expected to be based on coexistence of multiple different access network technologies. Mobile devices will then be equipped with multiple wireless interfaces enabling connectivity via multiple architectures. Different wireless technologies differ widely considering their capabilities and coverage. This requires a mobile node to maintain multiple active connections depending on the applications used and available access networks. To enable this, a mobile node needs to be multihomed and able to direct traffic flows via different interfaces. This paper describes a proposal extending Mobile IPv6 with multihoming functionality. Multihoming is managed using IP address, protocol and port number.*

Keywords: Mobile IP, Wireless network, Policy, Multihoming.

## 1. Introduction
In the new generations of wireless networks, seamless mobility across heterogeneous networks will be supported. A widespread vision of the fourth generation (4G) mobile networks or Next Generation Networks (NGN) includes coexistence of current wireless technologies such as WLAN, WiMAX, and Universal Mobile Telecommunications System (UMTS). Different technologies will be bound together into a single network and the IP will be the glue. The mobile nodes (MN) will be equipped with multiple access network interfaces and users will be able to roam transparently between networks in a seamless manner.

The rest of the paper is organized in the following way. Section 2 describes the port-based MIP architecture and section 3 presents the conclusion and future work.

## 2. The Port-based Mobile IP Architecture
In the scenario shown in figure 1, an MN should be able to direct traffic flows via different interfaces. In the proposed standard for Mobile IPv6 (MIPv6) an MN disconnecting from its home network (using one home address) can only use one wireless connection (i.e. register one care-of address) at a time. In the multihomed extension for MIP, M-MIP [1], multiple care of addresses (CoAs) are managed. With M-MIP, correspondent nodes (CNs) can associate the MN's home address (HoA) with different CoAs. In the case of two registered CoAs the home agent (HA) and CN may use different CoAs to reach the MN. Using multiple CoAs is beneficial if the total amount of traffic capacity needed extends the capability of one single interface. In that case flows can be sent via different interfaces.

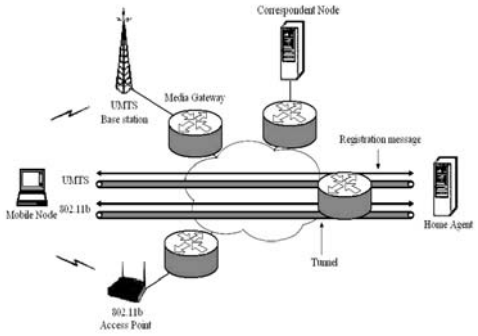


**Figure 1.** System overview when the MN is connected to both a WLAN and a UMTS network

To enable port-based MIP we extend the M-MIP proposal to include a flow mobility option header, specifying the protocol and port number when registering a binding. By doing this an MN can register a binding that informs the CN or the HA that only a single flow shall be forwarded to the specific CoA. To control multiple flows the MN can include several flow mobility option headers in the binding update (BU). Beyond enabling flow mobility at the network layer the extension also enables flow mobility between devices. If a user register multiple devices with the same HoA (e.g. a phone and a laptop), it is possible to redirect flows between the devices.

The modifications consist of two flags added in the BU message and a new option header hosting the

protocol number and the port number. Figure 2 illustrates the modified BU header.

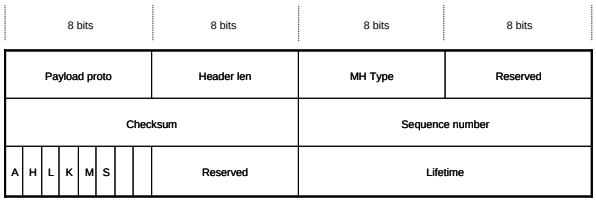


**Figure 2.** Binding update header with M- and S-flag

The M-flag indicates a multihomed binding. This means that with the M-flag, currently registered bindings will be kept and without the M-flag they will be deleted. The S-flag is used by the MN to inform the HA and CNs of which CoA to use as default. Figure 3 illustrates the flow mobility option header.

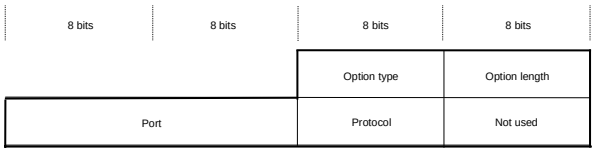


**Figure 3.** Flow mobility option header

The port field identifies the destination port at the MN. The protocol field represents the transport protocol number. In figure 4, bindings are shown for both an IP address as well as for a protocol and a port.

| HoA | CoA | Protocol | Port | Lifetime | Flags |
|---|---|---|---|---|---|
| 3ffe::a:b:c:d | 3ffc::1:5:a:b:c:d | -1 | -1 | 150 | A/H/L/K/M/S |
| 3ffe::a:b:c:d | 3ffc::1:6:a:b:c:a | 6 | 6935 | 200 | A/H/L/K/M |
| 3ffe::a:b:c:d | 3ffc::1:a:a:b:c:d | 17 | 7830 | 150 | A/H/L/K/M |

**Figure 4.** Binding cache

The proposed solution requires the network layer to look for the protocol and destination port numbers in the transport header. When an MN discovers a foreign network, it acquires an IP address and registers the CoA with its HA. If this is the first registration a BU is sent without the M or S flag. A BU without the M-flag means that previously added registrations are deleted and that this binding is the one selected (without using the S-flag).

If a second foreign network is discovered, another registration is sent to the HA. In this registration the MN adds the M-flag in the BU. When registering a new interface it should not be selected until an evaluation of the interface is conducted (see [1]), assuming a previously added interface is operational. If the new interface performs better than the interface previously used, a new binding update is sent for the new CoA with the M- and S-flag.

Without the flow mobility option header adding protocol and port numbers to the BU, all traffic is sent to the same CoA. By adding such an option, a single flow can be redirected to another interface (CoA). If e.g. the WiMAX interface is used and traffic from CNs via the HA congests the WiMAX connection, one or more flows should then be moved to an alternative interface, e.g. WLAN. Such a scenario could occur when using e-meeting applications like [2], where voice communication requiring rather strict jitter and delay values should be given high priority and kept at the WiMAX interface, while video showing presence of participants can be given lower priority and be moved to a WLAN interface. In this case a BU is sent to the HA with the option header informing the HA of what protocol number and destination port number to be redirected to another CoA.

For route optimization a BU is sent to the CN. This BU can be valid for all traffic sent from the CN or just for a specific flow. This means that some traffic may go via the HA and some traffic can be sent directly.

In the case of all traffic being redirected, a BU is sent to the CN without the S- and M-flags and without the flow mobility option header. In this case all traffic is sent from the CN to the registered CoA. To direct a flow from a CN to another CoA a BU is needed using the M- and S-flags as well as the flow mobility option header.

For each new CoA return routability is invoked, no changes in messages are needed except for the added option and the two extra flags in the BU. Return routability is only needed when adding a new CoA. In the case of handover for specific flows (by adding the flow mobility option header to the BU) to an already registered CoA, no return routability needs to be invoked.

## 3. Conclusion

In this paper, we described how Mobile IPv6 can be extended to handle port-based multihoming. By such extension different flows can be destined through different interfaces on the MN leveraging differences in coverage, Quality of Service, cost, bandwidth, delay, et cetera among different wireless and fixed access networks.

We are currently in the process of collecting performance metrics.

## Acknowledgments

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## References

[1] C. Åhlund, R. Brännström, A. Zaslavsky, “M-MIP: Extended Mobile IP to Maintain Multiple Connections to Overlapping Wireless Access Networks”, International Conference on Networking, April 2005.

[2] http://www.marratech.com